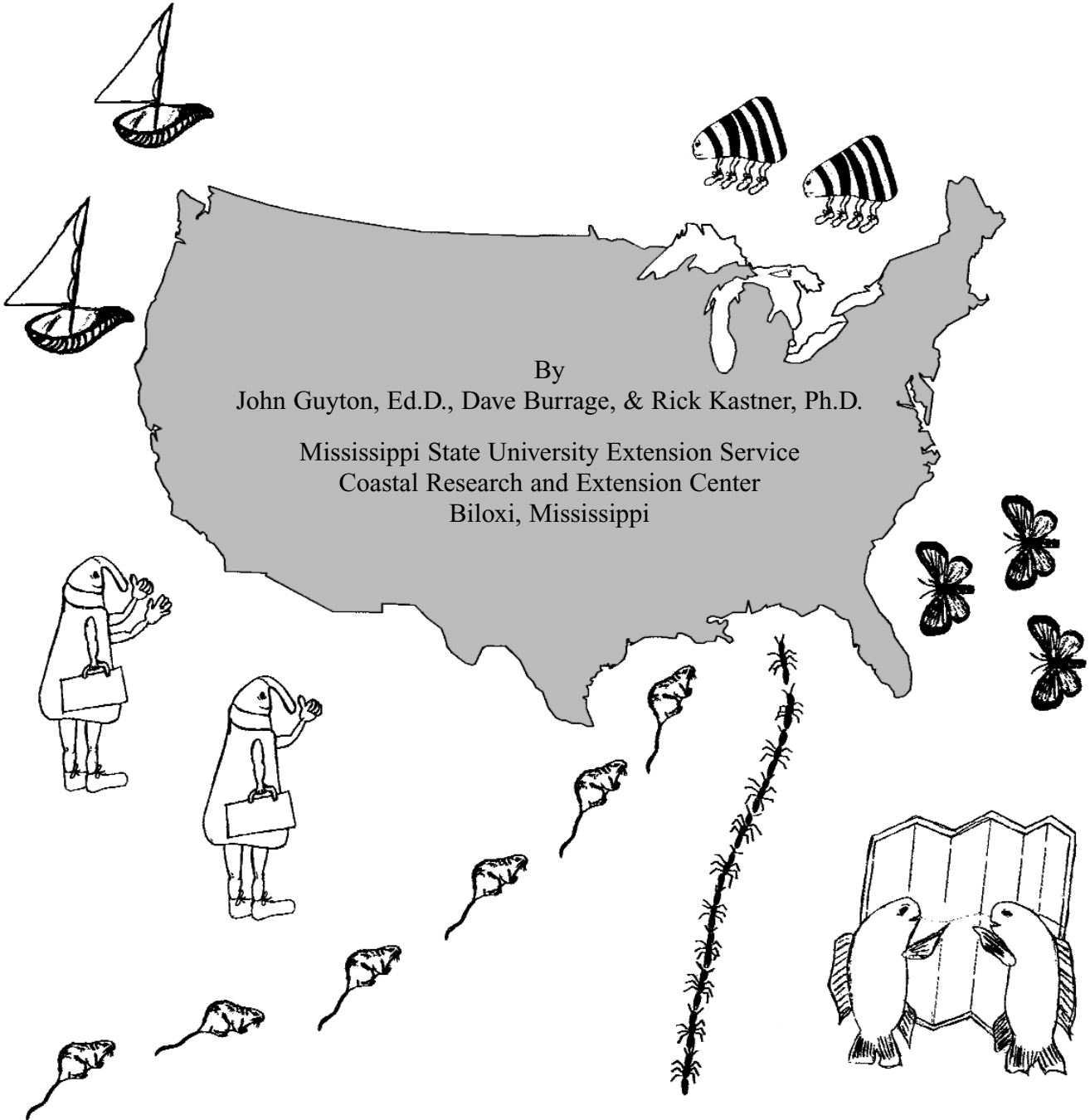


Nonindigenous Species Activities for Youth

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Nonindigenous Species Activities for Youth

Nonindigenous, exotics, introduced, and non-native all describe plants and animals living outside their natural geographic boundaries. Thousands of exotic plants, animals, and microbes have been introduced into the United States. Some of these organisms have been intentionally imported for use in agriculture, the pet industry, and fish and wildlife management. Others have been accidentally introduced from ships' ballast water, in packing materials and soils, or as hitchhikers on other plants and animals.

Many exotic species, such as soybeans and wheat, have been beneficial and contribute significantly to the economy. Others, such as the gypsy moth and kudzu, have a negative impact. In addition, plant and animal species from the Americas have been exported to other parts of the world, with similar effects.

Once established in new environments, many exotics displace native plants and animals, alter ecosystems, cause disease, and interfere with human activities in industry, agriculture, and recreation. The zebra mussel is a good example of a recent introduction that has caused untold damage to surface water users.

Exotics typically leave their natural enemies behind, upsetting nature's system of checks and balances and giving them an unfair advantage in their new homes. With time, an equilibrium is re-established, frequently to the detriment of the native species.

Examples of exotics present in the southeast that you may have seen or are familiar with include imported fire ants, kudzu, water hyacinth, hydrilla, boll weevil, cogongrass, Eurasian water milfoil, nutria, honeysuckle, tilapia, and the zebra mussel. Others such as the Asiatic clam, purple loosestrife, and gypsy moth have yet to be identified in this area.

The activities and resources in this manual will help you better understand what exotics are and how they may impact you. Profiles for selected exotics are provided to speed the learning process. Youth are challenged to create profiles of other exotics common to their area.

This manual contains three types of activities. First there are introductory, or awareness-building, activities. The second type focuses on both beneficial and detrimental characteristics of exotics. And finally there are activities intended as reinforcers. The best advantage can be gained from this set by selecting at least one introductory activity and several from the second set and following up with routine monitoring of a nonindigenous species in your community.

We strongly recommend you use the activity, Exotic Watch, as an ongoing activity and make notations throughout the year. The activities were designed for middle school students; however, you can scale them up or down and make them appropriate for any grade level where awareness of exotics is lacking.

Please consider this set of activities as a work-in-progress. As you see additional needs and gaps, or errors, please let us know, and we will make additions and/or corrections.

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A special thanks is due Peggy Guyton for the design and artwork on the cover. The cover design features selected nonindigenous species coming into the country, and although only animals are pictured, this manual covers both plants and animals.

Nonindigenous Species Activities for Youth

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Community Nonindigenous Survey

Background: Exotic or nonindigenous species have become so much a part of our lives that we depend on them and take them for granted. Migration and agricultural practices have helped intertwine nonindigenous species with many everyday activities. Exotics are not necessarily bad. This activity sets the stage for a closer examination of our relationship with exotics.

Purpose: This activity builds awareness of the wide variety of nonindigenous species in the local environment.

Subjects: Science, language arts (research), social studies (geography).

Time: This activity will require several days to complete. Plan to spend at least a half day at a plant nursery or arboretum and another half day at a grocery store and/or a pet shop. An Extension county agent or horticultural specialist would be helpful at the plant nursery or arboretum. A home economist would be helpful at the grocery store.

Materials: Notebooks and pencils or a laptop computer for collecting data. Later, access to encyclopedias or the Internet to research plant and animal origins found in the community would be useful. A Miscellaneous Exotic

Species Profile has been provided in the appendices to get you started.

Procedure:

1. Read the introduction to this manual to the class.
2. Get permission ahead of time and visit a plant nursery, an arboretum, grocery store, and a pet shop.
3. Divide the class into small groups (two or four students) and assign each group an area to survey.
4. Have each group list the species of plants and/or animals found in their assigned area and record any additional information that might help them determine its origin. The amount of information available will vary with the type of facility being surveyed. Nursery and pet store personnel can provide the genus species names and possibly the country of origin. While visiting the grocery store, the students will be limited to finding only the common names.
5. After returning to the classroom, begin searching for the country of origin for the plants and animals.

Everyday Exotics

Background: Read the introduction to this manual to the class.

Purpose: This is an alternative to the Community Nonindigenous Survey that helps students understand exotics are everywhere, including our backyards, kitchens, and neighborhoods.

Subjects: Science, social studies (geography), language arts, mathematics.

Materials: Exotic Species Fact Sheet, copies of a world map.

Procedure:

1. Have students list vegetables, fruits, or ornamental plants they encounter in their everyday lives at local supermarkets, plant nurseries, and gardens. Determine their origins (such as okra – West Africa) from the Miscellaneous Exotic Species Fact Sheet on page 33. What percentage of these are native to North America? South America? Africa? Asia? Europe? Australia? On a world map affix the names of these to their region of origin. Students will be surprised to learn the overwhelming majority of these are not native to the United States. Have each student determine the percentage of exotics in his or her life originating from different

countries (such as China 26%, Central and South America 35%, Europe 13%, Afghanistan 1%, Asia 8%, West Indies 2%, and Africa 15%).

2. Divide the class into small groups and assign each group a profile from the collection in the Appendix that they are to read carefully. Instruct each group to research its exotic and determine if it is found in its community. Let each group report its results to the class.
3. Based on the fact sheets, evaluate each of the non-indigenous species for its likelihood of being found in your region. Rate the probability of this happening as low, moderate, or high. What specific facts and information led you to make these conclusions?
4. Have students investigate their neighborhoods for any of these exotics. On a local map, make a record of each student's entry. Discuss how they might have gotten there. Discuss what effects they might have on human activities in the area.
5. Instruct students to write a newspaper article about each exotic species that could become a problem in the community, and publish one each week in the Letters to the Editor section of a local paper.

Exotics in the Web of Life

Background: Exotics are becoming a major environmental problem in many countries and are threatening native plant and animal communities. Possibly the best known exotics, or nonindigenous species, are kudzu and fire ants. What is less understood is that the nonindigenous invaders include insects, mammals, viruses, bacteria, birds, mussels, and representatives of almost every other organism group known. Exotics have frequently been imported for various reasons or have been stowaways unbeknown to world travelers. The Formosan termite has become a recent threat in New Orleans and along the Gulf Coast, and cogongrass is continuing to spread north and west from Mobile, where it entered the country. The Miscellaneous Exotic Species Fact Sheet lists both beneficial and potentially harmful exotics.

Purpose: This activity simulates the complex problems associated with invasive species.

Subjects: Science.

Materials: A ball of string, index cards, masking tape, Miscellaneous Exotic Species Profile, and possibly a pair of scissors.

Procedure: Begin playing Web of Life with participants sitting in a circle. Have each decide what animal, plant, or abiotic material he or she represents. Have them write the name they represent on the card and tape it to their shirts so all others can see it. Begin by commenting on what you are and why you depend on one of the other plants, animals, or abiotic materials represented; pass the string to that person and have that person repeat the scenario. When everyone is connected in the “web of life,” it is time to stop and introduce an exotic.

Introduce an exotic species that has no known predators. Give this person a pair of scissors and allow the person to move around freely through the web, snipping lines at random. During the wrap-up discuss how problematic exotics can be and what steps need to be taken to control them. Discuss agricultural practices and list the exotics.

An alternative to cutting the strands of the web would involve participants’ loosely holding their corner of the web with their little fingers close to the ground and allowing the exotic to walk through the web, gathering several strands on their feet and thus compromising the web. With a little work, this allows the string to be reused and eliminates the need for scissors.

Exotic Watch

Background: This activity was inspired by National Geographic and Audubon’s coverage of nonindigenous species. Often articles include information concerning the origin and movement of plant and animal species. Early explorers viewed the world as a mall where the early shoppers found the most exciting and profitable goods. Throughout history exotic plants and animals have been valued for their uniqueness or immediate use without regard for their long-term impact and environmental consequences.

Purpose: This activity documents the spread of exotic species mentioned in *National Geographic*, *Audubon*, newspapers, and other publications. You can use this activity for building awareness or reinforcement.

Subjects: Science, social studies, and language arts (organizing and filing).

Materials: World map, marking pencils, and a supply of *National Geographics* or *Audubons*, file folders.

Procedure: Using the *National Geographics*, *Audubons*, newspaper articles, or other sources, start by filling in the appropriate cells on the Exotic Watch Data Chart. As species are moved from place to place, several entries may be necessary.

After logging the exotic, copy the article and place it in an Exotic File for future reference.

Extension: After you make an entry, draw an arrow on the world map, showing the path the organism took. It is useful to use different-color pencils or different-style lines to represent different methods or causes for the organism’s relocation. It is also useful to put the date of movement on top of the line. You may enlarge the world map below or project it onto butcher paper on a classroom wall for sketching.



Kudzu Paper

Background: Paper making has a long history and seems to have been a closely guarded state secret in China before the time of Christ. Paper can be produced from any cellulose fiber. Kudzu is a bast fiber and requires more work to prepare than leaf or grass fiber.

Purpose: In this activity youth will produce environmentally friendly greeting cards. Youth will make paper from kudzu and place flower or vegetable seeds in the paper pulp, which will facilitate rapid decomposition of the card when it is planted.

Subjects: Sciences and social studies.

Materials: Kudzu vines (new green kudzu will result in a light green paper, and dried material will yield a yellow to tan paper), soda ash or lye, stainless steel boil pot, screen wire (in frame preferably), rubber gloves, safety goggles, blender, rubber mallet, and very small flower seed.

Procedure: Harvest enough kudzu for the amount of paper you plan to make (one pound of beaten pulp should make more than 50 sheets of paper).

Boil the kudzu in soda ash for two to four hours. Older vines will require longer boil times. Rinse thoroughly and hand beat until the fibers are easy to separate by hand. Rinse again and blend until it forms a smooth paste. Pick out the solid clumps that are not breaking down.

Fine clay can be dissolved in the pulp near the end of the pulping process. This results in a smoother-surfaced paper. The clay will make the paper less absorbent, heavier, and opaque. You should add seeds to the pulp just before dipping.

Stir the pulp before dipping the screen for each sheet. Dip the screen below the surface in the vat of pulp and lift horizontally so the pulp mats evenly on the screen. Invert the screen and deposit the sheet of paper (wetleaf or waterleaf) on a sheet of felt. Continue until the pulp is consumed, being careful to separate the individual sheets of waterleaf. Fresh waterleaf is very receptive to oil, ink, or dirt; be careful in handling it. After you have stacked all the waterleaves with felt pieces between them, place a heavy weight on top of the "post" to dehydrate and flatten the sheets. Transfer each sheet to a dry piece of felt. Stack, press again, and allow to dry. Dry in a well-ventilated area as quickly as possible to prevent the seeds from sprouting. You may dry individual sheets between two pieces of cotton muslin with a clothes iron (avoid ironing pulp containing seeds).

Once the sheets are thoroughly dry, they are ready to use.



Reference: *Kudzu: The Vine To Love or Hate* by D. Hoots and Juanita Baldwin, Suntop Press, ISBN 1-880308-12-6.

Plan a Weekly Native Plant Menu

Purpose: This activity focuses on the extensive use of exotics in agriculture. In developing an understanding of exotics it is important to understand the range of benefits derived from the use of exotics.

Subjects: Science, social studies, and nutrition.

Materials: Cookbooks, menus from local restaurants, Miscellaneous Exotic Species Fact Sheet.

Facilities: Could use an Extension demonstration kitchen or a Home Economics classroom to prepare the dishes on the menu.

Procedure: Use cookbooks and a list of native and exotic plants to identify the native plants to be included on the menu. It might be useful to collect menus from local restaurants.

Evaluation: Each group working on the project should come to the same conclusion. Preparing a menu without using exotics is very difficult. Expect a lot of repetition in the menu. Students could be rewarded for creativity in finding many different ways to cook each native plant used.

Extensions:

1. Plan a weekly exotic menu.
2. Calculate what percentage of your diet comes from exotic and native species.
3. Make an Exotic Guide to Local Restaurants.

Create an Exotic Herbarium

Background: Amateur scientists can play an important role in collecting, identifying, and preserving locally-found exotic plants. Schools or county Extension offices are logical places to store such collections. An herbarium is a collection of dried and pressed plants mounted to illustrate as many of their characteristics as possible. It represents a library of local exotic plants that could become a community resource.

Subjects: Science (collecting and classifying), social studies (mapping and community service), language arts (communicating with local citizens, 4-H agents, and the Chamber of Commerce).

Collecting Materials: Trowel for digging plants, sandwich bags, paper towels, flower press, corrugated cardboard, old newspapers, old thick telephone book (temporary press), notebook and pencil, field guides to plants you will include in your herbarium, water in a squeeze bottle, masking tape or markers to label the specimen bags.

Mounting Materials: Herbarium sheets (the American standard is 11.5 x 16.5 inches, or 29.2 x 41.9 centimeters), blotters or newspapers, tweezers, wax paper, corrugated cardboard cut to 12 x 18 inches, soft brushes, newspapers folded to 12 x 18 inches, white glue.

Basic Collection Rules: Resist the temptation to collect endangered species. Never collect solitary specimens – collect only from an area where specimens are numerous. If collecting on private property, ask permission from the owner. National and state parks typically do not allow collecting.

