geographies

MDPI

Article

The Silent Forest: Impact of Bird Hunting by Prehistoric Polynesians on the Decline and Disappearance of Native Avifauna in Hawai'i

Francisco L. Pérez

Department of Geography and the Environment, University of Texas, Austin, TX 78712-1098, USA; Halemauu@gmail.com

Abstract: This research focuses on the historical demise of Hawaiian avifauna due to hunting by ancient Polynesians. Numerous documents, published since the early 1800s, were scrutinized and evaluated; these provided information on bird hunting and traditional Hawaiian practices. Hawaiians used birds as sources of feathers and food. Feathers were important symbols of power for Polynesians; in Hawai'i, feathers were more highly prized than other types of property. Feathers used for crafts were obtained from at least 24 bird species, however, the golden feathers of *'ō'ō* and *mamo* birds made them primary targets for birdhunters; both birds became extinct by the late 1800s. Feathers were utilized for many items, including *'ahu'ula* [cloaks], *mahiole* [war helmets], and *kāhili* [standards]. Most garments utilized a considerable number of feathers; a cloak for Kamehameha consumed the golden feathers of 80,000 *mamo* birds. Bird meat was an important food item for native Hawaiians. It is believed that most birds were killed after being plucked; historical sources mention ~30 bird species were consumed. The *'ua'u* (*Pterodroma sandwichensis*), a currently endangered seabird, was ruthlessly hunted and avidly eaten. Its current geographical range is just a minute fraction of its former one; now, *'ua'us* are largely restricted to inaccessible cliffs at Haleakalā Crater (Maui).

Keywords: avifauna; bird hunting; extinction; featherwork; forest ecosystems; Hawai'i; human predation; *mamo*; *'ō'ō*; *'ō'ū*; *'ua'u*

Citation: Pérez, F.L. The Silent Forest: Impact of Bird Hunting by Prehistoric Polynesians on the Decline and Disappearance of Native Avifauna in Hawai'i. *Geographies* **2021**, *1*, 192–216. https://doi.org/10.3390/geographies1030012

Academic Editor: Ileana Pătru-Stupariu

Received: 8 September 2021
Accepted: 11 October 2021
Published: 18 October 2021

> 'One may spend hours in [Hawaiian forests] and not hear the notes of a single native bird. Yet a few years ago the same areas were abundantly supplied with native birds, and the notes of the oo, amakihi, iiwi, akakani, omao, elepaio and others might have been heard on all sides . . . So far as human eye can see, their old home offers to the birds practically all that it used to, but the birds themselves are no longer there.' Henry W. Henshaw, 1902 [1], p. 10.

1. Introduction: Bird Extinctions in the Hawaiian Islands

As a mountain ecologist and biogeographer, I have been hiking through the montane forests and high-elevation ecosystems of the four largest Hawaiian Islands for almost 30 years. In most places, I regrettably encountered a noticeable scarcity, or even absence, of endemic birds. They simply are not to be seen, and not to be heard; they do not appear to be there anymore.

Polynesian settlers seemed to greatly appreciate the rich diversity of forest birds, which were often portrayed as powerful and wise beings—e.g., 'The Battle of the Owls' [2], p. 188. The overwhelming feeling of wonder of ancient Hawaiians is evident in the traditional *mo'olelo* [myth] '*How birds became visible*', frequently told in different versions [3,4], [5], p. 33, [6], p. 74: it is said that, long ago, birds were invisible; people could hear—but could not see—them; only the demi-god Māui could. A visitor came to Maui from another island, and conceitedly boasted of his island, its beautiful mountains, waterfalls, and forests. Māui thought on how to outclass him with something unusual his own island had, and secretly called the forest birds and ordered them to perch on the trees and bushes around

them, where they filled the air with song. The boastful visitor was greatly surprised by this striking, magic music, and Māui, at last, using his mighty power caused the little feathered friends to become visible. Ever since that day, birds may be seen as well as heard.

However, these enchanting birds ultimately paid a steep price for their splendor, as Westervelt [3], ch.ix, finished his version of the story as follows: 'The beautiful red birds, iiwi and akakani, and the birds of glorious yellow feathers, the oo and the mamo, were a joy to both eye and ear and found high places in Hawaiian legend and story, and all gave their most beautiful feathers for the cloaks and helmets of the chiefs.' Thus, in a perverse and sad reversal of affairs, Hawaiian forest birds have now become invisible again, and their mysterious music is once more silent, but now they cannot be conjured up to magically reappear. In the words of Scott et al. [7], p. 1: 'The dawn song chorus of this ghost avifauna will never again be heard, but one can dream.'

The Hawaiian Islands have the dubious distinction of leading the world in numbers of historically extinct and currently endangered bird species [8], p. 15; sadly, this unfortunate situation is not a recent phenomenon. Bird extinctions after European discovery were extensive and are now well documented; however, native Polynesians caused extinctions of an even greater magnitude [9–16]. Fossil evidence shows at least 50% of the original avifauna became extinct after Polynesians arrived in Hawai'i around 400 A.D. Initially, 109 endemic species occurred in the Hawaiian Islands, 35 of which (32%) still survived in 2001; 19 additional taxa (17.5%) were extant in the 18th century, whereas 55 (50.5%) are known only from the fossil and subfossil record. As of 2001, 75% of historically known native birds were extinct or endangered [7,17–19]; recent estimates suggest that 77 Hawaiian bird species have vanished during the last ~700 years [20,21] and the surviving species have declined dramatically, and are rarely seen [22].

In pre-human Hawai'i, the large land area and extensive coastlines, coupled with a relative absence of predators, provided ample habitat for a spectacular assemblage of seabirds; millions of petrels, albatrosses, shear-waters, terns, and other seabirds populated the islands. These birds were the first to be easily decimated or exterminated by island settlers [13]. After the unwary, flightless, ground- and burrow-nesting seabirds were eliminated, Polynesians devised an astounding variety of techniques for catching forest birds [6,13,23–29]; these bird-hunting practices eventually wreacked havoc also among forest bird populations.

The severe past depredations of avifauna appear to have had a lasting negative effect on the Hawaiian forest birds and, as a result, the alarming trend of declining bird populations still continues. Overall, the USA has suffered the most recently recorded bird extinctions (25) on Earth, 84% of which have taken place in Hawai'i [30]. As of 1981, 25 of the 46 historically known species of Hawaiian forest birds remained; in 2009, only 24 still survived, and by 2016, this number had dropped to 23; of these, 13 (56.5%) were listed as either threatened or endangered. What is most alarming, some species (e.g., Hawaiian crow) are extinct in the wild and have fewer than 115 individuals surviving in captivity; others (e.g., Maui parrotbill, *Pseudonestor xanthophrys*, and O'ahu *'elepaio*, *Chasiempis ibidis*) may include extremely low populations (~500–1000) of remaining birds [21], p. 203, [31,32].

The specific causes of these extinctions have long been a subject of inquiry by ecologists; at one time or another, practically every possible agent has been proposed for the demise of Hawaiian avifauna, but conclusive evidence has seldom been provided [13]. In fact, no individual factor can be singled out for either the extinction of some species or the great reduction in numbers of others; instead, a series of interconnected causes contributed to the relentless demise of Hawaiian avifauna. There is, however, widespread agreement that most of the blame should be ascribed to anthropogenic factors [7,9,10,13,17,18,21,22,31,33–39]. Human-associated factors typically include: 1, modification of the natural habitat and destruction of original vegetation after initial settlement by Polynesians, followed by agricultural expansion; 2, bird catching by native Hawaiians (see below); 3, predation by animals introduced by settlers, such as Polynesian rats (*Rattus exulans*), pigs, chickens, dogs, and, later, mongoose and feral house cats; 4, imported avian parasites/diseases, such as avian malaria

and pox; 5, avian competition with introduced birds; 6, shooting and trapping of rare species by collectors, largely in the 1880s—1920s; 7, a host of abiotic factors that include hurricanes, tsunamis, fires, floods, volcanic eruptions, and various recurrent environmental perturbations.

In comparison with the other human-related causes, few researchers have focused on the role of bird catching and hunting [12,28,29,40–43]. Gomes [28,29] has recently provided the most valuable contributions in this area. Although it is known that Hawaiians hunted birds for feathers, food, and for tools, most references normally allude obliquely to the use of feathers in ancient Hawai'i, and only mention, in passing, that bird plumage was utilized for 'making capes and cloaks'; detailed information about birds as a source of meat is even more scanty, and the subject usually is carefully avoided by most authors. The specific goal of this study is to document, assess, and discuss much of the available information on birdhunting for feathers and food, widely scattered over a myriad of publications over the past two centuries. A detailed case study on an endangered Hawaiian bird, the dark-rumped petrel (*Pterodroma sandwichensis*), is also included.

2. Materials and Methods: Relevant Historical Sources, and Use of the Hawaiian Language

The documents assessed here cover three consecutive historical periods: first, I discuss those written by native Hawaiian chroniclers and historians in the mid-19th century; then, come a spate of scientific publications by western scientists and ornithologists that visited Hawai'i during the late 19th and early 20th centuries; later, a selected group of studies published during the 20th and 21st centuries.

A prominent native Hawaiian scholar, Davida Malo (1795–1853), was born in north Kona, Hawai'i island. Malo's father worked in king Kamehameha's army, and as a youth, Davida served with chief Kuakini, queen Ka'ahumanu's brother. Malo grew up immersed in native Hawaiian culture and developed an intimate acquaintance with the history and traditions of ancient Hawai'i; he was educated in Lahainaluna Seminary, Maui. Around 1838–1840, he wrote '*Moolelo Hawaii*' ['Hawaiian Antiquities'] [24] in Hawaiian, which was translated by N.B. Emerson in 1898. Samuel Mānaiakalani Kamakau (1815–1876) was born in Waialua, O'ahu; although he lived during the period after first contact with westerners, his elders imparted to him knowledge about traditional ways, lore, and genealogies. Kamakau also attended Lahainaluna Seminary and wrote many newspaper articles in Hawaiian during the 1860s and 1870s; these were translated and published as different volumes [44–46] by Mary Kawena Pukui (1895–1986). Kepelino Kahōʻaliʻi Keauokalani (c. 1830–1870) was born in Kailua-Kona, Hawai'i, into a family descended from the Hawaiian priestly class and nobility. Kepelino produced several works in the 1850s and 1860s; his '*Moolelo Hawaii*' were translated as 'Kepelino's Traditions of Hawaii' [47] by the anthropologist Martha W. Beckwith (1871–1959). Ioane (John) Kaneiakama Papa ʻĪʻī (1800–1870) was born in Waipiʻo, Oʻahu; he lived in Kamehameha's court at Honolulu after reaching 10 years of age, where he served as personal attendant to Liholiho (Kamehameha II). During the 1860s, Īʻi wrote a series of articles in the Hawaiian newspaper *Nupepa Kuʻokoʻa*, later translated by Pukui and published as 'Fragments of Hawaiian History' [48]; Īʻi 's work is a peculiar narrative, exclusively focused on his own personal experiences. For additional details on these Hawaiian scholars, see [49].

Numerous research publications of the 1890s and early 1900s provide valuable accounts of Hawaiian avifauna and featherwork during a critical period of rapid bird disappearance. Among these, it is worth consulting the following: Emerson (1895), 'The bird-hunters of ancient Hawaii' [23]; Brigham (1899), 'Hawaiian feather work' [25]; Henshaw (1902), 'Birds of the Hawaiian Islands' [1]; Perkins (1903), 'Vertebrata, in Fauna Hawaiiensis or the Zoology of the Sandwich (Hawaiian) Islands' [26]; and Bryan (1908), 'Some birds of Molokai' [27]. Two books, 'Aves Hawaiienses: The Birds of the Sandwich Islands' (1890–1899) [50] by Wilson and Evans, and 'The Avifauna of Laysan and the Neighbouring Islands' (1893–1900) [51] by Rothschild, provide particularly striking illustrations of rare and extinct Hawaiian birds. For many early references, I chose to provide citations with the original author's words, which provide unambiguous impressions of the original

situations they experienced [21], p. x. Many historical references have now been reprinted, and/or their pdf and HTML files can be readily found on the web.

Literally, scores of relevant references were published afterwards. Among these, 'Vikings of the Sunrise' (1959) [52], a charming book written in 1938 by Te Rangi Hīroa (Sir Peter H. Buck)—Director of the Bishop Museum in O'ahu from 1936 to 1951—assesses early Polynesian and Hawaiian settlement. Munro (1960), 'Birds of Hawai'i' [33]—published in 1944—discusses what was known of Hawaiian avifauna by the mid-20th century. Berger (1972), 'Hawaiian Birdlife' [31] is an early, thorough survey of Hawaiian birds. Rose et al. (1993) [53] provides details about feather uses. Walther and Hume (2016) [21] offers a succint summary of the extinction of Hawaiian avifauna. Two multiauthored volumes [7,54] deal with numerous aspects of the evolution, ecology, and conservation of Hawaiian birds. The many thorough publications by Pukui are simply invaluable, however, 'Place Names of Hawaii' (1974) [55] and 'Hawaiian Dictionary' (1986) [56] are extremely useful. Handy and Pukui (1958), 'The Polynesian Family System in Ka-'u, Hawaii' [57], and Handy and Handy (1972), 'Native Planters in Old Hawaii' [58] provide excellent accounts of traditional life in Hawai'i. References include the year of the consulted publication in parentheses ( ), and the year of the original appearance, if different, in brackets [ ].

