

## RESULTS

### Call Counts

Observers listened for calls for 64 nights for a total of 192 hours (Table 1). We did not detect `A`o or `Ake`ake during nighttime observations from any location, however, we recorded unprecedented observations (those that were not historically recorded at specific areas) of `Ua`u. At Kuiki, there was an `Ua`u observation (about 2130 h on 28 April 2005) where this species has not been recorded previously. This bird was flying overhead and traveling in a northwesterly direction. At Kaupō Gap, we heard 12 `Ua`u calls between 1932 and 2100 h on 18 May 2005; all birds were flying overhead and traveling in a northwesterly direction. In addition, we heard two `Ua`u calls on each of the nights of 18 July (1906 h) and 27 July (1903 h) 2005; the birds were flying overhead in a northeasterly direction from Kaupō Gap toward Manawainui. We also heard and saw one `Ua`u on 29 July 2005 (1916 h), flying in a northwesterly direction from Kaupō Gap toward Haleakalā Peak.

*Table 1. Locations, dates, and number of nights that three-hour call counts were conducted at Haleakalā National Park.*

Camp	Dates	Nights
Bravo	5/11–5/13	2
Charlie	4/26–4/29	3
Fern	5/3–5/6	3
Ginger	5/10, 6/13–6/17	5
Hōlua	5/10, 5/26, 8/3–8/4	3
Ka`āpahu	5/17	1
Kapalaoa	5/24–5/27, 6/20–6/22, 7/20–7/22	7
Kaupō	5/18, 7/13–7/14, 7/18–7/22, 7/25–7/29, 8/1–8/5, 8/29–9/2	14
Kuiki	4/25–4/29	4
Manawainui	4/25–4/29, 8/1–8/5	8
Palikea	5/2–5/10	8
Palikū	5/15–5/17	2
Smith	5/10–5/13	3
West	4/25	1
	Total Nights	64

### Ground-based Visual Surveys

Koa`e Kea, `Iwa, and Noio were observed during shoreline and Kaupō trail surveys (Table 2). Koa`e Kea were observed flying about 100 m (328 ft) inland at `Ohe`o and over cliffs above Ka`āpahu and Kaupō. `Iwa were flying about 75 m (246 ft) inland at `Ohe`o and about 30 m (98 ft) from the shore over the ocean at Ka`āpahu. Seven Noio were observed at the mouth of `Ohe`o Stream. All Noio were flying about 15 m (49 ft)

from the shore over the ocean, then landing in crevices under the shoreline cliffs at the mouth of `Ohe`o Stream.

**Table 2.** Seabirds observed during shoreline surveys at Haleakalā National Park, July 2005.

Species	Number Observed	Location(s)	Activity
Koa`e Kea	5	`Ohe`o, Puhilele, Ka`āpahu, Kaupō	Flying over land
`Iwa	2	`Ohe`o, Ka`āpahu	Flying over land (`Ohe`o) Flying over ocean (Ka`āpahu)
Noio	7	`Ohe`o	Flying over ocean and into shoreline cliff at mouth of `Ohe`o Stream

## DISCUSSION AND RECOMMENDATIONS

Although `A`o were not detected during the survey, the species does exist in the park. `A`o were detected at Delta Camp (940 m [3,100 ft]) elevation on the northeastern cliffs of the Kīpahulu Valley on 24 July 1998, at around 0500 h, by Chuck Chimera (pers. comm.) who heard several loud calls from the cliffs. Patricia Welton (pers. comm.) heard `A`o at the same location in July and August 2008 from early evening to dawn. Delta Camp was not surveyed during this study. `Ake`ake were not detected during this survey but were previously detected in the park. `Ake`ake calls were heard above Kapalaoa Cabin in Haleakalā Crater on 5 August 1992, between 2000 h and 2045 h (Hodges 1992a).

During this study, nest searches were not conducted since calls of `A`o or `Ake`ake were not detected and because nest searches require extensive hiking through thick vegetation, which could cause habitat damage. Regular call-counts and nest searches for `A`o in rainforest areas are difficult. The rainy weather interferes with accurate detection. Also, these areas are only accessible by helicopter, making regular observations logistically complex and expensive to conduct. Nest searches may open routes for predators to travel to seabird nests and therefore are not recommended.

Cooper and Day (2003) conducted radar-based surveys that can serve as baseline information for `A`o. When conducted at sea level, radar surveys detect the movement of flying seabirds likely traveling to inland nesting sites. These surveys suggest that what probably were `A`o were flying inland to park lands from sea level locations at Kaupō, Mokula Point, and `Ohe`o (Cooper and Day 2003). Radar surveys were important in

detecting declines of `A`o on Kaua`i (Day et al. 2003). Follow-up radar surveys from these locations could provide insight about `A`o locations and relative population trends within HALE. Beginning in 2009, we (HALE) will begin a cooperative study with the U.S. Fish and Wildlife Service, U.S. Geological Survey, and the State Division of Forestry and Wildlife to quantify trends in populations of `Ua`u and `A`o using radar. A combination of ornithological radar and individual birds of known breeding status marked with miniature, passive radio-frequency identification (RFID) tags (a.k.a. PIT tags), will be used to establish independent quantification of the variability in breeding `Ua`u visitation patterns. Results from this study can provide insight on the feasibility of radar as a tool for estimating population trends of `A`o and `Ua`u.

