An Aquatic Nuisance Species

Teaching Curriculum
for
South Dakota

Grades 4-12

South Dakota
Wildlife Division
Department of Game, Fish and Parks

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An ANS Teaching Curriculum for South Dakota

Introduction

Aquatic nuisance species (ANS), also known as, invasive, nonindigenous or exotic species, have become one of biggest threats to aquatic resources and ecosystems around the world. In the United States alone, economic impacts from ANS are estimated at $137 billion dollars each year and approximately 40% of the species forced to extinction in aquatic ecosystems are due to predation, parasitism, and competition from biological invaders. These statistics suggest that the aquatic environments that will be passed along to coming generations may be quite different from those enjoyed and taken for granted in the past. One of the most effective means of managing and preventing ANS introductions is through education and outreach efforts. While ANS education has benefits for the entire population, the education of our youth on ANS issues is critical to the effective stewardship of our aquatic environment and resources into the future.

With this in mind, the South Dakota Department of Game Fish and Parks funded the development of an ANS teaching curriculum to compliment state teaching standards for grades 4-12. The Department contracted with teachers from school districts across the State of South Dakota in order to provide effective and practical lesson plan development. These lessons include ANS issues and characteristics in variety of educational goals including: writing, geography, social studies, science, government and economics. Lessons describe many specific aspects nuisance species and aquatic environments including: food web interaction, biology and vectors and pathways of distribution and spread. Lesson plans include: test questions and answer keys, handouts, suggestions for projects and field trips along with recommended teaching time requirements. This guide is intended to be reproduced for redistribution. Please photocopy and distribute to fellow teachers and educators.

For additional information regarding aquatic nuisance species in South Dakota and links to additional sites, visit the ANS section of the South Dakota Game, Fish and Parks website at: http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx

or contact:
Andy Burgess
Aquatic Biologist
South Dakota Department of Game, Fish and Parks.
523 East Capitol Ave.
Pierre, SD 57501
Andy.Burgess@state.sd.us

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Grades 4-5

An Aquatic Nuisance Species Curriculum for South Dakota

Lessons created for

South Dakota Department of Game, Fish and Parks

by

Bria Peppel
Stanley County School District

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Lesson 1 (4-5)

Introduction of Water Resources and Wildlife of South Dakota

South Dakota Content Standards:

- **4.G.1.2** Students are able to locate major South Dakota geographical and political features:
- **5.R.5.1** Students can use select information from two or more reference sources to meet a goal.
- **4.R.5.2** Students can research a topic by gathering information from at least two source
- **5.R.5.3** Students can choose references to meet the needs of an assigned task.
- **5.W.1.1** Students can compose narrative, descriptive, expository, and persuasive text of one paragraph.
- **5.LVS.1.4** Students can deliver a narrative oral presentation.

Assessment Strategies:

- Class discussions
- Recorded information in journals on informational books.
- Recorded observations from the field trip.

Learning Objectives: Students will:

1. Locate the Missouri River on a map of South Dakota
2. Understand the importance of fish as a food and source of recreation
3. Learn about the characteristics of wetlands and the wildlife that inhabit it
4. Learn about the aquatic problems of the wetlands and the affects on resources and the wildlife living there.

Grade level: 4th or 5th grade

Time required: 3-5 days

Materials/Technology Needed:

- Maps of South Dakota
- Informational books on pond/river habitat and wildlife

  Fegely, Thomas D. **The World of Freshwater Fish**. 1978. Dodd, Mead and Co., NY. (Grades 3-5; index and bibliography; NF).

  Becker, Julie. **Animals of the Pond and Streams.** 1977. EMC Corporation, MN, 55p. (grades 2-4; NF).

  Parker, Steve. **Pond and River.** 1988. Alfred A. Knopf, Inc., NY, 64 p. (grades 3-5; NF).

  Gaal, Albro. T**he Pond Book.** 1955. A Rees Press, NY, 136 p. (grades 3-4; NF).

  Knight, Maxwell. **Small Water Animals.** 1968. McGraw-Hill Book Co., NY, 32 p. (grades 3-5; NF).

  Johnson, Sylvia A. **Water Insects.** 1990. Lerner Publications, MN, 48 p. (grades 3-7; glossary; NF).

  Stone, Linda M. **Wetlands.** 1989. Rourke Enterprises, Inc., Vero Beach, 48 p. (grades 3-5; glossary maps and index; NF).

Berrill, Jacquelyn. **Wonders of the Fields and Ponds at Night.** 1962. Dodd, Mead and Co., NY, 80 p. (grades 3-5; index; NF).

Gray, Kathlyn. **Water Pollution.** 1990. Impact Books Series, Watts, Kirkwood, 128 p. (grades 10-12; NF).

- Wet Resource Journal for recording data and information learned

Background Information: None

Lesson Description:

Part One: Introduction

1. Find some example of water resources on a map of South Dakota. Examples: Missouri River, Lake Sharp, James River, and Pactola Lake
2. Create a list of why these water resources are important to us (food, fishing, boating, swimming, skiing, etc).
3. Discuss the wildlife that is around these water resources. Define *aquatic nuisance species: "A nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters (EPA 1990)." Aquatic nuisance species can be introduced accidentally or purposely.* http://www.protectyourwaters.net/
4. Explain that we will be learning about the effects of aquatic nuisance species on wildlife and what we can do to prevent them.

