Activity #2

Rain Forest Species Research

● ● ● Class Period One *Species Cards*

Materials & Setup

- Research materials: at minimum the three listed in #3 below, and others that you can gather or check out of the library [See the Student Page "Rain Forest Species Cards" (pp. 36-41) for suggested resources.]

For each student

- Student Page "Rain Forest Species Cards" (pp. 36-40)
- One card from the "Rain Forest Species Assignments" (master, pp. 27-35)

Instructions

1) Hand out the Student Page "Rain Forest Species Cards" to each student. Also give each student one Species Assignment card—a different species for each student. There are 36 species total.

2) If you have a smaller class, you may select a representative sampling from the species cards, making sure you have a blend of invertebrates, birds, and plant species from the canopy, subcanopy, understory, forest floor, and vines categories. See the teacher background "Rain Forest Species Card Information Summary" for species that fit in each category (pp.15-26).

   OR

   You may offer extra credit to students who create more than one species card.

3) For the rest of this class, as homework, and during the next class period, students will create a card for the species assigned to them. The primary information resources available as part of this curriculum are:

   Hawai'i Audubon Society, *Hawaii's Birds*, 5th ed., Hawai'i Audubon Society, Honolulu, 1997.

   Medeiros, Arthur C., and Lloyd L. Loope, *Rare Animals and Plants of Haleakalā National Park,* Hawai'i Natural History Association, Hawai'i National Park, 1994.

   Moanalua Garden Foundation, *Forest Treasures* (CD ROM), 2000.

   Stone, Charles P., and Linda W. Pratt, *Hawai'i's Plants and Animals; Biological Sketches of Hawaii Volcanoes National Park*. Hawai'i Natural History Association, National Park Service, and University of Hawai'i Cooperative National Park Resources Study Unit, Hawai'i National Park, 1994.

   Additional sources of information can be found in the library and on the Internet. A beginning listing of resources is part of the student page.

4) Encourage students to create their own images for the species card rather than using the one on the Species Assignment card. Also encourage them to bring to the next class art supplies, reference books they have at home, and species information they photocopy from printed sources or download from the Internet so they can work on their species cards during class.

Note

If you have difficulty locating resources for student research or if you do not want students to research the species cards, give each student the relevant information from the teacher background (pp. 15-26). Students can create their species cards using this information.

● ● ● Class Period Two *Rain Forest Species Cards*

Materials & Setup

- Research materials (see Class Period One)
- Colored pens, pencils, scissors, glue and other supplies for student use in creating species cards

Instructions

1) Allow students to finish their species cards during this class period.

Journal Ideas

- Make up a chant or a poem about your rain forest species.
- What was the most interesting thing you learned about your species? Why?

Assessment Tools

- Rain forest species cards
- Journal entries

Teacher Background

Rain Forest Species Card Information Summary

The following summarizes some of the available information about each species. You may use these summaries to help check students' work. Note: Unless otherwise noted, "endemic" refers to the Hawaiian Islands, denoting species that today are thought to be unique to one or more of the Hawaiian Islands.

NATIVE INVERTEBRATES

Haleakalā flightless lacewing (*Pseudopsectra lobipennis*)

• Endemic to Haleakalā
• It no longer has lace wings. Its hardened and beetle-like front wings cup and protect its body and its rear wings are small and strap-like.
• In spite of alien rodent predators, this rare insect still survives in the dense rain forests of Kīpahulu Valley within the park.
• The adults hunt at night on tree trunks.

Hawaiian crickets (Family Gryllidae, one indigenous genus [*Paratrigonidium*] and 3 endemic genera [*Leptogryllus, Thaumatogryllus,* and *Prognathogryllus*)

• All Hawaiian crickets are brown and flightless.
• Some are loud, strong "singers." A male cricket sings by rubbing his wings together to attract females of his species. Each species has a unique song.
• It lives in *ʻōhiʻa* and *koa* rain forests up to 1500 meters (4920 feet) in elevation. Within Haleakalā National Park, most are found in the rain forests of Kīpahulu Valley.
• Alien rodents (mice and rats) prey on these rare insects.
• The number of named, endemic Hawaiian crickets is over 200 species, twice the total known for the continental U.S. One species is named *kipahulu* after Kīpahulu Valley.

Hawaiian ground beetles (Family *Carabidae*)

• Ground beetles prey on arthropods and snails.
• Ground beetles are an example of adaptive radiation. The 215 endemic species of ground beetles on the Hawaiian Islands are believed to have evolved from as few as six original immigrants.
• Ground beetles are found in many different natural communities on Haleakalā including high-elevation shrublands, the alpine/aeolian zone, and the rain forest.
• In the late 1980s, scientists discovered and described two new species of ground beetles inside deep lava tubes in Kīpahulu Valley.

Hawaiian long-horned beetles (*Plagithmysus spp.*)

• Endemic genus (There are other genera of Hawaiian Long-Horned Beetles, as well.)
• The larvae of these wood-boring beetles feed within living, often damaged trees. Females lay their eggs in the bark of trees. On hatching, the larvae burrow into the wood, feeding there for a year or more before pupating into adult beetles.
• Most often, one beetle species has only one tree species as its host. *Plagithmysus cheirodendri* is endemic to East Maui and feeds exclusively on the wood of *kōlea* trees. Other long-horned beetles are associated with *koa*.
• Wood-boring beetles are an example of adaptive radiation. Over 136 species are believed to have evolved from a single ancestral species that arrived on the islands millions of years ago, probably from North America.
• Long-horned beetles are found in many different natural communities on Haleakalā. The most common is associated only with the *māmane* tree, some are found only in rain forests, and one species has adapted to feed only on the *ʻāhinahina* in the alpine/aeolian zone.
• The Maui parrotbill, a Hawaiian honeycreeper, uses its bill to tear apart plant stems in search of the pale larvae of these beetles, one of its primary foods. The naturalist R. C. L. Perkins found that the stomachs of the parrotbills he collected in 1894 were filled with long-horned beetle larvae.

Haleakalā weevil (*Oodemas spp.*)

• Endemic genus
• These weevils are also known as snout beetles, for their long snout. They have small (1/4-inch long), shiny, black, rounded bodies that resemble seeds.
• At least 15 species of *Oodemas* are known from Haleakalā, either in the deep rain forests or in native shrublands.
• The 58 species of small, rare *Oodemas* weevils are found only on the Hawaiian Islands. They seem to have no close relatives in the rest of the world.
• These weevils are a favorite food for birds. The adults hide under bark and in mosses and leaf litter during the day. They emerge under cover of darkness to feed on native plants and to mate.