Procedure:

1. Locate the plant you wish to add to your herbarium.
2. Record pertinent data, including date, specific location, abundance of species, common name, species, a description of habitat in which it was found, and your name as collector.
3. Carefully dig up the plant, and wash the soil from its roots. Wrap the roots in moist paper towels, and place the specimen in a plastic bag. Label the bag and notes concerning the specimen with a reference number.
4. Preserve the plants by pressing them with a flower press. Flower presses are generally 12 x 18 inches (30 x 46 cm). You can make them with scrap plywood, paneling, or pegboard. They work best if they have air holes drilled in them. Strap these boards around the plants to compress them while they dry. Arrange each plant's flower and leaves facing you on a sheet of blotter paper or newspaper. Turn over one leaf to show its underside. If the plant is too tall, fold it into a "V," "N," or "W" shape. Cover with another sheet of blotter paper, and then sandwich between two sheets of corrugated cardboard. You can dry several plants in each press. Place the tightly strapped press in a warm, ventilated area. Change the blotter paper daily to speed drying. The quicker a plant dries, the better colors are preserved. Most plants dry in about a week. However, some plants, such as those in the mint family, turn black if not dried very fast. Experiment with ironing them under blotter paper with a medium-hot iron before pressing to preserve their color.
5. Mount the specimens by carefully brushing some glue onto the back side of a specimen, and place it on the herbarium sheet, using the tweezers. Glue a plant label card to the lower right side of the herbarium sheet. Use a damp paper towel to remove excess glue. Place the sheet on a piece of corrugated cardboard that has been covered with newspaper or blotting paper. Place a piece of waxed paper over the specimen, followed by several sheets of newspaper. Stack specimens and let dry.
6. Store the specimens in 12- x 16.6-inch (30 x 42 centimeters) lightweight papers called "species covers." Put species covers in heavier stock paper folders, 12 x 17 (30 x 43 centimeters), called "genus covers." Use a still heavier card stock as family boards to separate genus covers. Then store this in an air-tight rubber or plastic container or plastic garbage bags. Adding a couple of mothballs will also help.

Reference: Arbel, I., (October, 1991) How To Create an Herbarium, *Science Probe* Vol.1 No. 4.

Exotic vs. Indigenous Experimental Plot

Background: Exotics do their greatest damage to the web of life by displacing native species.

Purpose: This activity monitors the interaction of exotic and native species competing for the same space.

Subjects: Science and math.

Materials: Several exotic and native plants that compete with each other. For example, kudzu and blackberries, or privet and native blueberries.

Facilities: An area near the school that can be used as a garden plot.

Procedure: Plant native and exotic species close to each other in the garden plot. Monitor and record the growth rate and observed interactions, such as one growing taller or faster than the other and blocking the sun, or animals' preference as food. Taking pictures at set intervals would best illustrate the problem with exotics.

Extension: Locate a patch of cogongrass, and mark a 1-square meter next to the patch. Collect samples of the plants in the 1-square meter, and determine the appropriate density. List the different plants (use sketches if you don't know the plant names), and estimate the density of each plant in the square meter. What happened to the frequency of other species?

Adopting Nonindigenous and Native Species

Background: Many nonindigenous species have been intentionally introduced for specific reasons, often without carefully considering the consequences or alternatives. Often native species exist that could serve similar purposes. The ginkgo and Chinese tallow are examples of exotic species that live in the southern U.S. The ginkgo has not become a problem and does not easily reproduce, while the Chinese tallow (*Sapium sebiferum*) has become a serious problem. Both were introduced as ornamentals.

Purpose: This activity helps develop a sense of stewardship among the student body through adoption, propagation, and cultivation of nonindigenous and native species with similarities. Many schools have created theme gardens, and this activity could represent one such theme. Part of the task is to research potential nonindigenous and native species and learn as much about them as possible. Do they have desirable qualities or important uses? Are there undesirable traits? Will the nonindigenous species live, grow, and reproduce in our climate? Could it be accidentally released and spread to become a problem? What keeps it in check in its native habitat? What native species have similar properties, uses, or characteristics?

Subjects: Science, social studies (history), and language arts (research).

Material/Resources: The Internet has become a great research tool and should be used as a resource for gathering information for making the posters and deciding which species to adopt. Suggest adopting a plant species. Identify the source for the plants and the specific needs of the species selected.

Procedure:

1. Tell the class the story of the ginkgo (Appendix), a nonindigenous species in North America primarily used as an ornamental landscaping plant. Move to the next step if they are interested in adopting a native and a nonindigenous species.
2. Invite your Mississippi State University Extension agent, a local Master Gardener, or a horticulture specialist to visit the class and discuss possible species.
3. Let the students research several candidates and develop posters for each. Students should look into the level of care required, thinking about summer vacation, the climate, soil and water requirements, potential predators, and propagation potential. Another factor that could be researched is the species' potential as a landscape or food plant.
4. Select a species by popular vote.
5. Prepare a garden plot, and begin cultivating the adopted nonindigenous and native species.
6. Keep accurate records and the required level of care and the pests associated with each species. Over time, the native should require less care.
7. Carefully monitor the nonindigenous species to ensure it is not accidentally released.

Adopted Species Record Sheet

| Nonindigenous Species _____ | | Date Planted _____ |
|-----------------------------|---|------------------------------|
| Date | Observations (size, pest, overall health, etc.) | Maintenance or Care Provided |
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| Native Species _____ | | Date Planted _____ |
|----------------------|---|------------------------------|
| Date | Observations (size, pest, overall health, etc.) | Maintenance or Care Provided |
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An Exotic Invasion

Purpose: In this activity youth will plot the movement of exotics to the new world. They will also collect and graph information relative to the percentage influence different regions of the world have had on locally-used exotics.

Subjects: Social studies (geography), science, math, and computer class.

Materials: World map, almanac, Miscellaneous Exotic Species Fact Sheet.

Procedure: Students will use profiles found in the Appendix to determine which exotics have entered the U.S. and from which countries. They will plot this information on a world map using arrows. The width of an arrow can be used to illustrate how many exotics have been imported from each country. The Miscellaneous Exotic Species Fact Sheet will get you started.

Extension: Students could use computers to construct an Exotic Pie Chart using a spread sheet program to illustrate the contributions of various countries (countries of origin would be the slices of the pie).

Area Exotic Directory

Purpose: This activity produces a directory containing information on the exotic plants and animals found in the county or parish. A component of this directory could list and describe exotics that may be on their way to the county and should be watched for. This activity could be a forerunner to the Exotic Herbarium.

Subjects: Science, social studies, or environmental classes.

Materials: Lists found in the Appendix and local resources such as Master Gardeners and your Extension agent.

Procedure: Invite an Extension agent to class to discuss exotics found in the county. Using information provided by the agent, begin compiling the directory. This could be an ongoing activity and be worked on by successive classes. The directory should contain information such as the origin, life cycle, characteristics, illustrations, eradication techniques, and locations where exotics have been sighted in the county.

Extension:

1. You may want to explore a local nursery and add exotics found there to your directory.
2. Visit a local seed store and see what exotics are being used in county agriculture.

Evaluation: The first year, students could be divided into groups, with each group assigned an exotic to research. Each subsequent year, different exotics will be increasingly difficult to find, and the entire class might participate in researching a newly discovered exotic. Each group could take a different item to research, such as origin, life cycle, or uses, and be evaluated on the quality of their research and report.

Down the Drain – A Zebra Mussel Activity

Purpose: This activity documents the effects of zebra mussels on the water flow rate through a drain. This activity is a simulation of a water intake pipe such as is found at a power plant, an industry dependent on river water, or a city water supply intake.

Subjects: Math (measuring and calculating), science (exotic species, observation, measuring), social studies (interviewing, surveying), and language arts (writing letter of inquiry).

Materials: Zebra mussel shells (or other shells), wire screen, watch with second hand, zebra mussel profile.

Facilities: Laboratory sink.

Procedure:

1. Calculate the volume of water a sink holds either by filling it with a known volume of water or by multiplying its width times its length times its depth. If you measured the dimensions of the sink using centimeters, the results will be in cubic centimeters.
2. Determine the time, in seconds, required for the sink to completely drain through the empty wire screen basket placed over its drain.
3. Repeat the measurement three times and average the results to be reported in liters or gallons per minute.
4. Fill the wire screen basket with zebra mussel shells or coins, and measure the discharge rate of the sink in three trials. Average, and compare to results of zebra mussel clogged drain to non-clogged drains.
5. Contact the city water department to find out if the city water is from a well or if it is from a local stream or river. If from a well, find out if any local industries or agricultural operations get their water from streams or rivers. If your water comes from a river, you could invite the water department manager to visit the class to discuss the town's water source and zebra mussels.

Evaluation: Collect information from the water treatment facility manager on the volume of water used daily by the city and how long the pumps are operated per day. Determine how much restriction will be necessary before the filters have to be cleaned. For example, if the pumps run for 12 out of 24 hours, then the filters will need cleaning by the time they are half covered with zebra mussels.

Zebra Mussel Watch

Background: Confirmed sightings have been made along the Mississippi River, with New Orleans being the farthest point south. Given its track record, the zebra mussel should soon be in most Southern rivers. Despite the array of sophisticated detection systems (satellite telemetry, infrared sensors, computer predictions), experts have found a trained observer is best equipped to find zebra mussels in the field. A trained observer can cover literally thousands of square meters in an outing. Fishermen, boat owners, lock operators, and other locals can also be enlisted in these efforts.

Purpose: This activity informs of the occurrence, distribution, and abundance of zebra mussels in your locality.

Subjects: Science (sampling/monitoring), social studies (map skills), and language arts (reporting).

Materials/Resources: Zebra mussel profile and identification cards, plankton net, microscope with a polarized light, plastic mesh scouring pads, 3-4" PVC piping (4" lengths), Zebra Mussel Data Forms.

Procedure:

1. Organize your group into two or three teams. Each team should carefully read the profile and any other materials available on the zebra mussel. Remember,

you are now the expert. The more you know, the better chance you have of finding zebra mussels. Under adult supervision, explore areas along rivers and lakes that are likely to have zebra mussels. Record the information on the Zebra Mussel Data Forms. Plot sightings from all teams on a regional map.

2. In areas where you found zebra mussels, take several plankton samples. Examine these for veligers, using a microscope and polarized light.
3. Place several substrate samplers (short pieces of PVC and plastic mesh pot scrubbers) at each of these locations (five per location). Check these every two weeks for juvenile zebra mussels. They will feel grainy to the touch. Keep precise records. At the end of two months, summarize and report the results to the group. Answer these questions in your report:

Are these results what you expected?

What does this tell you about your sampling techniques?

What sampling techniques worked best? What explanations can you offer?

What conclusions can you draw from this exercise?

| Zebra Mussel Data Form | |
|---|--------------------------------|
| Collection Site Location | |
| Site location: _____ Water source _____ Depth found _____ | |
| Where found: riprap ___ boat hull ___ piling ___ stump ___ floating plants ___ submerged equipment ___ other _____ | |
| Type substrate: concrete ___ metal ___ PVC ___ plant ___ wood ___ plastic ___ other ___ | |
| Collection Data | Comments, Notes or Map: |
| Collected By: _____ | |
| Time/Date: _____ | |
| Density level: (Circle) Dense Moderate Sparse | |

Useful Resources

Claudi, R. and Mackie, G.L. 1994. *Practical Manual for Zebra Mussel Monitoring and Control*. Boca Raton: Lewis Publishers. pp. 227.

Marsden, J.E. 1992. *Standard Protocols for Monitoring and Sampling Zebra Mussels*. Illinois Natural History Survey Biological Notes 138. pp.40. Available from the Illinois Natural History Survey, Natural Resources Building, 607 East Peabody Drive., Champaign, IL 61820 (217) 333-6880.

Exotic Eradication

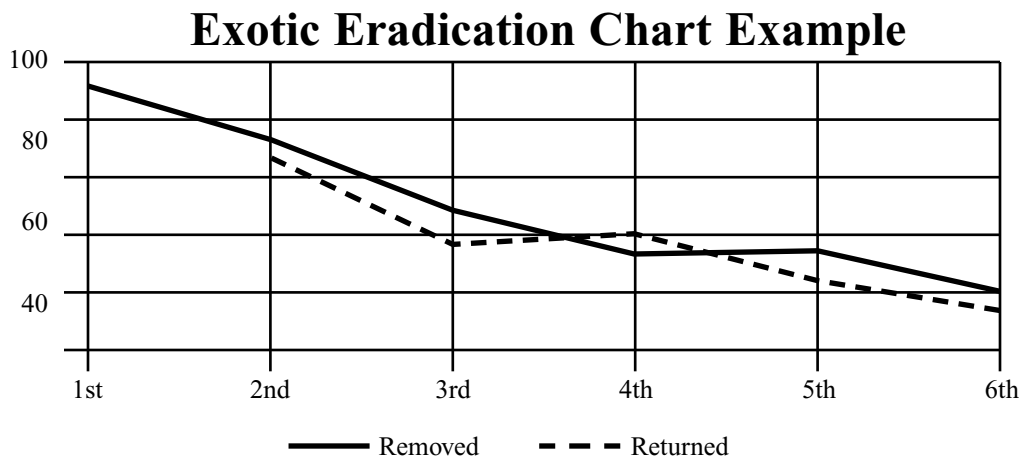
Purpose: In this activity you will select an exotic species that is considered a pest and work to eradicate it in a designated area. First, you will use physical techniques. Later, if necessary, with the help of your Extension agent, you can use chemical techniques.

Subjects: Science, social studies, and math.

Materials: Plant identification books.

Facilities: Local park or wooded area next to a school where an exotic plant, such as kudzu or privet, is growing.

Procedures: Begin by identifying an exotic in need of eradication. Learn as much about the plant as possible, and decide on a strategy for eradicating it. The most desirable method is physically removing the plant. Map the area, and estimate how extensive the infestation is. Begin the eradication, keeping accurate records as to when and how much plant material has been removed. Keep accurate records of plants that come back. Keep records by placing a number or dot on a map identifying where plants have been removed in each eradication effort. Record the date of eradication efforts associated with each number or dot. The number of plants removed in each eradication and the number that were removed and returned can be plotted on a graph using different colors.



Design an Exotic Fish

Purpose: This activity illustrates how introducing exotic species can be successful or unsuccessful.

Subjects: Science and art.

Materials: Paper, markers.

Procedure:

1. Lead students in a discussion of how various characteristics of a fish allow it to survive, such as protective coloration or special adaptation of its mouth. Discuss body shape, coloration, locomotion, habitat, reproduction, temperature range, and mouth design/food requirements. Include in this discussion how these characteristics enable a fish to survive. Finish this section by having students brainstorm a list of adaptations. List these adaptations on the board. An Exotic Idea Sheet has been included to help you lead the discussion.
2. Have students design an exotic fish, addressing each of the seven characteristics listed above. Students should draw a picture of their fish and describe the function, or range, of various parts on their illustrations. Students could cut out their fish or build them, using paper-mache or other art materials if time or opportunity permits. (With younger children, K-1, use fewer characteristics, such as color or habitat only. With grades 2-4, you could use three to four characteristics.)

For example: a student might construct a long, slender blue fish that swims like a snake and has teeth designed for crunching snails. This exotic fish lives in grass beds and reproduces in the fall when water temperature drops to about 5 °C (41 °F).

3. As students are designing and making their exotic fish, walk around the room and collect common characteristics you will then use as successful or limiting adaptations. Continue to add information to your chart as students present their exotic fish to the class. A chart, with an example, has been provided for you to use in collecting and using this information.
4. Have students briefly describe to the group the characteristics of their exotic fish and explain how these characteristics would enhance the fish's survival.
5. Have students arrange desks and other classroom props as you have mapped them for the second part of the activity.
6. Have students follow a path around the room, playing the roles of their exotic fish. As teacher you will serve as the environmental influence: eating the fish you see, designating climate changes, creating dams on streams, determining when prey is extinct, and such. The best adapted exotic fish survives.