Part Two: Informational Books and Journals

1. Introduce the informational books that the students will use to learn more about different wetlands and the habitat they provide.
2. Introduce the water resource journals.
3. Explain expectations for the informational books and for the journals.
    a. Students will use the informational books to learn more about water resources and the wildlife that inhabits them. Students will record this new information in their journals and cite what books the information came from.
    b. Students will record in their journals ten new or interesting facts from any of the informational books.

Part Three: Field trip

1. Explain the second part of the water resource journals: field work journaling. Discuss how scientists, researchers, and explorers, such as Lewis and Clark used field journaling to record their observations and findings.
2. Create a list of things that a field journal could include: location, date, weather observations, drawings, list of wildlife that you observe, etc.
3. Take a field trip to a local or near by water resource.
4. Students will record their observations in their journals.
5. Discuss as a class what individual students observed and what wildlife they know/think lives there. What recreational activities take place there as well?

Enrichment:

I would just use notebook paper in binders for their journals. However, a person could create a journal more specific to an area or wildlife type that you want students to observe. The

“protect your waters” site gives a good example of a more detailed field journal.

Bibliography/Resources:
http://www.protectyourwaters.net/
http://www.sd-discovery.com/sdprojectwet.htm

Lesson Created by: Bria Peppel, Stanley County School District

Lesson 2 (4-5)

Research of Aquatic Nuisance Species

South Dakota Content Standards:

- **4.US.1.2** Students are able to identify basic environmental, economic, cultural, and population issues of concern to South Dakota.
- **5.L.3.3** Students are able to describe how interrelationships enable some organisms to survive.
- **5.S.2.1** Students are able to explain the interrelationship of populations, resources, and environments.

Assessment Strategies:

- Observations during group work
- Group presentation
- Class discussions
- Group grade sheets: I will have each member of the group grade the other group members on their participation and willingness to help get the work done. This is confidential, however if I have a questions or need further explanation, I will also hold some one-on-one conferences where students can verbally explain why they graded the person the way they did.

Learning Objectives:

1. Students will use the internet to research about an aquatic nuisance species.
2. Students will learn about the affects the aquatic nuisance species has on the environment.
3. Students will give a group presentation on their aquatic nuisance species to teach the rest of the class about the species and the effects it has on the environment.

Grade Level: 4^{th} or 5^{th} grade

Time required: 3 days

Materials/Technology Needed:

- Internet
- Group Presentation Worksheet (see enrichment)
- Paper, crayons, markers, pencils, glue, scissors etc. for groups to use for their presentation to the class

Background Information:

If the students are not familiar with aquatic nuisance species, they will need an introduction to ANS (aquatic nuisance species) in general.

Lesson Description:

Introduction:

1. Re-define aquatic nuisance species (ANS for short). *"A nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities*

dependent on such waters (EPA 1990).” Aquatic nuisance species can be introduced accidentally or purposely

2. Use the South Dakota Game, Fish and Parks website: http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx to introduce the “terrible ten”.
3. Give a brief introduction of each of the terrible ten.

Group Research

1. Split the class into ten groups.
2. Explain that each group will research one of the terrible ten using the internet.
3. Each group will be responsible for learning about one species and the effects that species has on the environment and then making a presentation to give to the class so the other students learn about their species.
4. I will give each group sheets of paper to use to record information.
5. After I split the class into ten groups and assign each group an aquatic nuisance species to investigate, I will review the website the class will be using to learn about their ANS.
6. The class will be using the following website for their research: http://sgnis.org/kids/ . I will briefly introduce the website and how the students can find information on their species from this website.
7. Next, we will go to the computer lab where groups will begin researching their ANS. I will hand out a sheet of paper (see enrichment) for the students to use to record the information on their ANS.
8. Students will work in groups gathering information. They will then start to create their presentation for the class.
9. Each group will present their information on their ANS to the class. After each presentation, the students and I will have the opportunity to ask questions to the presenters.

Bibliography/Resources:

http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx
http://sgnis.org/kids/

Lesson Created By: Bria Peppel, Stanley County School District

Lesson 2 (4-5)

Group Research Worksheet:

Group members: _____

Aquatic Nuisance Species being researched: _____

1. Is your ANS an animal or plant?

2. Describe what your ANS looks like:

3. Where did it come from?

4. How did it get here?

5. What are the effects of this ANS?

6. What can we do to control it?

7. Draw a picture of your ANS

8. Any extra information or facts on your species:

Bibliography/Resources:

http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx
http://sgnis.org/kids/

Lesson 3(4-5)

Aquatic Nuisance Species and Photosynthesis

South Dakota Content Standards:

- **5.L.1.1** Students are able to describe the basic process of photosynthesis and the role of light as a source of energy in plants.
- **5.L.3.1** Students are able to describe how natural events and/or human influences may help or harm ecosystems.
- **4.US.1.2** Students are able to identify basic environmental, economic, cultural, and population issues of concern to South Dakota.