Hawaiian carnivorous inchworm (*Eupithecia* spp.)

• Endemic genus
• The larvae of at least 18 species of Hawaiian moths have abandoned the usual vegetarian diet of caterpillars throughout the world. These caterpillars practice ambush predation, in which they settle on the edges of leaves or on plant stems waiting for a tiny spider or insect to approach.
• These carnivorous species are related to other *Eupithecia* moth species on Haleakalā that feed on flowers, seeds, leaves, and other plant parts.
• The first species of carnivorous inchworms was discovered in 1972.
• These inchworms are about 1.25 centimeters (.5 inch) long.
• There are at least 18 different species using different types of perch sites. They are colored and shaped to blend in with their favored hunting sites. Some that perch on moss-covered tree trunks even look mossy themselves!

Happy-face spider (*Theridion grallator*)

• Endemic
• These spiders are found in many of the rain forests of Hawai‘i, although they may be difficult to spot.
• Happy-face spiders are named for the bright patterns that appear on their abdomens. Some of these patterns resemble smiling faces.
• They are so small that you need a magnifying glass to really appreciate their markings. Including their legs, they are only 1.25-2 centimeters (about .5-.75 inch) long.
• They live under the leaves of rain forest trees and shrubs such as *kanawao* (*Broussaisia arguta*), *kawa‘u* (*Ilex anomala*), and *‘oha wai* (*Clermontia* spp.). They spin irregular-shaped webs in which they catch their prey.
• Females lay eggs on the underside of leaves. Once the tiny spiderlings hatch, the mother captures food for them, wrapping it in silken loops.

Pulelehua or Kamehameha butterfly (*Vanessa tameamea*)

• Endemic (One of only two butterflies native to Hawai‘i)
• A striking orange, black, and white butterfly that measures about five centimeters (two inches) across.
• Most commonly found in mesic woodlands and low- to mid-elevation wet forests. Higher-elevation rain forests and dry forests are less favored but still provide habitat for these butterflies.
• Larvae of this butterfly feed on the leaves of the *māmaki* (*Pipturus albidus*) and other native plants that, like *māmaki*, belong to the nettle family (*Urticaceae*). Parts of the caterpillar resemble *māmaki* flower clusters, and the chrysalis looks like a dead, curled-up leaf.
• Adult *pulelehua* feed on nectar from many native plants and are probably important pollinators for those plants.

Picture wing flies (Family Drosophilidae)

• There are more than 800 species of Hawaiian *Drosophila*. They are a premier example of adaptive radiation.
• *Drosophila* species now occupy a range of habitats. Different species feed on different food items, including rotting fruit and leaves, tree sap, and fungi.
• About 100 of the Hawaiian *Drosophila* species are “giant” picture wing flies. With wingspans up to 2.5 centimeters (one inch), these flies have ornate wing and body patterns that enable the different species to recognize each other.
• Male flies set up breeding territories called “leks” and attract females there. Males have evolved a wide array of courtship behaviors that have been recorded by scientists studying the role of sexual selection in the development of new species.
• Like many of the native arthropod species in Hawai‘i, most of these fly species are endemic to single islands, and even to very small areas on specific islands. Since their populations are often small and have a limited range, they are especially sensitive to habitat changes.

Flying earwig Hawaiian damselfly or *Pinao ʻula* (*Megalagrion nesiotes*)

• Endemic to East Maui and Hawai‘i
• This species was recently rediscovered on Maui after 75 years with no specimens collected there. Originally known from both East Maui and Hawai‘i, this damsefly is likely to be extinct on Hawai‘i Island.
• “Flying earwigs” got their name from the pincer-like appendages on the tip of the male fly’s tail.
• Adults tend to fly and perch low amidst the tangled vegetation of the rain forest understory. Unlike many other damselfly species, this species tends to live well away from ponds and streams.
• Observations suggest that breeding habitat is probably fern banks, steep and moist slopes, and scattered pockets of water, such as those collected in the leaves of rain forest plants.
• Away from the water, the *pinao ʻula* often makes its home in the *pa‘iniu* plant.

Tree snails (*Partulina* spp.)

• Endemic
• Tree snails range from one to 7.5 centimeters (1/3 to three inches) in length. Their color ranges from white to brown to black, and many are banded. There is a great deal of variation in size, color, pattern, and shape.
• Graze on microscopic algae or fungi
• Various sources of introduced biota have had a negative impact on the snails and their habitat, among them the “cannibal snail” which was originally introduced to control the African snail. This predator eats the tree snail young and eggs. Rats are another chief predator on native tree snails.
• The “singing” tree snails were famous among European naturalists after early explorers brought specimens back from the Hawaiian Islands. It took about 50 years before crickets were found to be the source of the song!

NATIVE BIRDS

ʻIʻiwi (*Vestiaria coccinea*)

• Endemic
• A member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• The *ʻiʻiwi* is about 15 centimeters (six inches) long, scarlet-orange in color, with a deeply curved, orange bill.
• The *ʻiʻiwi* prefers nectar but will sometimes eat insects and spiders, and feeds its young on insects. It is often found high in the canopy, feeding in flowering *ʻōhiʻa* trees. It can also be found lower in the rain forest dipping into the long, curved flowers of mints (*Stenogyne spp.*), other native plants, and introduced species.
• Its feathers were prized by Hawaiians for use in making feathered capes for royalty.
• It is not as common on Maui as the *ʻapapane* and the *ʻamakihi*, but is still widespread at upper elevations. (It is very rare or extinct on Oʻahu, Molokaʻi, and Lānaʻi.)
• *ʻIʻiwi* build their nests five meters (16 feet) or higher up in trees.

ʻApapane (*Himatione sanguinea*)

• Endemic
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• The red plumage of these 13-centimeter (five-inch) birds matches the color of the red *ʻōhiʻa lehua* blossoms perfectly. It is often found in the forest canopy searching for nectar from the *ʻōhiʻa*, but it also frequents flowering *koa* and *māmane* trees.
• The *ʻapapane* forages in the forest canopy for nectar and insects.
• This species often nests in the crowns of *ʻōhiʻa lehua* or in tree ferns, but its nests have also been found in lava tube skylights.
• The *ʻapapane* is among the most common honeycreepers in the state. Its range extends from the rain forests into upper-elevation shrublands and even into planted forests. Unlike many other honeycreepers, it is still found down to sea level in some areas.
• Its feathers were used in some Hawaiian featherwork.

