Activity #2

Ant Alert: How Does Invasion Threaten Natives?

● ● ● **In Advance** *Student Reading*

- Assign the Student Page “That Ant is a Tramp” as homework reading (pp. 20-23).

● ● ● **Class Period One** *Ants Video*

Materials & Setup

- *Nova* video, “Ants! Little Creatures Who Run the World” (included with this curriculum)
- VCR

For each student

- Student Page “Ant Video Note Sheet” (pp. 24-25)

Instructions

1) Watch the *Nova* video entitled, “Ants! Little Creatures that Run the World.” The entire video lasts approximately 1 hour, so if you have a shorter period than that, play video from beginning through the leafcutter ant segment. This is 47 minutes of run time. Or play as much of the video as you can during the class.

2) During the video, ask students to fill in the Student Page “Ant Video Note Sheet.” Let students know they do not necessarily need to remember the species names of different kinds of ants on this note sheet. However, they should be able to describe the ant species well enough that someone who’s watched the video would know which ant they are describing.

3) As homework, have students review their class notes and the “Argentine Ants” student page from the previous homework assignment to prepare for a brief in-class quiz the following class period.

● ● ● **Class Period Two** *Argentine Ants Teaching Teams Preparation*

Materials & Setup

For each student

- Student Page “Argentine Ants Quiz” (pp. 37-38)

For each student teaching team

- One copy of the appropriate topic set (see class period two instructions) from the Student Page “Argentine Ants Teaching Teams Background” for each team member (pp. 26-36)

Instructions

1) Have students complete the Student Page "Argentine Ants Quiz."

2) Divide the class into four or more teams. Each team should consist of at least three students. Assign each team a topic from the list below, making sure that each topic is covered by at least one team. Explain to students that they will be working in teams to teach the rest of the class about a specific topic related to Argentine ants and the threat they pose to native ecosystems on Maui.
   Topic #1: The location and spread of Argentine ants in Haleakalā National Park
   Topic #2: The threat Argentine ants pose to native arthropods in the alpine/aeolian ecosystem
   Topic #3: Biological and behavioral characteristics that make Argentine ants a strong invader
   Topic #4: Characteristics of Argentine ants that affect how they spread and can be controlled

3) Hand out the appropriate section of the Student Page "Argentine Ants Teaching Teams Background" to the teams, making sure each team member receives a copy of the information on the group's topic.

4) Have team members use the information from the initial homework reading and the student page you just handed out to develop a creative presentation that will teach other students about the team's topic. Ideas include writing and performing a song or chant, making a visual representation, developing a multi-media presentation, or performing a skit or comedy routine.

5) Each team must also come up with two questions they want other students to be able to answer after their team presentation and have these questions written on a piece of paper that can be handed in.

Teaching Option

- If you want to pare down this activity from three class periods to two, or prefer to present the information yourself, substitute a lecture and discussion format. Use the Student Page "Argentine Ants Teaching Teams Background" for your background notes.

● ● ● Class Period Three *Team Presentations*

Instructions

1) Invite members of each team to stand up in front of the class and make their presentation. Go in the order in which the topics are listed above. Complete all the team presentations on a given topic before moving on to the next one. Prior to each presentation, have the team hand in its list of two questions that other students should learn to answer based on the presentation.

2) If there is time at the end of the class, have a class discussion focusing on the implications of what students have learned about Argentine ants for resource management in the park.

3) Select one or more questions from presentations on each topic, and either orally assign them as homework, or use them to prepare a quiz for the following class period or a later homework assignment.

Journal Ideas

- Do you think resource managers in Haleakalā National Park should make eradicating or controlling nonnative species such as Argentine ants a top priority? Why or why not?
- Think about the social structure and operation of ant colonies. Identify one aspect of ant behavior from which humans could learn valuable lessons and explain how that would benefit people. Then identify one aspect of ant behavior that would be destructive if people adopted it, and explain your thinking.

Assessment Tools

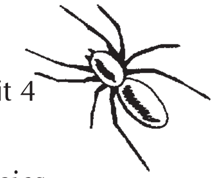
- Student Page "Ant Video Note Sheet" (teacher version, pp. 16-17)
- Student Page "Argentine Ants Quiz" (teacher version, pp. 18-19)
- Participation in preparing and delivering team presentation
- Team presentations: Assess on the basis of creativity, conformance with information provided, and thoroughness in answering the questions the team identified for other students.
- Journal entries

Teacher Version

Ants Video Note Sheet

This list of possible responses is not complete, but provides guidelines for assessment and discussion.

Write something you learned from the video about ants, termites, or other social insects that illustrates each of these traditional Hawaiian values.	
Laulima — Cooperation, many hands or people working together on a task to accomplish a goal	• Large numbers of wood ants feeding on caterpillars and moths ensures success. • Termites can repair tremendous damage to their home because so many work together. • Kenyan raid ants bunch together before invading a termite nest, combining the force of numbers with organized aggression. • Herdsman ants form living bridges over gaps. The moving colony crosses these bridges. • Millions of driver ants act like a super-organism, killing almost everything in its path. Ants release those trapped in slug slime, and several ants work together to carry heavy loads back to the nest.
‘Ohana — Extended family system, the primary component of society. Individual interests are not as important as the interests of the group.	• Living in family groups has been the key to cockroach success. They digest food only with the assistance of small organisms in their guts. These are passed from parent to offspring during feeding. • All ants belong to extended families and carry prey home to share. • Raising many close sisters together ensures success for the whole colony. Individual ants can afford to risk their lives since they will soon be replaced. • Desert ant workers may die after only a few days in the scorching heat, but when they do find food they carry it immediately back to the nest. • Leaf cutter ants are “robots,” programmed to serve the colony.
Kuleana — Responsibilities and roles. If each member of society fufills their *kuleana*, all needs for survival will be met.	• When their nest is damaged, soldier termites come out first to defend, then workers come out to repair. • Worker ants are dedicated to caring for the eggs, grubs, and cocoons of their younger sisters. • Male ants die soon after mating, and the newly mated queens establish new colonies. • During times of plenty, honeypot ants are filled by their sister workers with sweet food to eat during lean times. • When driver ants go foraging, soldiers guard the column, cut up prey, form living bridges for other ants to cross, and hold back obstacles along the trail. Workers clear the trail and carry prey back to the nest. Other workers throw out “garbage” from the nest. • Thousands of herdsmen ants link legs to form a living cradle that serves as the colony’s nest.



Write at least two similarities and two differences between Argentine ants and other ant species on the video. Here are six areas of comparison to use for ideas. There are others, as well.

Argentine Ant Characteristics and Behaviors

- Argentine ant colonies reproduce by "budding." The new queens walk to their new nest site after having mated in the nest. Argentine ant males die after mating.
- Argentine ants are voracious predators.
- Argentine ants do not have permanent nests. They may move the entire nest from time to time.
- Argentine ant nests have more than one queen.
- Argentine ants do not defend their nests from other Argentine ants in the same area.
- Other

Note Two Similarities and Two Differences Between Argentine Ants and Other Ant Species

Similarities

- Wood ants are voracious predators during the summer.
- Kenyan raid ants are also predatory, pursuing termites and raiding their nests.
- Driver ants are particularly voracious predators, forming rivers of ants from which very little escapes alive.
- Driver ants move their nests frequently (in search of food).
- Herdsman ants regularly move their nests.