Previous experience with night vision and infra-red spotlighting equipment shows that these tools are useful once the presence of nocturnally active seabirds is verified in a specific location (pers. obs.). Thermal imaging has not been used at HALE, but can also be considered. These tools could be used in conjunction with call counts and radar to survey for seabirds.

`Ake`ake calls at Haleakalā were faint and heard amid an abundance of `Ua`u calls in 1992 (Hodges 1992a). Observers during this 2005 survey may not have heard `Ake`ake calls over `Ua`u calls because `Ake`ake calls are higher-pitched and more difficult to hear. Specialized bird listening devices are designed to amplify sounds and are inexpensive (some are less than \$100). Regular surveys of `Ake`ake in strategic locations (away from high density `Ua`u calls) with this type of equipment should be considered to monitor the population.

`A`o or `Ake`ake could be occupying presumed `Ua`u burrows that show signs of seabird activity. While `A`o are currently known to nest only in forested areas, there is no evidence that suggests that `A`o do not also occupy the same nesting habitat as `Ua`u. `Ua`u nests at HALE are currently monitored with indirect methods. Toothpicks are placed across the burrow entrance to determine entry by a bird and the burrow entrance is examined for signs of `Ua`u activity (e.g., footprints, feathers, guano, egg shells, etc.); `Ua`u rarely are identified with these monitoring methods. `Ua`u and `A`o body sizes and eggs are similar, so indirect signs from birds found at the burrow may be from either species. Signs from `Ake`ake may be easier to distinguish since they are much smaller than and different in color from `Ua`u or `A`o; their eggs are also considerably smaller. Some burrows do not have definite signs at the entrances (i.e., only guano is seen at the burrow entrance) and could be occupied by any of these seabird species.

Burrows at HALE should be checked to verify the species of seabird occupying each burrow. At Hawai`i Volcanoes National Park, a seabird burrow that was thought to be occupied by an `Ake`ake was actually occupied by an `Ua`u (Hodges 1992b). Observers found the burrow during daytime surveys on Mauna Loa and remained near the nest site at night to determine the bird species occupying it. `Ake`ake calls were consistently heard by observers at the burrow and they therefore expected an `Ake`ake to inhabit the burrow. Surprisingly, the bird that landed and began entering the nest was an `Ua`u.

I recommend two types of methods for verifying species of seabirds occupying burrows. Visual confirmation of the species can be achieved by looking into the burrow with a flashlight or burrow camera (Hodges 1994), by setting traps at burrow entrances to capture birds entering at night, or by observing birds that land at burrow entrances (Hodges 1992a). However, these methods can be labor-intensive (pers. obs.). Examination of genetic components of guano or bird body parts found at burrows with tests such as polymerase chain reaction (PCR) may also be useful in identifying species (Sarah Allen, pers. comm.).

The `Ua`u calls over Kuiki and Kaupō were probably from birds traveling to their nesting sites somewhere in Haleakalā Crater. Kaupō is a common route for birds to travel from the ocean to Haleakalā (pers. obs.). Kaupō Gap was surveyed more than other sites during this survey because it was logistically easier for surveyors to access. `Ua`u may not have been detected previously at these sites simply because focused surveys have not occurred at these locations.

Seabird species found along the shoreline during this survey are commonly seen at HALE. Another seabird species, `Ua`u Kani (Wedge-tailed Shearwater, *Puffinus pacificus*), commonly nests along coasts of the main Hawaiian Islands, but does not occur at HALE (Hawai`i Audubon Society 1996). The nearest `Ua`u Kani nesting colony is on the off-shore islets at Hāmoa, approximately 10 km (6.2 mi) north of `Ohe`o (Fern P. Duvall, pers. comm.). Potential nesting habitat for `Ua`u Kani exists at `Ohe`o, although cattle (*Bos taurus*) grazing that occurred along the `Ohe`o shoreline for about 100 years may have damaged potential nesting sites. Cattle were recently removed from `Ohe`o (HALE unpubl. data), and the pastures are now overgrown with dense, tall (up to one meter [3.3 ft] in height) nonnative grasses. Although these grasses may make burrow excavation and flight take-off difficult, there is a potential for `Ua`u Kani to occupy these areas in the future. Regular shoreline and trail surveys should be conducted to monitor seabird species that are visible during the day and to determine if and when `Ua`u Kani colonize `Ohe`o.

HALE is currently working with the NPS Pacific Island Network Inventory and Monitoring program to refine methods to better monitor trends in `Ua`u populations. We intend to use these methods for future `Ua`u monitoring.

Predator control and habitat recovery through ungulate removal are essential to the survival of these seabird species. Management of introduced predators and feral animals was vital in the recovery of `Ua`u in Haleakalā Crater (Hodges and Nagata 2001). HALE has a modest predator control program at `Ohe`o to limit the impact of mongooses (*Herpestes auro-punctatus=javanicus*) and feral cats (*Felis catus*), animals that will depredate nesting `Ua`u Kani and other ground-nesting birds. Feral goats and pigs should be removed from Ka`āpahu where potential nesting habitat for `A`o exists.

Lastly, seabirds are dynamic and mobile. Species could enter or exit the park at any time. Follow-up inventories every 10 to 20 years could provide up-to-date information on seabird species that occur in the park.