ʻAmakihi (*Hemignathus virens*).
Also, Maui *ʻAmakihi* (*Hemignathus virens wilsoni*) a Maui endemic subspecies

• Endemic
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• This yellow-green bird measures about 11 centimeters (4.5 inches) in length and has a downcurved bill, shorter than that of the *ʻiʻiwi*.
• The *ʻamakihi* feeds on nectar, insects, spiders, and fruit from forest trees and plants.
• It generally nests in uppermost tree branches.
• The *ʻamakihi* is among the most common honeycreepers in the state. Its range extends from the rain forests into upper-elevation shrublands and even into planted forests and higher elevation residential areas such as Kula and Kēōkea.

ʻAlauahio or Maui creeper (*Paroreomyza montana*)

• Endemic to Haleakalā (formerly also found on West Maui and Lānai)
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• Found on East Maui only, most commonly in the rain forest but also in the upper-elevation shrublands.
• Females of this small (11-centimeter or 4.5-inch) species of honeycreeper are green, the males yellow-green.
• They forage in pairs or small flocks, usually in the trees and shrubs of the rain forest understory, feeding on insects and spiders. Less often, they will feed on the nectar of *ʻōhelo* and *ʻōhiʻa* flowers.
• Often, an *ʻalauahio* will be seen high above the forest floor, gleaning insects from the bark of a *koa* tree.

ʻĀkohekohe or Crested honeycreeper (*Palmeria dolei*)

• Endemic and endangered
• Once found on both Maui and Molokaʻi but now restricted to East Maui
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• This primarily black bird sports a distinctive tuft of head feathers that range in color from light gray to light orange. It is one of the larger honeycreepers at 18 centimeters (seven inches) in length.
• It is an aggressive bird that often drives off other honeycreepers from flowering trees, enforcing the top end of a "pecking order" among nectar-sipping forest birds.
• It builds its nests in tree tops high in the upper canopy.
• It feeds primarily on the nectar of *ʻōhiʻa* blossoms. Its crest probably aids in pollinating the brush-like flowers of the *ʻōhiʻa*. *ʻĀkohekohe* will take nectar from other native plants, and it also eats insects such as caterpillars.

Poʻouli (*Melamprosops phaeosoma*)

• Endemic to Haleakalā (The *poʻouli* is endangered, with a population possibly numbering only three individuals in early 2001.)
• First described in 1973 on the upper northeastern slopes of Haleakalā
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• The name *poʻouli* means "dark-headed," which is an apt description of this small (14-centimeter or 5.5-inch-long) honeycreeper. Brown above and pale gray below, *poʻouli* wear a dark mask over the face and head.
• It builds its nest of twigs, lichens, mosses, and grasses high up in the *ʻōhiʻa* canopy.
• It forages in understory shrubs and trees tearing at bark, mosses, and lichens on branches looking for invertebrates such as native tree snails and wood-boring larvae.

Maui parrotbill (*Pseudonestor xanthophrys*)

• Endemic to Haleakalā and endangered.
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• Parrotbills are small birds (14 centimeters or 5.5 inches long) that are mostly olive green with yellow and brown markings, a bold eye stripe, and a large bill that resembles a parrot's.
• The Maui parrotbill is a flocking bird. With its low numbers, it is often seen in flocks with *ʻalauahio*.
• It is found in the shrubs and trees of the rain forest understory and subcanopy, foraging for insect larvae in woody branches and stems. It can be found in *ʻōhiʻa* and *ʻōhiʻa-koa* rain forests, as well as in *koa*-dominated forests.
• The Maui parrotbill uses its beak like a can opener to split and crack branches, prying out insect larvae with its tongue and upper mandible.
• There is no known Hawaiian name for this species.

Nukupu'u (*Hemignathus lucidus*)
Also, Maui *Nukupu'u* (*Hemignathus lucidus affinis*), a Maui endemic subspecies

• Endemic and endangered, possibly extinct. (The last birds were seen in the 1980s.)
• This bird is a member of the Hawaiian honeycreepers, a group that at one time included some 52 species descended from one original finch species. The honeycreepers are an example of adaptive radiation.
• Yellow and olive-green birds range from 11 to 14 centimeters (4.5-5.5 inches) long with a long, curved upper mandible.
• The *nukupu'u* uses its upper bill to search in bark crevices for spiders, caterpillars, *Oodemas* weevils, and other insects.
• Its preferred habitat, the *koa* forest, has been destroyed on a large scale, occupying only a small part of its original range. Now, with the *koa* forests dramatically decreased in size, and the presence of malaria-carrying mosquitoes at lower elevations, the *nukupu'u* is most commonly found in *'ōhi'a*-dominated forests above 1500 meters (4,920 feet).

NATIVE PLANTS

Canopy

'Ōhi'a (*Metrosideros polymorpha*)

• Endemic
• *Polymorpha* means "many forms." This species is found in a variety of forms, both within and outside the rain forest. Geographically speaking, its closest relatives occur in Australia.
• In the rain forest, it may grow straight and tall, reaching a height of 18 m (60 feet) or more. In the cloud forest zone, a part of the rain forest where most moisture comes from a nearly-constant cover of fog and clouds, the tree is smaller, with a gnarled and twisted trunk and leathery leaves. In the extreme wet of mountain bogs, *'ōhi'a* stands only a few inches high.
• This is the dominant tree in the wetter rain forests at middle and upper elevations. It forms a nearly continuous canopy in these areas.
• Although its flowers are adapted to wind pollination, native birds feeding on nectar also assist in pollination.
• It may begin its life as an epiphyte—a plant that grows using another plant for support, and taking nutrients from air and rainwater. Wind-blown seeds often lodge and germinate on tree fern trunks.
• *'Ōhi'a* wood is important in Hawaiian canoe-making, used for the gunwale (*mo'o*) of the canoe because it is hard enough to take the constant rubbing of the paddle. It was also used for the seats, spreaders, decking, and mast of the canoe, and for the ridgepoles, posts, rafters and thatching poles in houses.
• In Hawaiian tradition, it is believed that picking the blossoms causes rain.