Assessment Strategies:

- Class discussions of photosynthesis and the ANS preventing photosynthesis in native plants.
- Student drawings and/or participation in acting out of Eurasian water milfoil preventing photosynthesis in native plants.

Learning Objectives:

- Students will learn about the process of photosynthesis and its importance to plant life.
- Students will learn how certain aquatic nuisance species are preventing the photosynthesis process from happening in native plants.

Grade Level: 4th or 5th grade

Time Required: One day (approximately 60 minutes)

Materials/Technology Needed:

- Internet
- Paper, crayons, markers, colored pencil for drawings

Background Information:

If the students are not familiar with the photosynthesis process, they will need to learn about it. If students are familiar with photosynthesis, they will still probably need a refresher lesson.

Lesson Description:

1. Introduction/review of photosynthesis: http://www.phschool.com/science/biology_place/biocoach/photosynth/intro.html
2. Define what photosynthesis is, what it involves, and why it is so important to plants.
3. Ask the group members from the previous lesson (investigation of Eurasian water milfoil and purple loosestrife) if they can explain how these two plants affect the native plants in the area. (They overcrowd the native plants and create a canopy on the top of the water so that the native plants do not receive the necessary sunlight needed to allow photosynthesis to happen.)
4. Use the websites: http://www.anstaskforce.gov/soc.php and http://sgnis.org/kids/ to help reinforce the effects that these two plants have on the native plants in the water.

Enrichment:

- Students can draw and color Eurasian water milfoil and purple loosestrife blocking the sunlight of the native plants on the bottom of the river/pond.
- Students can re-enact the process by having a few students sit on the floor representing the native plants on the bottom of the pond/river. Another student can be Eurasian water milfoil and stand over the other "plants" on the bottom of the pond/river. Soon, pieces of Eurasian water milfoil break off and grow into new plants. (pick a few more students to stand over the "plants" on the floor).
- If you have a plant in your classroom, you can cover some of its leaves with tinfoil to help demonstrate the importance of sunlight to a plant.

Bibliography/Resources:

- http://www.phschool.com/science/biology_place/biocoach/photosynth/intro.html
- http://www.anstaskforce.gov/soc.php
- http://sgnis.org/kids/

Lesson Created By: Bria Peppel, Stanley County School District

Lesson 4 (4-5)

The Effects of ANS on Food Chains and Food Webs

South Dakota Content Standards:

- **4.L.3.1** Students are able to describe the flow of energy through food chains and webs.
- **5.L.3.2** Students are able to analyze the roles of organisms to determine the transfer of energy using an energy pyramid model.
- **5.L.3.1** Students are able to describe how natural events and/or human influences may help or harm ecosystems.
- **4.US.1.2** Students are able to identify basic environmental, economic, cultural, and population issues of concern to South Dakota.
- **5.L.3.3** Students are able to describe how interrelationships enable some organisms to survive.
- **5.S.2.1** Students are able to explain the interrelationship of populations, resources, and environments.

Assessment Strategies:

1. Participation in class discussion.
2. Creation of food chain and food web.
3. Paragraph on the impact of ANS on native food chains and food webs and how this might affect us.

Learning Objectives:

1. Students will learn about food chains and food webs.
2. Students will learn about the effects of ANS on food chains and food webs.
3. Students will create a food chain and food web demonstrating their knowledge and understanding of the lesson.

Grade Level: 4^{th} or 5^{th} grade

Time Required: Approximately 45-60 minutes.

Materials/Technology Needed:

- Internet
- Paper, pencils, crayons, markers etc. for food chains/web illustrations.

Background Information:

Before instructing the students on how ANS affect food chains and food webs, the students need to understand what food chains and food webs are. The students also need to understand how population size, food availability, water resources, and habitat characteristics can all impact food chains and food webs.

Lesson Description:

1. Introduction of a food chain and food web. Use the following links: http://www.vtaide.com/png/foodchains.htm and http://www.cas.psu.edu/DOCS/WEBCOURSE/WETLAND/WET1/balnat.html
2. Together as a class, create a food chain. Discuss the different roles and levels of the food chain. Demonstrate what happens to the food chain if one of the levels experiences an impact in population (both low and high).
3. From the class created food chain, create a food web. Again, discuss what happens to the food web when one of the levels experiences a change in population.
4. Review the ANS animals that would affect a food chain or food web: sea lamprey, zebra mussels, crayfish, round goby, etc. Explain that these animals feed on native animals eggs (decreasing population) and eat plankton (which represents an essential level in the food chain/webs of many fish).
5. Discuss the results of these ANS on food chains/webs. How does that impact us?
6. Listen to audio messages on the site: http://www.protectyourwaters.net/impacts.php **This is a comical clip that uses humor to teach about the affects of ANS on food chain/webs.**

Enrichment:

- Students will create a food chain and a food web involving one ANS, plankton, and other native fish demonstrating the impact of ANS on native food chains and food web. Example: plankton gets eaten by minnow, which gets eaten by perch, which gets eaten by walleye, which gets eaten by northern, which gets eaten by people. However, ANS can affect the food chain by decreasing food supplies (Zebra Mussels) and eating large amounts of native fish eggs (Ruffe).
- Students will also write a paragraph explaining the effects of ANS on food chains/webs and how that impacts us.

