Conservation and Current Status of the Hawaiian Hawk (*Buteo solitarius*)

Sandy Kawano

Writer's Comment: *Writing is a pivotal component of science because researchers need to articulate their findings not only to other professionals but to the general public as well. Slowly courses are phasing out written assignments, which deprive students of an essential skill for their future. Writing this paper required extensive background research using scholarly journals and government documents, which is necessary for graduate school. This essay was written for AVS 115, and focused on the Hawaiian Hawk – one of only two endemic raptors within the archipelago and an endangered species. The Hawaiian Archipelago exhibits a high degree of endemism due to the islands' biogeography, so conservation of these unique populations is not trivial. This paper explains how the life history and long-term management of a threatened or endangered species is essential to evaluating a species' status, and outlines some inherent problems of conservation biology.*

—Sandy Kawano

Instructor's Comment: *With 300-plus birds of prey species on the planet, I am fascinated to see what species my Avian Sciences 115 students pick to focus on for their term papers. Sandy Kawano honed right in on one of the most enigmatic of raptors, the Hawaiian Hawk (known as 'Io to the native islanders), but instead of being satisfied with its numerous "gee-whiz" aspects, she moved right into its real-life, hot-button controversy: should this species be taken off the U.S. endangered species list? The endangered Hawaiian Hawk's range is today restricted to the big island of Hawaii, an area of just over 4000 square miles (imagine doubling the total land mass of California's Yolo and Sacramento counties). This is one of the smallest raptor species ranges*

on the planet. And this is why, as essayist Kawano tells us, the Hawaiian Hawk is worthy of its endangered status: there is no room for error with this species. One misstep with disease, urbanization, agriculture, or pesticide use, one wildfire, or one introduced predator-event could be devastating to the Hawaiian Hawk. Ancient Hawaiian people held up the 'Io as a symbol of royal bloodlines. But what a magnificent opportunity we have today to celebrate this regal little hawk and its perseverance in paradise, and bravo to Ms. Kawano for her informative and impassioned essay calling for a precautionary approach to its protection.

—Allen Fish, Avian Sciences

> Hawaiian forest birds represent perhaps the greatest challenge to United States conservation biology. Nowhere else in the United States are there so many endangered species, so little knowledge of basic biology, and so many potential causes of endangerment.
>
> —Freed et al. 1989

About 5000 km from the nearest landmass, the oceanic islands of the Hawaiian Archipelago are some of the most isolated on Earth, and they present some interesting biogeography and conservation issues (MacDowall 2003). By the 1980s, there were eighty-four recorded endemic species within the archipelago and twenty-nine of these species were "listed as endangered by the International Council for Bird Preservation" (Scott et al. 1988). One endemic bird of interest is the Hawaiian Hawk (*Buteo solitarius*), which is only one of two endemic raptors found within the archipelago (USFWS 1994). Given that island birds are more vulnerable to extinction than similar continental land birds (Restani and Marzluff 2001), thorough and effective conservation practices need to be utilized to maintain their population within the Hawaiian Archipelago. However, some argue that the Hawaiian Hawk has reached a sustainable population size and call for downlisting or even delisting it from the Endangered Species Act of 1973. Biology, history, and implemented conservation strategies will be presented to suggest that any reclassification of the Hawaiian Hawk would be premature due to the insufficient amount of information available for this species.

General Biological Information

The Hawaiian Hawk is "a medium-sized, broad-winged buteonine" that currently resides only on the island of Hawaii. Its fossils have been found on Hawaii, Molokai, and Kauai; and there have been eight documented cases of vagrants on Kauai, Oahu and Maui since 1778 (USFWS 1993; Griffin et al. 1998). However, Hawaiian Hawks have only been recorded to nest from sea level to 2600 m on the island of Hawaii, the largest island (10456 km^2) within the archipelago (Griffin et al. 1998).

Reverse sexual dimorphism (RSD) and two different morphs are found in this species. Males weigh 27% less than females, and overall are 13% smaller (Griffin et al. 1998; USFWS 1984). Adult and immature dark morphs are totally dark brown, except for some mottling on the immature hawks. Light morph adults have "a dark brown head and back[,] . . . underside is white with some brown streaking on the belly and upper chest," and immature light phases are paler. All juveniles have blue-green legs, feet, and cere, while adults have bright yellow ceres and pale yellow legs and feet (USFWS 1994). The resulting ratios of dark and light young from a light and dark morph mating indicate that the dark morph develops from an autosomal dominant allele (Griffin et al. 1998). Age of sexual maturity is not known but is estimated to be about three to four years of age (USFWS 1984).