Leaders' Exotic Fish Data Sheet



| CHARACTERISTIC | FREQUENCY | ENVIRONMENT | LIMITATION | ADAPTATION | ROOM MODIFICATION |
|------------------------------------|---------------------------|-------------------------------|--------------------------------|----------------------------|---|
| <i>blue color</i> | <i>used by 3 students</i> | <i>blue waters of lake</i> | | <i>can hide from birds</i> | <i>N/A</i> |
| <i>swims upstream to reproduce</i> | <i>used by 2 students</i> | <i>stream has been dammed</i> | <i>reproduction prohibited</i> | | <i>use desk to create stream and block with meter stick</i> |
| | | | | | |
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Exotic Idea Sheet

| ADAPTATION | ADVANTAGE/RISK | STRATEGY |
|--|--|--|
| BODY SHAPE bullet-like humped back | fast moving stable in rapid flowing water | easy prey in slow water |
| COLORATION dark top side light bottom stripes | invisible against dark bottom invisible from below can hide in aquatic weeds | white sand bottom weeds eaten to extinction by another exotic |
| LOCOMOTION snake-like motion | can move in water or on land | can migrate during drought |
| HABITAT | native to salt marshes | introduced in fresh water |
| REPRODUCTION | sexual | only one gender introduced |
| TEMPERATURE RANGE tropical | survive summers not winters | introduced in subtropics |
| MOUTH/FOOD sucker mouth teeth very large jaws | mouthparts modified for specific foods | lack of, or availability of, food |

Integrated Pest Management

Background: Annihilation is futile from both a biological and economical standpoint. Fire ants, zebra mussels, and purple loosestrife are good examples of this. Integrated Pest Management (IPM) is a multi-faceted approach to managing undesirable exotics. IPM systems use techniques that are economically and ecologically sound, reduce and maintain pest populations to acceptable levels, and minimize danger to humans and the environment. IPMs may be biological, chemical, physiological, cultural, mechanical, or physical in nature. Typically, an IPM combines two or more of these. As a result, dependence on chemicals is significantly reduced. Some examples follow:

- Biological - using carp to eat zebra mussels
- Physiological - sterilizing male gypsy moths by irradiation
- Cultural - placing a bounty on nutria
- Mechanical - using diatomaceous earth-based powders to kill gypsy moth caterpillars
- Chemical - using methyl parathion to control boll weevils
- Physical - hand pulling hydrilla or water milfoil

IPM programs are used on virtually all commodity crops, including tomatoes, soybeans, cotton, rice, corn, and wheat. In cotton, for example, IPM practices have resulted in reduced operating costs of nearly \$40 per acre and increased yields amounting to \$50 per acre.

Purpose: This activity introduces students to the concept of integrated pest management.

Subjects: Science.

Materials: Exotics profiles.

Procedure: Enumerate IPMs currently being used to control the exotics in the table.

Integrated Pest Management for Target Species

| Exotics | Biological | Chemical | Physiological | Cultural | Mechanical | Physical |
|---------------------------|------------|----------|---------------|----------|------------|----------|
| <i>Asiatic clam</i> | | | | | | |
| <i>Boll weevil</i> | | | | | | |
| <i>Cogongrass</i> | | | | | | |
| <i>Fire ant</i> | | | | | | |
| <i>Hydrilla</i> | | | | | | |
| <i>Kudzu</i> | | | | | | |
| <i>Water hyacinth</i> | | | | | | |
| <i>Gypsy moth</i> | | | | | | |
| <i>Purple loosestrife</i> | | | | | | |
| <i>Nutria</i> | | | | | | |
| <i>Tilapia</i> | | | | | | |
| <i>Water milfoil</i> | | | | | | |
| <i>Zebra mussel</i> | | | | | | |

2. Choose one exotic common to your area, and thoroughly discuss each of these aspects for that exotic: 1) identification of the problem(s) associated with each exotic; 2) site evaluation and detection; 3) pest identification; 4) economic, aesthetic, and recreational significance; and 5) current management methods being used. Is an IPM program currently being used to control this exotic in your area? If not, create a realistic IPM program for the exotic. Involve community leaders, farmers, Extension agents, and other concerned persons in your proposal.

Aquatic Nuisance Species Certification Program

Background: Most aquatic nuisance species (ANS) are introduced or dispersed into our environs by some type of human activity. Recreational boating, sport fish stocking, escapes from aquaculture facilities and the aquarium trade, bait business, and horticultural practices are just a few of these activities. It is apparent some type of national mandatory licensing program is necessary to target the responsible parties. At this time, there is no such program. The existing state and federal rules and regulations are largely ineffective. Their intent is commendable, but, for the most part, they have become buried within the political bureaucracy. Development and implementation of a nationwide Exotic Certification Program would significantly restrict the release and spread of undesirable exotics in the U.S.

Purpose: This activity suggests a certification program for businesses and persons who deal with exotic plants, animals, and products.

Subjects: Science, social studies (anthropology), and language arts (communication skills).

Materials: A sample Zebra Mussel Certification Form and ANS Profile have been included. Profiles on specific ANS are in the Appendix.

Procedure

1. List human-related activities that could introduce or spread exotics. List those in your local area. Which ones would benefit by some type of certification program?
2. Design a certification form for tropical fish dealers and growers. Approach local pet establishments with your ideas, and ask for their input.

Extension: Divide your class into two groups. Discuss the pro's and con's of such a national certification program.

Aquatic Nuisance Species (ANS) Profile

Aquatic nuisance species (ANS)* are a source of "biological pollution" that threaten the ecology, water resources, economy, and public health of our nation.

It is estimated that 3,000 species of aquatic organisms are in transit in ballast tanks around the world in any given 24-hour period.

The number of ANS in the Great Lakes is 143; in Chesapeake Bay, 100; San Francisco Bay, 213; and Hudson Bay, 113. One-third can be considered harmful in some respect. The cumulative costs to control zebra mussels in the Great Lakes region is estimated at \$120 million.

Four of the 10 busiest ports in the U.S. are located on the Gulf of Mexico, with the port of New Orleans handling some 170 million tons of cargo annually. The largest vessels can release as much as 14 million gallons of ballast water.

The Gulf of Mexico can be likened to a huge "incubator" for ANS.

Examples of ANS already present in the southern region include Asiatic clam, the brown mussel, tilapia, water hyacinth, hydrilla, grass carp, nutria, and the zebra mussel.

White spot, yellow head, and Taura syndrome are viruses now found in indigenous shrimp in Gulf waters. Experts believe these nonindigenous microbes came from local processing plants that repackaged contaminated frozen imported shrimp and crayfish.

A South American strain of cholera appeared in oyster and fish samples in the Port of Mobile in 1991, temporarily causing closure of oyster beds and many fishing operations.

The South American brown mussel *Perna perna*, the zebra mussel's saltwater counterpart, is found in the Gulf and threatens to foul water intake systems of commercial vessels, offshore oil platforms, and such.

The mitten crab from China is now found in San Francisco Bay and is host to a type of lung fluke that is transmittable to humans.

In the last decade, San Francisco Bay has received a new species almost every 24 weeks.

The southern region is home to a multi-billion dollar aquaculture industry. Currently more than 2,000 catfish farms with more than 160,000 acres of ponds produce 500 million pounds of fish annually. The total value of these crops represents more than 70 percent of the aquaculture production in the U.S.

Water milfoil, hydrilla, water hyacinth, walking catfish, and the pond snail *Helisoma trivolvis* are some of the ANS that have caused serious problems to the aquaculture industry.

**ANS is defined as any nonindigenous aquatic species that is generally considered to be harmful to its ecosystem, human health, or human activities.*

Zebra Mussel-Free Certification Form For Bait Fish Dealers & Growers

COMPANY NAME: _____

OWNER OPERATOR: _____

ADDRESS: _____

PHONE: _____ FAX: _____

ALL BAIT SOLD BY THIS COMPANY COMPLIES WITH THE CONDITIONS INDICATED BELOW:

I. RETAILER

- 1) Bait has been purchased from a dealer whose source of water is a well or spring or municipal supply not contaminated with zebra mussels (must provide copy of dealer certification).
- 2) Bait and water have been treated chemically with an approved treatment to eliminate zebra mussels.
- 3) All bait has been maintained and/or transported in water from sources listed in one and two above.
- 4) Retailer maintains records of bait purchases to allow determination of their source.
- 5) Retailer will provide the customer with a written receipt stating the following information: a) name of bait retailer; b) bait dealer's certification number; c) date of customer's bait purchase; d) type and amount of customer's bait purchase; e) a statement "This receipt must be in the customer's possession when using the purchased live aquatic bait. The receipt will remain valid for a maximum of forty-eight hours from the time of purchase and must be shown to enforcement personnel upon request. Failure to have a valid receipt in possession could result in fines from the Department."

II. WHOLESALE/TRANSPORTER (dealer)

- 1) Bait has been purchased from a dealer whose source of water is a well or spring or municipal supply that is not contaminated with zebra mussels (must provide copy of dealer certification).
- 2) Bait and water have been treated chemically with an approved treatment to eliminate zebra mussels.
- 3) All bait has been maintained and/or transported in water from sources listed in one and two above.
- 4) Wholesaler/transporter maintains records of bait purchases to allow determination of their source.
- 5) Wholesaler/transporter has treated transport or holding tanks and equipment with an approved method shown to kill all life stages of the zebra mussel.

III. GROWER/BREEDER (dealer)

- 1) Grower/breeder has maintained and/or transported all bait and brood stock in water from well, spring, or municipal supply sources.
- 2) Bait and water have been treated chemically with an approved treatment to eliminate zebra mussels.
- 3) Grower/breeder has purchased stock only from sources which meet the conditions of one and two above.
- 4) Grower/breeder maintains records of bait purchases to allow determination of their source.

I (signature), _____, do affirm that the statements made on this application are correct and request that (company name) _____ be certified as a zebra-mussel-free live aquatic bait dealer.

Developing a CCP for Exotics

Background: CCP stands for “Critical Control Point.” It is a way to identify a problem area where an exotic species can enter a home, business, or other area of concern, along with a practical solution. The adage, “An ounce of prevention is worth a pound of cure” could never be truer when it comes to unwanted exotics. Once established, an exotic species can be difficult, costly, and sometimes impossible to eradicate. That is why it is vitally important to keep undesirable exotics out. For this reason, using a CCP format can be a valuable exercise for students.

Purpose: To develop practical ways to keep exotics out of our homes and businesses, using a CCP format. One example is the aquaculture industry and the zebra mussel (ZM). Presently this small freshwater clam-like animal from southwestern Russia is not a problem for aquaculturists. On the other hand, it has cost public and industrial surface water users in the Great Lakes region hundreds of millions of dollars in cleanup and control costs over the last decade.

Given the right conditions, ZMs multiply at a phenomenal rate, stick to most hard surfaces, and form massive colonies. The obvious detriment of the ZM is its ability clog things, such as pipes, outboard motor intakes, screens, filters, and such. Any exposed surface is vulnerable, and those at aquaculture facilities are no exception. Zebra mussels are now in the Southern region. It is just a matter of time before their presence is felt by the aquaculture industry. The principal species cultured in the Southern region are channel catfish, baitfish, tilapia, hybrid striped bass, and crawfish.

Subjects: Science and language arts.

Materials: Exotics profiles.

Example: ZMs can enter aquaculture facilities three major ways. Here are CCPs for a typical aquaculture operation :

ZM/CCPs for Fish Producers

| Critical Control Point | Possible Solutions |
|---|---|
| Contaminated surface water sources | Filter water; use groundwater; treat water with chemicals. |
| Brood stock from contaminated sources | Properly dispose of hauling water; get brood stock from certified ZM-free source. |
| Water and equipment from contaminated sources | Keep out of facility; inspect equipment; steam clean equipment. |

Procedure:

1. Use the zebra mussel profile to create CCPs for a zebra mussel-free recreational lake.

| Critical Control Point | Possible Solutions |
|------------------------|--------------------|
| | |
| | |
| | |

2. Use the imported fire ant and kudzu profiles to build CCPs for nursery producers.

| Critical Control Point | Possible Solutions |
|------------------------|--------------------|
| | |
| | |
| | |

3. Use the fact sheets to build CCPs for other areas of interest.

| Critical Control Point | Possible Solutions |
|------------------------|--------------------|
| | |
| | |
| | |

Guide to the National Invasive Species Act of 1996

Background: The rapid spread of the zebra mussel throughout the Great Lakes and into surrounding rivers and lakes made it abundantly clear to the President and members of Congress there was an urgent need for a national policy to limit the entry of unwanted exotic species into U.S. waters. What followed was the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990, enacted November 1990. Until that time the federal effort had largely been a patchwork of laws, regulations, policies, and programs that were, as a whole, ineffective. The National Invasive Species Act (NISA) of 1996 re-authorized and amended the NANPCA of 1990 and was officially signed into law on October 26, 1996, as Public Law 104-332.

In its present form, the NISA of 1996 is lengthy, complicated, and far from being reader friendly. Needless to say, the average citizen must first be able to read and understand the law before he can comply with it. A citizens' guide is one way to put legal jargon into a form everyone can understand.

Purpose: To learn about national efforts aimed at the prevention and control of unwanted nonindigenous species through the National Invasive Species Act (NISA) of 1996.

Subjects: Science and language arts.

Materials: Summary of NISA (Appendix); access to the Internet.

Procedure:

1. After reading the Summary, write a newspaper article describing the need for and purpose of the National Invasive Species Act of 1996. The article should include the who, what, why, and where's of NISA of 1996 as they apply to the average citizen. Search the Internet for additional information.
2. Using the Summary and the Internet, construct a citizens' guide to Public Law 104-332.

The Positive Side of Exotics

Background: It is fairly modern thinking to question the introduction of a plant or animal. Introductions have always been a part of human history. Most of the species we encounter in our everyday activities originated somewhere else. In fact, the principal crop and livestock species in the U.S. are exotics. These include soybeans, wheat, corn, chickens, pigs, and cattle. Unfortunately, many exotics have met with unexpected results and caused more harm than good. A prime example is kudzu. Imported from Japan for its ornamental value and usefulness as soil stabilizer, kudzu was promoted throughout the South as a wonder plant. Uninhibited in its new environs, it soon outgrew its welcome after taking over millions of acres of prime farm land.

Purpose: To show students the positive side of exotics.

Subjects: Science, language arts, and social studies.

Materials: Exotics profiles and sample recipes.

Procedure:

1. List several exotics that were intentionally introduced into this country. When and why were they introduced?
2. Pick one and list at least two positive qualities this exotic might have. This exercise will require some creative thinking on your part. EXAMPLE: Imported fire ants as nature's recyclers soil drainage and aeration enhancers.
3. Eating is a favorite American pastime, and exotics are often overlooked as food sources. Have you ever tried kudzu jelly? Several recipes are given for your pleasure (see Appendix). Encourage students to test these as well as provide their own exotics recipes.

| Name of Species | Entry Date | Purpose(s) |
|-----------------|------------|------------|
| | | |
| | | |
| | | |
| | | |
| | | |

The Key to Exotics Is Using a Key

Background: You just have to step outside to see the world is filled with an assortment of plants and animals. Some have been around for eons, while others are newcomers. Learning to name and classify these fall under the science of taxonomy. Taxonomic keys are one of the ways biologists can identify unknown organisms. Probably the most commonly used type is a dichotomous key. It provides a series of opposing choices leading to the identity of an unknown. As monumental as the task of classifying thousands of exotic plants and animals in the United States appears, nevertheless, it is possible with this simple classification scheme.

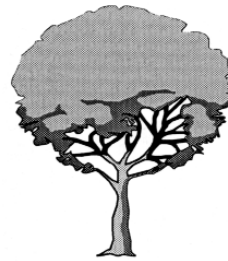
Purpose: To learn to use and make a simple dichotomous key.

Subjects: Science.

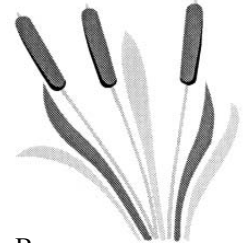
Materials: Exotics profiles.

Procedure: What type of plant is it? This is a practice key that will help you learn to use a dichotomous key. As you make choices and eliminate others, you eventually find out the name of the mystery item. Use this key to identify the plants depicted below.

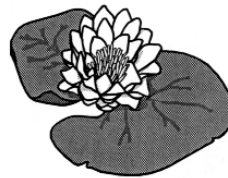
1. Stems and other parts of the plant are woody and rigid
Yes.....Go to 2.
No.....Go to 5.
2. Plant grows above ground and leans on other plants
Yes..... It is a VINE.
No.....Go to 3.
3. Plant is 20 feet tall or taller
Yes.....It is a TREE.
No.....Go to 4.
4. Plant has more than one main stem
Yes.....It is a SHRUB.
NO.....It is a SAPLING (a young tree).
5. Plant grows in open water such as a pond, lake, or permanent stream
Yes.....Go to 6.
No.....Start over.
6. Plant grows under water, floats on the surface, or has floating leaves
Yes.....It is an AQUATIC PLANT.
No.....Go to 7.
7. Plant has roots and part of the stem under water, but the rest of the plant sticks above the surface
Yes.....It is an EMERGENT PLANT.
8. What exotic is it? In this exercise, construct your own dichotomous key using the Exotics profiles.



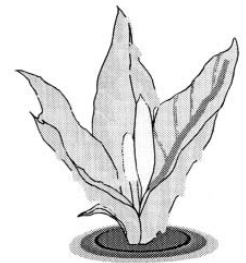
A _____



B _____



C _____



D _____



E _____



F _____

[Adapted from WOW! The Wonders of Wetlands
by Britt Eckhardt Slattery, et.al. 1995.
Environmental Concern Inc. St. Michaels, MD
and The Watercourse, Bozeman, MT]
11/07/96

Searching the Web for Exotics

Background: One of the most commonly asked questions about the Internet is “What is it?” It is basically a loose network of documents connected through a worldwide system of links. The Internet is one of the major technological phenomena of the 1990s. By means of it, anyone with a computer and modem can have almost instant access to a wealth of information, including text, graphics, sound, and video. This communication technology has developed and is developing at such a rapid pace that suddenly we have at our fingertips a medium that is at once global, interactive, dynamic, and graphical. Not only does it offer audiences unprecedented access to vast amounts of information, but it also allows them to be part of the creative process that drives it. The World Wide Web (WWW) is only one of the many resources available through the Internet that also includes e-mail, FAQs, FTP, Gopher, and news groups.