Bibliography/Resources:

- http://www.vtaide.com/png/foodchains.htm
- http://www.cas.psu.edu/DOCS/WEBCOURSE/WETLAND/WET1/balnat.html
- http://www.protectyourwaters.net/impacts.php

Lesson Created By: Bria Peppel, Stanley County School District

Lesson 5 (4-5)

Our Responsibilities in Preventing ANS from Spreading

South Dakota Content Standards:

- **4.C.2.1** Students are able to describe the actions and rights of a responsible citizen.
- **5.L.3.1** Students are able to describe how natural events and/or human influences may help or harm ecosystems.
- **5.S.2.1** Students are able to explain the interrelationship of populations, resources, and environments.

Assessment Strategies:

- Class discussions.
- Prevention posters.
- Participation.
- Discussion held with the visiting conservation officer or wildlife biologist.

Learning Objectives:

1. Students will learn and understand our role in preventing ANS from spreading.
2. Students will learn what we can do to prevent ANS from spreading or contaminating our water resources.
3. Students will help educate other people in what they need to do to prevent ANS from spreading.

Grade level: 4th or 5th grade.

Time Required: One or two days.

Materials/Technology Needed:

- Internet.
- Tag board or paper, markers, pencils etc. for posters.
- Conservation officer or wildlife biologist to visit and talk with the students about what we can do to help prevent ANS from spreading.

Background Information:

- Review how ANS spread from one water resource to another.
- What recreational sports take place in the water and how they might possibly spread ANS?

Lesson Description:

1. Review the impacts of ANS on native wildlife and water resources.
2. Introduce what we can do to help prevent ANS from spreading or inhabiting our water resources.
3. Use the following links to help explain what we can do:
    - http://www.protectyourwaters.net
    - http://100thmeridian.org
    - http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx

4. Discuss what simple things people can do to prevent the spread of ANS, and why it is important to do these things.
5. Invite a Conservation Officer or Wildlife Biologist to come in and visit with the students about ANS and how to prevent them from contaminating our water resources.

Enrichment:

- Students can create posters listing what we can do to help prevent ANS from spreading or contaminating our waters. After obtaining permission from local bait shops, gas stations, local park building, docking stations etc, students can hang their posters up to help educate other people on ANS and our responsibilities in preventing their spread.

Bibliography/Resources:

- http://www.protectyourwaters.net
- http://100thmeridian.org
- http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx

Lesson Created By: Bria Peppel, Stanley County School District

Grades 6-8

An Aquatic Nuisance Species Curriculum for South Dakota

Lessons created for

South Dakota Department of Game, Fish and Parks

by

Elizabeth Johnston
Flandreau School District

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Lesson 1(6-8)

Identifying SD Aquatic Nuisance Species

South Dakota Content Standard(s):

7.L.1.3 Students are able to classify organisms by using the currently recognized kingdoms.

7.S.2.1 Students are able, given a scenario, to predict the consequence(s) of human activity on the local, regional, or global environment.

Assessment Strategies:

Students are assessed informally throughout the activity, and formally at the end of the lesson by their group poster and individual worksheet completion.

Learning Objective(s):

During the course of the activity, the learner will be able to identify the "Terrible Ten" South Dakota Aquatic Nuisance Species based on visual and verbal clues to their look, habitat, classification, predators, prey, and scientific name.

Grade Level: 7th

Time Required:

2 class periods (45-65minutes)

Materials/Technology Needed:

Cards that identify separate characteristics of each nuisance species
Construction Paper
Art tools for poster design (markers, pencils, rulers, etc.)

Background Information:

The current classification system includes 5 kingdoms (bacteria, protest, fungi, plant, and animal) divided into phylum, class, order, family, genus and species. This classification allows scientists to group similar organisms to make generalizations possible (ex. Mammals have fur and live birth). This information is commonly contained within texts used in the 7th grade curriculum. Scientific names currently use binomial nomenclature, which utilizes an organism's genus and species. Thus the scientific name is a clue to the classification and the classification gives us the scientific name.

According to the EPA (1990) an aquatic nuisance species is a "nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." Aquatic nuisance species can be introduced accidentally or purposely. According to the South Dakota Game Fish and Parks the characteristics that allow aquatic nuisance species to thrive are that they; produce many offspring, have early and rapid development, adapt easily to the environment and diet, tolerate broad range conditions, and are free of natural controls (predation, disease, etc.).

Lesson Description:

Preparation: Using the included information on the terrible ten aquatic nuisance species, the instructor will prepare 5-6 cards with 2-3 bits of information about a particular species (all information is included throughout the card set). All 10 Terrible Ten ANS will need a card set. An example of a card set for the zebra mussel is below (note that there are repeats that allow the clues to be matched):

- Adults range from 1/4 to 1 1/2 inches long.
- Larvae can only be identified with the use of a microscope.