Koa (*Acacia koa*)

• Endemic (Geographically speaking, its closest relatives occur in Australia.)
• *Koa* can reach heights of 30 meters (100 feet), piercing the *ʻōhiʻa lehua* canopy in places and towering above the rain forest.
• *Koa* may dominate the canopy in relatively drier parts of the rain forest. Sometimes it shares the canopy with *ʻōhiʻa*. In other places, the *koa* will grow taller and can form a distinct upper canopy layer above the *ʻōhiʻa.*
• *Koa* forests have been greatly diminished by logging and ranching. These trees are slow-growing and not easily renewable.
• *Koa* is the host to many rain forest insects.
• Its small, fuzzy, yellow flowers are important sources of nectar for native forest birds, although not as important as the red flowers of *ʻōhiʻa lehua*.
• *Koa* wood was prized by the Hawaiians, and was used to carve canoes, paddles, surfboards, spears, and calabashes (*ʻumeke laʻau*) to hold food, kapa and feathered garments. *Koa* was not used to store *poi*, as it imparted a bitter taste.
• Hulls of single (*kaukahi*) and double (*kaulua*) canoes were carved out of a single *koa* log.
• *Koa* bark was used as a dye for *kapa* and for timbers of grass houses.

Loulu or Fan palm (*Pritchardia* spp.). Also, (*Pritchardia arecina*), the species found in the Haleakalā rain forest

• Endemic (The members of this genus are the only fan palms native to Hawaiʻi. There are 19 endemic species, each of which is unique to a particular island.)
• These palms grow emerge above the canopy singly or in small patches.
• Fossil evidence suggests that *loulu* was more common in ancient times than it is now.
• These fan palms were used in the construction of *heiau loulu*, temporary *heiau* where offerings were made to the gods who presided over fishing.

Subcanopy

Hāpuʻu pulu or Tree fern (*Cibotium glaucum*) Also *Hāpuʻu iʻi* (*Cibotium chamissoi*)

• Endemic
• These large ferns can grow taller than three meters (ten feet) on a stocky "trunk," which is actually a network of interwoven aerial roots that absorb moisture.
• They can be very abundant in the shade created by rain forest trees such as *ʻōhiʻa lehua* and *ʻōlapa*. Where pigs range through the rain forest, however, these ferns are greatly diminished. They are recovering in areas that have been damaged by pigs in the past but are now fenced and patrolled to keep pigs out.
• *Hāpuʻu* are sometimes called "the mother of *ʻōhiʻa*" because their trunks make a good place for seedling germination.
• Tree ferns are covered with brown silky hairs called *pulu*. *Pulu* was traditionally used for stuffing pillows, dressing wounds, and embalming the dead.
• During times of famine, the pith of the trunk was cooked and eaten, and the fiddleheads were eaten, as well.

ʻŌlapa (*Cheirodendron trigynum*)

• Endemic
• This tree ranges in height from five to 15 meters (16 to 50 feet). *ʻŌlapa* is sometimes part of the understory and sometimes part of the canopy.
• In Hawaiian rain forests, *ʻōlapa* often grows intermixed with *hāpuʻu* tree ferns and *ʻōhiʻa*.
• This tree bears clusters of small, purplish fruits which are eaten by native birds.
• *ʻŌlapa* is one host plant for native *Drosophila* flies.
• The soft wood of *ʻōlapa* makes good habitat for the burrowing insects on which many birds feed.
• *ʻŌlapa* sticks were used by the *kia manu* (bird catchers). They covered the sticks with *kēpau* (sap) and placed them in the forest. The sap trapped birds that landed on these sticks. The wood burns when it is wet and was used by the *kia manu* for fires in the wet forest.
• In hula, *ʻōlapa* is the name given to dancers who are graceful enough to imitate the motions of *ʻōlapa* leaves fluttering in the breeze.

Māmaki (*Pipturus spp.*)

• Two Kauaʻi endemic species and two Maui endemics (*P. albidus* and *P. forbesii*)
• *Māmaki* grows as a shrub or small tree two to six meters (six to 20 feet) tall.
• It is in the nettle family. It is unusual because it lacks the stinging hairs associated with most nettle species.
• Birds eat the fruits of the *māmaki*, helping disperse the seeds.
• *Māmaki* was used to make a *kapa* similar to that made from *wauke* but coarser in texture.
• Rope and cordage were made from *māmaki* fibers.
• The leaves of *Pipturus albidus* are the primary food of the larvae of the *pulelehua* or Kamehameha butterfly (*Vanessa tameamea*).
• *Pipturus forbesii* is endemic to Haleakalā, found at upper elevations in the rain forest as well as in subalpine shrubland.

Kanawao or *Pūʻahanui* (*Broussaisia arguta*)

• Endemic
• A multibranched shrub 1.5-4.5 meters (five to 15 feet) tall, *kanawao* bears clusters of small flowers that produce small red-maroon fruits that mature to a blue-black color.
• It often grows in association with *ʻōhiʻa lehua* and *ʻōlapa*.
• This plant is a favored habitat for the happy-face spider.
• The soft wood of *kanawao* makes good habitat for the burrowing insects on which many birds, such as the Maui parrotbill, feed.
• *Kanawao* fruits were believed to aid conception.
• The cluster of fruits was used to symbolize an expansion in the number of chiefs in traditional Hawaiʻi.

Kōlea (*Myrsine* spp.)

• *Kōlea* is the collective name for most of the 20 endemic species of *Myrsine* found in Hawai‘i. Only some of these species are found in the rain forest (such as *M. lessertiana* and *M. emarginata*).
• The 20 Hawaiian *Myrsine* species are thought to have evolved from one or two ancestral species, making this group an excellent example of adaptive radiation.
• Some *kōlea* grow as shrubs, while others are trees. *Kōlea* is a common understory tree.
• Dark-colored fruits are clustered along stems or branches.
• At least one *kōlea* species, *kōlea lau nui* (*Myrsine lessertiana*), provided wood for early Hawaiian house posts and beams as well as beaters for *kapa*. Red dye was made from the bark, and black dye was derived by burning the plant to make charcoal.

Understory

‘Ōhelo (*Vaccinium* spp.)

• Three endemic species (*V. calycinum*, *V. dentatum*, and *V. reticulatum*)
• Related to blueberries and cranberries
• *‘Ōhelo* grows as a shrub or tree, on the ground, or as an epiphyte using other plants for support. Depending on the species and the habitat, *‘ōhelo* can range from several centimeters to several meters in height.
• All three *‘ōhelo* species can be found in rain forest and bog areas on Haleakalā.
• Birds eat the small, usually red, fruits and help disperse seeds. When *‘ōhelo* is in bloom, nectar-feeding birds favor it.
• The fruits of the *‘ōhelo* were eaten by Hawaiians traveling to the uplands. They are still eaten by some people. Dried *‘ōhelo* leaves are still used to make tea.
• *‘Ōhelo* is considered to be sacred to Pele, the Hawaiian volcano goddess. Visitors to Kīlauea would customarily offer a branch bearing berries to Pele before eating themselves. This tradition lives on today when people offer a berry or two to Pele before eating. (Breaking branches off the plants is illegal in Haleakalā National Park.)