Purpose: To use WWW as a source of information about exotics. Note that some schools block the term “exotic.” Try “nonindigenous.”

Subjects: Science and language arts.

Materials: A computer, access to the Internet and a web browser such as Netscape or Microsoft Internet Explorer.

Procedure:

1. Find the following items on this exotics scavenger hunt. Some are easy, and some are hard; otherwise

this wouldn't be a scavenger hunt! You may follow the suggested links (if any) or try any of the search engines or indices, including Yahoo, Alta Vista, Google, and Webmaster.

- A. How can you identify a zebra mussel? Enter “Zebra Mussel ID Card” and see what you can find.
 - B. What do nutria look like? Use one of the search engines to find this one.
 - C. Arrange these exotics in chronological order in which they were detected in the Great Lakes: Eurasian milfoil, sea lamprey, zebra mussel, round goby, ruffe, purple loosestrife, and rusty crayfish. Enter the key phrase “aquatic nuisance species feature.”
 - D. Which one of these aquatic plants is not an exotic: *Eichhornia crassipes*, *Myriophyllum spicatum*, *Juncus effusus*, *Lemna validivana* and *Hydrilla verticillata*? Visit the University of Florida Center for Aquatic Plants site.
 - E. Download the “Can Mussels Be Scrubbed” article from the January 1997 issue of *Zebra Mussel Update*. What does it say, in a nutshell? Check out Wisconsin Sea Grant at <http://www.sea-grant.wisc.edu/>
2. Create a profile on the exotic *Maleleuca* tree. (Hint: Start with an Internet search; try the University of Florida Center for Aquatic and Invasive Plants at <http://aquat1.ifas.ufl.edu/>)

Getting the Word Out on Exotics

Background: The mass media can be an effective means of getting the word out on exotics. For the average American, the word “exotics” probably conjures up thoughts of far-away places and strange animals and plants. What most Americans fail to realize, however, is at least 4,500 species of foreign origin have free-living populations in this country.

It is estimated that 10 exotic newcomers become established in the U.S. yearly. One-third of these eventually become pests. Needless to say, measures must be taken to keep other unwanted exotics out. How the issue of exotic species is addressed could have severe economic and ecological consequences for all of us in days to come.

It is important to present the general public with an accurate and unbiased picture of what exotics are and how they can affect everyday lives. Radio, TV, newspapers, magazines, and the Internet are forms of mass media that can and should be used to help achieve this goal.

Purpose: Students will become familiar with the elements of mass media.

Subjects: Science and language arts.

Materials: Exotics profiles and A/V equipment.

Procedure:

1. Have students write short newspaper and magazine articles on exotics you have encountered. Submit these articles to a local newspaper or magazine for publication.
2. Put together a 2- to 3-minute radio or TV infomercial about the topic of unwanted exotics. Share these with your class and other classes in your school. Approach local radio or TV station managers about the possibility of having these aired.
3. Conduct an Exotics Day at your school or in your neighborhood. Invite friends, relatives, and neighbors.

Did you know that one of the best forms of advertising is word-of-mouth? You might be the local authority on exotic species, so don't hesitate to take a leadership role in helping with their control.

Proactive in the Community

Background: If exotic plants and animals, available from nurseries and aquarium shops, can live and reproduce in the local environment, their accidental releases could pose a real danger.

Purpose: To allow youth to become involved in a proactive exotic awareness campaign.

Subjects: Science and social studies.

Materials: Local aquarium shop or garden center that sells water plants for water gardens, aquarium plants, and fish guides.

Procedure:

1. Survey local nurseries to determine if they sell water garden kits and plants for water gardens, or survey an aquarium shop to determine what plants and animals they sell. Determine which plants and animals are exotic. Sometimes the merchant will know, but usually you will be required to use a guide to tropical fish.
2. Learn as much as you can about the environmental conditions these plants and/or animals need to survive.
3. Pose this question to participating youth: Are local environmental and climatic conditions hospitable to the



species available from local distributors? If so, they can cause great harm if accidentally released into the local environment, and an awareness campaign is warranted. Allow youth to decide how best to address the problem. Youth could develop posters for display in aquarium shops or at nurseries describing proper containment and disposal of exotic organisms. They could produce flyers to be distributed with exotic plants and animals describing how to dispose of them when necessary. They could also organize a used fish recycling program or assist teachers in procuring fish people are tired of and wish to dispose of.

Extension: Set up and maintain an aquarium at the local library that contains native aquatic plants and animals.

Mid-Western Wildflowers

Purpose: This activity monitors the survival rate of exotic species (non-native).

Subjects: Science and social studies.

Procedure:

1. Purchase a package of annual wildflower seed collected for use in another state. You may need to use a native plant guide to determine if a seed package contains exotics.
2. Plant these in a flower garden, and count the number of plants in each species that grow each year until all have died out. Most likely the first year will have the greatest number of species represented and the greatest number of plants in each species. This should decline rather rapidly, because the plants are adapted to living somewhere else. Use the chart to record the number of samples of each species found each year.

| | YEAR | | | | | | | | | | |
|---------|-------------------------|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | | | |
| SPECIES | NUMBER OF SAMPLES FOUND | | | | | | | | | | |
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Monitoring the Spread of Cogongrass

Background: The purpose of this activity is to participate in the monitoring and reporting of an exotic species, cogongrass, which is currently spreading north and across the Gulf Coast from Mobile.

Subjects: Science (observing and identifying an exotic plant), social studies (plotting the location on a map, contacting and using the expertise of the Extension county agent), language arts (collecting and reporting information), art (sketching a picture of cogongrass for use in identifying cogongrass).

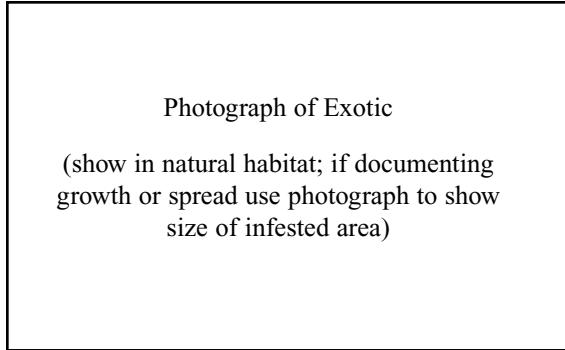
Materials: Cogongrass specimen (if available), plant identification book, map, and an Exotic Report Form.

Procedure:

1. Become familiar with cogongrass by examining illustrations in field guides or by having your county agent bring some to your class. Cogongrass is most easily recognized while it is flowering in the spring (see Exotic Fact Sheet).
2. Keep a copy of the Exotic Report Form, and use it when, and if, cogongrass reaches your area. Review some of the other exotics described in the Appendix and see how many are currently living in your area.
3. If you find evidence of cogongrass, contact your county Extension agent, and request her/him to collect a sample and verify its authenticity.

Exotic Species Report

Common Name _____
Genus _____ Species _____
Subspecies _____



Location of Collection Site

County _____ State _____
Latitude _____ Longitude _____
Locality _____

HABITAT

- | | | | |
|---|---|--|--|
| <input type="checkbox"/> Man Made Reservoir | <input type="checkbox"/> River/Stream | <input type="checkbox"/> Canal/Ditch | <input type="checkbox"/> Roadside |
| <input type="checkbox"/> Natural Lake/Pond | <input type="checkbox"/> Estuary/Bay | <input type="checkbox"/> Marsh/Swamp | <input type="checkbox"/> Pasture |
| <input type="checkbox"/> Deciduous Woodlands | <input type="checkbox"/> Savanna | <input type="checkbox"/> Field/Fence row | <input type="checkbox"/> Metropolitan area |
| <input type="checkbox"/> Coniferous Woodlands | <input type="checkbox"/> Grasslands | <input type="checkbox"/> Landfill/Waste Area | <input type="checkbox"/> Nursery/Pet Store |
| <input type="checkbox"/> Coastal Wetlands | <input type="checkbox"/> Coastal Shores | <input type="checkbox"/> Sound /Gulf | |
- Other _____

Temperature _____ Salinity _____ DO _____ pH _____

Current/Water Velocity _____ Substrate _____ Depth/Height _____

Vegetation _____ Soil Type _____

Ground Cover/Competing Plants _____ Local Predator/Prey _____

COLLECTION DATA

Collected by _____
name address and phone number

Identified by _____
name address and phone number

Method of Collection _____
cast net, gill net, hook/line, trawl, benthic sampler, cut off leaves, dug up, shot, trapped, etc

Number Collected _____ Age Class _____ Size _____
adult, larva, juvenile mm or cm

Method of Disposal _____

Specimen Storage _____

Oh Exotic!

Purpose: This activity is based on the popular Project Wild "Oh Deer" activity and deals with the elements that influence the success of an exotic, including a large-enough population to reproduce, climate, nutrients, water, and lack of predators.

Subjects: Science and math.

Materials: Newsprint or posterboard for recording data and markers.

Facilities: Open space or field.

Procedure: Divide group into three subgroups. One group will represent exotic species; another, the needs of the exotics such as sunlight, water, and nutrition; and the third group will represent obstacles exotics must overcome in a new location such as climate, competition, and susceptibility to predators. The Exotics and Needs will be on opposite sides of the field, and the Environmental Conditions will be located in the area between. The objective for the exotics is to run past the Environmental Conditions and find their need. The objective of the Environmental Conditions is to cause the exotics to flourish or become extinct. These are the roles:

EXOTICS

(pick one)

Kudzu
Zebra Mussel
Fire Ant
Boll Weevil

ENVIRONMENTAL CONDITIONS & SIGNS

Drought - hands over mouth
Lack of Predators - arms extended
Strong Competition - crouching
Use in Commerce - arms by side

NEEDS

Suitable climate
Water
Nutrition
No predators

The Exotics and Needs line up on opposite sides of the field, facing away from each other. Individuals in both groups make a sign for one of the needs, turn facing each other, and the Exotics run to the other side to have their needs fulfilled. Only one Exotic per Need. The Environmental Conditions hinder or help the Exotics flourish (use in commerce and lack of predators help; drought and strong competition hinder). Exotics that cannot find their needs perish. After they perish they are added to the Environmental Conditions group, with the leader deciding on which condition they will represent. Each round, the leader records how many exotics perished and how many survived. When drought or strong competition catch an exotic, the exotic dies. When lack of predators or use in commerce catch an Exotic, they become that species and play the next round as that Exotic.

Appendices

Contact your state environmental agency for the latest regulations before using any chemical treatment. Should you decide to treat with a chemical, it is best to conduct a simple on-site bioassay to protect the environment and your investment. **Always read the label on the container and strictly follow the directions!**

Miscellaneous Exotic Species Fact Sheet

Plant Origins by Country

| <u>Plant Origins by Country</u> | <u>Plants</u> |
|---------------------------------|---|
| Afghanistan | carrot |
| Africa | African violet, coffee, geranium, gladiolus, watermelon, yams, and okra |
| Americas | common bean, lima bean, maize, peppers, potato, sweet potato, tobacco |
| Asia | banana, apple, apricot, turnip, orange, cantaloupe, date, garlic, tulip, green pea, lemon, lime, onion, pear, plum, rhubarb |
| Australia | strawberries |
| Brazil | pineapple and rubber |
| Central and South America | avocado, tomato, corn, peanut, pepper, potato |
| China | apricot, azalea, camellia, chrysanthemum, clematis, forsythia, hollyhock, orange, peach, radish, rhododendron, soybean |
| Europe | brussels sprouts, cabbage, celery, cherry, parsnip |
| India | cow pea, cucumber, eggplant |
| Iran | spinach |
| Japan | wisteria |
| Mediterranean | artichoke, asparagus beet, broccoli, cauliflower, chives, grape |
| Mexico | poinsettia and zinnia |
| Northern Burma | lemon and lime |
| Persia | muskmelon |
| West Indies | grapefruit |

Harmful or Potentially Harmful Exotic Shellfish

crayfishes, mitten crabs, Asian clam, giant ram's horn snails, zebra mussel, penaeid shrimp, Pacific oyster

Harmful or Potentially Harmful Exotic Plants

giant duckweed, salvinia, water hyacinth, water lettuce, hydrilla, egeria, lagarosiphon, Eurasian water milfoil, alligatorweed, rooted water hyacinth, paperbark, torpedo grass, water spinach, kudzu, honeysuckle, cogongrass

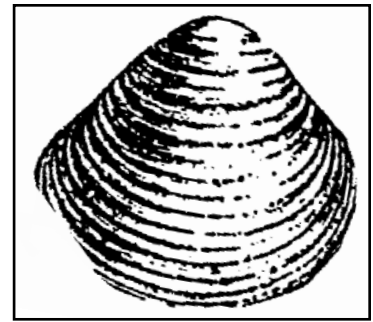
Harmful or Potentially Harmful Exotic Fish

lampreys, freshwater stingrays, South American pike, African tiger fishes, South American tiger fishes, African pike, knife fishes, electric eels, carps and minnows, walking catfishes, electric catfishes, South American parasitic candiru catfishes, pike killifish, marine stonefishes, South American pike cichlids, tilapia, Asian pikeheads, snakeheads, walleyes, Nile perch, drums, whale catfishes, ruff, air sac catfishes

ASIATIC CLAM

Corbicula fluminea

Background: The Asiatic clam is a small freshwater bivalve belonging to the family Corbiculidae, which is native to southeast Asia. The first live specimens were collected in the Columbia River in Washington state in 1938. Evidence suggests populations existed much earlier, however, and were probably introduced for their food value. Like the zebra mussel, another exotic mollusk, the Asiatic clam has spread rapidly throughout the United States and is now found in 35 states. It has proven to be a highly adaptable organism primarily because of its high reproductive capacity, rapid growth rate, and short generation time. The Asiatic clam is now the most dominant mollusk species in North America. It is considered a pest species because of its activity as a biofouling organism and its adverse effect on native clam populations. Most of its major movements can be attributed to human activities, such as its use as bait by fishermen. However, waterfowl and other wildlife have also been linked to its movement across the continent.



Problems: The Asiatic clam is a hermaphrodite, and one individual can found a new population. A mature *Corbicula* can produce as many as 75,000 veligers (planktonic larvae), and these can remain viable for several days. Byssal or mucous threads on post-larvae and young adults act like floats to carry them over long distances. Unlike native clams and other biota, the Asiatic clam thrives in disturbed environments created by human activities. It is an efficient filter feeder, and it can out-compete native mollusks for space and food. As a biofouler, the Asiatic clam impacts man in the following ways: it obstructs pipes and canals, it decreases the integrity of dredged sand and gravel for use in concrete, it gives a bad taste to municipal drinking water, and it constricts condensers and screens in the cooling systems of electric power plants. The U.S. power industry has spent more than one billion dollars in cleanup and control costs because of the Asiatic clam.

How To Identify: A newly released juvenile is microscopic (shell length approximately 0.25 mm, which is visible under 10 to 100 times magnification with a microscope or dissecting scope) and has a well-developed D-shaped bivalved shell and internal organs. The more mature forms have conspicuous mucous-like strands (byssal threads) coming from the base of the shell. The shell of a mature *Corbicula* is thick and glossy and averages between 3 to 4 cm in length. The outer shell has a typical clam-like appearance. It ranges from yellow or yellow-green to brown and has well-defined concentric ridges. The inner part of the shell is usually white with light blue, rose, or purple highlights. The margins near the hinges of each shell have many pairs of lateral teeth.

Monitoring and Verification Procedures: Monitoring determines population levels to detect new infestations and to assess the effectiveness of treatment measures. State and federal agency personnel regularly monitor streams, lakes, and rivers for the Asiatic clam. However, lake associations, 4-H clubs, and other citizen groups should be strongly encouraged to participate in these efforts. **It is important that you positively identify suspected specimens as Asiatic clams before taking any remedial action.** Treatment for the Asiatic clam can be expensive and be harmful to aquatic plants and animals as well as to the environment. *Corbicula* may be found in many habitats, ranging from rock and gravel to muddy bottoms. It can burrow and may be found deep in the substrate. Veligers can be collected using a plankton net. Samples are best kept alive and should be placed in a cooler after collection. Samples can be preserved using a 70% ethanol or isopropyl alcohol solution.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions are available to treat the Asiatic clam:

CONTAINMENT. Quarantine or curtail public access to infested sites if possible. Fishermen should be discouraged from using Asiatic clams as bait.

FILTRATION. Several types of back-washable sand filters and submerged infiltration beds are available on the market that will eliminate adults and veligers from intake waters.

DESICCATION. Contaminated gravel or sand should be allowed to air-dry for at least one month before use.

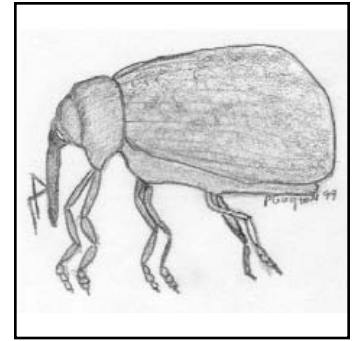
LEMMA TOXINS. Research conducted on Endod (*Phytolacca dodecandra*), a plant-derived molluscicide, has shown it to be lethal to adults at 15-20 ppm.