- Zebra Mussels
- *Dreissena polymorpha*
- Found in the Missouri River below Ft. Randall and Gavin's Point Dams.

- In high numbers, they can clog water intakes and boat motors and cause problems for boats, boat docks, and infrastructure.
- They filter vast quantities of water for microscopic organism, potentially altering the entire food web within a water body.
- Found in Missouri River below Ft. Randall and Gavin's Point Dams

- Kingdom: Animalia
  Phylum: Mollusca
  Class: Bivalvia
  Order: Veneroida
  Family: Dreissenidae
  Genus: Dreissena
  Species: polymorpha

- Originated in the Black and Caspian Seas in Europe.
- Eaten by fish, waterfowl, and muskrats. They filter debris & consume microorganisms in water.
- In high numbers they clog water intakes and boat motors.

- Spread by human transport on boats and boating equipment.
- Larvae can only be identified with the use of a microscope.

Introduction: The activity can be introduced by sharing a description of an aquatic nuisance species (as in the background) and by showing some pictures of damage from some of the "Terrible Ten" SD Aquatic Nuisance Species (ANS). (http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx)

Procedure (2 rounds of the activity are completed for classes of 25-30 students – for smaller groups, time can be decreased and students can create just 2-3 cards for the same species):

First period: Activity

1. Each student receives one of the characteristic cards; including a combination of the classification, current SD location, predator and prey, scientific name, and a picture of a "terrible ten" SD ANS.
2. Students have 10 minutes to group up with the 5-6 other students whose card matches the description of their ANS.
3. After all students have found their group, they spend 15 minutes designing a poster that includes all of the information on the card.

Second Period: Presentation of results by gallery walks or group presentations.

4. Once posters have been created for all 10 SD ANS, posters are hung around the room and students have a gallery walk to see the species their classmates discovered while completing the attached gallery worksheet. (Alternatively students may present their posters in groups and the audience can fill out their worksheet during the presentations).

Enrichment:

If students would like to research more information about the aquatic nuisance species they identified for their posters, they may start at the SD Division of Wildlife ANS page: http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx and add any additional information to their poster and/or presentation.

Bibliography/Resources:

ANS information primarily from SD Game Fish & Parks:
http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx
Additional ANS information: http://www.aquaticnuisance.org/index.php
Classification from www.wikipedia.org and verified through several other resources.
Didymo information: http://www.mddep.gouv.qc.ca/eau/eco_aqua/didymo/didymo-en.pdf

Documents:

Information for SD Terrible Ten ANS Characteristic Cards:

Lesson Created by: Elizabeth Johnston, Flandreau School District

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Zebra Mussels

Scientific name: *Dreissena polymorpha*

Classification:

Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroida
Family: Dreissenidae
Genus: Dreissena
Species: polymorpha

Predators: Fish, waterfowl, muskrats.

Consume: Filter debris & microorganisms in water.

How spread: Spread by human transport on boats and boating equipment. Larvae can only be identified with the use of a microscope.

Original Location: Originated in the Black and Caspian Sea in Europe.

Why is it a problem? In high numbers they can clog water intakes and boat motors and cause problems for boats, boat docks, and infrastructures. They filter vast quantities of water for microscopic organism, potentially altering the entire food web within a water body.

Current SD Location: Missouri River below Ft. Randall and Gavin's Point Dams.

Picture/Description

Adults range from 1/4 to 1 1/2 inches long.
Larvae can only be identified with the use of a microscope.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: New Zealand Mud Snail

Scientific name: *Potamopyrgus antipodarum*

Classification:

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
Order: Sorbeoconcha
Family: Hydrobiidae
Genus: Potamopyrgus
Species: antipodarum

Predators: Sometimes eaten by fish (including Brown Trout). "These fish gain little energy from the snails, however, because studies have shown that (they) are capable of passing through the digestive canal of trout alive and intact" (Aquatic Nuisance Species.org).

Consume: Decomposing animal and plant matter, bacteria, and algae.

How spread: Can be spread by any type of water users including both people and animals. It only takes one to produce an infestation. They can also survive for a long period of time out of water.

Original Location: New Zealand

Why is it a problem? They reproduce quickly (by asexual reproduction) and mass in high densities, and consume algae and compete with other native invertebrates for food sources, which can cause problems throughout the entire food chain. In its native environment it is not a problem because the population is regulated by a unique parasite.

Current SD Location: Has not been reported in South Dakota, but it is a species to watch out for since it has infested some waters as close as Minnesota.

Picture/Description

Grow to about 5mm in length and have brown or black cone-shaped shells that twirl to a point.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Rusty Crayfish

Scientific name: *Orconectes rusticus*

Classification:

Kingdom: Animalia
Phylum: Arthropoda
Class: Malacostraca
Order: Decopoda
Family: Cambaridae
Genus: Orconectes
Species: rusticus

Predators: Eaten by large fish (these fish prefer to consume the native crayfish as the claws are less dangerous).

Consume: Clip and consume aquatic plants, detritus, other crayfish, juvenile fish, and fish eggs.

How spread: They are spread by anglers using them as bait.
Since females carry fertilized eggs, it only takes one to cause a problem.