Although the Hawaiian Hawk's distribution is exclusive to the island of Hawaii, 95% of this range is occupied by these raptors (Scott et al. 1988). Hawks show site and pair fidelity and maintain their territories year-round. Eighty-three percent of the pairs formed in one year were observed in the following year, which is similar to the reproductive biology of insular Galapagos Hawks (*Buteo galapagoensis*) and resident Savanna Hawks (*Buteogallus meridionalis*) from Venezuela. Nests were predominantly made in native forests, and birds preferred larger trees that averaged fifty centimeters in diameter at breast height (Griffin et al. 1998).

Hawaiian Hawks exhibit one of the longest periods of parental care (30.2 weeks), a length of time that rivals durations experienced by tropical eagles that are seven times heavier than an adult Hawaiian Hawk. Pairs maintained breeding territories every year, but nesting did not occur every year. Only 61.5% of those pairs that experienced a successful season attempted to nest the following year. Since clutch size is typically one egg, nesting every other year or so causes this species to have a

relatively low reproductive rate (Griffin et al. 1998; USFWS 1994). This trend may be correlated with high juvenile dependence. Juveniles have been documented to return to their nest site begging for food a year after fledging (USFWS 1984). Only 33% of the unsuccessful pairs tried to nest in the same vicinity the following year, which suggests that habitat quality may factor into reproductive success (Griffin et al. 1998).

Urbanization has been a double-edged sword for the Hawaiian Hawk. Sakai (1988) recorded that Hawaiian Hawks did not nest in any areas that were clear-cut, perhaps due to their dependence on tree nesting. Similarly, United States Fish and Wildlife Service (1994) determined that, based on their ecology and behavior, these birds require densely forested areas that are far away from urbanization. Urbanization has introduced non-native species that have become predators to the Hawaiian Hawks or their eggs. This includes the domestic cat and several rodents. In addition, anthropogenic influence has resulted in land below 800 m elevation being transformed to agricultural and urban areas that are devoid of dense forests (USFWS 1984), which decreases the potential area in which these birds can nest. The increasing levels of urbanization and native habitat modification also increase the chances of nest site disturbance. Human disturbance has been recorded to cause nest/egg abandonment, which leads to an even lower reproductive success rate (USFWS 1993; Griffin et al. 1998; USFWS 1984; USFWS 1994). Adult survivorship has been found to be the most important determinant of population stability (Klavitter et al. 2003).

On the other hand, the Hawaiian Hawk seems to have adapted to these modifications. Individuals can be found in higher elevations with dense forests as well as in the lower elevations that host agricultural areas and pasture lands (USFWS 1993). Their diet consisted primarily of introduced species, and only three native species, so the Hawaiian Hawk has developed into a biocontrol for pest bird and small mammal species (Griffin et al. 1998), which may prevent some detrimental effects that the introduced mammals have imposed on their population (USFWS 1993, USFWS 1984, USFWS 1994).

Although disease has limited the ranges of other Hawaiian forest birds to higher elevations (Spiegel et al. 2006), the Hawaiian Hawk has relatively high immunogenic tolerance to disease. In 1985, Griffin found no hematozoa in thirty-two different Hawaiian Hawks, which suggests that this species has "very high immunogenetic capabilities for

avian malaria." Lesions from avian pox have also been found, but do not seem to affect the bird's reproductive success (Griffin et al. 1998; USFWS 1984). In 2003, low levels of ectoparasites were found (Klavitter et al. 2003).