Differences

- Harvester ants in Arizona reproduce through mating flights. Tens of thousands of winged males and future queens from many colonies gather in an "ant orgy." The mated females fly off to form new colonies.
- Malaysian herdsman ants get all their food from honeydew produced by bugs that they tend.
- Certain ants in South America make their homes in the hollow stems of a plant that also produces white nodules that serve as food for the ants. In return, the ants defend the plant against predators.
- In the Amazon, some ants grow hanging gardens in nests of chewed plant fibers.
- The ancestral piles of wood ants are passed through generations. Some may date back to the 1900s.
- Leaf cutter ant colonies, numbering two to three million workers, have a single queen.
- Honeypot ants defend their nests and prey against ants from other nests. Entire colonies may be overrun and the honeypots dragged off to the victorious colony.

Teacher Version

Argentine Ants Quiz

1) Explain Argentine ants' response to a disturbance in their environment, such as a vibration, change in weather, or a manipulation of their nest.

Answer should be based on this excerpt from the text:

> Even a slight disturbance such as a vibration or a small manipulation of the nest will send Argentine worker ants scurrying away from the nest trying to carry larvae and pupae (their "brood") to a safer place. Entire colonies may move in response to physical disturbance, changes in weather conditions, or changes in their food source.
>
> Argentine ants are so sensitive that even a hiker or picnicker walking by or sitting down could create enough of a vibration or disturbance to cause a nearby nest to relocate.

2) How could this type of response help Argentine ants "hitch a ride" with humans?

It would take no more than a few ants and their cargo of brood to relocate into a hiker's pack, a picnicker's cooler or garbage bag, shipments of nursery stock, or other items. Once they have reached their new destination, they might be able to establish a new colony.

3) How many different populations of Argentine ants are known in Haleakalā National Park today?

Two

4) Is the size of those populations getting bigger, getting smaller, or staying about the same?

Both are getting larger.

5) Give two reasons why Argentine ants are considered a threat to native insects and plants in Haleakalā National Park.

Responses should be based on the following points from the text:

There are no native ants on the Hawaiian Islands, so most of the insects that evolved here are not adapted to defend themselves against the aggressive predatory abilities of large colonies of Argentine ants. Native Hawaiian insects are often soft-bodied and flightless—easy prey for the Argentine ant.

Argentine ants also may prevent native insects from using rocks, logs, and other objects for cover. These ants often nest under objects of this type. In the extreme environment of the alpine/aeolian zone, that cover may be important refuge to the native insects to shelter them against the midday sun, the nighttime cold, and the wind.

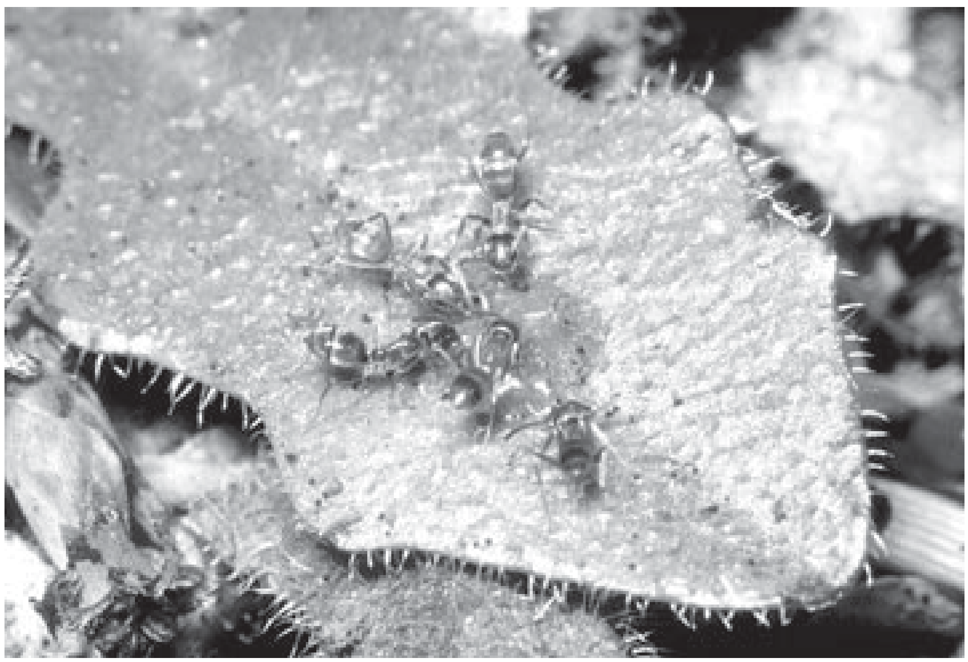
Argentine ants reduce the populations of native arthropod species. The effects are especially severe at higher elevations, where the prey species are fewer in number. Species that are known to be severely affected by Argentine ant predation in the park include native bees and moths, which are the main pollinators for native plants such as the silversword.

Argentine ants have no predators, competitors, or parasites in the alpine/aeolian ecosystem.

Argentine ants are well known for displacing native insect and ant species elsewhere in the world. Researchers and resource managers at the park are concerned that the same thing could happen at Haleakalā.

That Ant is a Tramp

In 1967, scientists identified a new species of ant in Haleakalā National Park: *Linepithema humile*, the Argentine ant. This ant is thought to be native to Argentina and Brazil. Like every other ant species on the Hawaiian Islands today, it is an alien species. There are no native ant species here, although as you quickly learn if you leave food out at home, there are now plenty of ants around.



Argentine ants (Photo: Neil Reimer, U.S. Department of Agriculture)

Most of the ants found on Maui and the other Hawaiian Islands cannot survive at the higher elevations of Haleakalā National Park. In fact, only two ant species other than the Argentine ant have been found above 2000 meters (6560 feet) within park boundaries. Neither of the other two species seem to pose a threat to the native plants, animals and insects of the alpine/aeolian zone of Haleakalā. But Argentine ants do.

Before we get into that part of the story, however, let's take a step back in time and look at the spread of Argentine ants in Hawai'i.

Argentine Ants Find a New Home

The Argentine ant probably established its presence in Hawai'i because of military activity. In 1940, it was discovered at Fort Shafter in Honolulu. There were several established colonies by that time. By 1949, the ants had spread beyond the confines of Fort Shafter. By that time, there was no looking back for the Argentine ant, which has since spread to all of the major Hawaiian Islands except Molokai. Even though Argentine ants first established their Hawaiian presence on O'ahu, they are no longer found there. They are believed to have been out-competed by another introduced species, the big-headed ant (*Pheidole megacephala*).

By 1950, Argentine ants had reached Maui, where they were reported in Makawao. And in 1967, the first Argentine ant was identified in Haleakalā National Park.

How did the Argentine ant get to the park? It did not fly. It was not carried there in the digestive system of a bird or a pig. Most probably, Argentine ants traveled to their new home on Haleakalā with people who did not even suspect that they were carrying such an aggressive intruder with them.