Hawaiian grammar usage follows Elbert and Pukui (2001) [59]. Spelling and punctuation of Hawaiian names and geographic features conform to Pukui et al. (1974) [55], or Pukui and Elbert (1986) [56]; words include diacritical marks as the *kahakō* [aka macron]—a bar placed above vowels that are long and stressed—and the *'u'ina* [snap] or *'okina* [break]—a reversed apostrophe for glottal stops or guttural breaks. Hawaiian words, but not Hawaiian place names are, as a rule, *italicized*; the English meaning of most Hawaiian words is shown in square brackets [ ].

3. Results

> "That the bird with tail alert may come to our snare; may alight on our deftly moving pole, limed with gum of bread-*fruit, akokoko, mamane. Good luck attend our house.*" '*Ōlelo Haole: E ku hoohei ia ka manu.* [Hawaiian Proverb: 'That the bird is swept off']' Noah Gomes, 2015 [28], p. 73.

3.1. The Birdcatcher's Trade

Traditional bird hunting in Hawai'i was commonly referred to as *kāpili manu*; birds were mainly captured by professional *kia manu* [birdcatchers] serving for, or licensed by, king Kamehameha or local *ali'i* [chiefs] [28]. This was a hard profession, demanding hunters to live in the forests and mountains for long, solitary periods; the ancient *mō'ī* [kings] are said to have brought warriors to the mountains to do the job, however, this was not an easy task, and a horde of men working in close proximity was not very successful in the venture [23].

Bird hunting, like many upland activities, was temporarily suspended during *ho'oilo* [rainy season], from November to March [57]. However, as tropical birds breed and molt continuously throughout the year [60], birds explicitly caught for their feathers were captured at the beginning of the molting season, when feathers might be loose and more easily removed from them [61]; some birds—e.g., *nēnē* (*Branta sandvicensis*)—were unable to fly at this time and could not easily escape the hunters [33], p. 42. Birds generally move from the lowlands to the highlands in coordination with seasonal plant flowering; as many birds, particularly honeycreepers, are attracted to the sweet nectar of trees such as *māmane* (*Sophora chrysophylla*) and *'ōhi'a* (*Metrosideros polymorpha*) [62,63], their two flowering periods (March–May and August–October) were also associated with the vertical migration of birds and the seasonal movements of birdcatchers following them [23], p. 103. Thus, the *'apapane* (*Himatione sanguinea*), *'amakihi* (*Hemignathus virens*), *'i'iwi* (*Vestiaria coccinea*) and other upland honeycreepers only descend *makai* [seaward] along the dry leeward flanks of Haleakalā (Maui) when these trees are flowering [64], p. 6.

The birdcatcher would usually offer a prayer before starting, and an offering to the gods would also be performed [28]; some hunters released the first captured bird, unplucked and unharmed. Birdcatchers were often accompanied by their wives, who could aid in plucking and organizing feathers, or in manufacturing *kapa* [cloth] with the fine fibers of *mamake* (*Pipturus albidus*) shrubs [62]. Hunters favored different dressing styles, but commonly used a long, hooded cloak that covered the body from knees to head. This clothing was made with a meshed network of dried *ki* (ti, *Cordyline fruticosa*) [62,65] leaves, with their tips hanging down, woven into a dense lattice of *olonā* (*Touchardia latifolia*) bark fibers [56]; this attire was very effective in shedding water, and served the double purpose of protecting the hunter from tropical downpours and shielding the delicate bird feathers [23], p. 110. High-altitude birdcatchers used *kapa lauʻi* [special kapa outfits] also made with *ki* leaves, plaited like mats, which made very warm clothing; hunters of *ʻuaʻu* birds, often working at up to ~3000 m elevation, greatly favored them [66], p. 95. As Kamakau [46], p. 108, explained: 'These thatched ti-leaf garments were worn in the icy mountains because the rain and cold did not penetrate them'.

Birdcatchers showed great ingenuity in devising methods for capturing birds; these varied considerably among island districts, seasons, and individual hunters (Table 1). The most common methods are mentioned by Malo [24], p. 61; briefly, these included the use of *kēpau* [bird-lime] made from the sticky sap of various plants, including *mamane*, *ʻakoko* (*Euphorbia lorifolia*), or *ulu* (breadfruit, *Arctocarpus altilis*) [65]; the *pahele* [snare], baited with flowers or fruits; poles, lines, and nets. Some birds were caught by hand, often in their nest hole, captured after concealment under a built covert—such as that provided by fern fronds or *ʻieʻie* (*Freycinetia arborea*) leaves [65]—by clubbing them, or running them down; birds might also be skewered in their burrows with barbed sticks, or pelted with stones. It was a regular practice to keep certain forest birds alive in special cages, such as *ʻōʻō* (*Moho nobilis*), *ʻiʻiwi* (*Vestiaria coccinea*), or *ʻapapane* (*Himatione sanguinea*), to be used as *maunu* [decoys] [23], p. 107, [28], p. 140. Townsend (1839) [67], p. 207, explained a 'singular mode of catching the honey sucking birds,' including the *mamo* (*Drepanis pacifica*) in 1835: young boys on Kauaʻi would lay down on the ground, cover themselves with bushes, and hold one of the campanulate flowers favored by the bird between finger and thumb. As a honeyeating bird dipped its long, curved bill into the flower, the boy would close his fingers into the flower and seize the bird by its tiny bill; dozens of birds were taken this way [33], p. 92, [50], p. xiv.

There were also specialized methods for capturing specific types of birds, such as the *kōlea* (*Pluvialis fulva*) (Table 1), or the *ʻuaʻu* (Section 5). Early capture methods for some birds (e.g., *moho*, *Zapornia sandwichensis*) included the rare use of bow and arrow [26], p. 454, [33], p. 52; however, after the introduction of firearms in the 19th century, they were indiscriminately shot with guns, a practice that no doubt helped to exterminate some species [33], p. 86. Henshaw [1], p. 71, bluntly painted a rather gloomy picture: 'As late as 1898 more than one thousand individuals of the species (*ʻōʻō*, *Moho nobilis*) were shot by the lei hunters in the heavily wooded district north of the Wailuku river, where their presence had probably been overlooked . . . the rapacity of the lei-hunters leaves little hope for the future of this beautiful and interesting bird, and the district alluded to is now almost depopulated.' Recent comprehensive studies of traditional Hawaiian bird trapping practices are found elsewhere [6,28,29], [31], p. 121.

Table 1. List of birds trapped and/or utilized by ancient Hawaiians; adapted from Malo (1908) [24], pp. 61–66. Current spelling of Hawaiian names and taxonomic classifications after [22,68]. Additional information on feather colors and uses, and capture methods from [13,21,23,26,31,33,53,61]; 'x' indicates the bird was a source of feathers or meat. Keys, feather sources, main uses: a: *'ahu'ula*, k: *kāhili*, l: *leis*, m: *mahiole*, Mi: *Makahiki*-idol. Feather colors and textures: b: black, bl: blue, br: brown, g: green, gr: gray, ir: iridesdent, p: pink, r: red, sp: spotted, spe: speckled, st: striped, w: white, y: yellow, var: variegated. Methods of bird capture: ba: bow and arrow, bl: bird-lime, bp: pole, ch: caught by hand, cl: clubbing, cn: caught in nest hole, co: covert, l: lines; n: nets; s: snare, sh: shot with guns; sk: skewering with barbed stick, st: pelting with stones, rd: running it down. Conservation status: EX (extinct), EXW (extinct in the wild), CR (Critically endangered), EN (endangered), VU (vulnerable), NT (near threatened), LC (least concern). IM (imperiled, TNC). Conservation status follows International Union for Conservation of Nature (IUCN), or NatureServe (The Nature Conservancy, TNC). See [21,32] for further extinction details. Island key: H: Hawai'i, K: Kaua'i, L: Lāna'i, Ma: Maui, Mo: Moloka'i, O: O'ahu. NW Hawaiian Islands: Ka: Ka'ula islet; Ni: Nihoa islet.

Number	Hawaiian Name	Current Taxonomic Name	Feather Source, Main Uses	Feather Color(s)	Meat Source	Methods of Capture	Conservation Status
1	*'akihi a loa*	*Akialoa obscura*	x	y, g	x	bl	EX (1903)
2	*'ākihipōlena*	(unknown)	x	r	-	-	EX ?
3	*'ākohekohe*	*Palmeria dolei*	-	-	-	-	CR, restricted: M
4	*'alae*	*Gallinula chloropus sandvicensis; Fulica alai*	x	bl-b	x	rd, st	IM, but stable
5	*'alalā*	*Corvus hawaiiensis*	x, k, Mi	b	x	bp, s	EXW
6	*'amakihi*	*Chlorodrepanis virens*	x, a, mm	y, g	x	bl	LC, EX: L
7	*'a'o*	*Puffinusauricularis newelli*	-	-	x	n, l	CR: K
8	*'apapane*	*Himatione sanguinea*	x, a, m	r, b	-	bp, bl	LC, still abundant
9	*'auku'u*	*Nycticorax nycticorax*	x	bl	-	st	LC
10	*'elepaio*	*Chasiempis sandwichensis*	x	y	x	-	LC?, common: K, H; EN: O
11	*'iao*	(unknown)	-	-	-	-	EX?
12	*'i'iwi*	*Vestiaria coccinea*	x, a, m, k	r, b	x	bl, s	VU, common: high elevation
13	*'io*	*Buteo solitarius*	x, k	var, st	-	bp, n, co	NT, restricted: H
14	*'iwa*	*Fregata minor*	x, k, Mi	b, gr, ir	x	ch	LC: Ka, Ni
15	*kākāwahie*	*Paroreomyza flammea*	-	r	-	-	EX (1963)
16	*kala*	*Onychoprion lunatus*	-	-	x	-	LC
17	*ka'upu*	*Phoebastria immutabilis*?	x, Mi	b	x	-	NT
18	*ki*	(unknown)	-	-	-	-	EX ?
19	*kīkī*	(unknown)	-	-	x	n	EX ?
20	*kioea*	*Chaetoptila angustipluma*	-	-	x	-	EX (1859)
21	*koa'e kea* [a]	*Phaethon lepturus*	x, k,	w, p	x	-	LC
22	*koa'e ula*	*Phaethon rubricauda*	x, k	r, b, w	x	-	LC
23	*kōlea*	*Pluvialis fulva*	-	-	x	s, ch [b]	LC
24	*koloa*	*Anas wyvilliana*	x, k	sp	x	st, cl	EN
25	*kūkuluae'o*	*Himantopus mexicanus knudseni*	-	-	x	st	IM
26	*li'oli'o*	(unknown)	-	-	x	n, l	EX?
27	*mamo*	*Drepanis pacifica*	x, a, k, l, Mi	y, b	x	bp, bl, ch, s, sh	EX (1898)
28	*moho*	*Zapornia sandwichensis*	x, k	-	x	ba, cn	EX

Table 1. *Cont.*

Number	Hawaiian Name	Current Taxonomic Name	Feather Source, Main Uses	Feather Color(s)	Meat Source	Methods of Capture	Conservation Status
29	*mōlī*	*Diomedea nigripes*	x, k, Mi	b	x	-	NT
30	*mū*	(unknown)	x	y	-	-	EX?
31	*nēnē*	*Branta sandvicensis*	x, k	sp	x	ch, sh	VU: K, H, Ma, Mo
32	*noio*	*Anous minutus*	x, k	br?	x	-	LC
33	*ʻoio*	*Anous* sp. (?)	x	spe	x	-	?
34	*ʻōmaʻo*	*Myadestes obscurus*	x	br, gr	x	bl, s	EX (1825, O; 1934, L; Ma?; 1980 Mo; 1980 K); VU: H
35	*ʻōʻō*[c]	*Moho nobilis*	x, a, k, l, Mi	b, y	x	bl, bp, sh, s	EX (1902)
36	*ʻōʻū*	*Psittirostra psittacea*	x, k, l	g	x	bl	EX? (1989)
37	*ʻouʻou*	*Bulweria bulwerii*	-	b	x	l	LC
38	*pueo*	*Asio flammeus sandwichensis*	x, k	var, str	-	bp, n, co	LC, EN: O
39	*pūhaʻakakaiea*	(unknown)	-	w, b	x	n	EX?
40	*uʻa*	(unknown)	-	g	-	-	EX?
41	*ʻuaʻu*	*Pterodroma sandwichensis*	-	b, gr	x	n, l, cn, sk	EN, mostly in Ma
42	*ʻuaʻukēwai*	(unknown)	-	w, b	-	-	EX?
43	*ʻula*[d]	*Ciridops* sp.	-	b	-	-	EX (1892)
	Average		60.5%		69.8%		

[a] Malo (1908) [24], p. 64, lists *Phaethon rubricauda* (*koaʻe ula*); *Phaethon lepturus* (*koaʻe kea*) also provided two showy, long tail feathers [53], p. 283, [68], p. 586. [b] Birds were captured with a specialized snare method, using *ʻkōloa* stones'—these were smooth lava rocks, grooved to receive a thin noose, set to trap birds [50], p. 2, *Charadrius fulvus*. Kolea ch.—or were caught by hand, after responding to hunter's whistling calls [24], p. 64. [c] The *ʻōʻō* is the bird most extensively—and most often—used in featherwork, especially in kāhili [53], p. 298, [68], p. 588, and provided feathers for kāhili of the 'choicest' descriptions [24], p. 62. [d] The *ʻula* was highly 'celebrated in song' by Malo [24], p. 63. [e] Another bird eaten by ancient Hawaiians was the Laysan Millerbird (*Acrocephalus familiaris*, no known Hawaiian name) caught by bp, n, EX (1923) [21], [33], p. 79. [f] In addition to the native birds above, the iridescent black tail feathers of the domestic chicken, *moa* (*Gallus gallus*), and the domestic peafowl (*Pavo cristatus*), were often used in *kāhili*-making [33], p. 50, [53], p. 293, [61]. As some bird species mentioned in historical records cannot be unequivocally identified in modern taxonomy, the question marks (?) are an honest appraisal of the birds' extinction status.