Historical Background

Given that the Hawaiian Archipelago arose serially as the Pacific Plate slid over a volcanic hotspot, the biota found there must have been a result of dispersal and/or human intervention. The nearest continent is about 5000 km away, so dispersal to the islands would have been a huge energy investment (MacDowall 2003). The eighty-four endemic species are believed to have originated from only twenty different dispersal events. One postulation is that the Hawaiian Hawk (or 'Io, its native appellation) resulted from an invasion by a Swainson's Hawk (*Buteo swainsoni*) (Mayr 1943). Perhaps two or more Swainson's Hawks strayed from the usual long-distance migration to Argentina, whether due to biological or environmental causes, and were able to successfully colonize one of the islands. This colonization and speciation of the Hawaiian Hawk must have occurred prior to the late 1700s when a naturalist employed by Captain James Cook recorded the Hawaiian Hawk on Kaua'i (USFWS 2007). In addition, in 2001, Flesicher and McIntosh used an "externally calibrated molecular clock" to estimate that the Hawaiian Hawk was less than 0.7 million years old (Price and Clague 2002).

Not only is the Hawaiian Hawk an intriguing biogeography case study, but it is also an interesting example in conservation biology. According to the International Union for the Conservation of Nature and Natural Resources (IUCN), "66% of the world's diurnal raptors are found mainly or completely in the tropics," and 27% of these tropical raptors are Near Threatened, Vulnerable, Endangered or Critically Endangered (Bildstein et al. 1998). The Hawaiian Hawk became part of this 27% when it was added to the list of endangered species on February 24, 1967 (Udall 1967). It was declared "endangered" due to a combination of factors: because its distribution was limited to the island of Hawaii and it had a low population size; because people believed that "agriculture, logging, [and] commercial development" threatened its forest habitat; and simply because information about the species was lacking (Klavitter et al. 2003). Population size at the time was estimated to be somewhere in the low hundreds (USFWS 1993).

In 1984, the Hawaiian Hawk Recovery Plan (HHRP) was approved by USFWS, based largely on a study by Griffin that was published in 1985 (USFWS 1993). The prime objective of the HHRP was the following:

> To ensure a self-sustaining [Hawaiian Hawk] population in the range of 1500 to 2500 adult birds in the wild as distributed in 1983, and maintained in stable, secure habitat. For purposes of tracking the progress of recovery, 2000 will be used as a target to reclassify to threatened status. Criteria for complete delisting will be further developed. (USFWS 1993)

Seven objectives were proposed in the HHRP to reach a sustainable population size (USFWS 1993).

Recent Events in Hawaiian Hawk Conservation Status

In 1993, USFWS proposed downlisting the Hawaiian Hawk from "endangered" to "threatened" status under the Endangered Species Act (ESA) due to updated population estimates provided by Griffin. Griffin estimated that there were somewhere between 1400-2700 adult birds residing on Hawaii, a range that encompassed the target number of 2000 declared by the HHRP. Also, listing under "endangered" status was based on the belief that the Hawaiian Hawk was restricted to purely undisturbed native areas, but it has since been recorded to feed on non-native prey and nest in monocultures. Downlisting would still provide protection to Hawaiian Hawks under Section 7(a)(2) of the ESA, and penalties for illegal take of the species would not be affected by reclassification (USFWS 1993). However, prospects for downlisting met opposition from the public who disapproved of relying on a data set from about ten years earlier. In December 1993, USFWS funded a survey spanning the entire island of Hawaii to provide more updated population size estimates for the Hawaiian Hawk. Hall et al. estimated that there were 1600 birds, and supported the notion for downlisting but urged the need to maintain long-term monitoring efforts to better understand population dynamics of this species. Nonetheless, USFWS withdrew their proposal for downlisting due to lack of public support and insufficient evidence to strongly support downlisting (Klavitter et al. 2003).

Hawaiian Hawks have also received protection and further support via grants and other government regulations. In addition to the protec-

tion provided by the ESA, Hawaiian Hawks are also protected under the Migratory Bird Treaty Act and maintain "endangered" status at the state level (USFWS 1993). On August 11, 2005, private landowners in Hawaii received a total of $894,644 as an incentive to restore and conserve native habitat for the benefit of threatened and endangered species (USFWS 2005). In 2006, Hawaii received the Yee Hop South Kona Multiple Parcel Acquisition that totaled $1,794,500. The 3148 acres was expected to provide lands with rare forest that threatened and endangered species, such as the Hawaiian Hawk, were known to inhabit (USFWS 2006).

