Module 3 ~ Why Manage Invasive Plants (UE/MS)

Effects of Alligator Weed Flea Beetles (*Agasicles hygrophila)* **on Alligator Weed Growth**

UF Brain Bowl Laboratory Exercise
Courtesy of Dr. Bill Overholt -- UF/IFAS Indian River Research & Education

Introduction

The greatest success in biological control of weeds in Florida was a program against alligator weed, *Alternanthera philoxeroides.* Alligator weed is an aquatic plant from South America that was first seen in the United States around 1890. In the 1960s, three species of insects from South America were introduced into Florida to control alligator weed; a thrips (*Amynothrips andersoni*), a moth (*Vogtia malloi*) and a flea beetle (*Agasicles hygrophila*). The flea beetle was, and continues to be, the most successful agent.

Methods and materials

Week 1

1) Each team receives 2 potted alligator weed plants.

2) Teams will count the number of leaves and nodes on each plant and measure the heights of the plants.

3) One of the plants will then be infested with 10 adult *Agasicles hygrophila*. The pots will be covered with an acrylic cylinder to contain the beetles. Control plants without beetles will also be held in acrylic cylinders.

Week 2

Continue to monitor the plants but take no action.

Week 3

1. The number of leaves and nodes on each plant will be counted and plant height will be measured. The growth of infested and control plants between week 1 and week 3 will be calculated.

2. Count the number of eggs, larvae, pupae and adults. Note that pupae are inside the stems so the stems will need to be dissected.

3. Assessment of overall plant conditions will be estimated using a scale of 0-5, with 0 = no damage and 5 = severe defoliation.

Week 3 (continued)

4. Students will describe the damage (parts of the plant consumed, consumption of new growth vs. old growth).

5. Data from the three teams will be pooled to calculate mean growth of infested and control plants based on three parameter:
    i. increase in number of leaves during two weeks
    ii. increase in number of stem nodes during the two weeks
    iii. increase in plant height during two weeks
    iv. average damage score

6. Students illustrate data using graphs and then discuss the impact the beetles had on plant performance.

Additional Resources and Background Information

- *How Scientists Obtain Approval to Release Organisms for Classical Biological Control of Invasive Weeds:* http://edis.ifas.ufl.edu/IN607 & http://edis.ifas.ufl.edu/pdffiles/IN/IN60700.pdf

- *Alligatorweed flea beetle* Agasicles hygrophila*:* http://edis.ifas.ufl.edu/in831

- *Hydrilla Tip Mining Midge (unofficial common name), Cricotopus lebetis (Insecta: Diptera: Chironomidae):* http://edis.ifas.ufl.edu/pdffiles/IN/IN21100.pdf

- *Biological Control of Weeds -- It's a Natural!* http://plants.ifas.ufl.edu/education/misc_pdfs/biocontrol_brochure.pdf

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Alligator Weed Flea Beetle – Background Information

LIKE ALL NATURAL ECOSYSTEMS, Florida's native habitats have developed a complex system of checks and balances that prevent the overpopulation of plant and animal species and maintain a healthy natural environment. Every native plant in Florida has evolved with specific natural control mechanisms such as fluctuating water levels, or natural enemies, including herbivores and pathogens. These various environmental restraints help regulate both our native plant and animal populations.
When a **non-native** plant species is introduced into a Florida habitat, it may have competitive advantages over native plant populations because the natural controls that regulate the introduced plant (in its native range) may not exist in Florida. As a result, the non-native plant often flourishes and out-competes Florida's naturally controlled native plants. When the non-native plant begins to do environmental or economic harm, it is considered invasive. This happened with a number of non-native aquatic plant species in Florida. Once introduced, the plants began to replace native species, clog waterways, degrade water quality, and impede recreation and navigation. Efforts to control these **invasive** plants in our state natural areas are costing many millions of dollars each year – and that's just for aquatic invasive plants!

ONE WAY TO MANAGE INVADING NON-NATIVE PLANTS in Florida's water systems is to use biological control agents such as insects, fish and pathogens. The term **biological control** refers to the purposeful introduction of natural enemies as a means of weakening and suppressing invading plants. **Biocontrol agents** are used to decrease the invasive plants' competitive ADVANTAGES over native species, and to weaken the invading population by:

- increasing leaf mortality;
- decreasing plant size;
- reducing flower and seed production;
- limiting plant population expansion.

For more than forty years, scientists and researchers have been working to introduce non-native biological controls to combat non-native invading plant populations in Florida. Thirteen biological control agents have been studied and released since the 1960s.

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Alligator weed and the alligator weed flea beetle

In 1963, there were 97,000 acres of alligator weed infestation in the US. By 1981 there were less than 1,000 problem acres. What happened?

Alligator weed flea beetles (*Agasicles hygrophila*) were imported from Argentina and first released in Florida in 1964. This was the first time biocontrol insects were used on aquatic plants in the US.
The beetles are a member of the *Chrysomelidae* family and consume the leaves and parts of the stems of the aquatic form of alligator weed. The alligator weed flea beetle has a short life cycle of only 30 days and both adults and larvae feed on alligator weed. It's been found that the flea beetle is only effective in warm, temperate areas where it can breed in high numbers in early summer. Oddly enough, it does not attack alligator weed growing on land. Given the difficulties and expense associated with chemical and mechanical control, biological control agents are an attractive option for controlling alligator weed over the long term.

However, the development of a biological control is a complex process, requiring success at a number of separate stages. Once identified, suitable agents must be approved for release, reared in captivity and then become established in the field. The hope for future biological control agents must therefore be balanced by the possibility that they may not be available or successful in all circumstances.