The Biology and Behavior of a Tramp

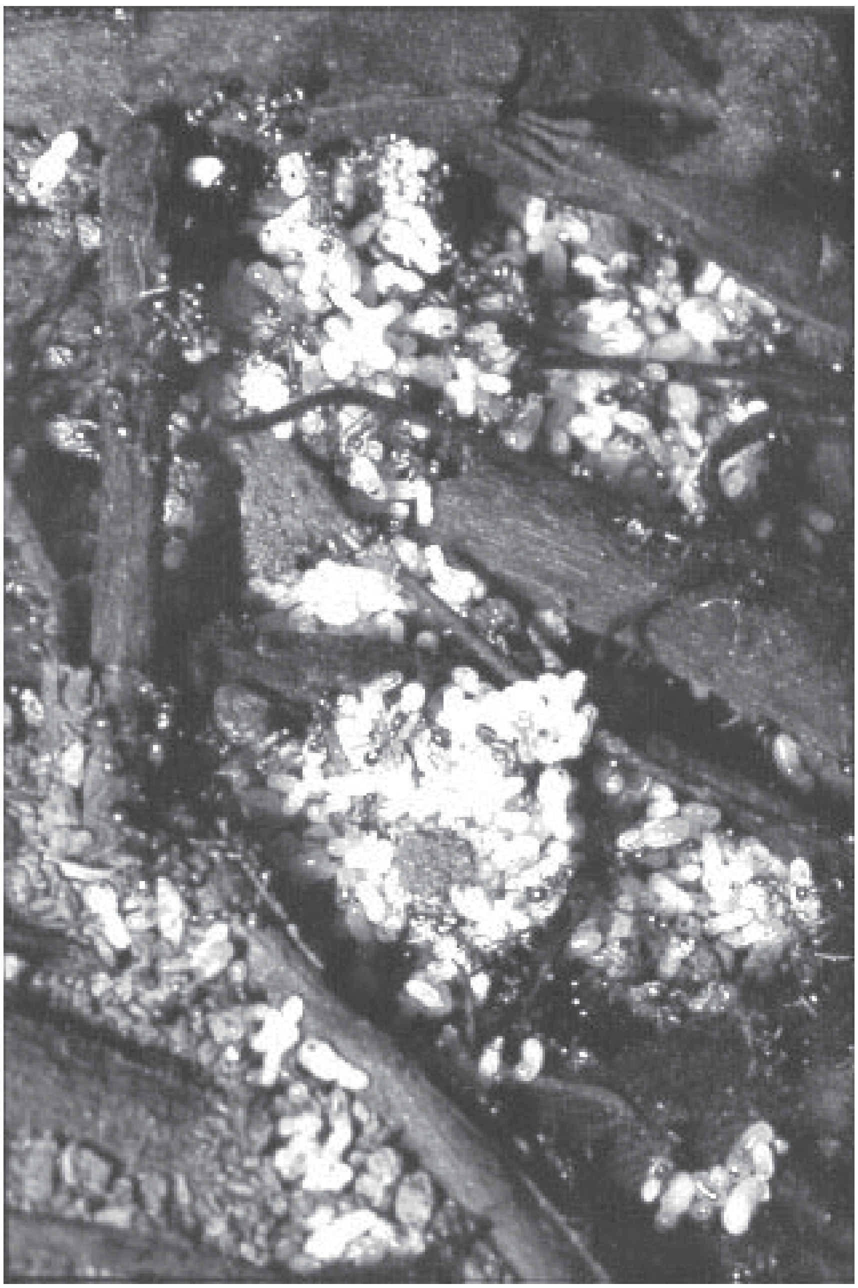
Argentine ants are one of several species of ants that have come to be called "tramp species." They are well adapted to living in close association with humans and are easily dispersed around the world as we ship goods and travel from one place to another.

One reason that tramp ants have been so successful at thriving in close proximity to humans is that they are well adapted to a changing environment. Human activity tends to create an unstable environment—one that is prone to change as we move things around, clear land, do landscaping, and go about other daily activities.

Tramp species are extremely mobile. Even a slight disturbance such as a vibration or a small manipulation of the nest will send Argentine worker ants scurrying away from the nest trying to carry "larvae" and "pupae" (the early developmental stages that constitute an ant colony's "brood") to a safer place. Entire colonies may move in response to physical disturbance, changes in weather conditions, or changes in their food source.

Argentine ants are so sensitive that even a hiker or picnicker walking by or sitting down could create enough of a vibration or disturbance to cause a nearby nest to relocate. If a few ants and their cargo of brood were to relocate into the hiker's pack or the picnicker's cooler or garbage bag, they could easily be transported to an uninfested area of the park. Once there, they could establish a new colony.

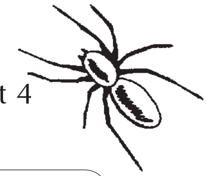
The rapid-response movement combines with other features of Argentine ant biology to make it a successful hitchhiker. These characteristics are shared among most tramp ant species.



Argentine ant nest (Photo: Ellen VanGelder)

Polygyne Colonies

These ants are "polygyne." In other words, each nest has more than one queen—one estimate is that there are typically one to 1.6 queens per 1,000 worker ants. Smaller queens sometime forage with worker ants. If a queen and some workers become hitchhikers together, they may be able to start a new colony in an uninfested area.



A Brief Look at Ant Society and Reproduction

Most ants in a colony are wingless, infertile female workers. They do the labor that keeps the colony alive, including defense, foraging, and brood-tending.

Ant queens are the only female ants that can reproduce. A queen mates once in her life, storing all the sperm from that mating in her body and using it as needed during the course of her reproductive life.

Ant males are produced only to mate. After mating, they die.

The difference between ant worker larvae and queen larvae is not in the genetics of the eggs they come from. Larvae are "differentiated" into these castes based on what they are fed and when. The development of male ants also depends on feeding. Ant workers feeding their "brood" of eggs, larvae, and pupae respond to environmental signals such as food availability and the presence or absence of pheromones (scent signals) from a queen.

If the queens are removed from an Argentine ant colony, worker ants respond by producing new males and queens from existing larvae. They do this through changes in feeding.

Colonies Reproduce by Budding

Unlike queens of many other ant species, Argentine ant queens and males do not fly from the nest at mating time. The colonies reproduce by "budding." Mating happens within the nest, and the new queens leave the nest on foot to establish a new nest close by. Like other tramp ants, Argentine ant populations spread outward from a single point. Unless, of course, the ants hitch a ride.

Unicolonial Populations

Argentine ants are "unicolonial." In other words, they form large colonies of many different nests. Unicolonial species do not exhibit aggressive behavior toward other ants from different nests in the same area. This non-competitive behavior allows Argentine ants and other tramp species to establish very large, high-density colonies. The sheer numbers of these ants, along with the aggressiveness of their workers, allows them to effectively prey upon and/or outcompete many other species of ants and insects. Since Argentine ants are most often imported and not native, this ability allows them to dominate the areas they invade. In Argentine ant-infested areas, other species of ants and insects may be virtually eliminated.

What Makes Argentine Ants a Potential Threat to Native Insects and Plants on Haleakalā?

There are no native ants on the Hawaiian Islands, so most of the insects that evolved here are not adapted to defend themselves against the aggressive predatory abilities of large colonies of Argentine ants. Native Hawaiian insects are often soft-bodied and flightless—easy prey for the Argentine ant's ground forces. Argentine ants are voracious feeders and other insects are only one item on their wide-ranging menu.

