

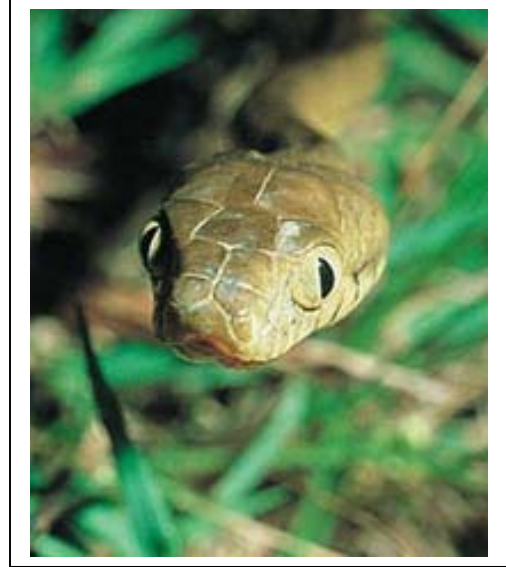
ISSUES – FIGURE SET

What Are the Impacts of Introduced Species?

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Brown tree snake, *Boiga irregularis*
photo © G. H. Rodda, USGS
{biology.usgs.gov/s+/
imagefiles/x181w02.htm}

Figure Set 3: Brown Tree Snakes and Bird Extinctions on the Island of Guam

Purpose: To help students understand the impact of snakes and other introduced predators on island fauna.

Teaching Approach: "guided class discussion"

Cognitive Skills: (see Bloom's Taxonomy) — knowledge, comprehension, application, synthesis, analysis

Student Assessment: rebuttal essay

BACKGROUND

Extinctions following species introductions have taken place in many different settings worldwide, but islands are especially vulnerable. For instance, some islands contain unique species and therefore lost species cannot be reintroduced. On islands such as New Zealand, animals, which have evolved in the absence of predators, are especially vulnerable to being eaten by rats, mongoose, snakes and other predators. The flightless birds are classic examples of this scenario. Hawaii is one of the hardest hit areas in the world in regard to extinctions due to alien species. There were 98 species of birds native to the Hawaiian islands before Polynesians introduced rats, dogs, and pigs around 400 A.D. As a result, about 50 bird species became extinct before European arrival in 1778. Since then about 20 more bird species have become extinct (Primack, 1995). In addition to habitat loss, introduced species are a main reason for this decline.

The disappearance of wildlife on the island of Guam is an intriguing example of damage due to an introduced species. On Guam, like Hawaii and many other islands, about half of the native birds were exterminated by prehistoric humans. After that, bird species numbers remained fairly stable - even through World War II - until the 1960's when biologists realized that birds were disappearing from the south end of the island. By 1985, most of the bird species were either completely gone or living in small, isolated pockets (Rodda et al., 1997).

Two popular theories in the '80's explaining this loss were pesticides left over from the war and disease. When Julie Savidge (Savidge, 1987; see student question) reported her findings about predation rates by the brown tree snake, most researchers were quite skeptical and did not believe that a snake could harm so many birds (ibid). Ecologists now understand that this is entirely plausible.

Stories about Guam's brown tree snakes are fascinating (Rodda et al., 1997). One concerns the bizarre cases of Guam's baby bites. Brown tree snakes are not venomous like vipers and so reports of their biting human babies were at first not believed. But the numbers of reported cases kept rising into the hundreds. Particularly surprising was the fact that most victims were infants sleeping at home, not outdoors. Apparently the snakes enter homes at night and repeatedly attempt to regrip a food source (the baby) that is much too large. Most infants were not harmed very much by the bites but a few needed assistance breathing in the hospital. In the wild, brown tree snakes can eat prey more than 70% of their mass, which is extremely unusual for non-vipers.

The snakes are thought to have been introduced to Guam during postwar salvage operations. Brown tree snakes are native in eastern Indonesia, New Guinea and in Australia. They are nocturnal and likely crawled into vehicles and equipment at night and were carried to Guam where they crawled out again undetected at night.

