VOLUME 28, NO. 4 Winter 2010

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Ope'ape'a
Solving the puzzles of Hawaii's only bat
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The Hawaiian hoary bat is described as the only land mammal native to Hawaii. In fact, this bat (*Lasiurus cinereus semotus*) arrived on the islands some 10,000 years ago â€“ in what must qualify as one of the most spectacular immigrations in the history of mammals. The Hawaiian islands, after all, are 2,400 miles (3,860 kilometers) from the nearest landfall on the North American continent, and the distance to Australia, New Guinea or Asia is even farther.

This wandering bat, called Ope'ape'a (oh-pay-ah-pay-ah) by early Hawaiians, was actually the second bat to colonize Hawaii. The lava-tube bat showed up thousands of years earlier, then disappeared about 6,000 years ago. That extinct species is being described by scientists from the Bishop Museum, American Museum of Natural History and the U.S. Geological Survey.

But the hoary bat, an immigrant from North America, where it is found from coast to coast (and has even been reported in Iceland), still survives in Hawaii. And after several thousand years of isolation on the islands, Ope'ape'a has evolved significant differences from its ancestors. The Hawaiian subspecies weighs about 30 percent less, is more acrobatic in flight and has lost much of the white frosting seen on the fur of its North American cousins. And our research finds that it has also acquired some unusual behaviors.

The Hawaiian subspecies of the hoary bat is listed as endangered by both the Hawaii Department of Forestry and Wildlife and the U.S. Fish and Wildlife Service.

My colleagues at the U.S. Geological Survey's Pacific Island Ecosystems Research Center and I have been conducting continuous field research on the ecology and population biology of the Ope'ape'a since 2004. Our research was supported in part by two grants from BCI's North American Bat Conservation Fund. To date, we have worked primarily on the Big Island of Hawaii, but we are now expanding to other islands of the archipelago.

Our research focuses on the hoary's geographic distribution, roosting and foraging behavior and reproductive timing in order to improve the conservation of this fascinating and endangered subspecies. And even as we have answered some long-standing questions, our results have also raised new mysteries.

Ope'ape'a is an extremely challenging bat to study. It is mostly a solitary, tree-roosting, nocturnal mammal that ranges across Hawaii's rugged lava-covered substrates all the way from sea level to nearly 14,000 feet (4,270 meters) in elevation. The Hawaiian hoary's roosting behavior is not well understood, and its coloration makes it almost impossible to spot in day roosts in a tree's leafy canopy.

To explore roost selection and movement patterns, we attached tiny radiotransmitters to bats captured in mist nets. Since 2004, we have successfully tracked more than 40 of these radio-tagged individuals. The data suggest some unexpected aspects of their nighttime

routine.

Ope'ape'a may fly more than 12 miles (19 kilometers) one-way in the course of a night and return to its original roost by sunrise. But after a night of foraging, some of these bats occasionally go not to their original roost, but to an alternative located miles away.

Although Hawaiian hoaries often roost in the widespread, native '?hi'a lehua tree, they show no strong preference for any single species and will roost in many non-native trees, including eucalyptus, mango and lychee.

Each bat establishes several distinct feeding areas that are scattered within a larger home range â€“ the total area in which the bat lives and moves. Feeding areas are quite small, typically stretching about 300 yards (275 meters) along a line of trees, a forest edge or a road. After spending 20 to 30 minutes hunting moths and other insects in one feeding area, a bat typically moves on to another some distance away. The bats usually establish their own pathways among feeding areas and move along them in a predictable sequence each night.

We have recaptured bats up to five years after their initial capture, suggesting that they were still following similar circuits as they forage among feeding areas. Some even used the same roosting trees, although not exclusively, over all that time. One local landowner described how generations of bats have used the same roosting tree for more than 50 years, as far back as his childhood.

To track the presence of bat populations from season to season, we deployed ultrasonic acoustic monitors/recording units, called bat detectors, across the Big Island, which is up to 90 miles (145 kilometers) across. These acoustic arrays record bat calls at 20 sites, from sea level to altitudes of 6,000 feet (1,825 meters), which we visit for one week every two months.

After four years of acoustic monitoring, we are beginning to find consistent seasonal patterns.

At lowland sites on the windward side of the island, bats are particularly active from May through December. This corresponds to the reproductive season of birthing, lactation and parental care for pups. Ope'ape'a females give birth, usually to twins, in July after about two months of pregnancy. Infants are weaned and able to fly about six weeks later.

Young bats must quickly learn the skills of finding and hunting their insect prey, which include large numbers of moths, beetles, true bugs, and flying wood-termites. From August through the approach of winter, mother bats continue to roost with their offspring and can be seen flying in pairs or triplets, possibly introducing the pups to good hunting grounds.

It is understandable that Hawaiian bats choose to reproduce in the lowlands in the warmest months of the year. Young pups, with small, poorly insulated bodies, should be better able to maintain body temperature in the warm temperatures of the lowlands. This is particularly true at night, when mothers are foraging and pups may be left on their own in a tree roost.

When winter arrives, our acoustic monitoring indicates that most bats occupying the windward lowlands move to higher elevations. Bat activity clearly increases in January through March at upland forests above 5,000 feet (1,525 meters). Hoary bats of mainland North America usually migrate each fall from colder northern climates to warmer southern

areas.

Exactly why this migration of Hawaiian bats to higher, colder elevations takes place each winter is still not clear. We suspect that rainfall patterns, population cycling of insect prey and the ability of hoary bats to use torpor as an energy-saving mechanism all play a role in this altitudinal migration.

The rainforests of eastern Hawaii receive the heaviest rainfall of the year during winter, with monthly precipitation often exceeding 30 inches (76 centimeters). The islands' weather patterns produce far less rain at elevations above 5,000 feet, and the higher you go, the drier it gets. During the winter periods of heaviest lowland rainfall, bats may find better hunting of their aerial prey at drier high elevations.

Our radiotelemetry studies of Ope'ape'a clearly show that even moderate rain causes bats to stop foraging and seek a temporary night roost. It may rain so frequently in the lowlands that bats simply do not have enough time for hunting. Winter is also when females are freed from caring for their now-independent juveniles.

Torpor may provide another piece of the puzzle to explain this vertical migration. Torpor is similar to a shallow hibernation, although it typically lasts only hours or days at a time. During that time, a bat's pulse, respiration and body temperature are reduced, with a dramatic reduction in the metabolic rate and energy expenditure. In cold weather, bats can either remain active with high body temperatures (if they can find prey) or enter torpor to conserve energy reserves, particularly when food is scarce or harsh weather prevents successful foraging.

Although we have no direct evidence that Hawaiian bats enter torpor, hoary bat populations on mainland North America are well known to enter torpor for energy conservation. To test whether Ope'ape'a also employs this tactic, we are trying to capture and radio-tag bats in their high-elevation, winter ranges. Radio-transmitters that can detect skin temperature, along with recording thermometers at roost sites, may soon give us an answer on the role of torpor among Hawaiian hoaries.

Our continuing research is finally answering many of the questions that have long surrounded Ope'ape'a and providing the knowledge we need to effectively conserve this remarkable endangered species â€“ Hawaii's only bat.

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