‘Ōhā and *Hāhā* (and others), or Hawaiian lobelias (*Lobelia, Cyanea,* and *Clermontia* spp.)

• Four endemic Hawaiian genera and many endemic species are represented among Hawaiian lobelias. (*Lobelia* is not an endemic genus. *Clermontia* and *Cyanea* are among the four endemic genera.)
• Rats and pigs can cause serious damage to these flowering plants, although pigs can be—and are—excluded from parts of the rain forest.
• The four endemic genera (totaling nearly 100 species) all evolved from a single common ancestral species that arrived in Hawai‘i millions of years ago. Among Hawaiian plants, this is the most prolific example of adaptive radiation.
• Hawaiian lobelias are shrubby species. Many of them have a characteristic lobeliad “rosette” growth form, in which leaves in circular formation grow at the end of single vertical stems (like palm trees). Others have branched trunks or vertical branches.
• The nectar of many lobelias is attractive to native honeycreepers. The flower shapes coevolved with the honeycreepers, so there is a correspondence between beak shape and flower shape.

Vines and Climbing Shrubs

ʻIeʻie or Climbing screwpine (*Freycinetia arborea*)

• Indigenous
• This woody, climbing plant is found in the rain forest at lower and middle elevations up to about 1400 meters (4592 feet).
• Sometimes *ʻieʻie* sprawls across the forest floor. It often wraps around and climbs the trunks of taller trees such as *koa* and *ʻōhiʻa*. It produces many aerial roots (*ʻie*) that attach the plant to the host tree.
• *ʻIeʻie* used to be pollinated by native honeycreeper species that are now extinct. Introduced birds such as the Japanese white-eye (*Zosterops japonicus*) now do the job.
• This plant was greatly diminished by pig damage. Rats are also major threats to *ʻieʻie.* It is now rare to find flowers that have not been eaten by rats. Rat predation on flowers impairs reproduction.
• The fibers in the stem were used to make cordage to tie together house rafters and bind the outrigger (*ama*) to the canoe (*waʻa*).
• Aerial roots were woven into very fine and durable baskets and funnel-shaped traps to catch fresh-water shrimp and fish as well as helmets (*mahiole*) which were worn by chiefs going into battle.
• *ʻIeʻie* was sacred to early Hawaiians. The plant was dedicated to the forest god, Kū. In a *hālau hula, ʻieʻie* represented the demigoddess Laukaʻieʻie.

Maile (*Alyxia oliviformis*)

• Endemic
• A climbing shrub or vine with glossy, leathery leaves, tubular yellow flowers, and purple-black fruits shaped like olives
• There are many varieties of *maile*, distinguished by differences such as leaf size and shape, and scent. Different Hawaiian names reflect these differences (e.g., *maile haʻi wale* or brittle *maile*, and *maile pākaha* or blunt-leaved *maile*) and illustrate ancient Hawaiians' acute observation skills.
• *Maile* is woven into a fragrant, open-ended lei that symbolizes respect for the wearer.
• *Maile* is dedicated to the *hula* goddess, Laka. It has inspired many songs, chants, and dances.

Hawaiian mints (*Stenogyne* spp.)

• Endemic
• Of eight *Stenogyne* species known from East Maui, five are thought to be extinct. Unlike most other mint species found elsewhere in the world, Hawaiian mints are "mintless"—they do not have aromatic foliage that deters browsing, because they evolved in an environment in which there were no browsing animals. So they are vulnerable to grazing by introduced cattle, pigs, and goats.
• Rat predation is a significant problem for these plants.
• *Stenogyne kamehamehae*, with its clusters of long, curved red or white flowers, is found in rain forests on both Molokaʻi and Maui. *Stenogyne rotundifolia* is a Maui endemic that still survives in the upper reaches of Haleakalā rain forests in areas not disturbed by feral pigs.
• Deep, curved *Stenogyne* flowers attract native nectar-sipping bird species whose beak shapes co-evolved with the mint flower shapes. These birds pollinate the flowers.

Forest Floor and Epiphytes

Uluhe or False staghorn fern (*Dicranopteris linearis*)

• Indigenous
• A shrubby, vining fern that forms densely tangled mats on the rain forest floor
• Thickets of *uluhe* can quickly take over when openings are created in the forest canopy, but they do not do well in deep shade. This dense growth can overtake other vegetation and prevent the growth of other plants, including most alien weed species. *Uluhe* can form vegetative mats as much as six meters or 20 feet deep!
• *Uluhe* is often found growing in association with *ʻōhiʻa lehua*.
• In traditional Hawaiian medicine, the bitter juice of this plant was taken as a laxative or emetic.

ʻAlaʻala wainui (*Peperomia* spp.)

• *ʻAlaʻala wainui* is the Hawaiian name for all the plants in this genus, most of which are endemic.
• These plants, which are members of the pepper family, are succulent herbs that range in height from seven or eight centimeters (three inches) to just over a meter.
• *ʻAlaʻala wainui* may grow on the ground or as epiphytes, perched on trees or rocks.
• This plant is extremely susceptible to pig damage, as its fragile stems are easily trampled.
• The sticky fruit are probably dispersed on birds' feet and feathers.
• Many plants in this group were used to make medicines for a variety of health problems and to produce a gray dye for *kapa*.

Paʻiniu (*Astelia* spp.) or *Kaluaha* (*Astelia menziesiana*)

• Endemic
• The long, silvery leaves of *paʻiniu* form rosettes from the center of which grow flowering stalks that bear a cluster of small, bright-orange fruits.
• It is an herbaceous plant that may grow as an epiphyte, using native tree trunks or branches for support, or it may be rooted in the ground.
• This species is used as an indicator of the presence or absence of pigs. If you find *paʻiniu* growing on the ground, you know there have not been pigs in the area.
• This is a favored home for *pinao ʻula*, the Hawaiian Damselfly.
• Birds eat the *paʻiniu* fruit, assisting in seed dispersal.
• The silvery skins of the leaves were woven into flower garlands called *lei paʻiniu*.