CHLORINE. Chlorine can kill all stages of the Asiatic clam in concentrations as low as 0.25 ppm.

BOLL WEEVIL

Anthonomus grandis

Background: The boll weevil is a destructive insect pest belonging to the family Curculionidae. It is native to Mexico and probably crossed the Rio Grande into Texas in the 1890s. From there it spread rapidly to the north and east and infested an average of 20,000 square miles of new territory in its first 35 years. In Enterprise, Alabama a monument was erected in honor of the boll weevil. Because of the boll weevil, farmers were forced to plant other crops besides cotton and in this way became more successful. The boll weevil continues to be a problem in the major cotton-growing states, which are located mainly in the southern United States. This pest feeds and reproduces almost exclusively on the cotton plant, although it does feed on other plants such as okra, hollyhock, *Hibiscus syriacus*, and *Thespesia populnea*. A nationwide boll weevil program was implemented in the 1970s to eradicate the boll weevil. That program had limited success.



Problems: The key factor in this insect's success is its ability to proliferate and spread at a phenomenal rate. The boll weevil is a prolific breeder (100 to 300 eggs) and can produce as many as 10 generations in a year. Eggs develop into adults in less than three weeks. Eggs are deposited in the immature flower of the cotton plant, which causes it to die or else produce inferior seed pods. The adult weevil is winged and can travel as much as 50 miles in a season. Boll weevils have few natural predators. Adult weevils overwinter in almost any kind of plant litter. Insecticides are lethal to most forms of the boll weevil but must be used several times and kill beneficial insects as well. In the U.S., the boll weevil ruins as much as 30 percent of the cotton crop each year, or an estimated \$12 billion in damages.

How To Identify: The adult boll weevil is a small, hard-shelled beetle averaging 3 to 5 mm in length. It has a yellowish, grayish, or brownish color and becomes nearly black with age. It has a slender snout half as long as the body. The most characteristic features of the boll weevil are projections from the front leg. The mature larva is much larger than the adult and is white with a brown head and mouthparts. Larval and pupa pictures can be found on the Internet.

Monitoring and Verification Procedures: Monitoring determines population levels to detect new infestations and to assess the effectiveness of treatment measures. Department of Agriculture and other state and federal agency personnel regularly monitor fields and crop land for boll weevils. An effective and inexpensive boll weevil trap has been developed that uses the pheromone (an insect attractant) grandlure. Although the main role of the trap is to detect weevil populations, it also acts as a control device when populations are low. **It is important that you positively identify suspected specimens as boll weevils before you take any remedial action.** Treatment for boll weevil can be expensive and can be harmful to plants, animals, and humans as well as to the environment. For identification, contact your state Extension entomologist or local USDA-APHIS-PPQ office.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken to treat for boll weevils:

INCINERATION OR CULTIVATION – Stalks and rubble of old cotton plants should be burned or plowed under shortly after harvest. These practices will eliminate over-wintering sites for adult weevils.

CROP MANIPULATION – Also known as Short-Season Techniques, this approach involves planting an early crop and using early-maturing varieties. This practice makes plants less susceptible to infestations of boll weevils and other cotton pests. Temperatures below 20 °F for several days can reduce densities by as much as 40 to 50 percent.

CHEMICAL TREATMENTS – EPA- approved insecticides that have proven effective against boll weevils include malathion, azinphos-methyl, diflubenzuron, and methyl parathion.

BIOLOGICAL TREATMENTS – Biological agents are available to control the boll weevil. More than 50 native parasites or predators are known to attack the weevil, including the imported fire ant.

INTEGRATED PEST MANAGEMENT – This approach uses a combination of the above tactics that are efficient, cost effective, and environmentally safe. The program in Texas has proven very successful in controlling the boll weevil.

For more information: Southeastern Boll Weevil Eradication Program, Bell Oaks Plaza, Suite B, 2424 East South Boulevard, Montgomery, AL 36116-2506, (334) 223-7532

COGONGRASS

Imperata cylindrica

Background: Cogongrass is an invasive grass species native to southeast Asia. It entered the U.S. in the 1930s, probably as seed in packing material. Subsequently, cogongrass was intentionally introduced for use as a forage plant, a soil stabilizer, and as an ornamental plant. Cogongrass is now established in 20 states and appears to be confined to the warmer, southern areas. Worldwide, it is ranked as one of the 10 worst weeds. Cogongrass can thrive in most soil types and under most soil conditions. Cogongrass reproduces primarily by rhizomes. Most of its major movements can be attributed to human activities, such as using contaminated soil and hay on highway construction sites.



Problems: Many features about cogongrass make it an undesirable plant. Cogongrass has razor-like leaves that have little nutritional value and are, for the most part, unsuitable as forage for livestock or wildlife. Another feature is its ability to produce allelopathic substances that can suppress the growth of other plants. Cogongrass has few natural pests and soon becomes the dominant plant wherever it becomes established. Uncultivated areas as pastures, parks, ditch banks, nurseries, and tree crops are significantly affected by its presence. It is also a troublesome weed in the production of cotton, soybeans, corn, sugarcane, peanuts, rice, and some vegetable crops. The specialized structure of its rhizomes enables it to grow in barren soils and even survive burning. New plants can grow from even small pieces of rhizome. Established stands of cogongrass may produce more than three tons of rhizomes per acre. *Imperata* may also be a host to a variety of plant pathogens, such as the rust *Puccinia rufipes*. Dried cogongrass is highly flammable and presents a substantial fire hazard in heavily infested areas. Cogongrass is now considered the seventh worst weed in the world.

How To Identify: Cogongrass varies greatly in appearance. It can grow to 4 ft. but typically is much shorter. The leaves are thin (3/4"), with finely serrated leaf margins and sharp leaf tips. This plant is characterized by a white midrib that is slightly off-center. The stems are short and usually obscured by its leaves. Leaves are usually yellowish-green, but one variant is red. During late spring, cogongrass may be recognized by its fluffy white plumes. In the more tropical climates, it can bloom year-round. Each spikelet (flower) has two stamens and two feathery stigmas. The seeds are small and can remain viable for at least two years. One plant may produce as many as 3,000 seeds. Rhizomes are scaly in appearance and are usually found in the upper layer of soil.

Monitoring and Verification Procedures: Monitoring determines infestation levels, detects new ones, and assesses the effectiveness of treatment measures. Natural resource and other state agency personnel regularly monitor roadways, parks, and forests for cogongrass and other noxious weeds. Environmental associations, 4-H clubs, and civic groups can help and are strongly encouraged to participate in these efforts. **It is important that you positively identify suspected specimens as cogongrass before you take any remedial action.** Treatment for cogongrass can be expensive and can harm plants, animals, and humans as well as the environment. Send samples to your county Extension agent or state weed specialists for identification.

Prevention and Control Measures: Several **chemical** and **nonchemical** treatments work on cogongrass.

CONTAINMENT – Transport, cultivation, or importation of cogongrass is strictly prohibited in many states. Abide by the laws in your state.

CULTIVATION – Plow under stands of cogongrass, and disc to a depth of at least 6 inches. To kill rhizomes, till affected areas several times in the dry season.

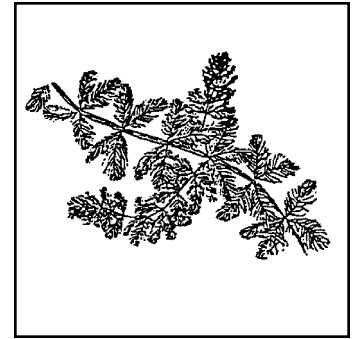
CHEMICAL CONTROL – Many chemicals, including Pramitol, Spike, Arsenal, and Roundup can be used to control cogongrass. Apply herbicides in late fall for best results.

INTEGRATED MANAGEMENT – A combination of burning or mowing, tillage, and repeated herbicide applications is the most cost effective way to control cogongrass.

EURASIAN WATER MILFOIL

Myriophyllum spicatum

Background: Eurasian water milfoil is an aquatic plant belonging to the Haloragaceae family. It is native to Europe and was probably introduced into the U.S. by the aquarium industry. It was first discovered in the eastern United States in the 1940s. It spreads mainly by fragmentation and runners but also can grow from seed. It thrives in both fresh and saline waters and is usually found in the undisturbed, shallow zones of lakes and streams. Eurasian water milfoil has been positively identified in 41 states and 3 Canadian provinces. It is spread primarily as the result of human activities such as recreational boating, fishing, water gardens, or collecting trips.



Problems: A key factor in its proliferation throughout the U.S. is its ability to reproduce through stem fragmentation. Segments of water milfoil can easily take root and form new colonies. A single strand can produce thousands of new plants in a growing season. Each plant can form dense stands of vegetation which, in many cases, choke out native aquatic plants. Eurasian water milfoil can be a nuisance to pond owners, fishermen, recreational boaters, aquaculturists, and home owners. Minnesota has spent more than \$1 million over the last five years to control Eurasian water milfoil in recreational lakes.

How To Identify: You can easily recognize Eurasian water milfoil by its feather-like leaves. Milfoil leaves are green, and stems are red or rust-colored. Leaves are whorled in groups of three and four and divided into 12 or more pairs of leaflets. Stems are long and branched, sometimes reaching lengths of 3 m (10 ft.) or more. Small reddish flowers are visible in late spring or early summer.

Monitoring and Verification Procedures: Monitoring detects established population levels, detects new colonies, and assesses the effectiveness of treatment measures. Department of Natural Resources and other state agency personnel regularly monitor lakes, rivers, irrigation canals, ponds, and streams for Eurasian water milfoil and other nuisance aquatic weeds. Lake associations, 4-H clubs, boaters, and other citizen groups can provide valuable assistance and are strongly encouraged to participate in these efforts. **It is important that you positively identify suspected aquatic plants as Eurasian water milfoil before taking any remedial action.** Treatment for water milfoil can be expensive and can harm aquatic plants and animals as well as the environment.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken to treat for Eurasian water milfoil.

CONTAINMENT – Quarantining or curtailing public access to infested sites is critical to keeping this nuisance plant in check. It is illegal to possess, cultivate, or transport this plant in many states. Here is a checklist for boaters, fishermen, and water craft owners:

- 1) Remove all aquatic plants from boats, trailers, fishing tackle, or other water craft and equipment before leaving any water body.
- 2) Discard in a trash bin or other location away from the water.
- 3) Rinse contaminated boats and equipment with hot water if possible.

CHEMICAL TREATMENT –

- 1) 2, 4-D 1.4 gallons per acre-foot (A/F)
- 2) AquatholR K: 1.3-1.9 gallons per A/F
- 3) Sonar AS: 8-12 ounces per A/F; Sonar 5P & SRP: 4-6 pounds per A/F

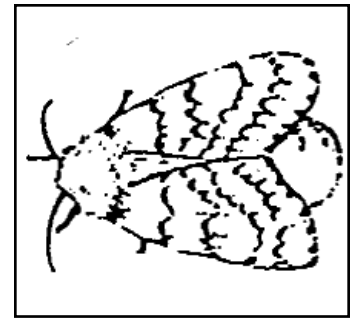
BIOLOGICAL TREATMENT – Stock grass carp (*Ctenopharyngodon idella*) in infested ponds or waterbodies **only** after contacting the DNR in your state. An indigenous weevil (*Euhrychiopsis lecontei*) promises to be another agent to control Eurasian water milfoil.

FERTILIZATION – Fertilization is an effective and economical way to control water milfoil in farm and sport fishponds. It stimulates a phytoplankton “bloom.” A good bloom acts like an aquatic “mulch” and shades out most aquatic weeds. Always follow a fertilization program that meets the needs of your specific locality. The first step in any successful program is removing existing water milfoil or other aquatic weeds by chemical or biological means. In the southern U.S., fertilization begins in early spring when water temperatures reach 60 to 65 °F. Fertilizer applications continue at two- to three-week intervals or until a bloom is established. Fertilizer applications are reduced to three- to four-week intervals. Fertilization is stopped in late fall.

GYPSY MOTH

Lymantria dispar

Background: The gypsy moth is the country's number one tree pest belonging to the family Lymantriidae. In 1869 it was introduced into New England from Europe to establish a silk industry in America. The industry failed, but this leaf-devouring moth prospered, much to the detriment of the region's forests. In its worst outbreak, in 1981, it defoliated almost 13 million acres of northeastern forest, an area the size of Connecticut, Massachusetts, and Vermont combined. Despite strict quarantine regulations, it continues to occupy new territory and is now present in 16 states mainly on the east coast. A recently discovered Asian strain of the gypsy moth could prove to be an even worse pest. The gypsy moth is a notorious hitchhiker, and egg masses have been found on everything from recreational vehicles to doghouses.



Problems: The caterpillar of the gypsy moth feeds on the foliage of almost every type of tree and shrub, including many garden plants. The resulting defoliation is extremely stressful to most trees and can lead to death. Oak trees are particularly susceptible to attacks from the gypsy moth. Generally speaking, deciduous trees can tolerate infestations by the gypsy moth better than most conifers. The mess caused by the caterpillars can disrupt outdoor activities as well as cause extensive property damage. Dying caterpillars can cause a stench that is often overwhelming. For allergic individuals, the hairs of the gypsy moth can cause serious health problems.

How To Identify : An adult gypsy moth is large and has a wingspan of about 2 inches. The female moth is generally larger than the male and can fly. It is nearly white with wavy, blackish bands across the wings. The male is dark brown with several black wing markings. It has noticeable, feathery antennae. In mid-summer, eggs are deposited on rocks, branches, buildings, and other structures. Each egg mass contains up to 1,000 eggs and is covered with buff or yellowish hairs from the abdomen of the female. It resembles a piece of fungus and may be the size of a dime or as large as a 50-cent piece. The individual eggs are pellet-like and range in color from brown to black. Hatching begins in late March in the southeastern U.S. A young caterpillar is pale-brown or grayish. Its hairs are hollow and enable it to drift with the wind. A mature caterpillar is dark brown and may be up to 2 ½ inches long. It is characterized by five pairs of blue dots or knobs, followed by six pairs of red dots along the top side of the caterpillar.

Monitoring and Verification Procedures: Monitoring determines population levels, detects new colonies, and assesses the effectiveness of treatment measures. Department of Agriculture and other state agency personnel regularly monitor forests, orchards, preserves, and other areas for gypsy moths. Nature associations, 4-H clubs, and other citizen groups can help and should be encouraged to participate in these efforts. One commonly used method of detection is to wrap bands of burlap around suspect trees and examine them daily for gypsy moth caterpillars. **It is important that you positively identify specimens as gypsy moths before taking any remedial action.** Treatment for gypsy moths can be expensive and can harm plants, animals, and humans as well as the environment. For positive identification, contact your state Extension entomology specialist or local USDA-APHIS-PPQ office.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken to treat for gypsy moths.

CONTAINMENT – State and federal regulations prohibit the transport, importation, or cultivation of this pest. If you live in an area where there are gypsy moths and plan to move to another state, be sure to have your belongings inspected for gypsy moths.

MANUAL REMOVAL – Remove egg masses with a putty knife or other sharp instrument and properly dispose of them.

BIOLOGICAL TREATMENTS – These biological agents are effective against the larval stages of the gypsy moth:

- 1) Virus. Gypcheck kills the gypsy moth larvae without eliminating non-target species.
- 2) Bacteria. *Bacillus thuringiensis*.
- 3) Fungus. *Entomophaga aulicae* and *E. maimaiga*.
- 4) Insects. *Ooencyrtus kuwanae*, an egg parasite; *Sturmia scutella*, a fly parasite; and *Calosoma sycophanta*, a predatory beetle.

CHEMICAL TREATMENTS –

- 1) Coal-tar creosote. Apply this chemical to egg masses in the winter.
- 2) Diflubenzuron. Apply when young caterpillars are present.

OTHER TREATMENTS – These treatments target the adult gypsy moth and include mass trapping, mating disruption, and sterilization techniques:

INTEGRATED PEST MANAGEMENT – This approach uses a combination of the above treatments to give results that are effective, economical, and environmentally safe.

HYDRILLA

Hydrilla verticillata

Background: Hydrilla is an aquatic plant belonging to the Hydrocharitaceae family. It is native to Asia and was likely introduced into the U.S. by the aquarium industry. The first hydrilla plants were discovered in Florida in the early 1960s. Hydrilla usually reproduces asexually by fragmentation or subterranean tubers. Hydrilla can be found in 14 states from coast to coast. Hydrilla is spread by recreational boats, trailers, jet skis, and other waterborne equipment.



Problems: Pieces of hydrilla can easily take root and form new colonies. Hydrilla can expand from a few acres to several thousand acres in two to three years. Hydrilla is hardy and thrives in most aquatic environments. Subterranean tubers live as long as 10 years, making eradication almost impossible once it has become established. Hydrilla crowds out other aquatic plants and eventually reduces the bio-diversity in an aquatic ecosystem. Its presence generally has a negative impact on navigation, aquaculture, waterborne recreation, and fishing. Cleanup costs can be expensive. **California spends roughly \$1 million annually to control this aquatic weed!**

How To Identify Hydrilla: Stems of hydrilla are long and branched, with leaves oppositely positioned in the lower portions and whorls in the higher portions. Each whorl has two to eight leaves. The leaves are oval-shaped and dull to bright green. Leaf margins are serrated and have pointed spines on the midribs. When you draw them through your hand, these spines feel harsh, coarse, and brittle. Small white flowers are visible in late summer or early fall.