A practice that contributed to significantly exarcebating hunting pressure on birds is that feathers were commonly demanded as tax by *mōʻī* and *aliʻi* [1], [37], p. 318. The yellow feathers of the *ʻōʻō* and *mamo* were especially valued, and, as they were difficult to procure, were traded at times among the *makaʻāinana* [common people] themselves, often at steep prices [28], p. 121. Malo [24], pp. 107, 190, mentioned that lands that produced feathers were heavily taxed, especially at the annual Makahiki time, and feathers of the *ʻōʻō*, *mamo*, and *iʻiwi* were the most acceptable offering to the Makahiki-idol; Kameʻeleihiwa [69] provides details of the tribute ceremonies during this important religious festival. Emerson [23,70] noted: 'The plumage-birds, like everything else in Hawaii, were the property of the *alii* of the land, and as such were protected by *tabu* . . . the choicest of the feathers found their way into the possession of the kings and chiefs, being largely used in payment of the annual tribute or land tax, that was levied on each *ahupuaʻa*.' [traditional land division] [57]. One cannot stop wondering about the eventual sorry fate of some hapless bird catchers that could not find any of the desired (*ʻapapane*?) birds in the mountains, and thus 'daubed the feathers red with dirt' to make them appear as the real thing before bringing them to royal tax collectors [71], p. 616, [72], p. 16.

'Kamehameha I is said to have reproved his bird-catchers for taking the life of the birds. "The feathers belong to me, but the birds themselves belong to my heirs," said the considerate monarch.' N.B. Emerson, 1895 [23], p. 110.

3.2. Bird Hunting for Featherwork

In the economic system of ancient Hawai'i, bird feathers were more highly prized than *any* other type of property, including *palaoa pae* [whale tooth], a kind of ivory monopolized as a perquisite of the king [31], p. 119. A sense of the high value attached to feathers in Hawaiian society is also shown by the alternate meanings of the word *hulu* [feather], 'choice' or 'esteemed' [56]. Feathers had, for centuries, been important symbols of power for Polynesians across the Pacific. A significant feather trade developed between Fiji and both Samoa and Tonga, where red Fijian parrot feathers were highly appreciated for the manufacture of fine mats and ornaments [52], p. 319. In the Society Islands, the red feathers of parrakeets had, early, become the mark of high chiefs and of gods, while the royal family of Bora Bora wore girdles of yellow feathers to denote that their line was junior to the royal house of Ra'iatea [52], p. 97. The settlers of Hawai'i kept this Polynesian tradition, and used capes and cloaks of fine meshed netting covered with red feathers that denoted chiefly rank elsewhere in Polynesia. Eventually, yellow feathers were added to generate elegant designs of crescents, triangles, and circles, and, as yellow feathers were more scarce, yellow finally became the chiefly color in Hawai'i [52], p. 264. Yellow became the exclusive color of the king—it was *kapu* [prohibited] to everybody else—whereas red was reserved for priests, and mixtures of these colors were used for the lesser members of nobility [6], p. 68, [73].

Feathers traditionally used for Hawaiian crafts were obtained from several birds. Malo [24], pp. 61–66, mentions the plumage of at least 24 birds, and the intended uses of their feathers; Brigham [25] lists 10 species, mostly the same ones. The *mamo* and the *ʻoʻo* were the main sources of yellow feathers; the *ʻiʻiwi* and the *ʻapapane* supplied red feathers, whereas green feathers were obtained from the *ʻōʻū* (*Psittirostra psittacea*) and sometimes from the *ʻakialoa* (*Akialoa obscura*). Other feather colors, such as black, grey, or white, came from a variety of birds [61]. Table 1—largely based on Malo [24]—provides a summary of birds utilized by ancient Hawaiians for featherwork, and of feather items commonly associated with each bird; more than 60% of the birds Malo mentioned were used. The vivid, much appreciated, yellow feathers of the *ʻōʻō* and *mamo* soon made them a prime target for birdhunters [4]. The birds themselves had a striking appearance (Figures 1 and 2); Emerson [23], p. 108, described the *ʻōʻō* as a 'proud and solitary bird,' and the *mamo* as 'the king of Hawaiian plumage birds . . . the king of the small birds of the uplands.' Keauokalani also referred to the *mamo* as 'the chief of small, mountain birds.' [53], p. 293. Alas, both the majestic *ʻōʻō* and *mamo* became extinct by the late 19th century [1,15,21,32].

Feathers were utilized to manufacture a wide assortment of items, which included *ʻahu* and *ʻahuʻula* [feathered capes and long cloaks], *kīpuka* [short shoulder capes], *mahiole* [feathered war helmets], *kāhili* [feather standards], *lei hulu manu* [feathered garlands], *kāʻei* [feathered belts or sashes], feathered *malo* [loincloth or girdle] worn over the waist and shoulder during the investiture of kings, and—for female chiefs—*pāʻū hulu manu* [feathered skirts for state occassions], *pāpale* [caps, or hats], basketry, and images, as well as 'for the decoration of the *Makahiki*-idol' [6], [24], p. 63, [53,56], [74], p. 491, [75]. 'Ī'ī [48], loc.626, who served as a personal retainer and *kāhili*-bearer for Kamehameha II [49,61,76], told how, as a small child, he used a ' . . . wonderful *malo* made of feathers from *mamo* and *ʻapapane* birds attached to a fine net, with rows of human teeth at the end'; this '*malo*' is actually a *kāʻei* [61], and is now kept at the Bishop Museum, in O'ahu.

The number of birds and feathers needed to produce all of these garments is simply staggering. Over time, *kāhili* evolved into different shapes and sizes; some were small fly whisks, others were much larger fans [75]. Rose et al. [53] examined many large *kāhili* at the Bishop Museum, meticulously counting feathers and estimating the numbers of birds needed for these; up to 3120 individual *ʻōʻō* birds were required for just one standard. On 10 January 1855, the funeral procession of Kamehameha III (Kauikeaouli) displayed 90 *kāhili*, which might have easily included the feathers of some 280,000 *ʻōʻō* birds [53], p. 279. Ancient *kāhili* fans were much larger than later ones; some imposing state *kāhili* were as high as 10 m, with 3 m of feathering [61]. The huge numbers of *lei* garlands manufactured must have also demanded vast quantities of feathers; Wilson and Evans [4], o-o ch, note 'That

large numbers of *o-o* (*Moho nobilis*) must have been taken in former days is clear from the quantities of *'leis'* or wreaths of feathers that now remain in the possession of the natives, who still set so great store by them'; Mr. Wilson was able to purchase for $50 ' . . . a small lei, for which (he) reckoned two hundred birds must have been sacrificed.' [31], p. 119, [50].

Figure 1. Male and female *'ō'ō* (*Moho nobilis*) perching on *'ōhi'a* tree; believed to be extinct by 1902. Illustration by Johannes Gerardus Keulemans, from: Rothschild, (1893–1900) [51], p. 72.

Figure 2. Male and female *mamo* (*Drepanis pacifica*); believed to be extinct by 1898. Illustration by Johannes Gerardus Keulemans, from: Rothschild (1893–1900) [51], p. 6.

The most sumptuous and ornate items were the full-length royal cloaks or capes, *ʻahuʻula* or *alaneo* (Figure 3), which were reserved for an *aliʻi ai moku* [king of the whole island] and were considered his *kapa wai-kaua* [cloak to use during battle] [1], p. 52, [24], p. 107. Full-length cloaks were worn ceremonially, whereas the shorter capes were battle apparel [75]. As noted, cloak color was an important sign of status for Hawaiians; the greater the percentage of yellow, the higher the prestige and power of the chief [57]. Kamehameha I is the only king known to have worn a completely yellow *ʻahuʻula* [61], now kept at the Bishop Museum; manufacturing this celebrated cloak would have taken the

golden feathers from 80,000 *mamo* birds [6,13,31]. Other feather cloaks may have contained more than a half million (red) feathers of *ʻapapane* and other birds [77]. The elaborate process of assembling *ʻahuʻula* garments is described by Brigham [25], p. 49, and Thrum [78], p. 97. Skillful workers gently wove the feathers into a fine netting network of twisted strands of *olonā* (*Touchardia latifolia*) bark [44], p. 239. The small feathers were knotted in small bunches of two or three with the *olonā*, a technique called *ʻuo* [56]; the whole procedure was laborious and intricate, and the making of a cloak might take several years. The fragrant roots of *kūpaoa* (*Dubautia menziesii*)—a common high-altitude shrub found above ~1950 m [79]—were used to perfume feather capes as well as *kapa* pieces [57], [80], p. 66.

It may seem peculiar, but feather capes were prominently worn by *aliʻi* during battle and, as they were very warm, chiefs did not use any *malo* or garment underneath [25], p. 54. The dazzling cape allowed chiefs to make sweeping gestures used to transmit battle commands, which would have been greatly enhanced by the vivid bright yellow and red cape colors [61]; the conspicuous *mahiole* helmets would only add to the swift recognition on the king by his fighting warriors. Shorter *kīpuka* capes were worn by lesser chiefs and some important warriors [23], p. 109. As cloaks were such prestigious symbols of power, triumphant warriors would take these, as well as feathered helmets and other booty, from the bodies of slain chief adversaries [24], p. 107, [74,78]. Women frequently accompanied their husbands into battle, and even fought with them [75], p. 49; a woman whose husband was killed in battle could put on his cape and continue to fight in his stead [61]. Over time, large numbers of cloaks were fashioned but, as Hawaiian chiefs often made an *ʻahuʻula* a token of their frienship, cloaks eventually found their way to many world museums, from Philadelphia to Sydney, from Lisbon to Berlin [25]. Hīroa [52], p. 325, wistfully commented: 'The (Polynesian) regalia and symbols of spiritual and temporal power have been scattered among the museums of other peoples.' It is noteworthy that *mahiole*, *ʻahuʻula*, and *kāhili* were so highly esteemed that they were all given individual names [53], p. 279.

Figure 3. Hawaiian (Haalelea's) feather cape. Cape of *ʻōʻō* crescent, four senncrescents, and two cordate figures of *ʻiʻiwi*. Length, 40.6 cm, front, 25.4 cm. B.P. Bishop Museum, Oʻahu. Use licensed as Public Domain, Wikimedia Commons.

Feathered *mahiole* were also important items of royal battle regalia, and were reserved for high-ranking chiefs [52], p. 264. The basic helmet design consisted of a basketry frame with a prominent central crest running from the back to front of the head; the ridge varied greatly in height and shape, and some *mahiole* displayed mushroom-shaped protuberances; feather patterns and types used were also diverse (Figure 4). As in other Polynesian helmets [52], p. 111, an air space between the top of the head and the helmet deflected or provided some cushioning against clubs and the heavy, polished basalt slingstones [75], ideally sparing the warrior's head from being split open. However, *mahiole* would be ineffective when slingers flung the 'white stones found in caves' (stalagmites), which could easily shatter into fragments going in all directions, and warriors might be hit in the eyes. Common soldiers wore just simple skullcaps, probably similar to the sennit helmets of coiled work used by Atituan Polynesians [52], p. 112, [61]. *Mahiole* were assembled over a woven wicker frame of *ʻieʻie* fibers; the sturdy aerial roots of this endemic woody climbing Pandanaceae vine were baked, split, and pounded to make them supple enough for twined basketry, then were plaited into a strong foundation for the helmet [58], p. 69, [61]. *Olonā* strands were later used to create a string or thread to tie the feathers to the basketry [25]. Incidentally, the fleshy flower bracts and ripe fruits of the *ʻieʻie* were the preferred food of the extinct *ʻōʻū* (Figure 5), a honeycreeper that was once a primary seed dispersal vector for this and other forest plants with small, seeded, fleshy fruits; this plant was also a favorite food for the *ʻalalā* (Hawaiian crow), presently extinct in the wild [26], pp. 372, 386, 434, [33], pp. 70, 124, [50], [81], p. 216.