Limu or Mosses and Liverworts

• *Limu* refers to many forms of algae, as well as mosses, lichens, and liverworts.
• Numerous species of mosses (*limu kele*) and liverworts live in the rain forests. They form a spongy, blanket-like cover on some native trees, rocks, and other surfaces.
• These fragile plants are easily destroyed by browsing and trampling pigs, goats, and deer.
• The "sponge" of *limu* absorbs water, providing a source of additional moisture during dry spells and helping prevent erosion caused by rapid runoff.

Rain Forest Species Assignments

Cut along dashed lines

Invertebrate
Haleakalā flightless lacewing
(*Pseudopsectra lobipennis*)
Order Neuroptera,
Family Hemerobiidae

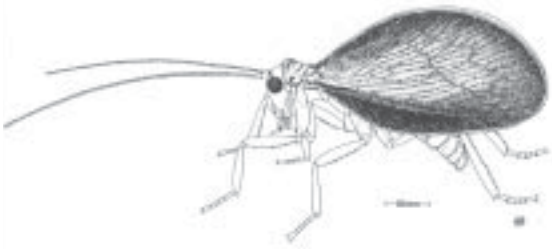


Illustration: Nanci Sidaras

Invertebrate
Hawaiian crickets
(One indigenous genus [*Paratrigonidium*] and 3 endemic genera [*Leptogryllus*, *Thaumatogryllus*, and *Prognathogryllus*])
Order Orthoptera, Family Gryllidae
(*Paratrigonidium* and *Leptogryllus* are most common on East Maui.)

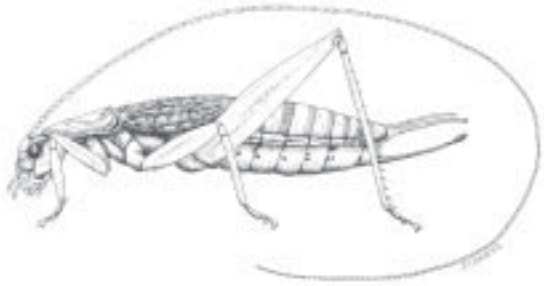


Illustration: Nanci Sidaras

Invertebrate
Tree snails
(*Partulina spp.*)
Order Pulmonata,
Family Achatinellinae

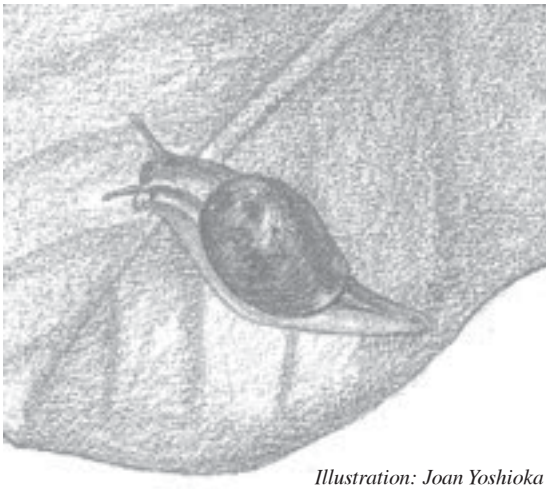


Illustration: Joan Yoshioka

Invertebrate
Hawaiian ground beetles
(Family Caribidae)
Order Coleoptera
(The genus *Mecyclothorax* is most common on East Maui.)

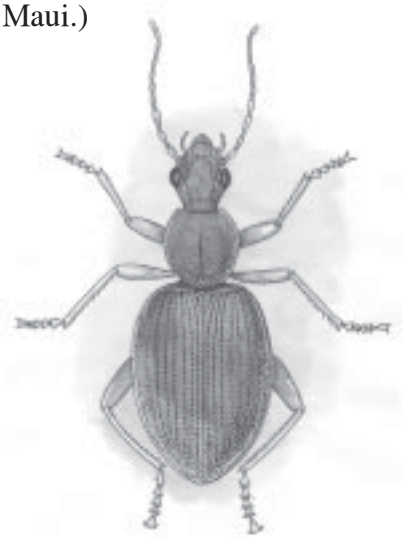


Illustration: Nanci Sidaras

Cut along dashed lines

Invertebrate
Hawaiian long-horned beetles
(Megopis reflexa and
Plagithmysus spp.)
Order Coleoptera,
Family Cerambycidae

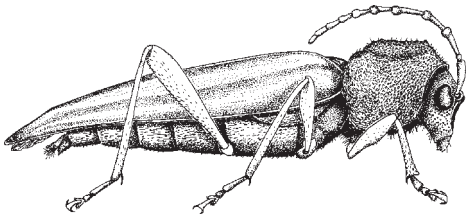
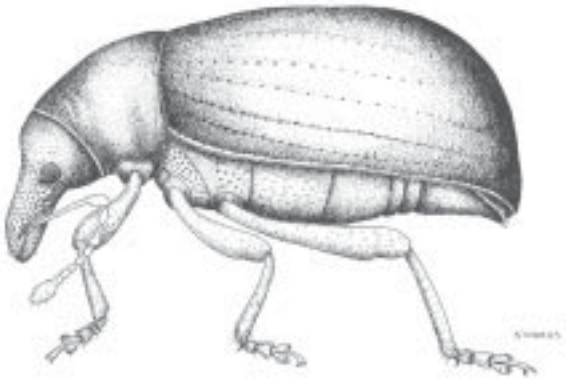


Illustration: Nanci Sidaras

Invertebrate
Haleakalā weevil
(*Oodemas* spp.)
Order Coleoptera,
Family Curculionidae



llustration: Nanci Sidaras

Invertebrate
Hawaiian carnivorous inch-worm (*Eupithecia* spp.)
Order Lepidoptera,
Family Geometridae
(The green grappler, *Eupithecia orichloris*, is a common East Maui species.)