Original Location: They originated from waters in Illinois, Indiana, and Ohio.

Why is it a problem? They can force out or completely replace native crayfish.
They can destroy plant bed abundance and diversity.

Current SD Location: The Rusty Crayfish has not been reported in South Dakota, but it is a species to watch out for since it has infested waters all around South Dakota including; Wyoming, Minnesota, Iowa, and Nebraska.

Picture/Description

They can be separated from native crayfish by their large black tipped claws and the rusty spots on the back of their torso.
They can range anywhere from 2-8 inches long.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Common Carp

Scientific name: *Cyprinus carpio*

Classification:

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: Cyprinus
Species: carpio

Predators: Larger fish, birds, people.

Consume: Omnivorous and will eat almost anything encountered, will eat vegetarian diet of water plants, but will also consume insects, crustaceans (snails & mussles), and dead fish.

How spread: Mistaken and used as bait when they are juveniles.

Original Location: Originates from Asia and Eastern Europe.

Why is it a problem? Juveniles closely resemble several bait and rough fish species. Highly adaptive, prolific spawners, quickly outgrow potential controls by predation, and compete with native fish for food resources, which includes native snails and mussels.

Current SD Location: They can be found in most bodies of water throughout South Dakota.

Picture/Description

They are gold/green in color with large scales, along with two barbells that hang from the rear of their upper lip. They can reach up to 4 feet long and weigh over 60lbs.

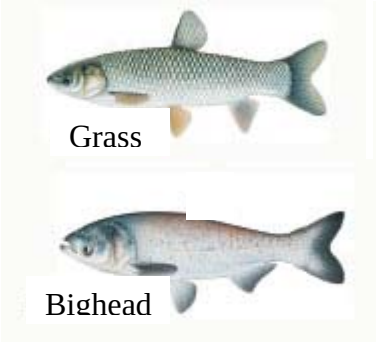
Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Asian Carps

Scientific name: Silver: Hypophthalmichthys molitrix
Black: Mylopharyngodon piceus
Bighead: Hypophthalmichthys nobilis
Grass: Ctenopharyngodon idella

Classification:
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: see scientific name
Species: see scientific name

Predators: Large fish, birds, humans (can become toxic due to consumed foods)
Consume: Algae, snails, mussels, plankton, detritus, aquatic plants
How spread: Mistaken and used as bait when they are juveniles.
Original Location: Originated from Asia and were introduced into the United States in the 1970's.
Why is it a problem? Juveniles closely resemble several bait and rough fish species. Highly adaptive, prolific spawners, quickly outgrow potential controls by predation and compete with native fish for food resources which includes native snails and mussels. Silver carp can cause a physical danger as a result of their leaping ability by colliding with boaters, personal watercraft, or water skiers and causing serious injury.
Current SD Location: Bighead, Silver and Grass carp are found in the Missouri River below Gavin's Point Dam, and the Lower James and Big Sioux Rivers.
Picture/Description



- Bighead and Silver carp do not have scales on their head and their body scales are very small.
- Mature Asian carp can grow to over 60 lbs. in weight and 4 ft. in length.
- Bighead and Silver carp have low-set eyes and a large upturned mouth.
- Silver carp may jump out of the water when disturbed by boat motors.
- Black carp have large scales, with a blackish brown body.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Eurasian Water Milfoil

Scientific name: *Myriophyllum spicatum*

Classification:

Kingdom: Plantae
Phylum: Magnoliophyta
Class: Magnoliopsida
Order: Saxifragales
Family: Haloragidaceae
Genus: Myriophyllum
Species: spicatum

Predators: Water veneer moth, fish

Consume: Producers (make own sugars from sun energy)

How spread: Reproduces by fragmentation, plant fragments easily transported in live wells, bilge water, and on boat trailers.

Original Location: Originates from Europe, Asia, and Northern Africa and was introduced into North America in the 1940's.

Why is it a problem? Forms dense stands of vegetation in the water column and thick mats at the surface, shading out native vegetation and reducing oxygen levels during decomposition. This dense vegetation also hinders some recreational activities.

Current SD Location: Currently found in Lake Sharpe.

Picture/Description

They produce small red flowers on top of the water in mid-summer.
They have about twice as many leaflet pairs (12-21) as native milfoils (5-10).

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Brittle Naiad

Scientific name: *Najas minor*

Classification:

Kingdom: Plantae
Phylum: Magnoliophyta
Class: Liliopsida
Order: Alismatales
Family: Hydrocharitaceae
Genus: Najas
Species: minor

Predators: Carp and other fishes.

Consume: Producer (makes sugars from sun's energy).

How spread: Reproduces by seeds, which are easily transported in live wells, bilge water, and on boat trailers.

Original Location: Originates from Europe, Turkey, Northern Africa, India and Japan.

Why is it a problem? Dense growth covers wide areas, inhibiting the growth of native species of aquatic macrophytes. The thick, clustering growths can make fishing access or the operation of a boat difficult in a pond or lake.

Current SD Location: Currently found in McCook Lake in Union County.