Figure 4. Hawaiian *mahiole*, 'red British Museum' helmet, London. Source: user:geni. Use authorized under Creative Commons (GDFL CC BY-SA 4.0).

Other, less conventional, uses of bird feathers took place. Canoes of Hawaiian *aliʻi* often wore giant *leis* and streamers of feathers, hanging from the stern and bow pieces, that drifted in the wind, signaling its direction and strength; these may also have bestowed canoes with the spirit and protection of the bird from whose feathers the *lei hulu manu* was made [61]. Similar uses are reported from New Zealand and the Austral islands near Tahiti, where war canoes were decorated with seabirds' feathers held under the lashings of the topstrake [52], p. 171. Malo [24], p. 63, mentioned that many religious icons were decorated with feathers, including the image of Ku-ka-'ili-moku, Kamehameha's war god, that wore a headdress of yellow feathers [74]. Feathers may rarely have been an unusual source of house thatching; there are several legendary instances of houses thatched with 'royal yellow', red, or 'smoke-colored' feathers, which were considered 'an exaggerated symbol of the rank of its owner' in Hawai'i, as well as in Samoa [4,23,74]. Westervelt [4], loc.2097, also mentioned ' . . . soft mats made from feathers of many birds, and sleeping-couches, better than had ever been seen before.' that were used by *aliʻi* at special gatherings and celebrations.

Figure 5. Male and female *ʻōʻū* (*Psittirostra psittacea*). Presumed extinct; last observed in 1989. Illustration by F.W. Frohawk, from Wilson and Evans (1890–1899) [50], p. 36.

Hīroa [52], p. 166, a Polynesian himself, had the rare privilege of observing some Polynesian practices before these disappeared. While visiting the Marquesas in the 1920s, he gazed in admiration at 'the lissome bodies of graceful and beautiful dancing girls' who swayed to the music while displaying long red feathers of the bosun (tropic) bird (*Phaethon rubricauda*) attached to their fingers on both hands. He also admired magnificent headdresses for men, adorned with 'the long, black tail feathers of roosters, waving vertically above their heads' and bedecked 'with iridescent pigeon feathers.' Sorrowfully, Hīroa [5], p. 325, later avows: 'The old world created by our Polynesian ancestors has passed away, and a new world is in the process of being fashioned.'

> 'Let us go to the clear waters of Kalulu. There. we will dwell together in the great ravine of Palawai, where we will eat the young of the uwau bird and we will bake them in ki leaf with the sweet pala fern root.' Traditional 'ōlelo, in Thomas Thrum, 1907 [78], p. 114.

3.3. Bird Hunting as a Source of Meat

Bird meat was a common food item for ancient Hawaiians. Dye [82], p. 4, wryly observes that when the first Polynesian settlers reached Hawai'i, they found forests that offered little in the way of plant food, but birds were abundant and easily captured. Gomes [28,29] suggests that the historical importance of native birds as a meat source for *maka'āinana* has been traditionally overlooked—and overshadowed—by the most prominent use of regal featherwork worn by Hawaiian nobility. Bird meat may have even been the primary source of protein for native Hawaiians in some areas. Gomes [28], p. 60, reports that Kumauna, a *kama'āina* [native resident] of Kahuku—a sizable *ahupua'a* in Hawai'i island—wrote in 1873: 'In ancient days the people of Kahuku did not go fishing, but were after birds of all kinds to eat, and this is the reason all the lands on the mountain belonged to Kahuku.' Illegal trespassing into neighboring areas was common, and caused much fighting among birdhunters of adjoining districts; intruders risked having the carcasses and feathers of illegally trapped birds confiscated by the rightful rulers of neighboring areas. Other *ahupua'a* in Hawai'i preserve numerous testimonies emphasizing the importance of historical bird catching. These frequent fights between bird catchers probably occurred because they were willing to protect their own source of food, rather than the supply of food for their chiefs [29], p. 36.

Malo [24], pp. 61–66, provided a stark—if candid—but detailed picture of the role of birds in native diets, as he went through a veritable exotic avian smorgasbord, worthy of the most refined chef's table. Malo mentioned no less than 30 birds that were a source of food—nearly 70% of those on Table 1—most of which can be specifically identified with today's taxonomy [22,68]. Malo did not simply offer a long bird list, but also commented on their various culinary qualities: ' . . . these birds are all eatable, . . . its flesh is good for food, . . . it is delicious eating, . . . it's good eating (gamey, but very tough), . . . its body is excellent eating, . . . its flesh is sweet, . . . their flesh is fine eating, . . . it is fit for food (very fishy)'; all this suggests that he was personally acquainted with these birds. Appallingly, only *one* bird, the *'ula* (*Ciridops* sp.), is mentioned as being 'celebrated in song' [24], p. 63. Keauokalani reportedly wrote in 1859 'the *koa'e* is a delicious bird, tasting almost like the *nēnē*,' and also calls *'ua'u* 'the most delicius of birds' [53], p. 298. The *'ua'u* is the specific focus of a Section 3.4 below. Several place names indicate their significance for bird hunting. Pu'u 'ua'u [hill of *'ua'u*] (O'ahu) was a nesting place for petrels before they were exterminated on that island [33], p. 26, [55], p. 206. 'Āhuli manu [bird cluster], in the north shore of O'ahu, is named ' . . . because the birds from nearby (offshore islet) Moku manu [bird island] were caught here and tied together in bunches.' [55], pp. 6, 155.

There has been much idle speculation as to whether small forest birds were killed and eaten after removing their feathers [6]. Some authors prefer to disingenuously believe that birdcatchers plucked only a few feathers from each bird, then 'set it free to raise its family and grow a new crop of feathers.' [61], [83], p. 217. Others [57], p. 287, [80], p. 7, more credibly assert that 'The meaty, flavourful large birds were regularly hunted for food.

Others only in famine times'; unfortunately, we are left wondering how often Hawaiians went hungry. Munro [33], p. 87, candidly pointed out that we do not really know whether birds were released, or killed and eaten, but that the latter was probably the case.

Numerous historical sources leave little doubt about the fate of most birds, regardless of the original reason for hunting them. Observations by the Cook expedition that reached Kaua'i on 18 January 1778 indicate that large numbers of small red birds (*'i'iwi*) were killed, and their feathered skins openly sold in bundles of 20 or more at the marketplace, as well as groups of bird carcasses held with a small wooden skewer run through their nostrils [6], p. 72, [25], p. 5, [53]. Emerson [23], p. 110. averred: 'The *mamo*, *i-iwi* and such birds as were destined to be eaten after being plucked, were, as soon as caught, killed by pressure over the thorax and then wrapped in the outer dried parchment of the banana-stalk . . . '; he also provided some rationale for this behavior: 'In the case of the *mamo*, *i-iwii*, *akakani*, *o-u* and *amakihi* the extent of skin surface left bare after stripping the plumage from the bird was so considerable that it would have been an act of cruelty, if not of destruction, to have set it loose'; see [28], p. 23. It is also known that small passerine birds sometimes die of shock merely as a result of being handled [21], p. 120. Brigham [25], p. 10, told how the small *'ō'ō* birds: ' . . . were a favorite article of food, and as the larder of the hunters in the mountains was poorly stocked, it seldom survived capture.' Wilson and Evans [50], p. 5, o-o ch., agree: 'The o-o is esteemed a great delicacy by the natives, and used formerly to be eaten by them, fried in its own fat.' Henshaw [1], p. 52, observed how 'birdcatchers in Kamehameha's time . . . were strictly enjoined not to kill any of the royal birds [*mamo*], but to turn their captives loose when stripped of their coveted yellow feathers.' However, Henshaw ironically commented: 'The forests in which the bird-catcher plied his calling was (sic) distant and deep, and it is possible that the injunction was not strictly heeded; for meat of any kind was always scarce in Hawaii and in any form was highly prized.' Unfortunately for the birds, bird killing became more efficient with the introduction of 'the quicker and more deadly shot gun, and the birds quickly met their doom' [1], [6], p. 63, [23]. Henshaw [1], p. 70, finally added: 'The above merciful and wise custom, if ever generally observed . . . died out together with the chiefs with whom it originated and with the old race of bird-catchers.'

It is relevant to know the actual fate of trapped birds; however, as Gomes [29], p. 49, perceptively points out, it is also important to understand *why* ancient Hawaiians hunted birds. Berger [31], p. 18, mentioned a critical point, suggesting that birds were eaten because of the protein-poor diet of Hawaiians. Other authors [13], p. 226, [53], p. 298, concur that the scarcity of protein in Hawai'i's agricultural society, and the difficulty of catching birds, make it likely that those caught for feathers were killed and eaten. Hawai'i's cultural landscape was dominated by an orderly system of agricultural fields centered on the production of starchy plant foods; two root crops, *kalo* [taro, *Colocasia esculenta*] and *'uala* [sweet potato, *Ipomoea batatas*], were the main food staples, supplemented with *uhi* [yam, *Dioscorea* sp.], *mai'a* or *waoke* [banana, *Musa* sp.], and *'ulu* [breadfruit] [46], pp. 23, 24, [47], p. 152, [57,58], [75], p. 83, [84,85]. This traditional system provided a diet heavily based on carbohydrates; Kirch et al. [85], p. 286, calculated an average daily consumption of three kcal of tubers per person in the Kaupō area (Maui); tellingly, no estimates for any protein intake were offered.

Hawaiians had few domesticated animals: *pua'a* [pigs], *'ilio* [dogs], and *moa* [chickens] [57], p. 285, with additional *pihi* [fish] in some coastal areas. It is not immediately clear whether the access of *maka'āinana* to these meat sources was widespread. Pigs were traditionally the preferred sacrifice to the gods and were, along with dogs, important in ceremonial practices [72], p. 37, [86], p. 2. Pigs and dogs were frequently mentioned by Kamakau [44], pp. 3, 12, 26, 177, 385, who clearly described how both animals were mainly consumed at chiefs' 'great pork-eating feasts' and during *heiau* [temple] dedications; annual taxes paid to Kamehameha also included such valuables as 'swine, dogs, chickens, mats, *ō'ō* and *mamo* feathers,' and 'Ewa pearls'. Malo [24], p. 228, described a ceremony in which ' . . . pigs were baked, and a fore-quarter was given to each kahuna' [priest], then the king '

. . . made an offering to his gods of four hundred pigs . . . and offered a sacrifice of human bodies on the *lele'* [altar]. Keauokalani [47], p. 148, mentions the *ho'o-kū-kū*, a celebration in which commoners honored their high chief by bringing food gifts: 'The next day bake pig, dog, turkey, chicken. Let the mountain chiefs bring petrels, geese, birds from their holes.' Dog meat, especially that of young puppies, was 'judged very tasty' by Hawaiians, who cooked them by inserting hot rocks in their cleaned abdominal cavity, then wrapping the bundle with *kī* leaves, or roasting them over charcoal [44], pp. 13, 53, 337, [87], p. 130. Dogs were an important portion of taxes during Makahiki festivities, when many dogs were contributed ' . . . until the *ali'i* pens were full of them' [24], p. 188.

Specific mentions about chicken use by Hawaiians are scarce. 'Chicken (*moa*), always pleasing to the gods, was once used as the most specific of food offerings' [86], p. 3. During the *ho'opalau* [bethrotal] period, 'the young man might send gifts to his wife-to-be, perhaps a pig, chickens, a feather lei, or a fat dog'; later, at the couple's wedding, 'In anticipation of the event, the head of the household had raised or acquired hogs, dogs, chickens.' [58], pp. 140–144, [88], p. 279. Such comments strongly suggest that chickens were, as the other animals, choice food items reserved for special occasions and festivities, and not part of everyday meals. Hīroa [52], p. 265, puts it more succintly: in ancient Hawai'i 'Pigs, dogs, and fowls were the food of the wealthy; fish remained the mainstay of the people.' Conversely, Handy and Handy [58], loc.51, challenge the assumption that Hawaiians consumed much fish: ' . . . fishing occupied a very small part of the time and interest of the majority of Hawaiians.' The rugged nature of the islands favored the dispersal of homesteads 'extending along the valleys into the heart of the mountains' rather than the development of compact villages. In contrast, the localities along the shore suitable for fishing, and favourable for clusters of dwellings, were extremely rare and far apart. Thus, ' . . . for every fisherman's house along the coasts there were hundreds of homesteads of planters in the valleys and on the slopes and plains between the shore and the forest' [57], p. 23, [89], p. 174.