In addition to preying on native insects, Argentine ants also may prevent these natives from using rocks, logs and other objects for cover. These ants often nest under objects of this type. In the extreme environment of the alpine/aeolian zone, that cover may be important refuge to the native insects to shelter them against the midday sun, the nighttime cold, and the wind.

In Haleakalā National Park, researchers who surveyed native "arthropods" in ant-infested areas and non-infested areas found that the ants reduce the populations of native species. (Arthropods are a group of invertebrate animals with jointed bodies and limbs that includes insects, spiders, scorpions, mites and centipedes.) The effects are especially severe at higher elevations, where the prey species are fewer in number. Species that are known to be severely affected by Argentine ant predation in the park include native bees and moths, which are the main pollinators for native plants such as *'āhinahina*.

Another advantage Argentine ants have is that there are no predators, competitors, or parasites in the alpine/aeolian ecosystem. Argentine ants are well known for displacing native insect and ant species elsewhere in the world. Researchers and resource managers at the park are concerned that the same thing could happen at Haleakalā.

How Are the Ants Spreading in the Park?

Since the first Argentine ants were found in Hosmer Grove in 1967, the ants have expanded their territory each year, spreading steadily outward through the budding process described above. In 1982, a second population of Argentine ants was discovered in the park, at the parking lot at Kalahaku Overlook, further up the mountain.

Given the Argentine ant's tendency to hitch a ride with humans, it is not surprising that the first population found in the park was near Hosmer Grove, a picnic area and campground that receives a lot of visitors. Likewise, Kalahaku Overlook is frequented by large numbers of people.

Just over thirty years after it was first recorded in the park, the Argentine ant range has expanded to over 500 hectares (1200 acres, or about two square miles). That is about 4.5 percent of the entire area of the park. Researchers believe that much of the "crater" at Haleakalā could be inhabited by Argentine ants eventually, if no way is found to control their spread. According to one analysis, approximately 50 percent of the area of the park—including the west slope of the volcano and most of the western and central parts of the crater—is potential Argentine ant habitat.

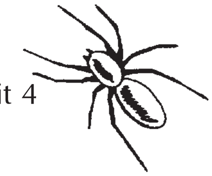
Sources

Fellers, J. H. and G. M. Fellers, "Status and distribution of ants in the Crater District of Haleakala National Park," *Pacific Science,* Vol. 36, 1982, pp. 427-437.

Krushelnycky, P. D., et al, *A Thirty Year Record of Argentine Ant Range Expansion in Haleakala National Park, Maui, Hawaii,* U.S. Geological Survey, Biological Resources Division, Makawao, Hawai'i, in preparation.

Krushelnycky, P. D. and Joe, S., *HNIS Report for* Linepithema humile, Hawaiian Ecosystems at Risk Project, March 1997.

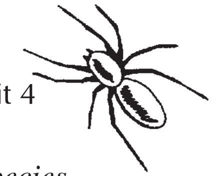
Passera, L., "Characteristics of Tramp Species" in *Exotic Ants: Biology, Impact, and Control of Introduced Species,* D. F. Williams (ed.), Westview Press, 1994.



Ants Video Note Sheet

Write notes based on what you learn watching *Ants! Little Creatures Who Run the World*.

Write something you learned from the video about ants, termites, or other social insects that illustrates each of these traditional Hawaiian values. *Laulima* — Cooperation, many hands or people working together on a task to accomplish a goal	
‘Ohana — Extended family system, the primary component of society. Individual interests are not as important as the interests of the group.	
Kuleana — Responsibilities and roles. If each member of society fufills his or her *kuleana*, all needs for survival will be met.	



Write at least two similarities and two differences between Argentine ants and other ant species on the video. Here are six areas of comparison to use for ideas. There are others, as well.

Argentine Ant Characteristics and Behaviors	**Note Two Similarities and Two Differences Between Argentine Ants and Other Ant Species**
• Argentine ant colonies reproduce by "budding." The new queens walk to their new nest site after having mated in the nest. Argentine ant males die after mating.	
• Argentine ants are voracious predators.	
• Argentine ants do not have permanent nests. They may move the entire nest from time to time.	
• Argentine ant nests have more than one queen.	
• Argentine ants do not defend their nests from other Argentine ants in the same area.	
• Other	

Argentine Ants Teaching Teams Background

Topic #1: The Location and Spread of Argentine Ants in Haleakalā National Park

Where Are the Argentine Ants?

[See Figure 1: Argentine Ant Populations in Haleakalā National Park, 1997, p. 28.]

Argentine ants were first found in the park at Hosmer Grove in 1967. Since then, the ants have expanded their territory each year, spreading steadily outward through the budding process described in the next section. In 1982, a second population of Argentine ants was discovered in the park, at the parking lot at Kalahaku Overlook, further up the mountain.

Just over thirty years after it was first recorded in the park, the Argentine ant range has expanded to over 500 hectares (1200 acres, or about two square miles). That is about 4.5 percent of the entire area of the park.

The lower elevation population is located southwest (leeward) of Hosmer Grove picnic and camping area, the original site of introduction at 2074 meters (6803 feet). This population is in native subalpine shrubland.

The upper elevation population was first discovered at Kalahaku Overlook at 2775 meters (9102 feet). Vegetation at this site is much more sparse, as in the alpine/aeolian ecosystem. This population has expanded primarily down the crater wall to the “crater” floor, and is now advancing across the “crater” floor.

How Far Could They Spread?

[See Figure 2: Potential Range of the Argentine Ant in Haleakalā National Park, p. 29.]

Based on patterns in range expansion over the past 30 years, researchers believe it is likely that the Argentine ant is capable of colonizing large parts of the park’s subalpine shrubland and aeolian zones.

Researchers have estimated the potential range of the Argentine ant within the park, taking into account rainfall, elevation, and habitat suitability (including nest site availability, vegetative cover, and estimated levels of food resources such as arthropods and nectar or honeydew sources). This predicted potential range covers the west slope and most of the west and central “crater.” If Argentine ants spread to this whole range, they would occupy nearly 50 percent (5500 ha or 13,585 acres) of the park’s total area.

This estimate does not account for the potential range outside of park boundaries, as you can see on the map.

How Quickly Are They Spreading?

[See Figure 3: Spread of the Lower Population, p. 30 and Figure 4: Spread of the Upper Population, p. 31.]

The two populations of Argentine ants are expanding at different rates.