Picture/Description

They grow below the water surface. In deep water they have long wavy stems, and in shallow water they are dense and bushy similar to milfoil and Curlyleaf Pondweed. Frequently mistaken for Chara, which has a musky smell when crushed, unlike this plant.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Curly-Leaf Pondweed

Scientific name: ***Potamogeton crispus***

Classification:

Kingdom: Plantae
Phylum: Magnoliophyta
Class: Liliopsida
Order: Alismatales
Family: Potamogetonaceae
Genus: Potamogeton
Species: crispus

Predators: Primary consumers.

Consume: Producer (makes sugars from sun's energy.

How spread: Curly pondweed spreads by hardened buds (sometimes called turions) and by seeds.

Original Location: Originates from Europe, Africa, and Australia.

Why is it a problem? Can form dense mats at the water surface, shading out native vegetation and creating problems for boaters, especially in protected areas (marinas).

Current SD Location: Found in several water bodies across the state, including Sheridan Lake, Canyon Lake, Rapid Creek, Angostura Reservoir and Lakes Oahe, Sharpe, and Lewis and Clark.

Picture/Description

They have flat stems with some branching that are 1-3 inches long and about 1/8 inch in diameter. Long narrow leaves are attached to the stem, and it produces brown flowers between May and October.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: Didymo

Scientific name: ***Didymosphenia geminata***

Classification:

Kingdom: Protista *
Phylum: Heterokontophyta
Class: Bacillariophyceae
Order: Cymbellales
Family: Gomphonemataceae
Genus: Didymosphenia
Species: germinata
* Some sites show the kingdom as chromalveolata as part of a 2006 discussion to include an additional kingdom to the 5 kingdom system.

Consume: Producer (makes sugars from sun's energy), uses plant stalks for growth and survival.

How spread: Can stick to anything (boats, fishing gear, and wading gear) it touches and be transported without the proper removal.

Original Location: Originates in Europe, Asia and parts of North America.

Why is it a problem? It can form in large masses driving out food sources for other plants and animals. It has been a leading problem for the decline of Brown Trout in Rapid Creek.

Current SD Location: Rapid Creek in Pennington County in the Black Hills

Picture/Description:

Microscopic diatom, attaches to the streambed by a stalk, which have a rough texture similar to wet wool. It is tan, light brown, and whitish that has clumps of ropy strands, a rough cottony feel and fibrous. Doesn't feel slimy like other algae.

Information for SD Terrible Ten ANS Characteristic Cards: Lesson 1(6-8)

ANS: VHS (Viral Hemorrhagic Septicemia)

Scientific name: Viral Hemorrhagic Septicemia
Classification: Classification of viruses is difficult and there is a dispute over whether they are living or non-living. They do not fit easily into any of the domains of biological classification, and classification begins at the family rank.
Predators: None
Consume: Infects fish
How spread: Infected fish can transfer the virus through urine and reproductive fluids or spread can occur by consumption of infected food. The virus can survive alone in water for up to 14 days.
Original Location: Not sure how the virus arrived in the United States. It may have come in with migrating fish from the Atlantic Coast, or may have hitch-hiked in ballast water from ships.
Why is it a problem? The virus threatens to kill fish and disrupt food webs and decrease sport fishing opportunities. People are not effected by the virus and don't have to worry about catching and eating fish.
Current SD Location: It is not currently found in South Dakota, but it is as close as the Great Lakes watershed.
Picture/Description:

Physical symptoms found in fish are: Hemorrhaging (bleeding), bulging eyes, unusual behavior, anemia, bloated abdomens, and rapid onset of death.

Gallery Walk Worksheet(s): Lesson 1(7)

Aquatic Nuisance Species Gallery Walk

Name: _____ Period: _____ Date: _____

Please fill in the chart with the information you gather through your gallery walk:

ANS	Description/Sketch	SD Location	Why is it a problem?	How is it spread?
VHS (Viral Hemorrhagic Septicemia)				

After making the chart spend 5 additional minutes looking through the chart and posters to identify any classification commonalities (same family, kingdom, prey, spread, etc).

_____

_____

Lesson 2 (6-8)

Invasion: Aquatic Nuisance Species
Creative Writing

South Dakota Content Standard(s):

8.W.1.1 Students can compose narrative, descriptive, expository, and persuasive text of five paragraphs.

8.W.1.3 Students can compose text using information from multiple sources to support a topic.

8.S.2.1. Students are able, given a scenario, to offer solutions to problems created by human activity on the local, regional, or global environment.

Assessment Strategies:

Assess student product using the included rubric.

Learning Objective(s):

Through writing a creative narrative from the view of an invasive species, the learner will demonstrate knowledge of a particular aquatic nuisance species and the ways in which it travels from one location to another.

Grade Level: 8th

Time required: 1 week

Materials/Technology Needed:

Rubric (included).
Computer Access (internet, word processor, printer).
Note cards (at least 5 per student).
Colored pen/pencil for peer edit.

Background Information:

According to the EPA (1990) an aquatic nuisance species is a "nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." Aquatic nuisance species can be introduced accidentally or purposely. According to the South Dakota Game Fish and Parks the characteristics that allow aquatic nuisance species to thrive are that they produce many offspring, have early and rapid development, adapt easily to the environment and diet, tolerate broad range conditions, and are free of natural controls (predation, disease, etc.).