We must now consider the unpleasant reality of *kapu*. Hawai'i was, in European terms, a feudalistic society; the ruling *ali'i* controlled access to resources and rigidly prescribed their use [37], p. 318, [58], loc.1344. Food taboos mainly develop to reduce the chances of communal over-exploitation [90], p. 175, however, on many Pacific islands and atolls, evolved to monopolize access to scarce resources, reserving these for the exclusive use of local rulers, and forbidding them mainly to women and children [91–93]. Hawaiian chiefs refined the *kapu* into an exceedingly complex system [94], creating ' . . . such a number of taboos that an official executioner was appointed to inflict the punishments that the gods might have overlooked' [52], p. 265. Malo [24], p. 52, meticulously catalogued the ' . . . articles of food that were set apart for the exclusive use of man, of which it was forbidden (for) the woman to eat', including pork, many types of fish, and *honu* [sea turtle] [95], p. 109, [96]. Women and boys were not allowed to eat pork, because this was 'the favored sacrifice food for the gods, chiefs and priests' [86], p. 7, [97], p. 312; dogs apparently were also *kapu* for women [57], p. 151. *Kapu* transgressions were no trivial matter, and ' . . . if a woman was detected in the act of eating any of these things . . . she was put to death' [24], p. 52. Particularly grievous offenses—such as forgetting an important *kapu* day—might be punished more severely, and all persons who lived in an *ahupua'a* might become subject to death [45], loc.310.

It may regrettably be concluded that *all* domesticated animals, and many kinds of fish, were not commonly or frequently available to most *maka'āinana*, thus providing a strong incentive for inland Hawaiians to hunt and consume wild birds.

> 'Once the ('ua'u) bird is in hand it is easily despatched (sic) by the native hunter in a neat and efficient manner. The forefinger is violently forced down the bird's throat. It is then slightly bent at the first joint so as to catch the heart and lungs, which are given a slight twist and sharp pull, with the result that the bird dies instantly, with scarcely a struggle.' William A. Bryan, 1908 [27], p. 50; see also [28], p. 180.

3.4. Case Study: Hunting of ʻuaʻu (Pterodroma sandwichensis)

The dark-rumped petrel is a large seabird, with a wingspan greater than 90 cm (Figure 6); a closely related petrel species is found in the Galapagos Islands. The Hawaiian bird's name, *ʻuaʻu*, is derived from its haunting nocturnal call [1], p. 120, [27], [33], p. 26. These birds ' . . . dwell in the mountains by night, but during the day they fly out to sea to fish for food' [24], p. 64; they were once common and 'extremely abundant' along the Hawaiian archipelago 'across a range of elevations' [31,33], [98], p. 12, and sizable colonies existed in all main islands except Niʻihau [99]. In former times, such numbers of *ʻuaʻu* returned nightly to their nests on Molokaʻi that the incoming birds were said to have 'darkened the skies' [98], p. 12. Olson and James [34], p. 43, reported ''*ʻuaʻu* were the most abundant bird recovered from ancient bone deposits on coastal Oʻahu'; *ʻuaʻu* remains were also, by far, the most common among faunal assemblages in the island of Hawai'i [12], p. 40, [41], p. 138, thus supporting the notion of their previous significance as a food source [29], p. 50.

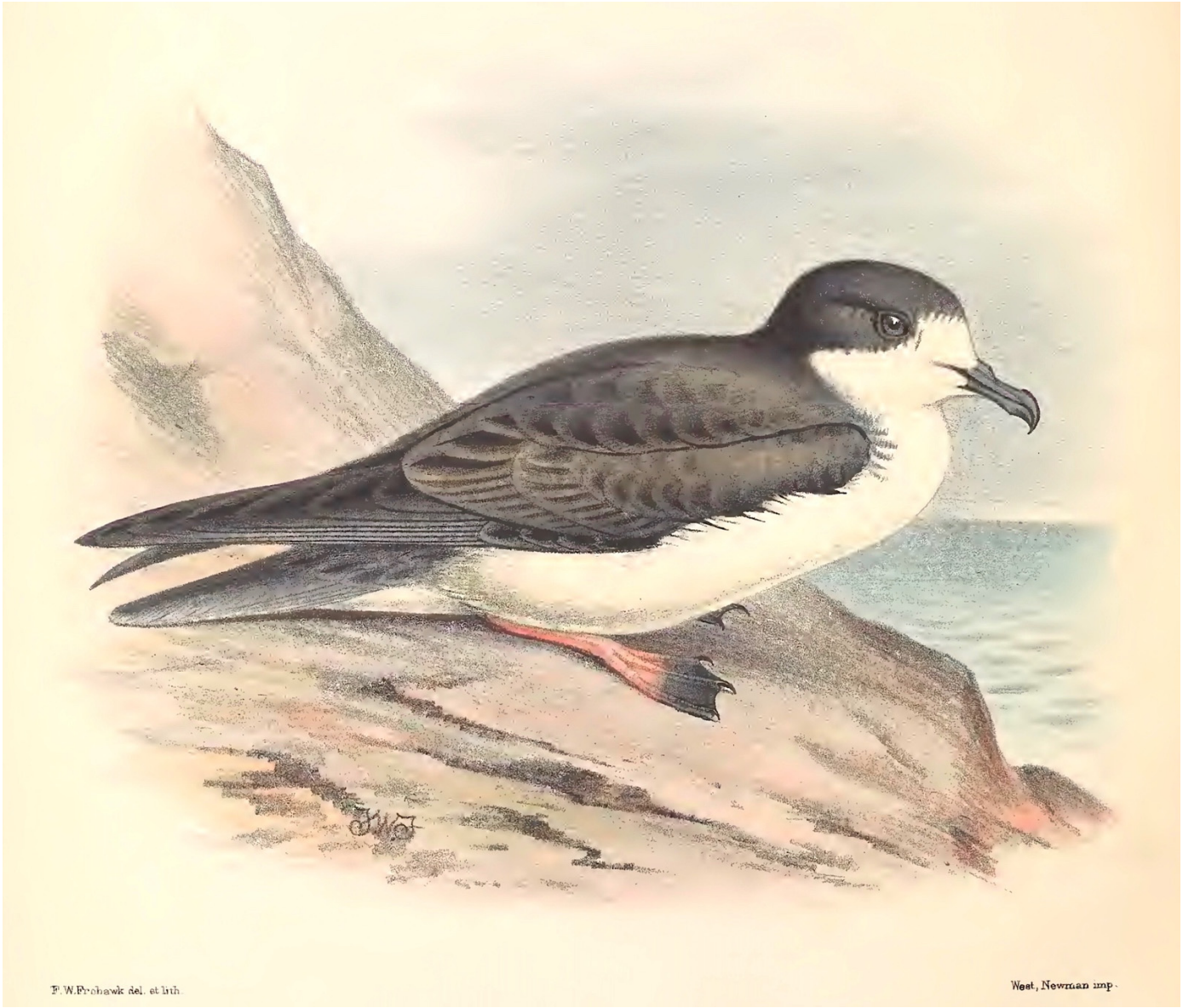

Figure 6. *ʻUaʻu* (*Pterodroma sandwichensis*), originally labeled '*Oestrelata phaeopygia*'; currently endangered. Illustration by F.W. Frohawk, from Wilson and Evans (1890–1899) [50], p. 67.

Dark-rumped petrels are now listed as an endangered species. They are rarely seen, as they nest almost exclusively in Haleakalā Crater (Maui), near Haleakalā's summit, at 2400–3055 m; *ʻuaʻu* live in deep, 1 to 2—but up to 10—meter-long burrows excavated in the cinder Andisols on rock ledges, below spectacular and inaccessible, 250–300 meter-tall *palis* [cliffs] bounded by long, alluvial/colluvial talus slopes which extend to the crater floor below [63,100] (Figure 7). This site makes it one of the highest colonies of nesting seabirds anywhere in the world [101]. As *ʻuaʻu* cannot readily fly from a level surface, the nesting sites on the steep Haleakalā slopes are especially suited for taking flight [102], and also provide a remote location that shelters the birds. Birds dig up burrows with their legs and wings, often excavating the loose cinder and tephra found underneath large boulders or outcrops [98]; lapilli samples at one site contained >88% coarse gravel pebbles, making it extremely easy to excavate [100], p. 228. Many tunnels, with rather unobtrusive entrances, are found along the lithologic contact at the base of basaltic alkali-olivine *ʻaʻā* lava outcrops (Figure 8). Some 700 established burrows have been documented in the National Park; these are recurrently utilized by petrels that return to their nest year after year [98], p. 13.

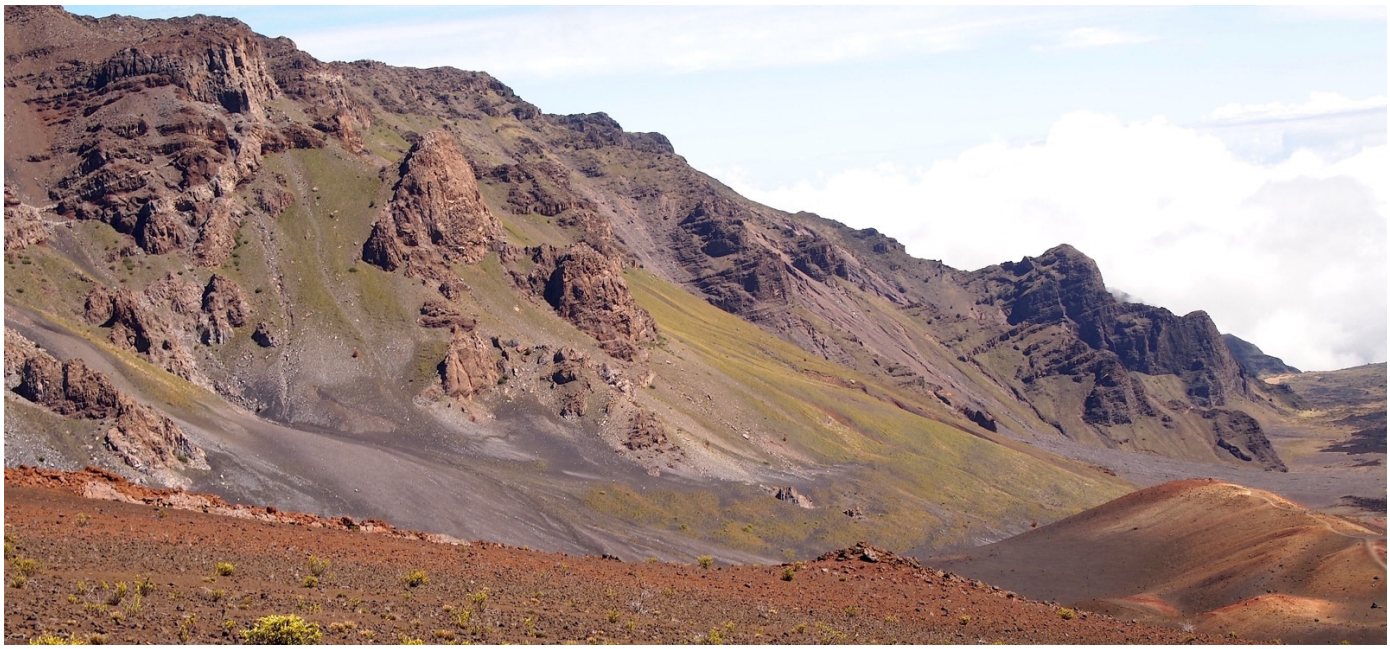

Figure 7. Haleakalā Crater *palis* [cliffs] along its western rim, seen from the Sliding Sands trail, at ~2810 m; the crater rim on the upper left is at ~2950 m, the crater floor on the right, below the talus slopes, is at ~2430 m. A small reddish cinder cone ~970 years old, *Ka luʻu o ka ʻōʻō*, appears on the lower right; the western edge of the Kau-pō Gap opening on the crater wall is seen on the upper right. The largest population of *ʻuaʻu* in the Hawaiian Islands nests on the cliffs below the rim. Photo: F.L. Pérez, Hk-2014-57, 14 September 2014.

A much smaller colony, with about 50 nests, was fortuitously discovered in 1990 at Mauna Loa, Hawai'i island, at 2440–2900 m [103]. This colony was much larger in 1887, when 'a considerable number (of *ʻuaʻu*) had their nests in holes in the ground . . . in the lava between Mauna Kea and Mauna Loa'; however, by the early 1900s, birds had been seriously affected by the proliferation of the introduced Indian mongoose (*Herpestes auropunctatus*), which invaded the nesting sites [1], p. 120, [50], p. 2, Uuau ch. A similar fate was met before 1908 by the dense*ʻuaʻu* colonies in Molokaʻi, where mongoose ate the birds and then occupied their burrows after killing the original occupants [27], p. 51. Petrels are still reported from Kauaʻi, and some small colonies might yet survive in Molokaʻi and Lānaʻi [101,103]. Recent estimates indicate fewer than two thousand*ʻuaʻu* remain in all of the the Hawaiian Islands; ~95% of these, including <650 breeding pairs, nest in Haleakalā Crater [98,101,104]. Although Maui's colony is protected within Haleakalā National Park, it was also affected by predation from mongoose and feral cats (*Felis catus*), which were

responsible for destroying ~40% of their yearly egg and chick production before 1980, when an extensive trapping program was started [98,102,105].