Some have suggested the use of Blue Lists under circumstances where a threatened species experiences stabilized or increasing abundance, which may apply to Hawaiian Hawks. These Blue Lists are a separate category under the Red Lists of Threatened Species that are published by the IUCN, and are a set of criteria to assess the risk of extinction for a species (Gigon et al. 2000). Such a designation may serve as a transitional category between "endangered" and "threatened" status. Gigon et al. (2000) suggest that use of the Blue Lists would invoke positive sentiments from the public by giving them a sense of progression and success on recovery efforts made on threatened and endangered species.

Problems in Conservation Biology

We seldom have clearly documented records on the history of a threatened or endangered species, so our management practices rely on inherent assumptions. Sometimes these assumptions and estimates can have positive effects, but other times there can be either no or negative impacts on the species in question. For instance, twenty-seven species were delisted from the ESA before 1999, and later seven went extinct (Abbitt and Scott 2001). Although these extinctions may have been caused by extraneous variables such as natural disasters, obviously our estimates for maintaining stable, viable populations did not accurately foresee the future for about 26% of the species delisted that year.

Essentially there are two errors that may result from ambiguous cases under the ESA. Either one can list species that are not in danger of extinction, or delist a species that actually is in danger of extinction. Consequences of the former error may include funding wasted on a non-threatened species and/or funding taken away from another species that

is in more need of protection/support. Consequences of the latter error have more serious risks because the worst-case scenario is that delisting causes the species to become extinct. Unfortunately, limited budgets force the USFWS to provide protection/support only for those species that are in the most need (Restani and Marzluff 2001), so federal agencies tend to use the precautionary principle when making final decisions on delisting. This principle "favors not delisting a species when there is insufficient evidence on the efficacy of state management plans for protecting them" (Prato 2005), so federal agencies take the "better safe than sorry" approach to these management decisions. This principle is especially important to the Hawaiian Hawk population because there are no other populations that could be used to repopulate Hawaii. Once the population on Hawaii is lost, there will be no more Hawaiian Hawks, which would be the ultimate loss in conservation biology.

Studying insular biota also raises an important epistemological question: "How do we know that the concepts so often used on continental species will be applicable to insular species?" According to Walter (2004), "endemic oceanic island taxa are functionally insular as a result of long-term island stability, confinement, isolation, and protection from continental invasion and disturbance." Thus, the processes that occur on islands are different from those occurring on continental landmasses. These differences may be reflected in management strategies because although we would never expect a volcano to wipe out a threatened or endangered population in California, volcanic activity has destroyed Hawaiian Hawk habitat and nests in the past (USFWS 1984). Principles derived from the Equilibrium Theory of Island Biogeography have been considered, but even this concept is not free from exceptions. For instance, larger islands were found to have a greater number of threatened avifauna, which contradicts one of the main principles of this theory (Trevino et al. 2007). It has even been suggested that federal agencies such as USFWS develop special levels of categorization for islands. This would be similar to the listings used by the IUCN, and would provide more practical and more customized distinctions (Klavitter et al. 2003).

Conclusion

The literature available for the Hawaiian Hawk has developed over the past few decades but still remains insufficient to rationalize any

downlisting and especially any delisting efforts. So little is known about the population dynamics and stability of this species that reclassification could risk this species being denied essential resources (e.g. funding and government protection). Negative impacts as a result of reclassification can range anywhere from reversal of successful management and rehabilitation practices to extinction. Especially considering that captive breeding programs have not been properly developed (USFWS 1984), it would be unwise to risk exacerbating the Hawaiian Hawk's status.

Although delisting is out of the question for the majority of experts, my personal bias also opposes any proposals for downlisting. Even though some believe that downlisting to "threatened" status could provide positive reinforcement for the ESA from the general public, a majority of us know that the ESA is effective and do not need papers to be shuffled and ink blotted to tell us this. Downlisting may cause the Hawaiian Hawk to lose priority under the USFWS's list of threatened and endangered species, and consequently, may result in reduced funding and support for these raptors since funds are usually appropriated to the most at-risk species. This reduced support may have detrimental effects, such as reducing the population size once again, and may undo what progress has been achieved through the HHRP. Urbanization is only expected to increase, and although the Hawaiian Hawk appears to be adapting well, available habitat for nest sites will continue to recede in the future. Given its relatively low reproductive rate, even slight losses in reproductive output may have significant effects. At this point, the precautionary principle seems to be logical, and I believe that data received from further monitoring will illustrate trends in the Hawaiian Hawk's population dynamics that will facilitate analyses of its long-term stability.