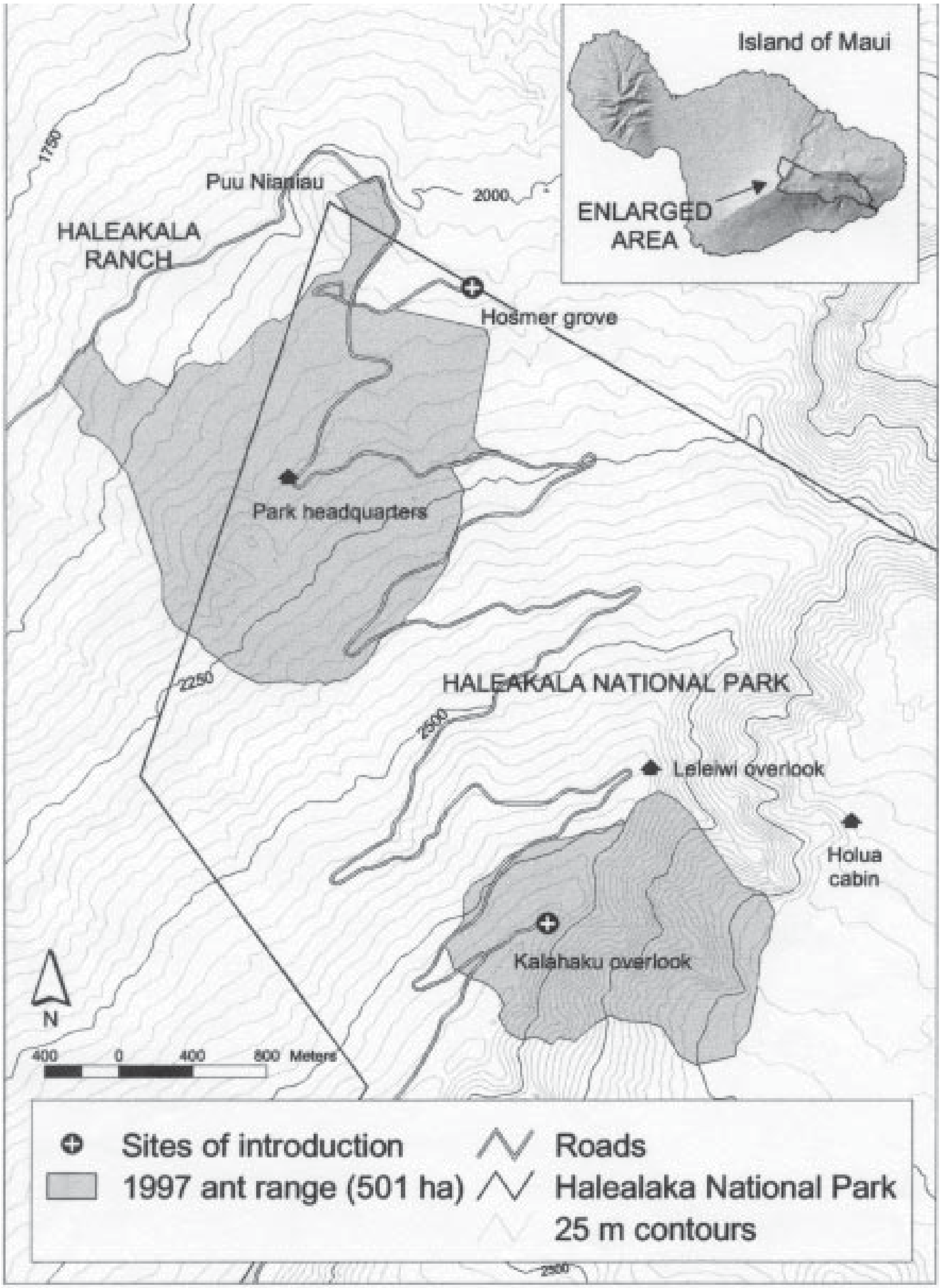
<u>Lower population</u>: The first surveys of ant distribution were done in the early 1980s, more than ten years after the ant was found at Hosmer Grove. The population’s rate of radial spread (expansion of the population boundaries outward from a central point) since 1982 has averaged approximately 29 meters/year.

Upper population: Expansion of this population has been much more dramatic, with spread exceeding 150 meters/year in some areas.

- For the first seven years in which this population was monitored, it spread roughly equal distances in all directions at a rate of approximately 24 meters/year.
- By 1993, westward spread continued at this pace, but the rate of spread toward the east had increased to about 81 meters/year, bringing the upper population to the "crater" floor.
- From 1993 to 1997, peak rates of spread (exceeding 150 meters/year) occurred at lower elevations in the crater. The population spread more slowly (23 meters/year) at the higher elevations west of Kalahaku Overlook on the "crater" rim.

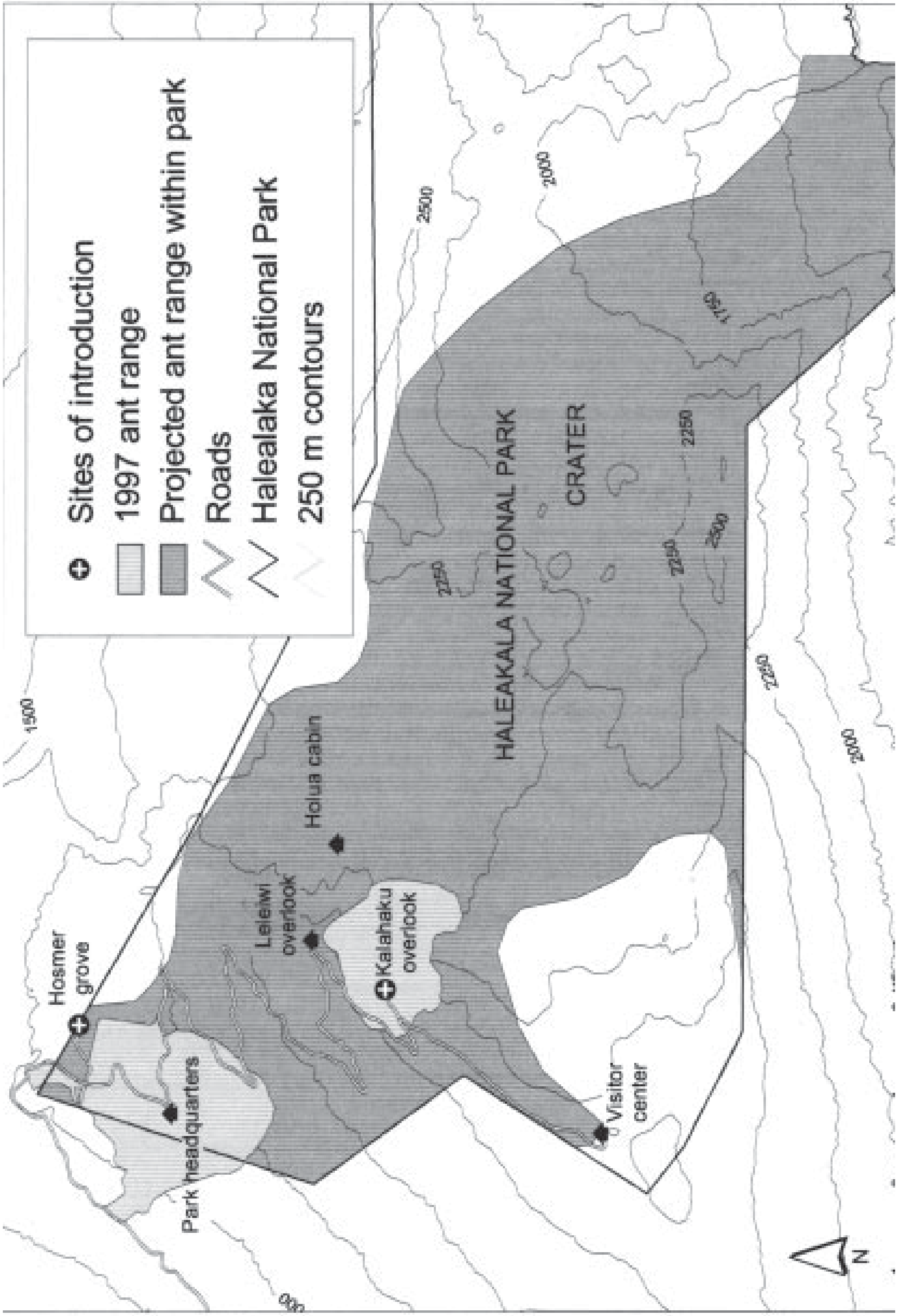
Note: On Figures 3 and 4, "pitfall sites" are indicated. Pitfall sites are the location of traps used to assess population numbers.