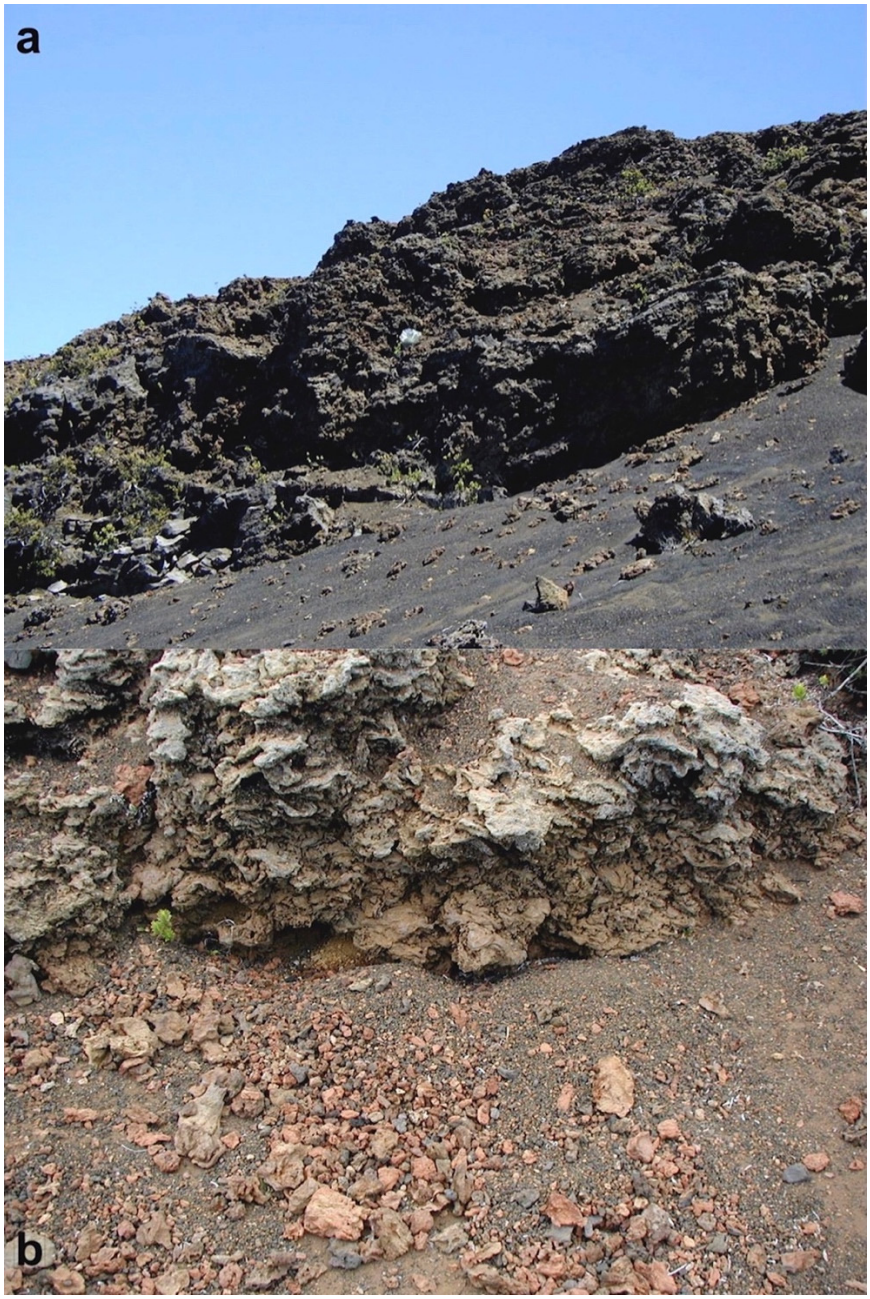

Figure 8. (**a**). A *pali* section in area of *ʻuaʻu* nesting (Figure 7, left). The view shows a ~5.5 m-tall *ʻaʻā* basaltic lava deposit, and the upper section of the colluvial talus below; many petrel burrows are located along the cliff base. Plants on this site include many green *kūpaoa* (*Dubautia menziesii*) seedlings and a large, white silversword (*Argyroxiphium sandwicense*) rosette perched atop a rocky ledge. Altitude: ~2725 m. Photo: F.L. Pérez, Hk-2001-155, 3 August 2001. (**b**). Close-up of contact between basaltic lava-flow above, and colluvial talus slope beneath, along the base of cliff in (**a**). Photo shows the small, narrow entrances to three—or possibly four—presumed *ʻuaʻu* burrows, found along the lithologic contact. Tiny seedlings of *kūpaoa* (*Dubautia menziesii*), and moss cushions (*Grimmia trichophylla*), appear near the burrow openings. Note the loose cinder and tephra on the ground; the photo shows an area ~240 cm wide. Photo: F.L. Pérez, Hk-2002-551, 29 July 2002.

Feral runaway goats (*Capra hircus*) were formerly abundant on the steep crater walls, where goats chose some of the same cliff ledges and outcrops where bird burrows are located as bedding sites [100,104]; however, goat activities probably did not affect the petrels adversely [102]. The roof rat (*Rattus rattus*) was also identified in the 1960s as an important *ʻuau* predator [31], p. 49. Argentine ants (*Linepithema humile*) were first recorded in Haleakalā N.P. in 1967; however, a study showed that the alien ants are not significantly affecting the nesting success rate of the *ʻuaʻu* at present [106]. Ultimately, current ecological management efforts seem to have been successful, and the endangered birds are slowly increasing in number [66], p. 47, [98].

Ancient Hawaiians mercilessly hunted *ʻuaʻu*, and habitually utilized them as a source of meat [29]. Young birds were esteemed as a great delicacy for their tasty flesh [24], p. 64, [50] and were reserved for the *aliʻi*, hence were *kapu* to the common people; old birds tasted too strong and were unpleasant to eat, and needed to be salted for a considerable time, thus probably were not *kapu* [28], [33], p. 26, [63]. *ʻUaʻu* chicks were so valuable a commodity that some hunters may have even stolen young birds from neighboring lands, obeying the commands of their *aliʻi* [29], p. 48. *ʻUaʻu* were captured with a variety of methods; Gomes [28], p. 176, provides an excellent analysis of this knotty topic. Adult birds returning in the evening from the sea to their rookeries used specific routes along the coast and followed flight corridors inland. Large nets were deployed in these areas; as hunters imitated their call, birds would descend to the ground and be trapped [26], p. 463, [27], p. 49, [33], p. 26, [63]. Specially crafted nets in the shape of a bag with a wide-spreading opening were also placed in ravines or narrow valleys to intercept the paths of flying birds [28], p. 203.

A widespread and effective strategy was to catch the petrels directly in their nesting burrows during the *Kaulua* [summer] months (June-July), when ' . . . birds went into holes and nested in pairs' (*moe palua*) [46], p. 17. A traditional Hawaiian *ʻōlelo* [proverb] reminded natives that the *ʻuaʻu* season had arrived: '*Aia a pohā ka leo o ka ʻaʻo, kāpule ke momona o ka ʻuwaʻu i ka puapua*' [When the *ʻaʻo* birds' voices are distinctly heard, the *ʻuwaʻu* birds are fat even to the very tails.] [107], *ʻŌlelo Noʻeau* #32. The *ʻaʻo* (*Puffinus auricularis newelli*) birds (Table 1) would return from the sea to nest on cliffs in late July, when their very loud and noticeable nasal calls would alert birdcatchers that the hunting season had come [28], p. 187, [31], p. 47, [33], p. 25. At this time, petrels would be captured and dragged out by hand from their burrows. However, as Bryan [27], p. 50, noted, 'Digging out an Uau is not the easy and pleasant task one might imagine.' After finding their burrows, birds inside needed to be precisely located—not an easy task—but once the hunter's hand touched a bird, it ' . . . started to bite with their hooked, pincer-like bill, and kick and scratch with their feet most savagely'. To avoid being wounded, hunters would often thrust the bird's upper mandible through the lower at its base [28], p. 190, or instantaneously kill it in an even more effective but cruel manner (see last epigraph above).

Young birds in their downy stage would be taken later, in late September or early October [33], p. 26, when chicks looked much like a plump ball of down and often weighed twice as much as an adult bird [98]. Chicks could not present such resolute resistance, and they were simply ' . . . pulled from the holes by means of a stick that is split at one end. The split end is twisted into the down, and in this manner it is easily pulled forth' [1], p. 120, [26], p. 462, [27], p. 51. *ʻUaʻu* are long-lived birds, perhaps up to 25–30 years [98], p. 13; as adult birds returned to their burrows annually, an ingenious method for trapping young birds was devised by birdcatchers. After determining the position of a chick inside a burrow, a vertical hole was excavated directly above it, and the bird captured; the hole was then covered with a fitted stem segment of arborescent fern—probably *hāpuʻu* (*Cibotium menziesii*); the following year, hunters would just relocate the hole, pull out the wedged fern piece, and remove the newly hatched chick [28], p. 182.

ʻUaʻu hunting in Maui was traditionally centered along the western rim of Haleakalā Crater, precisely where the bird colony still survives [102]. Archaeological excavation of 57 campsites at 2020–3030 m along the inner crater rim provided evidence of repeated short-

term visits associated with the collection of birds for food and feathers, and with quarrying of high-quality basalt outcrops [42]; camps also preserved abundant lithic tools, such as flake-knives and scrapers, presumably used for processing captured birds and many bird bones—some of them charred [66], pp. 88, 98. Sites were recurrently but intensely occupied *ca* A.D. 1410–1670; abundant bird bones showing evidence of human consumption indicate hunters were particularly targeting the *ʻuaʻu* population. Bone analysis revealed that nine additional native bird species, including *nēnē* (*Branta sandvicensis*), *ʻalalā* (*Corvus hawaiiensis*), and *olomaʻo* (*Myadestes lanaiensis*), were also subjected to human predation [66], p. 155. Bird catching ceased in this area immediately after European contact (A.D. 1778) [43]. Intensive petrel hunting also took place in the island of Hawai'i. Many *ʻuaʻu* bones, ostensibly chewed by Hawaiian hunters, were found in Hopukane Shelter Cave, at ~3050 m, on the south side of Mauna Kea [102], p. 327. Bird-bone deposits left by prehistoric hunters in 14 high-altitude lava tubes on Mauna Loa showed that *ʻuaʻu* comprised 94.7% of bones collected; an additional 4.2% belonged to *nēnē*, now the only surviving Hawaiian goose [21].

> 'Had not *Homo sapiens* arrived in these islands some 16 centuries ago, these birds would still be alive today—skin, feathers, songs, enzymes and all'. Storrs L. Olson and Helen F. James, 1991 [18], p. 7.

4. Discussion

Ancient Hawaiians probably viewed native birds as an inexhaustible resource, and seem to have treated them as such. Bird hunting was also important in other Polynesian islands. Maories captured, in New Zealand, *kaka* (*Nestor meridionalis*) parrots, where ' . . . an expert bird-catcher will sometimes bag as many as 300 in the course of a day'; this resulted in ' . . . 10,000 to 12,000 of these birds . . . killed during a good rata season' in some districts [50], p. 4, o-o ch.

Milberg and Tyrberg [36] argue that there is still a pervasive notion—the 'environmentalist myth'—that 'primitive' people are 'natural conservationists' living in a state of 'ecological balance,' without causing any significant deleterious effects to their environment [93,94,108]; this naive view, derived from a romanticized concept of the 'noble savage'—unfairly attributed to J.J. Rousseau—is simply untenable in the 21st century. Kirch [10] criticized the idea that ancient Hawaiians lived in symbiotic harmony with nature, and thought it should not go unchallenged. Although it is believed that native Hawaiian avifauna was affected by several interdependent factors (Introduction), the extensively documented bird overkill by humans must have played a crucial role in their decline. The extent to which humans contributed to bird demise may be unclear; however, as Berger [31], p. 114, argues, some birds—such as the *ʻōʻō*—went extinct in other islands (Figure 1), whereas the sole surviving *ʻōʻō* species in Kaua'i has 'fewer yellow feathers than any of the other species'; this possibly helped it escape being overhunted. The *ʻōʻū* (Figure 5) was at one time ' . . . common to all the larger Hawaiian islands' [70], p. 51; 'Next to *Vestiaria coccinea*, it is perhaps the most noticeable bird of the forest-birds of the islands' [50], Ou ch.; however, its ' . . . conspicuous bright yellow head and neck plumage' were eagerly used for highly valued leis. Now the bird is gone. Humans avidly consumed *ʻuaʻu* meat, severely restricting the distribution of one of the most abundant birds in the Hawaiian Islands into just a minute fraction of its former range. Now the *ʻuaʻu* is an endangered bird, likely to become extinct in the near future. *That* is the undeniable legacy of overexplotation and disregard of ancient Hawaiians toward their magnificent avifauna [21], p. 203, [31], p. 18.