Illustration: Nanci Sidaras

Invertebrate
Happy-face spider
(*Theridion grallator*)
Order Araneae, Family Theridiidae

Illustration: Nanci Sidaras

Cut along dashed lines

Invertebrate
***Pulelehua* or Kamehameha butterfly**
(*Vanessa tameamea*)
Order Lepidoptera,
Family Nymphalidae

Illustration: Nanci Sidaras

Invertebrate
Picture wing flies
(Family Drosophilidae)
Order Diptera

Illustration: Joan Yoshioka

Invertebrate
Flying earwig, Hawaiian damselfly or *Pinao ʻula*
(*Megalagrion nesiotes*)
Order Odonata,
Family Coenagrionidae

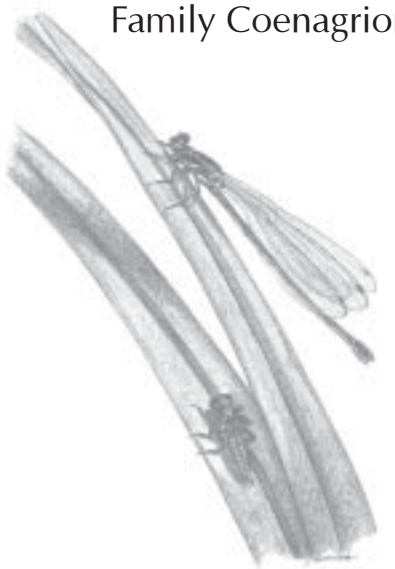


Illustration: Joan Yoshioka

Bird
Nukupuʻu
(*Hemignathus lucidus*)
Order Passeriformes, Family
Fringillidae, Subfamily Drepanidinae

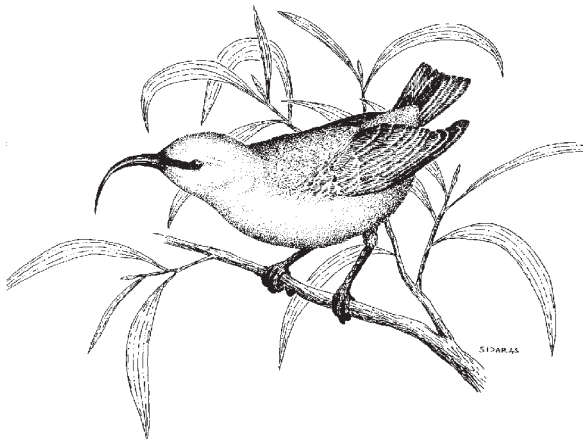


Illustration: Nancy Sidaras

Cut along dashed lines

Bird
ʻIʻiwi (*Vestiaria coccinea*)
Order Passeriformes,
Family Fringillidae,
Subfamily Drepanidinae

Photo: Eric Nishibayashi

Bird
ʻApapane (*Himatione sanguinea*)
Order Passeriformes,
Family Fringillidae,
Subfamily Drepanidinae

Photo: Eric Nishibayashi

Bird
ʻAmakihi (*Hemignathus virens*)
Order Passeriformes,
Family Fringillidae,
Subfamily Drepanidinae

Photo: Eric Nishibayashi

Bird
Maui *ʻAlauahio* or Maui creeper
(*Paroreomyza montana*)
Order Passeriformes,
Family Fringillidae,
Subfamily Drepanidinae

Photo: Eric Nishibayashi

Cut along dashed lines

Bird
***ʻĀkohekohe* or Crested honeycreeper** (*Palmeria dolei*)
Order Passeriformes, Family Fringillidae, Subfamily Drepanidinae

Photo: Eric Nishibayashi

Bird
Poʻouli
(*Melamprosops phaeosoma*)
Order Passeriformes, Family Fringillidae, Subfamily Drepanidinae

Photo: Paul Baker, Maui Forest Bird Recovery Project

Bird
Maui parrotbill
(*Pseudonestor xanthophrys*)
Order Passeriformes, Family Fringillidae, Subfamily Drepanidinae

Photo: Eric Nishibayashi

Plant
***Limu* or Mosses and Liverworts**
Class Musci (Mosses),
Class Hepaticae (Liverworts)

Limu *growing on tree trunks (Photo: Steve Anderson)*

Cut along dashed lines

Plant
ʻŌhiʻa lehua
(*Metrosideros polymorpha*)
Order Myrtales, Family Myrtaceae

Illustration: Joan Yoshioka

Plant
Koa (*Acacia koa*)
Order Fabales, Family Fabaceae

Illustration: Joan Yoshioka

Plant
***Loulu* or Fan palm**
(*Pritchardia spp.*).
Order Arecales, Family Arecaceae
(*Pritchardia arecina* is a common East Maui species.)

Illustration: Joan Yoshioka

Plant
***Hāpuʻu pulu* or Tree fern**
(*Cibotium glaucum*)
Also ***Hāpuʻu iʻi***
(*Cibotium chamissoi*)
Order Filicales, Family Dicksoniaceae

Illustration: Joan Yoshioka

Cut along dashed lines

Plant
ʻŌlapa
(*Cheirodendron trigynum*)
Order Apiales, Family Araliaceae

Illustration: Joan Yoshioka

Plant
Māmaki (*Pipturus* spp.)
Order Urticales, Family Urticaceae

Illustration: Joan Yoshioka

Plant
ʻŌhelo (*Vaccinium* spp.)
Order Ericales, Family Ericaceae
(*Vaccinium calycinum* is a common East Maui species.)

Illustration: Joan Yoshioka

Plant
***ʻŌhā* and *Hāhā* (and others) or Hawaiian lobelias** (*Lobelia, Cyanea,* and *Clermontia* spp.)
Order Campanulales,
Family Campanulaceae,
Subfamily Lobelioideae
(Common East Maui species include *Lobelia grayana*, *Cyanea hamatiflora*, and *Clermontia arborescens*.)

ʻŌhā (Clermontia parviflora) (Illustration: Joan Yoshioka)

Cut along dashed lines

Plant
Kanawao* or *Pūʻahanui
(*Broussaisia arguta*)
Order Rosales, Family Hydrangeaceae

Photo: Steve Anderson

Plant
Kōlea (*Myrsine* spp.)
Order Primulales, Family Myrsinaceae
(*Myrsine lessertiana* is a common East Maui species.)

Illustration: Joan Yoshioka

Plant
***ʻIeʻie* or Climbing screwpine**
(*Freycinetia arborea*)
Order Pandanales,
Family Pandanaceae

Photo: Carol Gentz

Plant
Maile (*Alyxia oliviformis*)
Order Gentianales,
Family Apocynaceae

Illustration: Joan Yoshioka

Cut along dashed lines

Plant
Hawaiian mints (*Stenogyne* spp.)
Order Lamiales, Family Lamiaceae
(*Stenogyne rotundifolia* is a common East Maui species.)

Illustration: Nanci Sidaras

Plant
***Uluhe* or False staghorn fern**
(*Dicranopteris linearis*)
Order Filicales, Family Gleicheniaceae

Illustration: Joan Yoshioka

Plant
ʻAlaʻala wainui
(*Peperomia* spp.)
Order Piperales, Family Piperaceae
(*Peperomia cookiana, lilifolia,* and *waikamoiana* are common East Maui species.)