References

- Primack, R.B. 1995. *A Primer of Conservation Biology*. Sunderland, MA: Sinauer.
- Rodda, G. H., T. H. Fritts, and D. Chiszar. 1997. The disappearance of Guam's wildlife. *BioScience* 47: 565-574.
- Savidge, J. A. 1987. Extinction of an Island Forest Avifauna by an Introduced Snake. *Ecology* 68: 660-668.

STUDENT INSTRUCTIONS

Read the information below and then examine Figure 3. Take your time with this graph; make sure you understand the labels on the axes, the legend, and the experimental design before you attempt to interpret the data.

Guam is a tiny island halfway between Japan and New Guinea (which is north of Australia). Many lovely forest birds were abundant on Guam - birds with names like the White-tailed Tropicbird, the Blue-Crested Quail, the Nightingale Reed-warbler, and the Mariana Fruit-dove. But in the 1960's and '70's these and many other birds disappeared from the island. Some are now extinct, others rare.

Two popular theories explaining this loss were pesticides left over World War II (Guam was at the center of fighting in the Pacific) and disease. When Julie Savidge reported her findings about predation rates by the introduced brown tree snake (see Figure 3), most researchers were quite skeptical and did not believe that a snake could harm so many birds. Her's was some of the first research to show that this is entirely plausible.

Savidge examined the theory that brown tree snakes were preying on birds on Guam by baiting traps with birds (quail) and counting birds eaten. The traps contained seeds and waters for the birds inside and a hinged door that allowed a predator to enter but not escape. Because the snake and the birds lives in trees, she hung the traps about 1-3 meters above the forest floor.

After you describe and then interpret the figure, consider the following questions:

- Why did Savidge use 3 different types of sites (birds extinct, declining, stable)? What question was she asking?
- Why might predation rates be high in one location and low in another? How would you test your ideas?
- What other evidence, in addition to the data in this figure, would help convince you that bird extinctions on Guam are due to predation by the introduced brown tree snake?