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Literature Cited

Abbitt, R.J. and J.M. Scott. 2001. Examining differences between recovered and declining endangered species. *Conservation Biology* **15(5)**: 1274–84.

Bildstein, K.L., W. Schelsky, and J. Zalles. 1998. Conservation status of tropical raptors. *J. Raptor Res.* **32(1):** 3–18.

Freed, L.A., R.L. Cann, J.M. Scott, C.B. Kepler, C. van Riper III, C. Stone, and S.I. Fefer. 1989. Integrated conservation strategy for Hawaiian forest birds. *BioScience* **39(7):** 475–79.

Gigon, A., R. Langenauer, C. Meier, and B. Nievergelt. 2000. Blue Lists of threatened species with stabilized or increasing abundance: A new instrument for conservation. *Conservation Biology* **14(2):** 402–13.

Griffin, C.R., P.W. Paton, and T.S. Baskett. 1998. Breeding ecology and behavior of the Hawaiian Hawk. *The Condor* **100(4):** 654–62.

Klavitter, J.L., J.M. Marzluff, and M.S. Vekasy. 2003. Abundance and demography of the Hawaiian Hawk: is delisting warranted? *Journal of Wildlife Management* **67(1):** 165–76.

MacDowall, R.M. 2003. Hawaiian biogeography and the islands' freshwater fish fauna. *Journal of Biogeography* **30:** 703–10.

Mayr, E. 1943. The zoogeographic position of the Hawaiian islands. *The Condor* **45(2)**: 45–8.

Prato, T. 2005. Accounting for uncertainty in making species protection decisions. *Conservation Biology* **19(3):** 806–14.

Price, J.P. and D.A. Clague. 2002. How old is the Hawaiian biota? Geology and phylogeny suggest recent divergence. *Proc. R. Soc. Lond. B* **269:** 2429–35.

Restani, M. and J.M. Marzluff. 2001. Avian conservation under the Endangered Species Act: Expenditures versus recovery priorities. *Conservation Biology* **15(5):** 1292–9.

Sakai, H.F. 1988. Avian response to mechanical clearing of a native rainforest in Hawaii. *The Condor* **90:** 339–48.

Scott, J.M., C.B. Kepler, C. van Riper III, and S.I. Fefer. 1988. Conservation of Hawaii's vanishing avifauna: Hawaiian birds provide one of the best, and most spectacular, showcases of divergent evolution. *Bioscience* **38(4)**: 238–53.

Spiegel, C.S., P.J. Hart, B.L. Woodworth, E.J. Tweed, and J.J. LeBrun. 2006. Distribution and abundance of forest birds in low-altitude habitat on Hawai'i Island: Evidence for range expansion of native species. *Bird Conservation International* **16:** 175–85.

Trevino, H.S., A.L. Skibiel, T.J. Karels, and F.S. Dobson. 2007. Threats to avifauna on oceanic islands. *Conservation Biology* **21(1):** 125–32.

Udall, S.L. 1967. Native fish and wildlife: Endangered species. United States Fish and Wildlife Service. *Federal Register* **32(48):** 4001. F.R. Doc. 67-2758.

United States Fish and Wildlife Service (USFWS). 1984. Hawaiian hawk recovery plan. USFWS, Portland, Oregon, USA.

USFWS. 1993. Endangered and threatened wildlife and plants; proposed reclassification of the Hawaiian Hawk from endangered to threatened status. U.S. Fish and Wildlife Service, Honolulu, Hawaii, USA. *Federal Register* **58(149):** 41684–8.

USFWS. 1994. Surveys of distribution and abundance of the Hawaiian Hawk within the vicinity of proposed geothermal project subzones in the district of Puna, Hawai'i. USFWS, Honolulu, Hawaii, USA.

USFWS. 2005. Private landowners in Hawaii awarded grants for endangered species conservation. PIEA-05-19.

USFWS. 2006. FY2006 Cooperative Endangered Species Conservation Fund Grants.

USFWS. 2007. Website: http://www.fws.gov/pacificislands/wesa/io.html. Reviewed 2/28/07.

Walter, H.S. 2004. The mismeasure of islands: Implications for biogeographical theory and the conservation of nature. *Journal of Biogeography* **31:** 177–97.

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