Alligator weed flea beetles can be found throughout Florida wherever alligator weed occurs.
The plant grows both terrestrially along the banks of canals, ditches, rivers and lakes and also rooted in shallow water where mats form and expand over water surfaces. Interestingly, the beetles only attack alligator weed which is growing in the water.

Adult beetles are easily recognized by the black and yellow longitudinal bands on their forewings, and are about 3/8" long. The eggs are yellow-cream colored and laid in groups of about 30 eggs, which hatch into dark colored larvae. Fully grown larvae chew a hole in the hollow stem and pupate inside the stem. Adult beetles can easily be collected in an insect net by sweeping the net over alligator weed infested with beeltes. Beetle populations are highest from spring through fall, but decline in the winter.

Eggs of alligator weed flea beetle

Big larvae of alligator weed flea beetles

Small larvae of alligator weed flea beetles

Text excerpted from http://plants.ifas.ufl.edu/guide/biocons.html
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Sunshine State Standards

Note: Standards listed in *italics* are touched on briefly and can be more fully developed by the teacher.

6th Grade
LA.6.4.2.1: TSW write in a variety of informational/expository forms (e.g., summaries, procedures, instructions, experiments, rubrics, how-to manuals, assembly instructions).
LA.6.4.2.2: TSW record information (e.g., observations, notes, lists, charts, map labels, legends) related to a topic, including visual aids as appropriate.
LA.6.5.2.1: TSW listen and gain information for a variety of purposes, (e.g., clarifying, elaborating, summarizing main ideas and supporting details).
SC.6.N.1.4: TSW discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
MA.6.A.3.6: TSW construct and analyze tables, graphs and equations to describe linear functions and other simple relations using both common language and algebraic notation.
MA.6.S.6.1: TSW determine the measures of central tendency (mean, median, mode) and variability (range) for a given set of data.

7th Grade
LA.7.4.2.1: TSW write in a variety of informational/expository forms (e.g., summaries, procedures, instructions, experiments, rubrics, how-to manuals, assembly instructions).
LA.7.4.2.2: TSW record information (e.g., observations, notes, lists, charts, legends) related to a topic, including visual aids to organize and record information, as appropriate, and attribute sources of information.
LA.7.5.2.1: TSW use effective listening strategies for informal and formal discussions, connecting to and building on the ideas of a previous speaker and respecting the viewpoints of others when identifying bias or faulty logic.
SC.7.L.17.2: TSW compare and contrast the relationships among organisms such as mutualism, predation, parasitism, competition, and commensalism.
SC.7.L.17.3: TSW describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.
SC.7.N.1.1: TSW define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.7.N.1.4: TSW identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.

8th Grade
LA.8.4.2.1: TSW write in a variety of informational/expository forms (e.g., summaries, procedures, instructions, experiments, rubrics, how-to manuals, assembly instructions).
LA.8.4.2.2: TSW record information (e.g., observations, notes, lists, charts, legends) related to a topic, including visual aids to organize and record information, as appropriate, and attribute sources of information.
LA.8.5.2.1: TSW demonstrate effective listening skills and behaviors for a variety of purposes, and demonstrate understanding by paraphrasing and/or summarizing.
LA.8.5.2.2: TSW use effective listening and speaking strategies for informal and formal discussions, connecting to and building on the ideas of a previous speaker and respecting the viewpoints of others when identifying bias or faulty logic.
SC.8.N.1.6: TSW understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.
MA.8.A.1.3: TSW use tables, graphs, and models to represent, analyze, and solve real-world problems related to systems of linear equations.

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A Collaboration of the UF/IFAS Center for Aquatic and Invasive Plants
and the Florida Fish and Wildlife Conservation Commission / Invasive Plant Management Section

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9th - 12th Grades

LA.910.4.2.1: TSW write in a variety of informational/expository forms, including a variety of technical documents (e.g., how-to-manuals, procedures, assembly directions).

LA.1112.4.2.1: TSW write in a variety of informational/expository forms, including documents using precise technical and scientific vocabulary (e.g., manuals, procedures, directions).

LA.910.4.2.2: TSW record information and ideas from primary and/or secondary sources accurately and coherently, noting the validity and reliability of these sources and attributing sources of information.

LA.1112.4.2.2: TSW record information and ideas from primary and/or secondary sources accurately and coherently, noting the validity and reliability of these sources and attributing sources of information.

LA.910.5.2.1: TSW select and use appropriate listening strategies according to the intended purpose (e.g., solving problems, interpreting and evaluating the techniques and intent of a presentation).

LA.1112.5.2.1: TSW demonstrate effective listening skills and behaviors for a variety of purposes, and demonstrate understanding by critically evaluating and analyzing oral presentations.

SC.912.L.17.5: TSW analyze how population size is determined by births, deaths, immigration, emigration, and limiting factors (biotic and abiotic) that determine carrying capacity.

SC.912.L.17.6: TSW compare and contrast the relationships among organisms, including predation, parasitism, competition, commensalism, and mutualism.

SC.912.N.1.1: TSW define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: 1. pose questions about the natural world, 2. conduct systematic observations, 3. examine books and other sources of information to see what is already known, 4. review what is known in light of empirical evidence, 5. plan investigations, use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs), 7. pose answers, explanations, or descriptions of events, 8. generate explanations that explicate or describe natural phenomena (inferences), 9. use appropriate evidence and reasoning to justify these explanations to others, 10. communicate results of scientific investigations, and 11. evaluate the merits of the explanations produced by others.

MA.912.A.2.1: TSW create a graph to represent a real-world situation.

MA.912.S.3.2: TSW collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.

MA.912.S.3.3: TSW calculate and interpret measures of the center of a set of data, including mean, median, and weighted mean, and use these measures to make comparisons among sets of data.

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