FIGURES

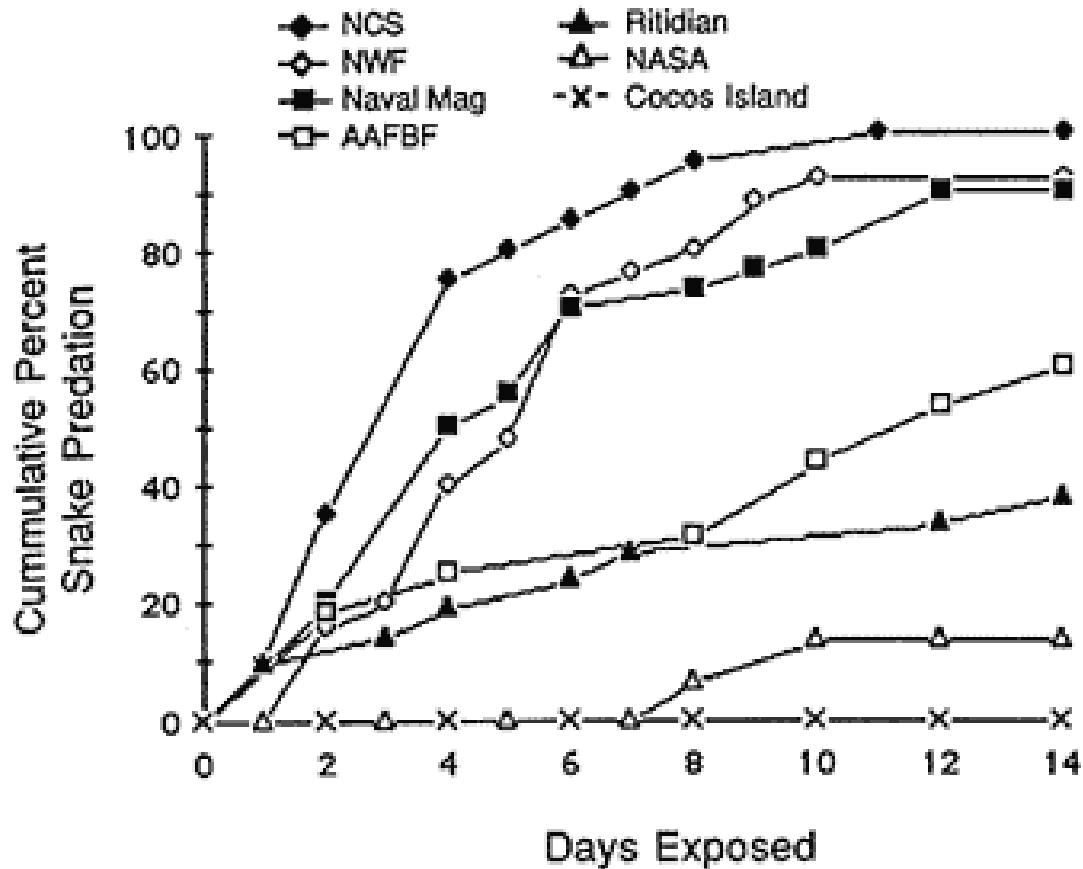


Figure 3. Predation by snakes on birds in traps exposed for up to 14 days in 7 different sites on the island of Guam and comparison locations. In the NCS, NWF, and Naval Mag. sites, birds were extinct or rare. In the Ritidian and AAFBF sites, birds were declining. In the Coos Island and NASA sites birds were stable. Once the bait was preyed on, it was not replaced. The number of traps ranged from 15-30 at the different sites. Predation by rats and lizards were excluded. (from Savidge, J. A. 1987. Extinction of an island forest avifauna by an introduced snake. *Ecology* 68: 660-668).

FACULTY NOTES

Savidge found very high rates of predation by brown snakes in areas where bird numbers had declined, but little or no predation in areas where populations of birds were stable. She attributes the difference to different habitats in grassy savannas and wetlands snakes are less abundant (and some birds more so) because of the scarcity of trees. Also urban sites are a refuge for some birds.

Savidge attributes *Boiga's* success on Guam to several factors 1) availability of alternative prey (small reptiles, rats, chicken eggs) maintain high populations, 2) absence of predators and competitors, and 3) low forest canopy on Guam which allows easy access to birds.

There is a strong negative relationship between snake density (average is around 1 snake/acre) and bird density. This evidence supports Savidge's predation data.

Data are from:

Savidge, J. A. 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68: 660-668.

Student Assessment: Rebuttal Essay

In an article from the Honolulu Star Bulletin (2/26/97) announcing millions of dollars for control of the brown tree snake in Hawaii, some dissenters disagreed with the new initiative: "Taxpayers' groups routinely dismissed the appropriation as wasteful, the U.S. News and World Report scorned it as 'silly spending,' and Vice President Al Gore, in his 1993 report on 'reinventing government,' called it pork-barrel politics at its worst." In a 200 word essay, rebut these critics. (Note: additional references are in the Introduced Species Overview)

Evaluating an Issue: How do you know whether it is working?

On-going (also called formative) evaluation of the approaches you are using is critical to the success of student-active teaching. Why try out new ideas if you don't know whether or not they are working? This is a brief overview of formative evaluation. For more information, go to the Formative Evaluation essay in the Teaching Section.

Course Goals:

Formative evaluation only works if you have clearly described your course goals - because the purpose of the evaluation is to assess whether a particular technique is helping students reach these goals. For instance, most of us have "learn important ecological concepts and information" as a course goal. If I reviewed the nitrogen cycle in a class, for evaluation I might ask students to sketch out a nitrogen cycle for a particular habitat or system. Each student could work alone in class. Alternatively, I might ask students to work in groups of 3 and give each group a different situation (e.g. a pond receiving nitrate from septic systems, an organic agricultural field, an agricultural field receiving synthetic fertilizer). The students could draw their flows on a large sheet of paper (or an overhead transparency) and present this to the rest of the class.

The Minute Paper:

Minute papers are very useful evaluative tools. If done well they give you good feedback quickly. Minute papers are done at the end of a class. The students are asked to respond anonymously to a short question that you ask. They take a minute or so to write their response in a 3x5 card or a piece of paper. You collect these and learn from common themes. In the next class it is important that you refer to one or two of these points so that students recognize that their input matters to you. The [UW - FLAG site](http://www.wcer.wisc.edu/nise/cl1/flag/) (www.wcer.wisc.edu/nise/cl1/flag/) gives a good deal of information about using minute papers including their limitations, how to phrase your question, step-by-step instructions, modifications, and the theory and research behind their use.