The effects of introduced slugs and snails on native Hawaiian snails and plants

Standards addressed:

5-ESS3 *Earth and Human Activity*
5-ESS3-1.

- Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Language Arts-Common Core Math

- Reading-informational
- Writing-text, types, and purposes
- Students will learn about native Hawaiian snails and the impact introduced slugs, snails, and flatworms had on their populations.
- Students will understand biocontrol and why or why not it may be effect in controlling pest populations.
- Studens will learn of the impact of introduced gastropods on rare, native plant species.

Reading for understanding:

Native snails

There are native, endemic terrestrial snails in Hawai'i, many species of which are now endangered or threatened. It is estimated that there may have been 750-1200 different native snail species before western contact with the Hawaiian Islands. Snails may have arrived drifting on **floatsam**, or even hidden in the feathers of birds that are capable of long-distance flight. Once the snails arrived they went through something called **addaptive radiation**, which is a process familiar to many new plant and animal arrivals to these isolated islands and makes Hawai'i's **endemic** species so unique. Addaptive radiation is the **diversification** of groups of organisms that results as different **ecological niches** are filled. When nature is left with a blank canvas it gets creative. Many of Hawai'i's native plants and animals are the result of adaptive radiation from the original **founder** organism. A founder

organism is the one that got here first. The islands of Hawai'i have different ages, with the youngest island to the east (Hawai'i Island) and the oldest island to the west (Kaui, Ni‘ihau, and the Northwest Hawaiian Islands). The oldest and most colorful native snails are found on the oldest islands, where they have had a longer time to evolve.

Introduction of invasive slug and snail species

The Hawaiian Islands have been impacted by both the intentional and accidental introduction of non-native species, many of which have had bad effects on native species. Among these are slug and snail species that arrived with horticultural shipments and as **bio-control** agents. One of the earliest observed non-native gastropod arrivals is the giant African snail *Achatina fulica*. This snail was intentionally brought into Hawai'i in 1936 by a young woman returning from Taiwan, which was called Formosa at the time. She carried them in her baggage and released them into her garden on Oahu. She did not tell inspectors she was bringing them into Hawai'i and the inspectors did not discover them. In November of the same year, another man from Makawao, Maui imported giant African snails from Japan through the mail with the intention of breeding them and selling them for medicinal purposes. The infestations on both islands were not discovered for two years, by which time, despite intensive control measures, populations grew so large they were impossible to eradicate.

Bio-control gone bad

This large-bodied snail population grew so dense that in the 1950’s the Hawai’i Board of Agriculture and Forestry, which is now called the Department of Agriculture, began to examine the potential for bio-control of the giant African snail with **predacious** snail species. Due to public pressure to reduce the population of this large snail, a thorough study was not carried out to determine the possible detrimental effects of **bio-control** (biological control). Between 1952 and 1957, three predacious snail species were released: *Gonaxis kibweziensis, Gonaxis quadrilateralis, and Euglandina rosea,* the rosey wolf snail. These three species became established and began to prey on the giant African snail, but they also preyed on the approximately seven hundred and fifty species of endemic terrestrial snails, destroying many of these populations. Most native species are now extinct with estimates of only 10-35% of original native species remaining. None of these

introduced predacious snails were effective in controlling the giant African snail and instead, these introduced species have added to the problem of disease as the rosey wolf snail has been identified as an intermediate host of *A. cantonensis*. The predacious New Guinea flatworm *Platydemus manokwari* was also introduced to control the giant African snail and it has also been identified as a carrier of the rat lungworm parasite in Hawaii. An excellent story about the invasion of Hawai'i by the giant African snail, the selection and release of predatory snails, and the effects of those predators on the giant African snail can be found here: http://hl-128-171-57-22.library.manoa.hawaii.edu/bitstream/10125/10889/1/18_377-390.pdf

Native versus non-native snails

Native Hawaiian snails once thrived on all of the major island. Many of these were banded with bright colors and were very beautiful. These snails did not roam far but spent their lives in one or several trees that grew in a very small area. The snails did not hurt the trees but fed on fungus growing on the trees. These nocturnal snails had no predators and they evolved to be slow-moving creatures that had a low reproduction rate. Some of these still remaining native snails do not become mature enough to reproduce until they are three to five years old, and then they may only have four to seven offspring per year. Some of these native snails have eggs that are hatched inside the snail and born alive. These snails may live for over ten years. The low reproduction rate of native snails make it difficult for their populations to rebound if the population is impacted by **adverse** factors, such as from predators and competition from outsiders.