Monitoring and Verification Procedures: Monitoring determines population levels, detects new colonies, and assesses the effectiveness of treatment measures. Natural resource and other state agency personnel regularly monitor lakes, rivers, irrigation canals, ponds, and streams for hydrilla and other nuisance aquatic weeds. Lake associations, 4-H clubs, and other groups can help and should be encouraged to participate in these efforts. **It is important that you verify hydrilla before taking any remedial action.** Treatment for hydrilla can be expensive and may harm aquatic plants and animals as well as the environment.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken to treat hydrilla.

CONTAINMENT – Quarantining or curtailing public access to infested sites is critical to keeping this nuisance plant in check. It is illegal to possess, cultivate, or transport hydrilla in many states.

CHECKLIST FOR BOATERS, FISHERMEN, AND WATER CRAFT OWNERS –

- 1) Remove all aquatic plants from boats, trailers, fishing tackle, or other water craft and equipment.
- 2) Discard these in a trash bin or other location away from the water.
- 3) Rinse contaminated boats and equipment with hot water if possible.

CHEMICAL TREATMENT –

- 1) Cutrine-Plus: 1.2-3.0 gallons per acre-foot (A/F)
- 2) AquatholR K: 1.3-1.9 gallons per A/F
- 3) Sonar AS: 8-12 ounces per A/F; Sonar 5P & SRP: 4-6 pounds per A/F

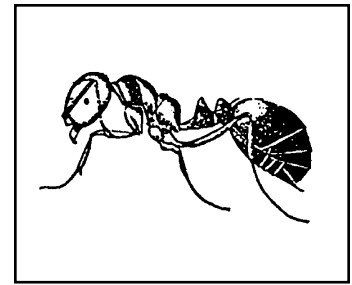
BIOLOGICAL TREATMENT – Stock grass carp (*Ctenopharyngodon idella*) in infested ponds or water bodies only after contacting the DNR in your state. Stock 10 to 15 8-inch fish per acre in water bodies with moderate hydrilla infestations and 15 to 20 fish in water bodies with heavy infestations.

FERTILIZATION – Fertilization is an effective and economical way to control hydrilla in farm and sport fish ponds. It stimulates a phytoplankton “bloom.” A good bloom acts like an aquatic “mulch” and will shade out most aquatic weeds. Always follow a fertilization program that meets the needs of your specific locality. The first step in any successful program entails removing existing hydrilla and other aquatic weeds by chemical or biological means. In the southern U.S., fertilization begins in early spring when water temperatures reach 60 to 65 °F. Fertilizer applications continue at 2- to 3-week intervals or until a bloom is established. Fertilizer applications are then reduced to 3- to 4-week intervals. Fertilization is stopped in late fall.

IMPORTED FIRE ANT

Solenopsis invicta

Background: *Solenopsis invicta* is one of three fire ant species that inhabit the U.S. It is native to Brazil and was first discovered in Mobile, Alabama shortly after the end of the First World War. This species probably came into the U.S. with cargo or in soil used as ballast in ships. It quickly spread throughout the area, and its range now encompasses most of the southeastern U. S. from Oklahoma to North Carolina. This species now infests more than 260 million acres. In 1957 the Federal government launched a massive program to eliminate the imported fire ant (IFA). This program failed, but a new program is underway that will use integrated pest management techniques. IFA spread by natural mating flights; by flood waters; in infested soil, sod, or nursery stock; and by other human mediated activities.



Problems: Unlike native ant species, *S. invicta* has few natural enemies. It also has an enormous reproductive capacity. Mature females can lay 200 eggs a day. The biggest problem associated with imported fire ants is their stinging and biting behavior. Imported fire ants can inflict painful stings that can result in serious medical consequences for small children and allergic individuals. Fire ants are a serious agricultural pest and cause millions of dollars in crop losses. Fire ants can impede feeding by livestock, interfere with farm operations, and damage crops and equipment. Fire ants can play havoc with gardeners and homeowners by foraging for food, damaging electrical equipment, causing structural problems in roadways and sidewalks, and feeding on fruits and vegetables. More than \$172 million was spent by federal, state, and other governmental agencies to control the imported fire ant from 1957 to 1981. Because of the aggressive nature of this species, they can displace indigenous ant species and reduce biodiversity in ecosystems.

How To Identify: One way to identify imported fire ants is by their aggressive behavior. Disturbed nests are soon covered with thousands of ants, which indiscriminately sting almost anything in sight. The sting of the fire ant is painful and sometimes produces a conspicuous white pustule. Unlike other ant species, the mounds of imported fire ants are usually found in open, sunny places. Mounds are from several inches to two feet in height and diameter and covered with a fine layer of soil. In heavily infested areas, there can be as many as 200 to 800 mounds per acre. A typical IFA nest contains 100,000 to 500,000 worker ants. Worker ants are small and range in size from 3.2 to 6.4 mm. They may be reddish-brown or black. The queen is usually three to four times larger than a typical worker ant. There is usually one queen per nest, but some have multiple queens. Several hundred winged ants will leave the nest in late spring and form new colonies.

Monitoring and Verification Procedures: Monitoring determines population levels, detects new colonies, and assesses the effectiveness of treatment measures. Department of Agriculture and other state agency personnel regularly monitor pastures, fields, farms, and other areas for imported fire ants. Nature associations, 4-H clubs, and other groups can help and should be encouraged to participate in these efforts. **It is important that you positively identify suspected specimens as IFA before you take any remedial action.** Treatment for fire ants can be expensive and may harm plants, animals, and humans as well as the environment. Distinguishing between fire ant species can be difficult. Contact your state Extension entomology specialist or USDA-APHIS-PPQ office for help.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken to treat for fire ants.

HOT WATER – Boiling water will eliminate small IFA colonies. Several applications may be necessary for large nests.

BIOLOGICAL TREATMENTS – *Thelohania solenopsae*, a protozoan parasite; *Solenopsis daugerri*, a parasitic ant; and phorid flies are biological agents that hold promise to control fire ants. However, native ant species are probably the most effective of the biological agents.

CHEMICAL TREATMENTS – Many chemical agents are available on the market that kill imported fire ants. Several of the less toxic forms are listed below:

- 1) Sprays. Spray infested area with “ready to use” (RTU) Chlorpyrifos, Diazinon, or Propoxur.
- 2) Baits. Baits containing Hydromethylnon, Fenoxycarb and Avermectin B1.
- 3) Organic insecticides. Boric acid, rotenone, and pyrethrins.

INTEGRATED PEST MANAGEMENT – This approach recognizes the imported fire ant is here to stay, and it does have some beneficial qualities. It uses a combination of tactics, chemical and non chemical, which are effective, economical, and environmentally safe.

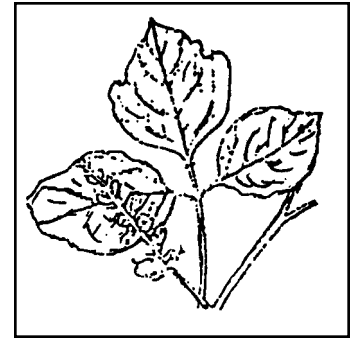
For more information:

Vinson, S.B. and A.A. Sorenen. *Imported Fire Ants: Life History and Impact*. Texas Department of Agriculture, P.O. Box 12847, Austin, Texas 78711, (512) 463-7540.

KUDZU

Pueraria lobata

Background: Kudzu is an invasive vine belonging to the legume family (Fabaceae). It is native to China, Taiwan, and India and was introduced into the U.S. in the late 1800s as an ornamental plant. In the Orient it was used for its food and medicinal value and for making paper. Kudzu's introduction into the New World encountered mixed emotions, as evidenced by the names it was given, for example, "mile-a-minute vine" or "wonder vine" and books such as *Kudzu: The Vine To Love or Hate*. In the 1930s kudzu was used for erosion control, soil enrichment, and as a forage plant. Government programs even paid Southern landowners to plant kudzu. Kudzu clubs were formed throughout the South, and it was christened a "miracle vine." By the 1950s it had spread throughout the southeastern U.S. and was generally recognized as a nuisance. The USDA officially declared kudzu as a noxious weed in 1972.



Problems: Kudzu is among the fastest growing plants in the world. Vines can grow a foot a day and easily reach 60 feet in a growing season. Kudzu vines can easily kill trees, shrubs, and grass by its intense shading. Vines can root every few feet at nodes, essentially forming many new plants. Established stands may contain tens of thousands of plants per acre. Kudzu can be controlled, but control is expensive. Initial costs can range from \$80 to \$150 per acre. Several applications are usually necessary to keep mature stands in check. Utility and timber companies, highway and railroad departments, landowners, and others spend millions of dollars each year to control kudzu. Kudzu can grow in almost any soil. As a forage plant, kudzu produces low yields (2 to 3 tons/Y) and is difficult to cut and bale.

How To Identify: Kudzu has large, tri-lobed leaves that have a velvety texture. Areas having kudzu will literally be draped in green foliage. The vine is semi-woody and has nodes every few feet. Leaves are sensitive to the cold and usually die after a severe frost. It has tuberous roots that may weigh 200 to 300 pounds. Flowers are purple or magenta colored and are wisteria-like in appearance. They have the fragrance of grapes and usually bloom in late summer.

Monitoring and Verification Procedures: Monitoring determines population levels, detects new infestations, and assesses the effectiveness of treatment measures. State and federal agencies regularly monitor forests, parks, and roadways for kudzu. Nature associations, 4-H clubs, and other citizen and school groups can help and should be encouraged to participate in these efforts. **It is important that you positively identify suspected specimens as kudzu before you take any remedial action.** Treatment for kudzu can be expensive and may harm plants, animals, and humans as well as the environment. Contact your state Extension weed specialist or your local USDA APHIS, PPQ office for help in identifying plant specimens.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be used to control kudzu.

OVERGRAZING OR MOWING – Overgrazing or mowing young patches for two or more successive years will control most stands of kudzu.

CHEMICAL TREATMENTS –

- 1) Picloram (Tordon 101 or Tordon K)- For use in open area sites; a waiting period (9 months) is necessary before you can plant other crops in this area.
- 2) Dicamba (Banvel 720)- For use around ponds, streams, and other aquatic areas.
- 3) Garlon 4- For use on vines in older pine trees; do not use around hardwoods.
- 4) Roundup- For residential use only.

For more information:

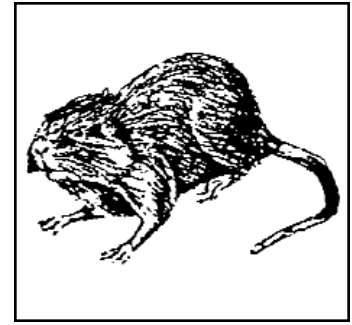
Everest, J., J. Miller, D. Ball and M. Patterson. 1991. Kudzu in Alabama. The Alabama Cooperative Extension Service Circular ANR-65.

Hoots, D. and J. Baldwin. 1996. Kudzu: *The Vine To Love or Hate*. Suntop Press. Virginia Beach, Virginia.

NUTRIA

Myocastor coypus

Background: The nutria is an aquatic mammal belonging to the Capromyidae family. It is native to Argentina and Chile and was introduced to south Louisiana by E.A. McIlhenny, the hot sauce baron, in the 1930s for its high-quality fur. Several animals escaped after a hurricane and soon spread throughout the region. Today the nutria is well established along the Gulf coast, and scattered populations can be found in North Carolina, Maryland, Oregon, and Washington. Nutrias thrive in areas where there is an abundance of water. It is an opportunistic herbivore and grazes on a variety of wetland plants, including duckweed and water hyacinth. In some cases nutrias have been known to feed on lawns and shrubs in residential areas. Like most rodents, nutrias are adaptable and prolific breeders. Nutrias can bear young as early as four months of age and have as many as 8 to 13 in a litter, every month.



Problems: Besides man, the nutria is largely responsible for the degradation of many marsh and wetland areas. Having few natural predators, nutrias soon overpopulate and over graze areas into which they are introduced or spread. Unfortunately, nutrias feed on saplings of valuable wetland trees such as the cypress. They also ruin crops such as rice, corn, and sugar cane by eating the tender stems and stalks. Its burrowing activities can cause extensive damage to levees and canal banks. In Jefferson Parish, Louisiana, officials estimate nutrias have caused \$8 million in such damages. Nutrias carry roundworms, salmonellosis, and other diseases that can be transmitted to man. Like most wild animals, nutrias can inflict severe damage to pets or livestock if provoked.

How To Identify: The nutria has the body of a large brown rat and the head of a beaver. Some biologists describe it as an overgrown guinea pig. The nutria can readily be identified by its naked, round tail and four large front teeth that are orange. The body hair is long and coarse, with a grayish underfur. The average weight is 12 to 16 pounds at maturity. Each foot has five toes. The hind feet of a nutria are webbed and help make it an excellent swimmer. The sexes can easily be distinguished by external sex organs.

Monitoring and Verification Procedures: Monitoring gauges population levels, detects new ones, and assesses the effectiveness of treatment measures. In states where the nutria is a nuisance, natural resource and other state agency personnel regularly monitor marshes, wetlands, and other areas for nutria. Nature associations, 4-H clubs, and other citizen groups can help and should be encouraged to participate in these efforts. **It is important that that you positively identify suspected specimens as nutria before taking any remedial action.** Treatment for nutria can be expensive and can be harmful to plants, animals, and humans as well as to the environment. When in doubt, contact your state Extension wildlife specialist for positive identification.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken to treat for nutria.

AROMATIC PLANTS – *Justicia lanceolata*, or the lance-leafed water willow, is a plant that is offensive to the nutria. Planting *Justicia* around other more desirable aquatics will keep nutria out of an area.

TRAPPING – At one time, the nutria was one of the most important fur bearing animals in Louisiana, and trappers could easily get \$8 for each skin. The state must now offer trappers a per-pelt bounty to make it worthwhile.

SHOOTING – This is an effective method for eliminating small, isolated groups of nutria.

POISONING – Zinc phosphide is a rodent poison that has proven lethal to nutria. Unlike other poisons, it kills nutria with a single dose, breaks down when dissolved in water, and is relatively harmless to other animals and humans.

EATING – “A nutria-a-day helps keep erosion at bay” is a new slogan espoused by recipients of a \$2.1 million grant to encourage cooks and others to create a market for nutria meat. It tastes a lot like rabbit and can be grilled, smoked, or used in a stew.

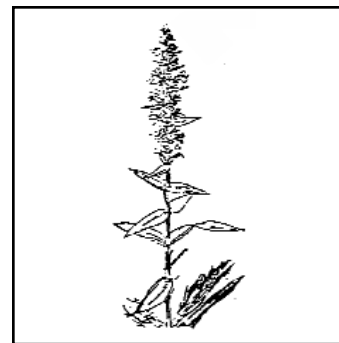
For more information:

Hesse, I.D., W.H. Conner and J.M. Visser. 1997. “Nutria, Another Threat to Louisiana’s Vanishing Coastal Wetlands.” *ANS Digest* 2 (1): 4-5. (612) 471-9773.

PURPLE LOOSESTRIFE

Lythrum salicaria

Background: Purple loosestrife is a wetland plant from Europe. It was imported to the east coast of the U.S. in the 1800s because of its value as a medicinal herb. In recent times its appeal as a nursery plant has resulted in its presence in 40 states and all Canadian border provinces. Purple loosestrife spreads primarily by seed but is also easily propagated from root stock and stem parts. Purple loosestrife thrives on disturbed, moist soils, often becoming the dominant species. Because it has few natural pests, the purple loosestrife continues to expand its range in North America.



Problems: Purple loosestrife alters marshes, wetlands, and other aquatic ecosystems by displacing native wetland plants such as cattails, bulrushes, sedges, and willows. Its foliage is generally unsuitable as cover, food, or breeding sites for native wildlife. Many rare and endangered plants and animals are threatened by its invasive activities. In some areas, it may adversely affect fisheries, forage production, and wild rice crops. One plant can produce up to two million seeds in a season. Seeds are easily spread by water, air, and wildlife and remain viable when submerged for several years. Purple loosestrife can grow in most soils and can tolerate a wide range of climatic conditions. Because of its extensive root system, it can clog drainage systems and result in costly cleanup bills to landowners and municipalities.

How To Identify: Adult plants stand 2 to 7 feet and have multiple (30 to 50) stems emerging from a single rootstock. Stems are stiff, four-sided, and characterized by many fine hairs. Leaves are oblong and arranged opposite to each other. The shallow woody root system forms a dense mat. The flowers are on a long spike closely attached to the stem. Magnificent displays of purplish-pink flowers in late summer make it easily recognizable. The flowers are generally six-petaled.