Figure 1: Argentine Ant Populations in Haleakalā National Park, 1997



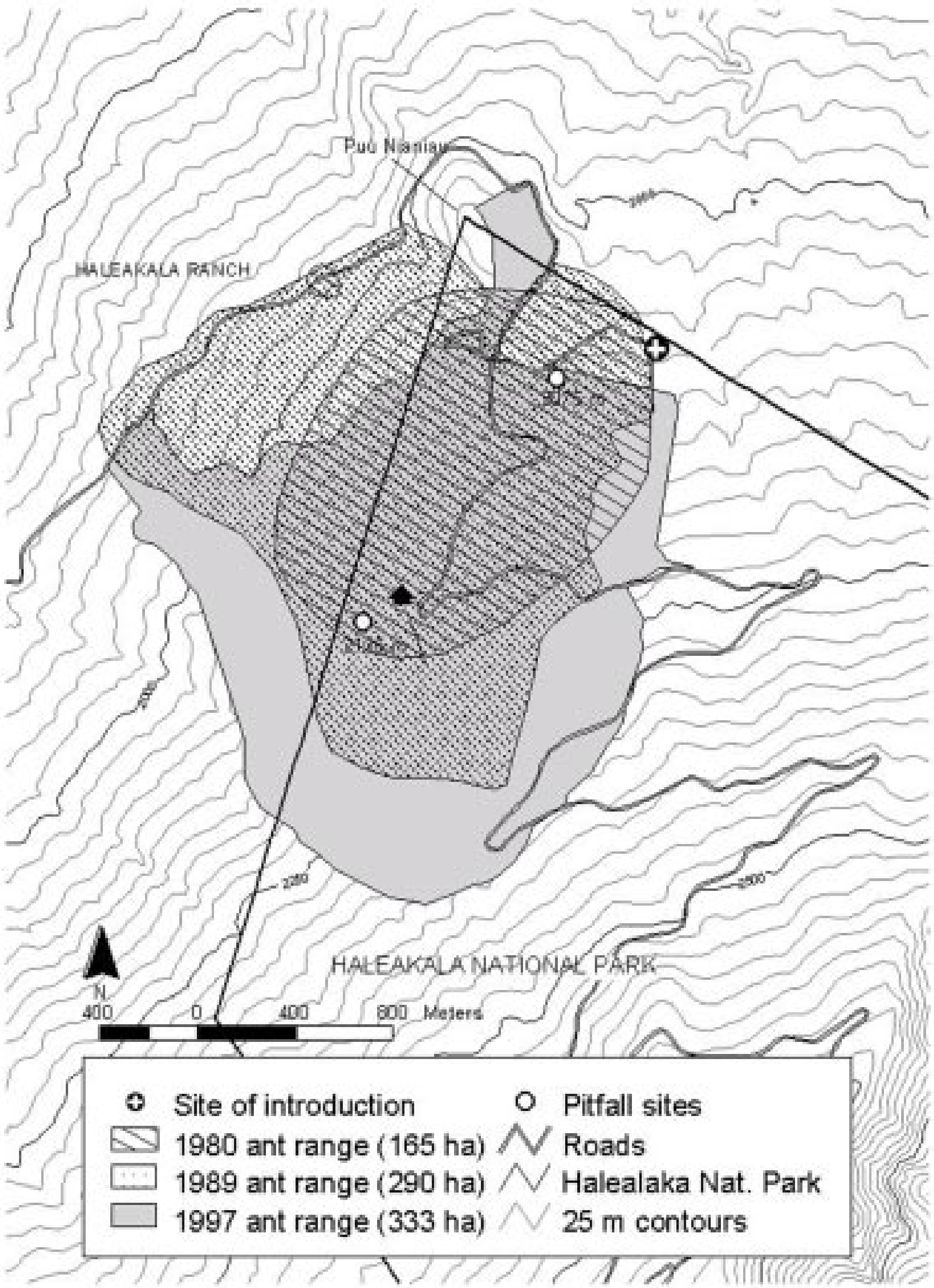
Map: Krushelnycky, Paul, S. Joe, Lloyd Loope, and Arthur Medieros, unpublished data.

Figure 2: Potential Range of the Argentine Ant in Haleakalā National Park



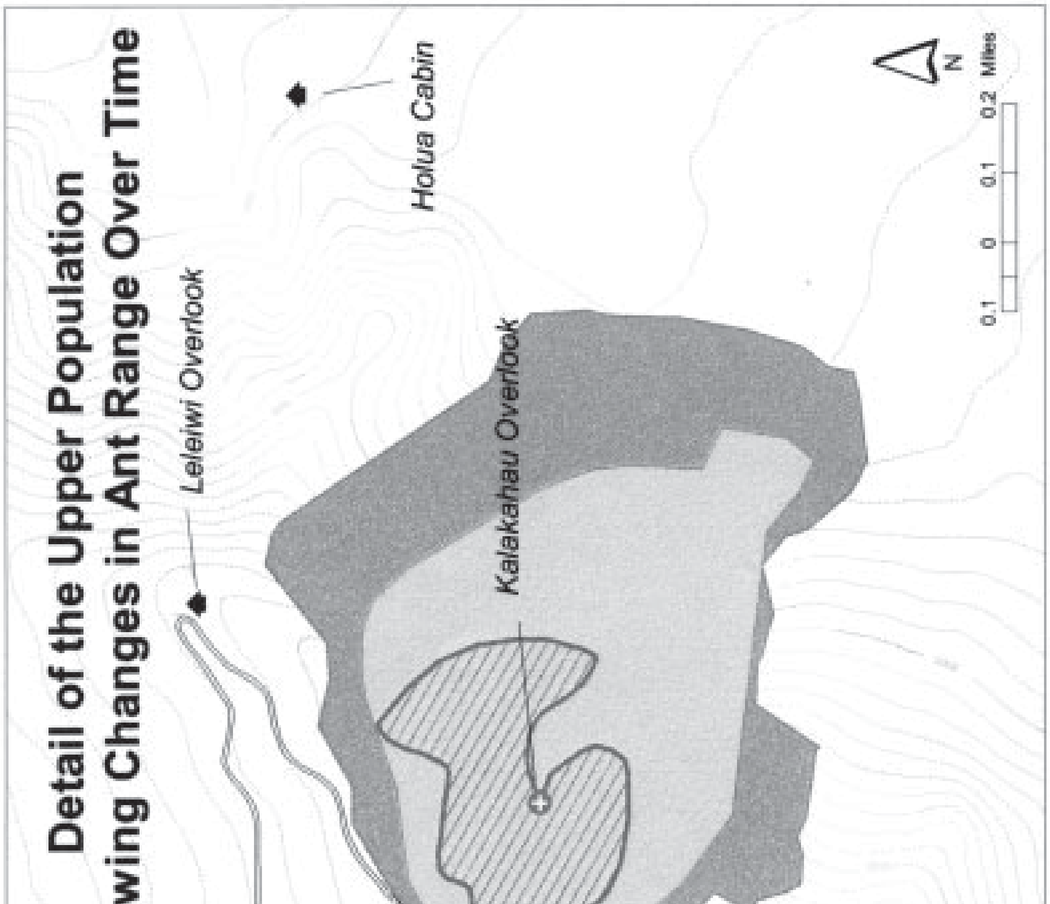
Map: Krushelnycky, Paul, S. Joe, Lloyd Loope, and Arthur Medieros, unpublished data.