Because of their great beauty, the native snails were valued by people, including Native Hawaiians. As westerners settled on the land men came from around the world to gather these beautiful snails and collections of snails became something desired by people. Where there was once an abundance of snails living in a single tree, numbers began to decline with over-harvesting. Besides the over-collection by humans, native snails were also impacted by habitat destruction from many sides and invaders. Destruction of habitat by both humans and invasive species, including pigs, rats and invasive predacious slug, snails, and flatworms, further threatened populations of native snails. Populations crashed and many species are now extinct or threatened. There is a small population of endangered native snails on Oahu that are protected by an enclosure designed to keep out rats, and slugs and

snails. The population is monitored, and the Department of Land and Natural Resources (DLNR) has a captive breeding program to try to raise more snails. The Bishop Museum is an excellent repository for native snail collections and more information on these unique gastropods can be found at the museum. Dr. Norine Yoeung is the malacologist at the Bishop Museum and is very knowledgeable about native and invasive gastropds. This link from the Bishop Museum is informative.

: https://www.bishopmuseum.org/collections-3/malacology/

Dr. Robert Cowie at UH Manoa, is also very knowledgeable about native snails and invasive snails and is a good resource for more information

.

Invasive slugs and snails damage native plants

Native plants are also impacted by invasive species including slugs and snails, which eat them, particularly seedlings. This impacts forest **regeneration** and the preservation of endangered plant species. Because native plants evolved relatively free from competition by **herbivores**, native plants do not have the defenses to protect themselves from these invaders, such as strong, **offensive** tastes and smells. Hawai'i does have native snails but there is no evidence that native snails ate live plant tissue, and instead, they grazed on algae and fungi growing on the trees they inhabited. Invasive species, however, were shown in a review by the Rare Plant Recovery Plan produced by the U.S. Dept. of Fish and Wildlife, to be very detrimental to plants. Slugs were a potential threat to 22% of all of Hawai'i's endangered and threatened plants. Scientists also found that plants that are **critically endangered** (those plants that without intervention their extinction is **immenent**), when exposed to slugs had 50% higher **mortality** than those plants that were protected from slugs, and these plants were fairly large, grown in nurseries, and **outplanted**. We can assume that the damage would be even higher in seedlings. The slugs chewed on the stems of the seedlings, often returning to the plant night after night to continue feeding, until they finally killed the seedling. When considering the loss of our forests due to rapid ohia death, germination of native seedlings is crucial to prevent total forest loss.

Learning Activities:

- If possible, visit a museum, such as the Bishop Museum in Honolulu, or the Lyman Museum in Hilo, and look at the native snail collections. Visits can be in real time or virtual. The Bishop Museum has a good website on native snails.
- What are the differences in the geological ages of the main Hawaiian islands, starting from the oldest, Ni‘ihau, and going to the youngest, Hawai'i? Can you see differences or similarities in the appearances of the snails that are native to each of the main islands? Describe them.
- Students are asked to define what the meaning of the terms non-native, and invasive. Students research these terms and then define, in their own words using examples, the difference, if they feel there is one, between the two terms.
- How have native species been impacted by invasive species? Pick a subject and then conduct research and create a presentation on the effect of an invasive species on native Hawaiian species.
- Students research the measures the State of Hawai'i takes to prevent the entry of invasive organisms into Hawai'i. Discuss if you feel these methods are effective. How can they be changed to improve? What can one of us do to help our native species? What can each one of us do to control invasive species?
- Learn about efforts to protect native snails in Hawai'i at http://dlnr.hawaii.gov/ecosystems/hip/sep/ https://blogs.scientificamerican.com/guest-blog/singing-snails-and-killer-whales-parallels-in-conservation/
- Learn cultural stories about native Hawaiian snails. http://www.huapala.org/Kah/Kahuli_Aku.html

http://hawaiianforest.com/wp/investigating-the-singing-kahuli-oahu-tree-snails/

This material is written by Kathleen Howe and produced by the Hawaii Island Rat Lungworm Working Group with funding from the Hawaii Invasive Species Council and support from the Daniel K. Inouye College of Pharmacy. Photo credits: Jarvi Lab.