Monitoring and Verification Procedures: Monitoring gauges population levels and the rate of spread and assesses the effectiveness of treatment measures. Federal and state agencies currently monitor populations of purple loosestrife in many states. Civic groups, 4-H clubs, and environmental groups can help and are encouraged to participate in these efforts. **It is important that you positively identify suspected plants as purple loosestrife before you make any remedial action.** Treatment can be expensive and may harm aquatic plants and animals as well as the environment.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions are being taken to treat for purple loosestrife.

CONTAINMENT – Quarantine or curtail public access to infested sites. In 13 states, possession, importation, and distribution of purple loosestrife are prohibited.

BIOLOGICAL TREATMENTS – Several insect species and fungal pathogens have shown promise for long term control of purple loosestrife.

1) Insects. *Nanophyes marmoratus*, a flower-feeding weevil; *Hylobius transversovittatus*, a root-boring weevil; and *Galerucella californiensis* and *G. pusilla*, leaf-eating beetles are currently being evaluated in 18 states.

2) Fungal pathogens. Several promising candidates have been isolated and field tested. To date, the results are inconclusive.

CHEMICAL TREATMENTS – Rodeo, 2,4-D and Garlon 3A are EPA-approved herbicides that can control purple loosestrife.

HAND-PULLING – Hand pulling is recommended where stands are small and localized. Dig older plants to remove as much of the root system as possible.

INTEGRATED PEST MANAGEMENT – This approach combines tactics, chemical and nonchemical, that are cost effective and environmentally safe.

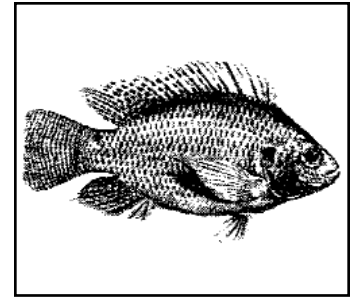
For more information:

Skinner, L.C., W.J. Rendall and E.L. Fuge. 1994. *Minnesota's Purple Loosestrife Program: History, Findings and Management Recommendations*. Minnesota Department of Natural Resources. Special Publication 145.

TILAPIA

Tilapia species

Background: Tilapia is the general name for a large group of mouthbrooding fishes belonging to the family Cichlidae. Tilapia are native to Africa but can now be found worldwide. They were originally introduced into the U.S. in the 1960s for aquatic weed control. In recent years tilapia have become increasingly popular with American aquaculturists as a food fish. They are also used as a game and forage fish in sportfish ponds.



Problems: Tilapia are prolific breeders and can spawn year-round in the southern U.S. and in Hawaii. A mature female tilapia can produce several thousand young in one year. Fry survival is high because of parental care and the aggressive nature of these fish. Tilapia pose a threat to natural fish populations by physically disrupting spawning sites and patterns of other fish and out-competing these for food and niches. Once introduced, tilapia soon take over and displace indigenous fish. Tilapia are tropical fish and will die if water temperatures drop below 55 °F for prolonged periods and, in some cases, result in massive fish kills.

How To Identify: Many species of tilapia closely resemble native sunfishes. Unlike members of the Centrarchidae family, tilapia have a broken lateral line and single set of nostril apertures. Tilapia are normally blue, green, or black, depending on the species and the season. During spawning, tilapia create numerous saucer-like depressions in pond bottoms similar to some species of sunfish. Adults can often be found with numerous fry in their mouths at this time.

Monitoring and Verificaiton Procedures: Tilapia can be found in lakes, rivers, irrigation canals, ponds, streams, and most water bodies in the South. Treatment for tilapia can be expensive and can harm aquatic plants and animals as well as the environment. **Be sure you positively identify tilapia before you take any remedial action.** In most cases, fish specimens can be identified by a state biologist or fisheries specialist.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be implemented to control tilapia.

CONTAINMENT – Quarantine or curtail public access to infested sites. Many states have strict regulations on the importation and cultivation of tilapia.

BIOLOGICAL CONTROL – Largemouth bass, channel catfish, and hybrid striped bass have been shown to control populations of tilapia.

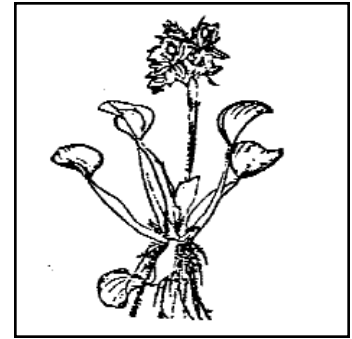
DESICCATION - Ponds should be completely drained and allowed to air-dry for at least two weeks. Hydrated lime should be liberally applied to the pools of water that remain.

ROTENONE – One ppm of 5% rotenone will eliminate most scaled fish species, including tilapia. Potassium permanganate can be used to neutralize the effects of rotenone (2 parts $KMnO_4$ to 1 part rotenone).

WATER HYACINTH

Eichhornia crassipes

Background: Water hyacinth is a floating aquatic plant belonging to the Pontederiaceae family. It is native to South America and probably was imported into the United States in the late 1800s for its ornamental value. Plants can reproduce by runner stems or by seed. Established water hyacinth populations can now be found in 13 states and 53 countries worldwide. NASA and other agencies have experimented with water hyacinth as a biological agent for water purification and methane generation.



Problems: The water hyacinth grows at a phenomenal rate and can double in size in less than two weeks. Left unchecked, it can choke out native aquatic plants and eventually alter the bio-diversity of the ecosystem. The water hyacinth can cause flood control problems in irrigation canals and severely restrict recreational activities such as fishing, boating, and skiing. It can provide a habitat for malaria and encephalitis-bearing mosquitoes. Seeds from the water hyacinth can remain dormant for years and later reinfest areas that have been cleared. One acre of water hyacinth can weigh as much as 500 tons. Because the water hyacinth is a tropical plant, it will die after a severe freeze and, in some cases, cause a fish kill. **In Florida, controlling water hyacinth in public lakes and rivers costs about \$2 million each year!**

How To Identify: The water hyacinth is a free-floating plant but typically is found in large, compacted beds. The leaves are dark green, glossy, and oval-shaped. The stems are bulbous and spongy on the free-floating plants. Plants vary in size from a few inches to several feet in height. The flowers are blue, violet, or white and have an orchid-like appearance. The roots are dark, feathery, and fibrous.

Monitoring and Verification: Monitoring determines population levels, detects new colonies, and assesses the effectiveness of treatment. State and federal agency personnel regularly monitor lakes, rivers, irrigation canals, ponds, and streams for water hyacinth and other nuisance aquatic weeds. Lake associations, 4-H clubs, and other citizen groups can help and should be encouraged to participate in these efforts. **It is important that you positively identify suspected aquatic plants as water hyacinth before you take any remedial action.** Treatment for water hyacinths can be expensive and can harm aquatic plants and animals as well as the environment.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be implemented to control water hyacinth.

CONTAINMENT – Quarantine or curtail public access to infested sites. It is illegal to possess or transport this plant in many states.

BIOLOGICAL TREATMENTS –

- 1) Insects. *Neochetina eichhorniae* and *N. bruchi*, leaf-eating weevils; *Sameodes albiguttalis*, an introduced moth; and *Arzama densa*, an indigenous moth.
- 2) Plant pathogen. *Cercospora rodmanii* is an indigenous fungus and is harmless to other aquatic life.
- 3) Manatee. Water hyacinth is a favorite food of this animal.

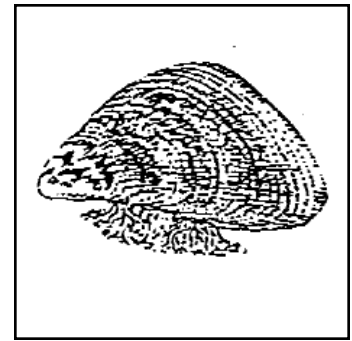
CHEMICAL TREATMENTS – Rodeo, Diquat, and 2,4-D can be used to control the water hyacinth.

HAND-PULLING – Hand-pulling or mechanical control is recommended for most small-scale projects.

ZEBRA MUSSEL

Dreissena polymorpha

Background: The zebra mussel is a small mollusk indigenous to the drainage basins of the Aral, Caspian, and Black seas of southwestern Russia. It was probably introduced into North American waters via ballast water from transoceanic ships. Since its discovery in the Great Lakes in 1988, the zebra mussel has swiftly penetrated North America's freshwater resources, particularly in the Great Lakes and Mississippi River Basin. Mussel infestations can be found in 19 states and as far west as Oklahoma. The range of the zebra mussel will continue to expand as it adapts to new environments and is inadvertently spread by humans.



Problems: Each mature female can release as many as 1.6 million eggs per year and spawn throughout the year in warm, fertile waters. The planktonic larvae (called veligers) can float long distances and attach to hard substrates by adhesive abysal threads to form dense colonies. Zebra mussels can affect drinking water, electric power, and other industrial plants by restricting the water flow in pipes, damaging valves, and clogging filters, screens, heat exchangers, and condensers. Because the zebra mussel is an efficient filter feeder and has been associated with harmful trematode parasites, it can also have a negative impact on other aquatic forms and aquaculture activities. Estimated economic impact of this exotic mussel in the US could total in the billions of dollars.

How To Identify: Zebra mussels typically have a small, thumb-sized, “D-shaped” shell with zebra-like bands, but some are solid brown or black. Stand pipes, screens, gratings, boat hulls, submerged equipment, and other hard surfaces are good places to find zebra mussels. They usually grow in clusters and have extremely fragile shells. Shells or shell fragments should be present in filters or screens. In some cases, foul-smelling odors will come from contaminated waters. Zebra mussels can be found on such aquatic weeds as naiad, coontail, milfoil, or hydrilla.

Zebra mussels are easily recognized by a simple “shell” test. When placed ventral side down, zebra mussel shells remain upright. If you suspect that you have zebra mussels, contact your nearest state Sea Grant office. Handy zebra mussel ID cards are available free from these offices.

Monitoring and Verification Procedures: Monitoring determines population levels, detects new infestations, and assesses the effectiveness of treatment measures. State and federal agency personnel regularly monitor streams, rivers, and lakes for zebra mussels and other aquatic nuisance exotics. Environment associations, 4-H clubs, and other citizen groups can help and should be strongly encouraged to participate in these efforts. **It is important that you positively identify suspected specimens as zebra mussels before you take any remedial action.** Treatment for zebra mussels can be expensive and can harm aquatic plants and animals as well as the environment. Monitoring surfaces for settled, immature zebra mussels should include materials currently being used around your facility, for example, polyvinyl chloride (PVC) piping. A plastic mesh pot scrubber is an inexpensive alternative that can work equally as well. Place these at strategic locations throughout your facility. Adults are recognizable by their dark, zebra-like markings; immature forms feel grainy.

Veligers (microscopic larval stage) can be collected using a plankton net. Samples are best kept alive and should be placed in a cool place after collection. To preserve samples, use a 70% solution of ethanol or isopropyl alcohol. A dissecting microscope with a cross-polarized light system is necessary to see veligers. To increase your chances of finding zebra mussels, take a combination of plankton samples and settlement device samples and examine other hard surfaces around your facility. Check these at least every two weeks.

Prevention and Control Measures: Several **chemical** and **nonchemical** actions can be taken.

FILTRATION SYSTEMS – Filtration is probably the most efficient and economical method for operations that use surface waters. Several types of back-washable sand filters and submerged infiltration beds are on the market that will eliminate veligers and juvenile mussels from intake waters.

TREATMENT WITH STEAM OR HOT WATER – Contaminated equipment should be steam cleaned or immersed in hot water (140 °F or 60 °C) for 3 to 4 minutes.

DESICCATION – Contaminated equipment should be allowed to air-dry at least one week in humid climates.

SALT – 1% treatment of sodium chloride (24 hours) in hauling tanks or vats will kill all larval stages of the zebra mussel. Boaters should thoroughly wash their boats with a saltwater solution (½ cup of salt per gallon of water), and follow it with a freshwater rinse.

BENZALKONIUM CHLORIDE- Use this chemical only to disinfect contaminated equipment. It will kill all stages of the zebra mussel at 100 ppm for three hours; and 250 ppm for 15 minutes. Benzalkonium chloride is highly toxic to most

aquatic life and should be used with extreme care.

LEMMA TOXINS – Endod (*Phytolacca dodecandra*) is a plant-derived molluscicide that has been proven to be lethal to adult zebra mussels at 15-20 ppm. At slightly lower doses, Endod will keep larval forms from settling. Endod degrades rapidly over time and is environmentally compatible.

BOATERS' AND FISHERMENS' CHECKLIST –

- 1) Empty bait buckets, live wells, and other sources of contaminated water in a safe area.
- 2) Dispose of aquatic plants from motors, trailers, and fishing equipment away from the water.
- 3) Rinse boat and equipment with hot water or steam.
- 4) Dry boats for at least five days before launching somewhere else.

For more information:

Monitoring - Refer to the booklet *Standard Protocols for Monitoring and Sampling Zebra Mussels* by J. Ellen Marsden. Illinois Natural History Survey, Biological Notes 138. April 1992. Available from Illinois Natural History Survey, Natural Resources Building, 607 East Peabody Dr., Champaign, IL 61820, (217) 333-6880.

Chemicals - For information on a particular compound, contact Technical Information Officer, National Fisheries Research-La Crosse, WI, (608) 781-6200.

Contacts

| | | | |
|-----------|---|-------------|---|
| Alabama | Auburn University Marine Extension & Research Center 4170 Commanders Drive Mobile, AL 36615 (334) 438-5690 | Mississippi | Baton Rouge, LA 70803-7507 (225) 578-6710 Mississippi State University Coastal Research & Extension Center 2710 Beach Blvd. Suite 1-E Biloxi, MS 39531 (228) 388-4710 |
| Florida | University of Florida PO Box 110400 Gainesville, FL 32611-0400 (352) 392-5870 | Texas | Texas A&M University 1716 Briarcrest, Suite 702 Bryan, Texas. 77802 (409) 845-3854 |
| Louisiana | Louisiana Sea Grant 103 Sea Grant Building Louisiana State University | | |

Summary of the National Invasive Species Act of 1996

Section 1

Amends the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 to mandate regulations to prevent the introduction and spread of aquatic nuisance species into the Great Lakes through ballast water.

Section 1101

Authorizes education, technical assistance, and other measures to promote compliance. Mandates voluntary guidelines to prevent such introduction and spread in U.S. waters by ballast water and other vessel operations. Mandates education, technical assistance, and other measures to encourage compliance. Requires mandatory regulations if guideline compliance is inadequate. Provides for enforcement through civil and criminal penalties and revocation of clearance. Encourages negotiations with foreign governments to develop and implement an international program for preventing such introduction and spread. Allows a vessel to not conduct a ballast water exchange if the exchange would threaten the safety or stability of the vessel. Allows a vessel that does not, for that reason, conduct an exchange to discharge ballast in any harbor, except in the Great Lakes. Mandates a study and report to the Congress on the effectiveness of existing shoreside ballast water facilities used by crude oil tankers in the coastwise trade off Alaska in preventing such introduction and spread.

Section 1102

Mandates studies of Lake Champlain, the Chesapeake Bay, San Francisco Bay, Honolulu Harbor, the Columbia River system, other estuaries of national significance, and other waters. Provides for making specified amounts available for research on aquatic nuisance species prevention and control in the Chesapeake Bay, the Gulf of Mexico, the Pacific coast, the Atlantic Coast, and the San Francisco Bay-Delta Estuary. Establishes a clearinghouse of national data on ballasting practices and compliance with guidelines under this Act.

Section 1103

Mandates a ballast water management program for vessels of the Department of Defense and the Coast Guard.

Section 1104

Requires (1) a ballast water management program to demonstrate technologies and practices to prevent aquatic nonindigenous species from being introduced into and spread through ballast water in U.S. waters; and (2) that the installation and construction of those technologies and practices be performed in the United States. Modifies (1) the composition and research priorities of the Aquatic Nuisance Species Task Force; and (2) zebra mussel demonstration program requirements.

Section 1202

Mandates research grants regarding environmentally sound methods for controlling the dispersal of aquatic nuisance species. Authorizes appropriations. Requires research on environmentally sound methods for preventing and reducing dispersal between the Great Lakes-Saint Lawrence drainage and the Mississippi River drainage through the Chicago River Ship and Sanitary Canal.

Section 1203

Requires the Task Force to encourage development and use of regional coordination panels and similar entities in regions in addition to the Great Lakes and Western regions.

Section 1204

Provides for interstate (in addition to existing State) aquatic nuisance species management plans, allowing Indian tribes as well as States to participate.

Section 1301

Authorizes appropriations, including for research on the prevention, monitoring, and control of aquatic nuisance species in Narragansett Bay, Rhode Island.

Exotics Recipes

Kudzu Quiche

1 cup heavy cream
3 eggs, beaten
1 cup washed and chopped young, tender kudzu leaves and stems
½ teaspoon salt
1 cup grated mozzarella cheese
1 9-inch unbaked pastry pie shell

Preheat oven to 350°. Mix first six ingredients. Place in pie shell. Bake in oven for 35 to 45 minutes or until set. Makes 4 to 6 servings.