> 'The evolutionary play was going on in the evolutionary theater when as a part of the plot men entered, romping and stamping on the stage and bringing it almost to the point of collapse' Ramón Margalef López, 1968 [109], p. 96.

5. Conclusions

Overhunting did not help many other bird species, which ended up adorning the garments of the Hawaiian nobility, or filling the bellies of the common people. Most birds

victimized by Hawaiians are now either extinct or endangered; many are simply unknown to us, and their names have faded from Hawaiian memory (Table 1) [22]. Sadly, it is not just the birds that have vanished, but their collective unique identities have been erased as well: 'When the birds disappear, so do their Hawaiian names. This means that as bird sounds are silenced, the chants that transmitted their names and associated stories also disappear' [110]. The birds may be gone, forever, but they should not be forgotten.

Funding: This research received no external funding.

Data Availability Statement: No additional data is available.

Acknowledgments: The author sincerely appreciates the unstinting institutional and financial support of the University of Texas-Austin, particularly from the College of Liberal Arts, and the Department of Geography and the Environment, for the past four decades. At Haleakalā National Park (Maui), the author thanks E. Gordon, R.J. Nagata, D.W. Reeser, P. Welton, and the late Lloyd L. Loope (1943–2017), for their kind help. The author is grateful to Martha Marie Kowalak-Pérez, for patiently listening to all his Polynesian stories and to his bizarre ornithological inquiries; she and Alejandro Gabriel Pérez-Bergquist provided skillful assistance and enjoyable company during much trekking and fieldwork across the Hawaiian Islands. The author thanks two anonymous referees for greatly improving the original manuscript. The author declares his humble admiration for Samuel Kamakau, Kepelino Keauokalani, Davida Malo, and Mary Kawena Pukui, for having had the foresight to preserve many Hawaiian traditions for future generations, and the courage to comment on all facets of their culture, even the less endearing ones.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Henshaw, H.W. *Birds of the Hawaiian Islands, Being a Complete List of the Birds of the Hawaiian Possessions with Notes on Their Habits*; Thos, G., Ed.; Thrum: Honolulu, HI, USA, 1902; Volume 146.
2. Pukui, M.K.; Curtis, C. *The Water of Kāne and Other Legends of the Hawaiian Islands*; Kamehameha Schools Press: Honolulu, HI, USA, 1994; Volume 213.
3. Westervelt, W.D. *Legends of Ma-ui—A Demigod of Polynesia and of His Mother Hina*; Hawaiian Gazette Co.: Honolulu, HI, USA, 1910.
4. Westervelt, W.D. *Legends of Gods and Ghosts (Hawaiian Mythology)*. GlobalGrey. 1915. Available online: ebooks.com (accessed on 15 May 2021).
5. Pukui, M.K.; Curtis, C.; Burningham, R. *Tales of the Menehune*; Kamehameha Schools Press: Honolulu, HI, USA, 1985; Volume 130.
6. Amante-Helweg, V.L.U.; Conant, S. Hawaiian culture and birds. In *Conservation Biology of Hawaiian Forest Birds. Implications for Island Avifauna*; Pratt, T.K., Atkinson, C.T., Banko, P.C., Jacobi, J.D., Woodworth, B.L., Eds.; Yale University Press: New Haven, CT, USA, 2009; pp. 59–79.
7. Scott, J.M.; Conant, S.; Van Riper, I.I.I. Evolution, Conservation, and Management of Hawaiian Birds: A Vanishing Avifauna. *Stud. Avian Biol.* **2001**, *22*, 1–428.
8. Curnutt, J.; Pimm, S. How many bird species in Hawaii and the central Pacific before first contact? *Stud. Avian Biol.* **2001**, *22*, 15–30.
9. Olson, S.L.; James, H.F. Fossil birds from the Hawaiian Islands: Evidence for wholesale extinction by man before Western contact. *Science* **1982**, *217*, 633–635. [CrossRef]
10. Kirch, P.V. The impact of the prehistoric Polynesians on the Hawaiian ecosystem. *Pac. Sci.* **1982**, *36*, 1–14.
11. Kolb, M.J. Ritual activity and chiefly economy at an upland religious site on Maui, Hawaii. *J. Field Arch.* **1994**, *21*, 417–436.
12. Moniz-Nakamura, J.J. The role of seabirds in Hawaiian subistence: Implications for interpreting avian extinction and extirpation in Polynesia. *Asian Perspect.* **1997**, *36*, 27–50.
13. Van Riper, C.; Scott, J.M. Limiting factors affecting Hawaiian native birds. *Stud. Avian Biol.* **2001**, *22*, 221–233.
14. Athens, J.S.; Tuggle, H.D.; Ward, J.V.; Welch, D.J. Avifaunal extinctions, vegetation change, and Polynesian impacts in Prehistoric Hawaii. *Archaeol. Ocean.* **2002**, *37*, 57–78. [CrossRef]
15. Boyer, A.G. Extinction patterns in the avifauna of the Hawaiian islands. *Divers. Distribut.* **2008**, *14*, 509–517. [CrossRef]
16. Banko, P.C.; Banko, W.E. Evolution and ecology of food exploitation. In *Conservation Biology of Hawaiian Forest Birds. Implications for Island Avifauna*; Pratt, T.K., Atkinson, C.T., Banko, P.C., Jacobi, J.D., Woodworth, B.L., Eds.; Yale University Press: New Haven, CT, USA, 2009; pp. 159–193.
17. James, H.F.; Olson, S.L. Descriptions of thirty-two new species of birds from the Hawaiian Islands: Part II. *Passeriformes. Ornithol. Monogr.* **1991**, *46*, 1–93. [CrossRef]
18. Olson, S.L.; James, H.F. Descriptions of thirty-two new species of birds from the Hawaiian Islands: Part I. Non-Passeriformes. *Ornithol. Monogr.* **1991**, *45*, 1–88. [CrossRef]
19. Reynolds, M.H.; Snetsinger, T.J. The Hawaii rare bid search 1994–1996. *Stud. Avian Biol.* **2001**, *22*, 133–143.

20. Banko, P.C.; David, R.E.; Jacobi, J.D.; Banko, W.E. Conservation status and recovery strategies for endemic Hawaiian birds. *Stud. Avian Biol.* **2001**, *22*, 359–376.
21. Walther, M.; Hume, J.P. *Extinct Birds of Hawai'I*; Mutual Publishing: Honolulu, HI, USA, 2016.
22. Gomes, N. Reclaiming native Hawaiian knowledge represented in bird taxonomies. *Ethnobiol. Lett.* **2020**, *11*, 30–43. [CrossRef]
23. Emerson, N.B. The bird-hunters of ancient Hawaii. In *Almanac and Annual*; Thrum, T.G., Ed.; Hawaiian Press Publ. Co.: Honolulu, HI, USA, 1895; pp. 100–111.
24. Malo, D. *Hawaiian Antiquities (Moolelo Hawaii)*; Translated from the Hawaiian by N.B. Emerson, 1898; Hawaiian Gazette Co. Ltd.: Honolulu, HI, USA, 1908.
25. Brigham, W.T. *Hawaiian Feather Work*; Bishop Museum Press: Honolulu, HI, USA, 1899.
26. Perkins, R.C.L. Vertebrata. In *Fauna Hawaiiensis or the Zoology of the Sandwich (Hawaiian Isles (Vol. 1, Part 4)*; Sharp, D., Ed.; Cambridge University of Cambridge: Cambridge, UK, 1903; pp. 365–466.
27. Bryan, W.A. *Some birds of Molokai*; Bishop Museum Press: Honolulu, HI, USA, 1908; Volume 4, pp. 43–86.
28. Gomes, N. Meha ka Leo i ka Nahele: He Noi'ina i ka Po'e Kāpili Manu o ke Au Kahiko. A Lonely Voice in the Woods: Research on the Bird Hunters of Ancient Times. Ph.D. Thesis, University of Hawaii, Manoa, HI, USA, 2015.
29. Gomes, N. Some traditional native Hawaiian bird hunting practices on Hawaii Island. *Hawaii. J. Hist.* **2016**, *50*, 33–51. [CrossRef]
30. Rutt, C.L.; Mittermeier, J.C.; Wang, A.X. The case for Hawaii's birds. Why the ABA area should include America's 50th state. *Birding Amer. Birding Assoc.* **2016**, *47*, 32–39. Available online: https://www.aba.org/birding-archive/ (accessed on 13 October 2021).
31. Berger, A.J. *Hawaiian Birdlife*; University of Hawaii Press: Honolulu, HI, USA, 1972.
32. Pratt, T.K.; Atkinson, C.T.; Banko, P.C.; Jacobi, J.D.; Woodworth, B.L.; Mehrhoff, L.A. Can Hawaiian forest birds be saved. In *Conservation Biology of Hawaiian Forest Birds. Implications for Island Avifauna*; Pratt, T.K., Atkinson, C.T., Banko, P.C., Jacobi, J.D., Woodworth, B.L., Eds.; Yale University Press: New Haven, CT, USA, 2009; pp. 552–580.
33. Munro, G.C. *Birds of Hawaii*; Charles, E., Ed.; Tuttle: Rutland, VT, USA, 1960.
34. Olson, S.L.; James, H.F. Prodromus of the fossil avifauna of the Hawaiian Islands. *Smithson. Contrib. Zool.* **1982**, *365*, 1–59. [CrossRef]
35. Olson, S.L.; James, H.F. The role of Polynesians in the extinction of the avifauna of the Hawaiian Islands. In *Quaternary Extinctions: A Prehistoric Revolution*; Martin, P.S., Klein, R.G., Eds.; University of Arizona Press: Tucson, AZ, USA, 1984; pp. 768–780.
36. Milberg, P.; Tyrberg, T. Naïve birds and noble savages—A review of man-caused prehistoric extinctions of island birds. *Ecography* **1993**, *16*, 229–250. [CrossRef]
37. Quammen, D. *The Song of the Dodo. Island Biogeography in an Age of Extinctions*; Scribner: New York, NY, USA, 1996.
38. Hume, J.P.; van Grouw, H. Colour aberrations in extinct and endangered birds. *Bull. Br. Ornithol. Club* **2014**, *134*, 168–193.
39. Wood, J.R.; Alcover, J.A.; Blackburn, T.M.; Bover, P.; Duncan, R.P.; Hume, J.P.; Louys, J.; Meijer, H.J.M.; Rando, J.C.; Wilmshurst, J.M. Island extinctions: Processes, patterns, and potential for ecosystem restoration. *Environ. Conserv.* **2017**, *44*, 348–358. [CrossRef]
40. Athens, J.S.; Kaschko, M.W.; James, H.F. Prehistoric bird hunters: High altitude resource exploitation on Hawaii Island. *Bish. Mus. Occas. Pap.* **1991**, *31*, 63–84.
41. Moniz-Nakamura, J.J. The Archaeology of Human Foraging and Bird Resources on the Island of Hawaii: The Evolutionary Ecology of Avian Predation, Resource Intensification, Extirpation, and Extinction. Ph.D. Thesis, University of Hawaii, Manoa, HI, USA, 1999.
42. Carson, M.T.; Mintmier, M.A. Radiocarbon chronology of prehistoric campsites in alpine and subalpine zones at Haleakalā, Maui island, USA. *Radiocarbon* **2006**, *48*, 227–236. [CrossRef]
43. Mintmier, M.A. Adze Production in Maui: An analysis of lithic materials from the west rim of Haleakalā. *Hawaii. Archaeol. Soc. Hawaii. Archaeol.* **2007**, *11*, 3–17.
44. Kamakau, S.M. *Ruling Chiefs of Hawaii*, revised ed.; Kamehameha Schools Press: Honolulu, HI, USA, 1992.
45. Kamakau, S.M. *The People of Old, Ka Po'e Kahiko*; Bishop Museum Spec. Publ. 51; Dorothy, B., Barrère, B.P., Eds.; Bishop Museum Press: Honolulu, HI, USA, 1964.
46. Kamakau, S.M. *The Works of the People of Old: Na Hana a ka Po'e Kahiko*; Bishop Museum Spec. Publ., 61; Dorothy, B., Barrère, B.P., Eds.; Bishop Museum Press: Honolulu, HI, USA, 1976.
47. Keauokalani, K. *Moolelo Hawaii. Kepelino's Traditions of Hawaii. Hō'ano hou 'ia a unuhi 'ia e*; Bishop Museum Bulletin 95; Beckwith, M.W., Bernice, P., Eds.; Bishop Museum Press: Honolulu, HI, USA, 1932.
48. 'Ī'ī, I.P. *Fragments of Hawaiian History*; Dorothy, B., Barrère, B.P., Eds.; Bishop Museum Press: Honolulu, HI, USA, 1959.
49. Murabayashi, K.; Dye, T.S. *Historians of Traditional Hawaii: An Annotated Bibliography*; T.S. Dye & Colleagues, Archaeologists, Inc.: Honolulu, HI, USA, 2010.
50. Wilson, S.B.; Evans, A.H. *Aves Hawaiienses: The Birds of the Sandwich Islands*; R.H. Porter: London, UK, 1890–1899.
51. Rothschild, W. *The Avifauna of Laysan and the Neighboring Islands. With a complete History to date of the Birds of the Hawaiian Possessions*; R.H. Porter: London, UK, 1893–1900.
52. Hīroa, T.R. *Vikings of the Sunrise*; University of Chicago Press: Chicago, IL, USA, 1959.
53. Rose, R.R.; Conant, S.; Kjellgren, E.P. Hawaiian standing kāhili in the Bishop Museum: An ethnological and biological analysis. *J. Polyn. Soc.* **1993**, *102*, 273–304.