Figure 3: Spread of the Lower Population (1997 range projected)



Map: Krushelnycky, Paul, S. Joe, Lloyd Loope, and Arthur Medieros, unpublished data.

Figure 4: Spread of the Upper Population



Map: Krushelnycky, Paul, S. Joe, Lloyd Loope, and Arthur Medieros, unpublished data.

Argentine Ants Teaching Teams Background

Topic #2: The Threat Argentine Ants Pose to Native Arthropods in the Alpine/Aeolian Ecosystem

In 1985 and 1986, researchers did a study to determine the impact of the Argentine ant on the native ground-dwelling "arthropods." (Arthropods are a group of invertebrate animals with jointed bodies and limbs that includes insects, spiders, scorpions, mites and centipedes.)

Researchers used two techniques in this study: "pitfall traps" and "under-rock surveys." They set up two study sites within the Argentine ant range and two outside of it.

The "pitfall traps" were specimen jars and baby food jars partially filled with an antifreeze solution to preserve trapped organisms. The inside rim of each jar was baited with finely blended salted fish. These traps were buried flush with the ground surface where they attracted foraging invertebrates that fell into the preservative in pursuit of the bait. After two weeks, the jars were removed and the contents sorted and identified in a lab.

The under-rock surveys provided additional information. From plots within the study site, researchers lifted rocks and catalogued the invertebrates they found under the rocks. The under-rock surveys provided information about some types of invertebrates that were unlikely to be caught in pitfall traps (because of their food source preferences, for example).

The study suggests that many native arthropod species are negatively affected by the presence of the Argentine ant. Other invertebrate species are positively affected, while still others do not seem to be affected one way or the other. Here are the native species the study suggests are most negatively affected by the Argentine ant.

- Large Lepidopteran larvae (the young of one of the endemic noctuid moth species)
- *Nesoprosopis* larvae (the young of the endemic Hawaiian yellow-faced bees). The study suggests that ants destroy the nests this ground-dwelling bee builds under rocks and feeds on the larvae.
- Carabid beetles
- Spiders including *Lycosa hawaiiensis*, the endemic wolf spider.

[See the following pages for informational cards about the native arthropods mentioned above.]

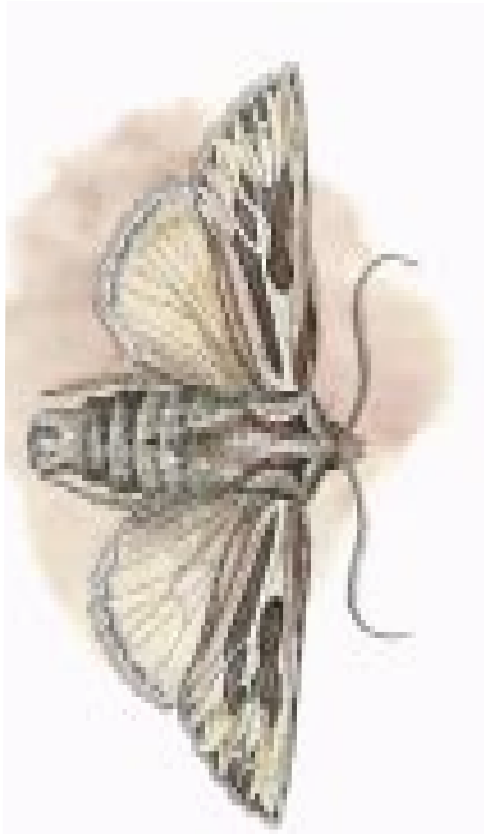


Image: Nancy Sidaras

Hawaiian Noctuid Moth (*Agrotis arenivolans*)

Order Lepidoptera, Family Noctuidae

Status Endemic to Hawai'i.

Habitat •Larvae have been seen feeding on the leaves of the native shrubs *pūkiawe* and *na'ena'e*. They also feed on the seeds of the *'āhinahina*.
•Caterpillars burrow in cinders during the day and feed at night.

Characteristics •Adults have a layer of long, thick hairs on their wings and bodies that help keep them warm, reflect sunlight and prevent water loss.
•Adult noctuid moths visit flowers at night, probably acting as pollinators for native plants.

Think about it: Noctuid larvae are abundant in the alpine/aeolian zone. But wherever the Argentine ant is established, very few of these caterpillars can be found. What do you think is happening?

Did you know? The larvae (caterpillars) of most Lepidoptera species around the world feed on plants. But the larvae of at least one Hawaiian noctuid moth species in the alpine/aeolian zone feed on other arthropods as well as on the leaves of the few plants that occur in the area. Their arthropod prey is either dead or in a stupor from the cold night air.

Image: Nancy Sidaras

Hawaiian Yellow-Faced Bee (*Nesoprosopis [Hylaeus] volcanicus*)

Order Hymenoptera, Family Colletidae

Status Endemic to Haleakalā.

Habitat Lays eggs in a winding, silken tube nest, usually under a rock.

Characteristics
•Solitary, unlike the social honeybee that lives in cooperation with other bees.
•Visits flowers to gather pollen and nectar to feed its young.
•Small—only 6-12 mm (.024-.048 in) long.

Think about it: Why would these small bees be so critical to the pollination of many native plants including *pūkiawe* and the *'āhinahina*?

Did you know? Another species of Hawaiian yellow-faced bee (*N. volatilis*) found in the alpine/aeolian zone is a nest parasite. It lays its eggs in the nest of *N. volcanicus* or the related *N. nivalis*. It may visit flowers, as well, but only to gather nectar to feed itself.

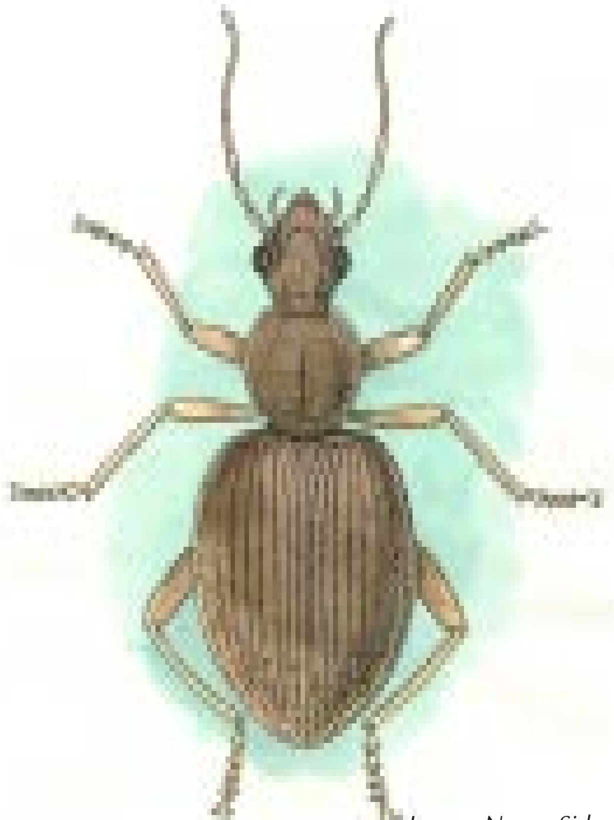


Image: Nancy Sidaras

Carabid Beetle (or Ground Beetle) (*Mauna frigida*)

Order Coleoptera, Family Carabidae

Status Endemic to Haleakalā. Of ten carabid beetle species recorded within the alpine/aeolian zone, nine are endemic to Haleakalā.