Tilapia Gumbo

2 cloves garlic, diced
1 cup onion, diced
1 cup green pepper, diced
1 cup celery, diced
1 tablespoon hot sauce
1 tablespoon butter
4 cups beef broth
1 16-ounce can whole tomatoes, cut up
4 tablespoons olive oil
1 bay leaf
½ teaspoon dried thyme
2 lbs. tilapia fillets, cut into bite-sized pieces
1 10-ounce package frozen sliced okra
seasoning salt, salt, and pepper to taste
4 cups hot cooked rice

In a large kettle or Dutch oven cook celery, onions, green peppers, and garlic in hot oil until tender. Stir in beef broth, tomatoes, bay leaf, salt, thyme, and oregano. Bring to boil; reduce heat. Cover and simmer for 15 minutes.

Add catfish and okra to kettle. Return to boil. Cover and simmer for 15 minutes or until fish flakes. Remove and discard bay leaf. Serve in bowls over hot cooked rice. Makes 8 servings.

Nutria Delight*

1 nutria, dressed
2 cups fresh vegetables, cut
2 sweet potatoes, peeled and diced
1 large onion, diced
1 large apple, peeled and diced
1 (28 oz.) can of sauerkraut
seasonings including salt, pepper, and hot sauce

Salt and pepper entire carcass. Combine vegetables, sweet potatoes, and apples, and stuff cavity with these ingredients. Place prepared carcass in a roasting pan with the stomach side up. Drain the can of sauerkraut, and spread the sauerkraut over the vegetables and cavity. Mix a few drops of hot sauce in the sauerkraut juice and pour mixture over the carcass. Cover and roast at 350° for 3 to 4 hours or until it is tender. Makes 6 to 8 servings.

* Adapted from a recipe in the *Native Indian Fish and Wild Foods Cookbook* (ISBN# 56523-008-6-093) edited by David Hunt.

Kudzu Jelly**

4 cups of kudzu flowers
1 tsp. lemon juice
4 cups boiling water
2 boxes Sure-Jell
5 cups sugar

Wash kudzu flowers in cold water, rinse, and drain. Put flowers in a large bowl, and pour boiling water over the blossoms. Refrigerate overnight. Strain and discard blossoms. Add lemon juice and Sure-Jell to remaining juice; bring to a rolling boil. Add sugar and stir constantly. Bring to rolling boil again. Boil for 1 minute. Pour liquid into sterilized jars, clean rim, and seal. Water bath 5 minutes in hot water.

** Recipe compliments of Flora Tolar

New Orleans Jambalaya a la Zebra Mussel

½ lb. steamed zebra mussel
2 cloves garlic, diced
1 onion, diced
1 cup green pepper, diced
1 cup celery, diced
1 tablespoon Tabasco hot sauce
6 cups cooked rice
1 tablespoon butter
½ lb. cooked chicken, shredded
½ lb. precooked Cajun sausage, diced
1 can tomato sauce and 2 diced tomatoes
5 tablespoons olive oil
Seasoning salt, salt, and pepper to taste

Saute celery, onions, garlic, tomatoes, and green pepper in olive oil until crisp. Mix in tomato sauce with one cup of water and allow it to simmer 15 minutes. Saute rice in butter until light brown. Mix in remainder of ingredients. Serve hot. Makes 4 to 6 servings.

Nutria Sausage

2 pounds nutria meat
1 pound pork meat
10½ ounces potato, peeled
2¼ teaspoons salt
2 teaspoons Enola's Secret Seasoning (or Creole Seasoning)
1 teaspoon sage

Ground nutria and pork with potato. Add all other ingredients; mix well. If using a bar-b-que pit to smoke, build fire on one side of pit. Place sausage on the other side of pit; this will allow smoke to get to sausage without cooking too fast. If you have used bacon fat, put on your fire. This will create lots of smoke. This will take less time to get a good smoke taste. Let sausage smoke 1 hour and 15 minutes; turn, let smoke 1 hour; remove from pit; let cool. Makes 4 pounds 5 ounces.

Recipe by Chef Enola Prudhomme

Heart Healthy "Crock-Pot" Nutria

2 hind saddle portions of nutria meat
1 small onion, sliced thin
1 tomato, cut in big wedges
2 potatoes, sliced thin
2 carrots, sliced thin
8 brussel sprouts
½ cup white wine
1 cup water
2 teaspoons chopped garlic
salt and pepper to taste
1 cup demi glace (optional)

Layer onion, tomato, potatoes, carrots, and brussel sprouts in crock pot. Season nutria with salt, pepper, and garlic to taste, and place nutria over vegetables. Add wine and water, set crock pot on low, and let cook until meat is tender. Cook for approximately 4 to 6 hours. Garnish with vegetables and demi glace. Serves 4.

Nutria Chili

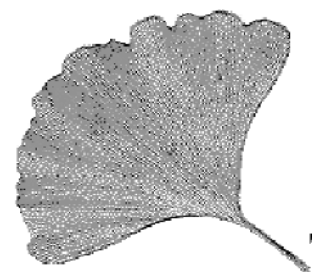
3 tablespoons vegetable oil
2 pounds nutria ground meat
1 tablespoon + 1 teaspoon salt
1 teaspoon red pepper
1 tablespoon + 1 teaspoon chili powder
1 cup diced onion
1 cup diced green bell pepper
1 cup diced red bell pepper
1 cup tomato paste
4 cups beef stock (or water)
1 can red kidney beans (opt.)

In a heavy 5-quart pot on high heat, add oil; heat until very hot. Add nutria meat; cook and stir 10 minutes. Add salt, red pepper, chili powder, onion, and both bell peppers. Cook and stir 15 minutes. Add tomato paste and 4 cups stock. Cook 30 minutes; reduce heat to medium. Add red kidney beans; cook an additional 10 minutes. Serve hot!

Recipe by Chef Enola Prudhomme

The Ginkgo Biloba: Maidenhair-Tree

One of the world's oldest natural medicines is derived from what might be the world's oldest living tree, the Ginkgo. The Ginkgo is a hardy deciduous tree today and is found all over the world; however, it had a close call with extinction. Fossil evidence indicates the Ginkgo had been around for more than 300 million years and evolved into 50 different species found in Asia, Europe, and the Americas when the last Ice Age (about 10,000 years ago) almost annihilated its family. If it weren't for the Buddhist monks in northern China, the last species would have perished. Ginkgoes were cultivated by monks in their monastery courtyards partly because of their medicinal value, their edible seeds, and perhaps their beauty. The Ginkgo biloba is the last surviving member of its plant family.



These hardy trees that Charles Darwin called “living fossils” were re-introduced to North America in 1784 and have recently become popular as an ornamental tree because of their beauty; pollution tolerance; and insect, fungi, disease, and heat resistant properties. Ginkgoes grow well in just about any type of soil and tolerate even salty soil. It is not unusual for the grey barked ginkgo to grow more than 120 feet tall and live for 1000 years. As a testimonial to their hardiness, one survived the atomic blast that destroyed Hiroshima. The leaves have even been placed in books to protect them from bookworms, and the astringent seeds are antifungal and antibacterial.

Ginkgo trees are dioecious, with male and female reproductive organs on different trees. The Ginkgo's sperm are motile (have flagellae), a trait found only in Ginkgo and cycads among living seed plants. The pollen grains, which contain the sperm, are found in clusters attached to short shoots coming off the branches of the tree. In the spring these clusters open, and the pollen grains are carried away by the wind until they land on a female ovule. It then pollinates the seed, but the actual fertilization of the seed does not occur until fall, after the seed has fallen off the tree and the fleshy seed coat has rotted away, giving off a disgusting odor. The seed, a yellow plum-like fruit, is considered a delicacy in China, where it is usually roasted before being eaten. The word “Ginkgo” comes from the Chinese “yinhsing,” meaning silver apricot, and “biloba” comes from the leaves’ having two lobes. The leaves are harvested in fall as they start to turn yellow, when the flavonoid content is highest.

The Ginkgo is considered a sacred tree by the Chinese. Its distinctive fan-shaped leaves, with unusual near-parallel venation, have been used in Oriental medicine for more than 5,000 years for respiratory ailments and for brain function. Hundreds of studies have been performed, with *Ginkgo biloba* extracts supporting many of the ancient uses as well as identifying new applications.

Ginkgo has become the most prescribed herb in Europe and the fifth-best seller in U.S. health food stores, after echinacea, garlic, goldenseal, and ginseng. With more than 20 million people in the world using *Ginkgo biloba*, it may be the most popular and widely used health supplement in history. Statistical studies of the effects of using Ginkgo are in their infancy. However, the prestigious *Journal of the American Medical Association*, in reporting the results of the first double-blind study in the U.S. on the effects of Ginkgo, reported that an extract has a small but measurable effect on dementia. The world's first great herbalist, the Chinese emperor Shen Nung, called Ginkgo "good for the heart and lungs." One of the major effects attributed to Ginkgo is as a free radical scavenger, or an antioxidant. Compounds within the plant are thought to absorb reactive toxic chemicals.

Products from the Ginkgo tree have been used to treat a variety of ailments, including Alzheimer’s disease, anxiety, asthma, bladder irritation, blindness, blood clots, cancer, catarrh, cerebral arteriosclerosis, deafness, dementia, depression, diabetes, diphtheria, dysentery, frequent urination, hearing loss, heart disease, hemorrhoids, impotency, incontinence, kidney weakness, macular degeneration, memory loss, pain, phlebitis, Raynauds disease, skull injuries, stroke, tinnitus, tuberculosis, typhoid, vaginitis, varicose veins, vascular disease, and vertigo to name a few. **Note: This profile is not intended as medical advice or an endorsement of the reported uses for Ginkgo.**

Pertinent Facts Concerning the Loss of Other Potentially Valuable or Beneficial Organisms

- 40 percent of all prescriptions in the US are based on or synthesized from natural compounds found in plants and animals;
- more than 99 percent of the plants and animals that have ever lived on earth are now extinct;
- less than 10 percent of the known plant species have been studied and only a fraction of the invertebrates;
- the 6th great period of extinction is underway, and plant and animal species are disappearing at least 1,000 times faster than at any other time in the last 65 million years;
- habitat loss causes almost 75 percent of the extinctions now occurring;
- the human population is growing exponentially, and we use more than half the fresh water;
- 50 to 100 species are becoming extinct every day. In a few decades, millions of species will become extinct, perhaps 50

percent of the present number. The majority of extinctions are occurring among the invertebrates, especially the insects. The extinction of plants is also important, since about 20 to 40 animals depend on each plant. When a species of plants becomes extinct, animals follow. Worldwide 50,000 species become extinct every year!

The exchange of ginkgo leaves is a symbol of warm friendship.

The *Franklin alatamaha*, the southeast's "Ginko Story," is about a nonindigenous hitchhiker on a nonindigenous agricultural import that caused the demise of a native species that, in the end, was conserved by America's first naturalist.

Early American naturalist William Bartram (1739 – 1823), and his father John, are credited with saving the *Franklin alatamaha* (Franklin Tree - wonder who it was named for? Yep, they were contemporaries and acquaintances!), found along the banks of the Altamaha River in Georgia in 1770, from becoming extinct. The Franklin Tree became extinct in the wild about the time cotton was brought in. It appears the wilt caused by *Ptytophthora cinnamoni* (a root-rotting fungi associated with commercial plants) accompanied cotton and is credited with the demise of wild Franklin Trees. All Franklin Trees today are derived from plant material collected by the Bartrams and preserved in their garden.

Exotics Glossary

Alkalinity - a measure of the concentration of bases in a water sample expressed as parts per million of an equivalent amount of CaCO_3

Allelopathic - substances produced by certain plants that inhibit the growth of other plants

Anterior End - the shorter end of the shell as measured from the umbo; near the front end

Aperture - an opening

Aromatic - fragrant odor emitted by certain plants

Autacoidal - something that is self-destructive

Bast Fiber - fibrous plant material typically used for cordage and textiles

Bioassay - tests designed to determine the toxicity level of a chemical necessary to kill a plant or animal

Biodiversity - the variety of plant and animal forms present in an ecosystem

Biofouler - animal or plant forms that cause clogging or obstruction

Biomass - total weight of an organism per unit area

Bivalve - class of mollusks that are laterally compressed and have a shell made of two hinged valves

Bulbous - shaped like a balloon

Byssal - tough, adhesive strands secreted by some mollusks used to attach to a substrate

Calcium - a measure of the concentration of calcium ions present in a water sample; it is usually expressed as milligrams/liter or parts per million

Chevron - a "V"- shaped marking

Compressed - flattened or pressed closely together laterally

Concentric - having a common center

Conductivity - a measure of the ability of water to conduct an electrical current; it is usually given in units of Siemens

Confluent - continuous or running together

Defoliation- loss of leaves

Desiccation - process where the moisture is removed

Detoxify - process of removing or neutralizing the toxic agents

Dichotomous - division into two usually contradictory parts or categories

Distal - away from the center or origin

DO - an acronym for the concentration of dissolved oxygen in water; it is usually expressed as parts per million (ppm)

Dorsal - referring to the top part of a shell or fin

Ecosystem - system formed by the interaction of animals, microbes, and plants with each other and their environment

Elliptical - having the form of an ellipse or oval

Elongate - long or extended

Entomologist - one who studies insects

Exotic species - foreign, not native, introduced

Extirpated - locally extinct

FAQ- an abbreviation for Frequently Asked Questions, FAQ is a document that assembles answers to common questions about sites or areas of the Internet

Femur - the third segment of the leg of an insect

Forage - food for livestock or wildlife

Fragmentation - method by which some plants can be propagated by pieces of stems or roots

FTP- an abbreviation for File Transfer Protocol, FTP is a system for the transfer of data on the Internet

Grub - the larval stage of several insect species, primarily members of the beetle family

Hardness - a measure of the concentration of calcium and magnesium ions in a water sample expressed as parts per million of an equivalent amount of CaCO_3

Hermaphrodite - animal or plant having the reproductive organs of both sexes and, in some cases, capable of self-fertilization

Hinge - the elastic part of the shell that unites the valves along the top of the shell

Inflated - swollen or expanded

Infestation - massive invasion by some plant, animal, or microbe

Insecticides - substances used to kill insects or their larval forms

Integrated pest management - a cost-effective and environmentally sound approach to controlling pest species using a combination of biological, cultural, physiological, mechanical, and/or chemical treatments that keep the insects at an acceptable level

Iridescent - having rainbow colors

Juvenile - the immature stage of some animal form

Lateral teeth - the elongated teeth along the hinge line of the shell

Legume - plants that harbor nodes of nitrifying bacteria

Medicinal - plants that have healing properties

Microbial- a minute life form

Molluscides - substances used to kill mollusks

Mollusk - invertebrates that have a calcified outer shell

Mouth brooding - fish that incubate their fry in their buccal cavities, such as Tilapia

Native Species - plant and animal species that originate in the area under study. These species are adapted to local growing conditions, including predators and climate.

Nodes - joint in a stem; part of stem that normally bears leaves and can produce new plants

Nonindigenous species - foreign, not native, introduced exotic, significant threat to biodiversity

Non-native species - foreign, not native, introduced exotic

Noxious - organisms that have harmful properties

Oblong - having the shape of or resembling a rectangle or ellipse

Opportunistic - animals, plants, or microbes that feed on whatever is available

Ovate - egg-shaped

Pathogen - a harmful viral or bacterial form

pH - a measure of the concentration of hydrogen ions in a water sample; usually expressed as the negative (that is, reciprocal) log of the H⁺ concentration

Pheromone - a chemical substance, usually a glandular secretion, used for some specific behavioral response from another animal of the same species

Plankton net - fine mesh net designed to capture microscopic aquatic plants and animals

Posterior end - the longer end of the shell as measured from the umbo; the back end

Proximal - the part of an appendage nearest the body

Pustule - a bump or raised knob on the outside surface of the shell; a small circumscribed elevation of the skin containing puss and having an inflamed base

Quarantine - to isolate or prevent contact with other animals or plants

Rhizome - underground stem usually horizontally elongated; it has all the stem organs, buds, leaves, and such

Runners - a prostrate, slender, above-ground stem that roots at nodal points

Salinity - the total concentration of all ions dissolved in a water sample expressed in milligrams per liter

Saplings - young trees

Serrated - notched or grooved

Shell margin - the edge of the shell

Spinous - having needle-like projections

Striated - marked with lines or grooves

Stamen - the male reproductive organ in flowering plants

Stigma - the female reproductive organ in flowering plants

Substrate - materials or structures on which plants or animals can live or grow

Truncate - having the end shortened or squared off

Tuberous - knob-like root stock

Tubercle - a pointed, rounded, or knob-like projection on a shell

Umbo - the inflated dorsal part of the shell; also called the beak

USDA-APHIS-PPQ - United States Department of Agriculture - Animal and Plant Health Inspection Service- Plant and Pest

Quarantine; branch of the Department of Agriculture that monitors the entry of nonindigenous plants and animals into the United States

Valve - one of the two halves of the shell

Variance - the average of the squares of the differences of a set of numbers from their mean

Veligers - the microscopic, planktonic larval forms of most mollusks

Ventral- referring to the bottom edge of the shell or the lower part of an organism

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