Photo: Kim Martz and Forest Starr

Plant
Paʻiniu (*Astelia* spp.) or
Kaluaha (*Astelia menziesiana*)
Order Liliales, Family Liliaceae

Illustration: Joan Yoshioka

Rain Forest Species Cards

Species card instructions

Based on your research, fill in your blank species card using the following suggestions and questions as guidance. The answers to all of these questions are not readily available for every species, so work with the information you can find.

Species type and names
These appear on your species assignment card. Include common, Latin, and Hawaiian names, where appropriate.

Status
Is this an endemic or indigenous species? Where else in the world is this species found? Is it common, rare, threatened, or endangered? Why? Is it threatened by alien species? If so, how?

Description and characteristics
What does the species look like? How does it behave? What could you tell others about this species that would help them identify it?

Where in the rain forest?
Where does it fit in the structure of the rain forest? If it's a plant, is it a canopy species? Subcanopy? Understory? Ground cover or forest floor? Epiphyte, vine, or climbing shrub? If it's an invertebrate or bird, where would you be most likely to find it?

Rain forest relationships
How does this species interact with other rain forest species? What is its habitat?

Think about it…
A thought-provoking question about this species

Did you know?
A fun fact about this species (This could be a native Hawaiian cultural use, a unique characteristic, or something else that interesting.)

Sources of information
Citations for the information source(s) you used in creating this species card

Species image
An image of the plant or animal that you draw, colorize, or photocopy

A Beginning List of Resources for Research

Available through your teacher

Hawai'i Audubon Society, *Hawaii's Birds*, 5th ed., Hawai'i Audubon Society, 1997.

Medeiros, Arthur C., and Lloyd L. Loope, *Rare Animals and Plants of Haleakalā National Park,* Hawai'i Natural History Association, Hawai'i National Park, 1994.

Moanalua Garden Foundation, *Forest Treasures* (CD ROM), 2000.

Stone, Charles P., and Linda W. Pratt, *Hawai'i's Plants and Animals; Biological Sketches of Hawaii Volcanoes National Park*, Hawai'i Natural History Association, National Park Service, and University of Hawai'i Cooperative National Park Resources Study Unit, Hawai'i National Park, 1994.

Websites

Bishop Museum Natural Sciences Department at <www.hbs.bishopmuseum.org>. Click on Natural Sciences Department under the Research and Collections icon.

College of Tropical Agriculture and Human Resources at <www.ctahr.hawaii.edu>. Click on "forests" under "environment," or the "ornamentals and flowers" subsection.

Hawai'i Biological Survey at <www.hbs.bishopmuseum.org/hbsl.html>.

Hawaiian Ecosystems at Risk at <www.hear.org>.
Contains links to many other informative websites

Native Hawaiian Plant Society at <www.philipt.com/nhps>.

The Nature Conservancy at <www.tnc.org/hawaii>.

University of Hawai'i Botany Department, "Hawaiian Native Plants" at <www.botany.hawaii.edu/faculty/carr/natives.htm>.
Includes photos of many native Hawaiian plants

U.S. Fish and Wildlife Service, Pacific Islands Ecoregion, "Hawaiian Endangered Species" at <pacificislands.fws.gov/wesa/endspindex/html>.

Also, try doing Internet searches through a search engine, using the common or Latin name of your species.

Check the library or friends and family for these additional resources

Abbott, Isabella Aiona, *Lā'au Hawai'i: Traditional Hawaiian Uses of Plants,* Bishop Museum Press, Honolulu, 1992.

Hadfield, Michael G., "Extinction in Hawaiian Achatinelline Snails," in E. Alison Kay (ed.), *A Natural History of the Hawaiian Islands; Selected Readings II,* University of Hawai'i Press, Honolulu, 1994, pp. 320-334.

Howarth, Francis G., and William P. Mull, *Hawaiian Insects and Their Kin,* University of Hawai'i Press, 1992.

Krauss, Beatrice H., *Native Plants Used as Medicine in Hawai'i,* Harold L. Lyon Arboretum, Honolulu, 1991.

Polhemus, Dan and Adam Asquith, *Hawaiian Damselflies: A Field Identification Guide*, Bishop Museum Press, Honolulu, 1996.

Pratt, H. Douglas, *A Pocket Guide to Hawai'i's Trees and Shrubs*, Mutual Publishing, Honolulu, 1998.

Wagner, Warren Lambert, and S. H. Sohmer, *Manual of the Flowering Plants of Hawai'i*, University of Hawai'i Press, Honolulu, 1999.

Sample Species Card

ʻŌpeʻapeʻa or Hawaiian hoary bat (*Lasiurus cinereus semotus*)

Order Chiroptera, Family Vespertilionidae

Status

- Endemic subspecies to the Hawaiian Islands (Other members of this species are found in temperate areas of North and South America, and several island groups including the Galapagos archipelago.)
- Hawaiian hoary bat populations were probably never very large, and there are now approximately a few thousand left. They are less common on Maui than on Kauaʻi and Hawaiʻi.

Description and characteristics

- This small reddish-gray bat weighs just over half an ounce.
- A nocturnal animal, the bat hunts at night and roosts during the day.
- It uses high-pitched cries and sonar to locate its food—flying insects.

Where in the rain forest?

- It clings to tree branches or rocks to roost upside down during the daytime.

Rain forest relationships

- It feeds on flying insects.
- It can be found in native *ʻōhiʻa* and *koa* forests. It has also adapted to human-altered landscapes, sometimes roosting in nonnative macadamia and eucalyptus trees.

Think about it…

One hundred years ago, there were proposals to introduce nonnative bat species to the Hawaiian Islands to help keep insect pests in check. If they'd been successfully introduced, what effects might these nonnative species have had on the native Hawaiian bat?

Did you know?

The Hawaiian name, *ʻōpeʻapeʻa*, may come from the Hawaiian word *peʻa* which means "cross-shaped" or "sail-shaped."

Sources of information

Medeiros, Arthur C., and Lloyd L. Loope, *Rare Animals and Plants of Haleakalā National Park.* Hawaiʻi Natural History Association, Hawaiʻi National Park, Hawaiʻi, 1994, pp. 3-5.

Illustration: Nanci Sidaras

Blank Species Card

Species type

Species name (common and scientific)

Status

Description and characteristics

Where in the rain forest?

Rain forest relationships

Think about it…

Did you know?