Habitat Five of the endemic carabid beetle species, including *Mauna frigida* have been found only on the upper 150 meters (492 feet) of the mountain's summit.

Characteristics

•These five species are flightless scavenger-predators.
•Thick exoskeletons protect them from water loss and extreme cold.

Think about it: These five species are extremely rare. Little is known about their current status or biology. Some of them may be extinct. How would you go about trying to find out?

Did you know? The 215 Hawaiian endemic carabid beetle species probably evolved from as few as six original immigrants.

Photo: Haleakalā National Park

Wolf Spider (*Lycosa hawaiiensis*)

Order Araneae, Family Lycosidae

Status Endemic to Haleakalā.

Habitat

•Live only at or near the mountain's summit
•Makes shallow burrows under rocks by cementing windblown leaves and other detritus together with silk. The burrows protect it from the cold, dry climate.

Characteristics

•Normally dark in color, turns silver when hunting among the *'āhinahina* rosettes.
•A predator-scavenger that hunts on the ground rather than building web.
•A large spider, measuring between 3.5-5 cm (1.4-2 in) in length.

Think about it: How might a dark-colored body and long legs help a wolf spider survive in the cold temperatures of the alpine/aeolian zone?

Did you know? Mother wolf spiders carry silk egg sacs (larger than their own bodies) beneath them. As the young hatch, they ride on their mother's back while she hunts.

Argentine Ants Teaching Teams Background

Topic #3: Biological and Behavioral Characteristics That Make Argentine Ants a Strong Invader

and

Topic #4: Characteristics of Argentine Ants That Affect How They Spread and Can Be Controlled

[For more information about these topics, see the Student Page "That Ant Is a Tramp."]

Because of the constant expansion of this species and its potential to seriously deplete endemic arthropod species (including essential pollinators for native plant species including the silversword), park researchers and resource managers began looking for a way to keep the ants from spreading to new areas.

Several basic biological and behavioral characteristics of the Argentine ant suggest that it would be vulnerable to a control strategy that uses toxicants (poisons). In brief, here are four of these characteristics and what that means for designing a control program:

1) Polygyne Colonies & Flightless Queens Disperse by Budding

These characteristics usually go together.

- "Polygyne" colonies have many queens.
- "Budding" is a process by which new queens will locate their new nests near their birth colony—usually within meters. Mating takes place within the birth nest. Afterward, along with a few workers from her birth nest, the new queen walks away to a new site and begins her own nest. She lays eggs and the workers that accompanied her in her relocation do the work of digging the nest and tending the brood.

This suite of characteristics is crucial to designing a control program. With Argentine ants, it is possible to treat the boundaries of the population to keep it from spreading further. This is because of the budding process through which the population expands slowly outward. A new, noncontiguous population will only be established if people transport the ants to a new place.

2) Unicolonial and Non-competitive

Argentine ant workers are not territorial. In other words, they do not defend territories against ants of the same species. In fact, workers born elsewhere are readily accepted into the nest. Workers often wander between nests, helping out in whatever nest they happen to be in at the time. New queens that disperse from their birth colony may also be accepted into an existing nest.

Because workers move around so readily and move the nest contents at the slightest disturbance (see the Student Page "That Ant is a Tramp" for more detail about this) there is no well-defined colony. It is often impossible to distinguish between nests. This is called a "unicolony." The population is essentially one large colony with high densities of ants. These high-density colonies often dominate their habitat and usurp other ground-dwelling arthropods.

This set of characteristics has two major impacts on a control program:

i) There is no way to control the Argentine ant population one nest at a time; and
ii) Argentine ants respond in large numbers to introduced baits. In areas of high ant

densities, researchers believe ants will quickly take most of the bait back to their nests, leaving little behind for whatever non-target species are left in the area. If that is true, the use of toxicants combined with bait is likely to have maximum impact on the Argentine ants and minimal impact on other species.

3) Seasonal Food Preferences

Argentine ants prefer different food types at different times of the year. During the summer, they are attracted to protein-based baits. During the winter, the same baits are much less effective. This characteristic is important for determining what time of year to treat using a particular bait. It is also a good reason to do a year-long bait preference test.

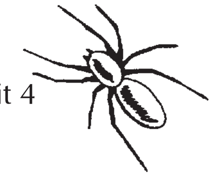
4) Trophallaxis

"Trophallaxis" is a process by which regurgitated food is passed among colony members. Food is exchanged in this way between workers, from workers to brood, and from workers to queens. The process of trophallaxis within ant colonies allows food to be passed quickly through the nest. This process is typical of most ant species.

In designing a control program aimed at eradicating ants, it is important that the workers pass on the toxicant to other ants, especially the queen, so the whole colony is poisoned and cannot repopulate itself. Since workers are the first to eat the food (then pass it on to others through trophallaxis) the toxicant needs to be slow acting, so workers have a chance to pass it on before they die. Combining a slow-acting toxicant with a highly attractive bait is a key to success.

In Contrast to the Argentine Ant…

- Many ant species have "monogyne" (single queen) colonies. Tramp species often have the polygyne colony type.
- Many ant species disperse by a process in which new queens go on a "nuptial flight" or mating flight along with winged males. In these species, the new nest can be kilometers away from the new queen's birth colony. The males die after mating, and the new queen has not been accompanied by any workers. She digs a hole in the ground and seals herself in. She raises the first brood of workers by herself and feeds them off her fat reserves. When these workers are born, they take over the work of the nest (gathering food, maintaining the nest, tending the brood, etc.) and the queen continues laying eggs.
- In species whose queens disperse by flight, new populations can be established far away from the original colony and are difficult to track.
- For many ant species, the nest and the colony are the same. The colony is distinct from other colonies.
- Colony workers in many ant species are territorial. They defend the area from all other ants, including ants of the same species from other colonies.
- Most ant species are "multicolonial." A population of these ants is made up of many separate colonies. One common control method is to exterminate an individual colony, for example by dousing the nest with a liquid that kills ants on contact.



Argentine Ants Quiz

1) Explain Argentine ants' response to a disturbance in their environment, such as a vibration, change in weather, or a manipulation of their nest.

2) How could this type of response help Argentine ants "hitch a ride" with humans?

3) How many different populations of Argentine ants are known in Haleakalā National Park today?

4) Is the size of those populations getting bigger, getting smaller, or staying about the same?

5) Give two reasons why Argentine ants are considered a threat to native insects and plants in Haleakalā National Park.

   i)

   ii)