54. Pratt, T.K.; Atkinson, C.T.; Banko, P.C.; Jacobi, J.D.; Woodworth, B.L. (Eds.) *Conservation Biology of Hawaiian Forest Birds. Implications for Island Avifauna*; Yale University Press: New Haven, CT, USA, 2009.
55. Pukui, M.K.; Elbert, S.H.; Mookini, E.T. *Place Names of Hawaii*, 2nd ed.; University of Hawaii Press: Honolulu, HI, USA, 1974.
56. Pukui, M.K.; Elbert, S.H. *Hawaiian Dictionary, Hawaiian-English, English-Hawaiian*; University of Hawaii Press: Honolulu, HI, USA, 1986.
57. Handy, E.C.; Pukui, M.K. *The Polynesian Family System in Ka-u, Hawaii*; Charles, E., Ed.; Tuttle: Rutland, VT, USA, 1972.
58. Handy, E.C.; Handy, E.G. *Native Planters in Old Hawaii: Their Life, Lore, and Environment*; Bishop Museum Bulletin 233; Bishop Museum Press: Honolulu, HI, USA, 1991.
59. Elbert, S.H.; Pukui, M.K. *Hawaian Grammar*; University of Hawaii Press: Honolulu, HI, USA, 2001.
60. Berlin, K.E.; Simon, J.C.; Pratt, T.K.; Kowalsky, J.R.; Hatfield, J.S. Akohekohe response to flower availability, seasonal abundance, foraging, breeding and molt. *Stud. Avian Biol.* **2001**, *22*, 202–212.
61. Yuen, L. Hulu Manu–Hawaiian Featherwork. 2006. Available online: https://www.kaahelehawaii.com/hulu-manu-hawaiian-featherwork/ (accessed on 18 May 2021).
62. Rock, J.S. *The Indigenous Trees of the Hawaiian Islands*; Facsimile Publisher: Honolulu, HI, USA, 1913; p. 518.
63. Culliney, J.L. *Islands in a Far Sea: Nature and Man in Hawaii*; Sierra Club: San Francisco, CA, USA, 1988.
64. Medeiros, A.C.; Davenport, C.F.; Chimera, C.G. Auwahi: Ethnobotany of a Hawaiian Dryland Forest. *Techn. Rep.* **1998**, *117*, 1–49.
65. Rock, J.S. Revised list of Hawaiian names of plants native and introduced with brief descriptions and notes as to occurrence and medicinal or other values. Transcribed annotated by S.M. ʻOhukaniʻōhiʻa Gon III. *Ethnobot. Res. Appl.* **2008**, *6*, 405–422.
66. Mintmier, M.A. The Haleakalā Adze Economy: Landscape, Political Economy, and Power in Ancient Maui. Ph.D. Thesis, University of Hawaii, Manoa, HI, USA, 2014.
67. Townsend, J.K. *Narrative of a Journey across the Rocky Mountains, to the Columbia River, and a Visit to the Sandwich Islands, Chili, &c., with a Scientific Appendix*; Henry Perkins: Philadelphia, PA, USA, 1839; Library of Congress. Available online: https://www.loc.gov/resource/lhbtn.th021_0107_0370/?sp=2&st=gallery (accessed on 18 August 2021).
68. Amante-Helweg, V.L.U.; Pratt, L.W.; Pratt, T.K. Hawaiian pronunciation guide and glossary. In *Conservation Biology of Hawaiian Forest Birds. Implications for Island Avifauna*; Pratt, T.K., Atkinson, C.T., Banko, P.C., Jacobi, J.D., Woodworth, B.L., Eds.; Yale University Press: New Haven, CT, USA, 2009; pp. 581–590.
69. Kame'eleihiwa, L. *Native Lands and Foreign Desires*; Bishop Museum Press: Honolulu, HI, USA, 1992.
70. Pratt, H.D.; Jeffrey, J. *A Pocket Guide to Hawaii s Birds*; Mutual Publishing: Honolulu, HI, USA, 1996.
71. Fornander, A. *Fornander Collection of Hawaiian Antiquities and Folk-Lore*; Bishop Museum Press: Honolulu, HI, USA, 1917.
72. Maly, K.; Maly, O. *He Moʻolelo no Maui Hikina-Kalialinui i Uka a me Nā ʻĀina o Lalo. (A cultural-historical study of East Maui—The Uplands of Kalialinui, and the Lands That Lie below, Island of Maui). The Waikamoi Preserve*; Kumu Pono Associates, and the Nature Conservancy of Hawaii-Maui Program, LLC.: Makawao, HI, USA, 2006.
73. Kalakaua, D. *The Legends and Myths of Hawaii. The Fables and Folk-Lore of a Strange People*; Daggett, R.M., Ed.; Mutual Publishing: Honolulu, HI, USA, 1990.
74. Beckwith, M. *Hawaiian Mythology*; University of Hawaii Press: Honolulu, HI, USA, 1940.
75. Kāne, H.K. *Ancient Hawaii*; Kawainui Press: Captain Cook, HI, USA, 1997.
76. Brown, M.A. *Facing the Spears of Change: The Life and Legacy of John Papa ʻIʻī*; University of Hawaii Press: Honolulu, HI, USA, 2016.
77. Fancy, S.G.; Ralph, C.J. Apapane (Himatione sanguinea). In *The Birds of North America, No. 296*; Poole, A., Gill, F., Eds.; The Academy of Natural Sciences: Philadelphia, PA, USA; The American Ornithologists' Union: Washington, DC, USA, 1997; pp. 1–16.
78. Thrum, T.G. *Hawaiian Folk Tales. A Collection of Native Legends*; McClurg & Co.: Chicago, IL, USA, 1907.
79. Pérez, F.L. Steady as a rock: Biogeomorphic influence of nurse rocks and slope processes on kūpaoa (Dubautia menziesii) shrubs in Haleakalā Crater (Maui, Hawaii). *Geomorphology* **2017**, *295*, 631–644. [CrossRef]
80. Handy, E.C.; Pukui, M.K. The Polynesian Family System in Ka-u, Hawaii: VIII. Ka-u, Hawaii, in ecological and historical perspective. *J. Polyn. Soc.* **1955**, *64*, 56–101.
81. Couzens, D. *Tales of Remarkable Birds*; Bloomsbury Publ.: New York, NY, USA, 2015.
82. Dye, T. Population trends in Hawaii before 1778. *Hawaii. J. Hist.* **1994**, *28*, 1–20.
83. Hīroa, T.R. *Arts and crafts of Hawaii*; Bishop Museum Special Publication 45; Bishop Museum Press: Honolulu, HI, USA, 1957.
84. Kirch, P.V.; Hartshorn, A.S.; Chadwick, O.A.; Vitousek, P.M.; Sherrod, D.R.; Coil, J.; Holm, L.; Sharp, W.D. Environment, agriculture, and settlement patterns in a marginal Polynesian landscape. *Proc. Natl. Acad. Sci. USA* **2004**, *101*, 9936–9941. [CrossRef]
85. Kirch, P.V.; Holson, J.; Baer, A. Intensive dryland agriculture in Kaupō, Maui, Hawaiian Islands. *Asian Perspect.* **2010**, *48*, 265–290. [CrossRef]
86. Pukui, M.K.; Haertig, E.W.; Lee, C.A. *Nānā I Ke Kumu (Look to the Source)*; Hui Hānai, Queen Liliʻuokalani Children's Center: Honolulu, HI, USA, 1972; Volume 1.
87. Coren, S. *The Intelligence of Dogs. Canine Consciousness and Capabilities*; MacMillan: Toronto, ON, Canada, 1994.
88. Handy, E.C.; Pukui, M.K. The Polynesian Family System in Ka-u, Hawaii: V.—The life Cycle. *J. Polyn. Soc.* **1952**, *61*, 243–282.
89. Handy, E.C.; Pukui, M.K. The Polynesian Family System in Ka-u, Hawaii. 2. The Physical Environment. *J. Polyn. Soc.* **1950**, *59*, 232–240.
90. Woodley, E. Indigenous ecological knowledge systems and development. *Agric. Hum. Values* **1991**, *8*, 173–178. [CrossRef]

91. Falanruw, M.V.C. Conservation in Micronesia. *Atoll Res. Bull.* **1971**, *148*, 18–20.
92. Chapman, M.D. Environmental influences on the development of traditional conservation in the South Pacific. *Environ. Conserv.* **1985**, *12*, 217–230. [CrossRef]
93. Meyer-Rochow, V.B. Food taboos: Their origins and purposes. *J. Ethnobiol. Ethnomedicine* **2009**, *5*, 1–10. [CrossRef] [PubMed]
94. Kirch, P.V. *How Chiefs Became Kings. Divine Kingship and the Rise of Archaic States in Ancient Hawaii*; University of California Press: Berkeley, CA, USA, 2010.
95. Titcomb, M.; Pukui, M.K. Native use of fish in Hawaii. Installment No. 2. *J. Polyn. Soc.* **1951**, *60*, 97–145.
96. Orr, K.J. About Hawaiian Foods and Ancient Customs. *Univ. Hawai'i Coop. Ext. Service. Home Econ. Circ.* **1981**, *343*, 1–6.
97. Handy, E.; Pukui, M.K. The Polynesian Family System in Ka-'u, Hawaii. VII. Traditional manners and customs, and the social order. *J. Polyn. Soc.* **1953**, *62*, 295–341.
98. Medeiros, A.C.; Loope, L.L. *Rare Animals and Plants of Haleakalā National Park*; Hawaii Natural History Association: Maui, HI, USA, 1994.
99. Brandt, C.A.; Parrish, J.K.; Hodges, C.N. Predictive approaches to habitat quantification: Dark-rumped petrels on Haleakala, Maui. *Auk* **1995**, *112*, 571–579.
100. Pérez, F.L. Biogeomorphic relationships between slope processes and globular Grimmia mosses in Haleakala's Crater (Maui, Hawaii). *Geomorphology* **2010**, *116*, 218–235. [CrossRef]
101. Simons, T.R. Biology and behavior of the endangered Hawaiian dark-rumped petrel. *Condor* **1985**, *87*, 229–245. [CrossRef]
102. Richardson, F.; Woodside, D.H. Rediscovery of the nesting of the dark-rumped petrel in the Hawaiian Islands. *Condor* **1954**, *56*, 323–327. [CrossRef]
103. Hu, D.; Glidden, C.; Lippert, J.S.; Schnell, L.; MacIvor, J.S.; Meisler, J. Habitat use and limiting factors in a population of Hawaiian dark-rumped petrels on Mauna Loa, Hawaii. *Stud. Avian Biol.* **2001**, *22*, 234–242.
104. Simons, T.R. *Biology and Conservation of the Endangered Hawaiian Dark-Rumped Petrel (Pterodroma Phaeopygia Sandwichensis)*; National Park Service Cooperative Park Studies Unit, College of Natural Resources. Univ. Washington: Seattle, WA, USA, 1983.
105. Hodges, C.S.N.; Nagata, R.J. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. *Stud. Avian Biol.* **2001**, *22*, 308–318.
106. Krushelnycky, P.D.; Hodges, C.S.N.; Medeiros, A.C.; Loope, L.L. Interaction between the Hawaiian dark-rumped petrel and the Argentine ant in Haleakalā National Park, Maui, Hawaii. *Stud. Avian Biol.* **2001**, *22*, 243–246.
107. Pukui, M.K. *'Ōlelo No'eau: Hawaiian Proverbs & Poetical Sayings*; Bishop Museum Special Publ. No. 71; B.P. Bishop Museum Press: Honolulu, HI, USA, 1983.
108. Diamond, J.M. The environmentalist myth. *Science* **1986**, *324*, 19–20.
109. Margalef, R. *Perspectives in Ecological Theory*; University of Chicago Press: Chicago, IL, USA, 1968.
110. Sault, N. Avian voices, avian silences: Learning by listening to birds. *Ethnobiol. Lett.* **2020**, *11*, 1–4. [CrossRef]