Nuisance or invasive species often arrive in a new location due to human involvement. One important means of transport involves ballast water (fresh or saltwater held in tanks and cargo holds of ships, sometimes containing sediments) which is pumped onto and discharged from ships to modify weight. This ballast water contains organisms that are transported and released to all of the ports the ship visits. Recreational boating and fishing equipment is also a major type of transport for nuisance species. Attaching to or being carried with the recreational equipment can spread ANS to any of the waterways the

equipment visits. Another common way that infestation occurs is when organisms are unintentionally or intentionally released through fish farming, aquarium trade, or exotic bait. Typically native species are kept in check by predators, competitors, etc. When species are transported to a new location they may not have native competitors or predators, allowing them to thrive and destroy the area's ecosystem.

Narrative essays are those that; are told from a particular point of view, make and support a specific point. These essays are filled with precise detail, use sequence, and contain plot (setting and characters), climax, and ending. Students will use themselves as an ANS (the first person) and describe the story of their transport and take over of a "Lake Nature Al".

Lesson Description:

Day 1: Introduction: After describing an aquatic nuisance species (see above), the creative writing element is introduced. Using the RAFT (Role, Audience, Format, and Topic) model, introduce the narrative:

Role: South Dakota Terrible Ten Aquatic Nuisance Species
Audience: Future offspring
Format: 5 paragraph Narrative of Invasion (Brag Story)
Topic: Invasion of "Nature Al Lake"

After describing the RAFT, students are given the rubric. Depending on the class, students may read and ask questions about the rubric or the instructor may read the high level benchmarks on the rubric and discuss with students.

Role Choice: Students determine which of the SD Terrible Ten ANS roles to fill in their writing.

Initial Research: Students make 2 note cards (see format below) for 2 websites that help them to learn about the species they've selected.

Day 2: Research: Students complete the 5 note cards (see format below) for the 5 websites they are using to help write their narrative.

Outline: Students make a general outline of the 5 paragraphs they will use when writing their invasion story. The first paragraph should introduce the storyline. The middle paragraphs are used to tell the story of the ANS invasion. The last paragraph should describe the current condition of the ANS.

Day 3: Rough Draft: Students develop a draft of their narrative with the ANS as the first-person character.

Day 4: Critique: Students partner up and read their drafts to their partner. While reading, students are asked to pause and make corrections to the paper. After reading their own papers, students trade papers with their partner and allow their partner to make corrections.

Day 5: Final Draft: Students make final corrections to drafts and prepare final drafts. Including a bibliography of the 5 note cards they used to write their narrative, and a title page with their story title.

Enrichment:

The instructor can choose to have students read or summarize their stories to the class. This will allow the whole class to benefit from the research of each of the students.

Bibliography/Resources:

SD Game Fish & Parks Website:
http://www.sdgfp.info/Wildlife/AquaticNuisance/WhatIsAnAquaticNuisanceSpecies.aspx

ANS Transport: http://www.great-lakes.net/teach/pollution/ans/ans_4.html
For information on narrative writing: http://essayinfo.com/essays/narrative_essay.php
Rubric assistance from rubrics are for teachers: http://rubistar.4teachers.org/

Lesson Created By: Elizabeth Johnston, Flandreau School District

Documents:

Rubric: Invasion of Nature Al Lake

Reference format

Author/Organization. (Last edited date moth day, year). *Title of resource*. Retrieved month day, year, from http://www.website.com/specific.html.

Note card format

Site title/descriptor (4 words or less) Student Name

Website address (http://www.website.com/specificpage.html)
Website author/Organization (who wrote/identifies site)
Website edit date
Retrieval date(s)

Information gathered from site. Any information written word-for-word needs to be in quotations.

Rubric: Lesson 2(6-8)

Invasion of Nature Al Lake

Teacher Name:

Student Name: _____

CATEGORY	5 to 6 points	3 to 4 points	1 to 2 points	0 points
Writing Process	Student devotes a lot of time and effort to the writing process (researching, drafting, reviewing, and editing). Works hard to make the story wonderful.	Student devotes sufficient time and effort to the writing process (researching, drafting, reviewing, and editing). Works and gets the job done.	Student devotes some time and effort to the writing process but was not very thorough. Does enough to get by.	Student devotes little time and effort to the writing process. Doesn't seem to care.
Title	Title is creative, sparks interest and is related to the story and topic.	Title is related to the story and topic.	Title is present, but does not appear to be related to the story and topic.	No title.
Introduction	First paragraph has a "grabber" or catchy beginning.	First paragraph has a weak "grabber".	A catchy beginning was attempted but was confusing rather than catchy.	No attempt was made to catch the reader's attention in the first paragraph.
Organization	The story is very well organized. One idea or scene follows another in a logical sequence with clear transitions.	The story is pretty well organized. One idea or scene may seem out of place. Clear transitions are used.	The story is a little hard to follow. The transitions are sometimes not clear.	Ideas and scenes seem to be randomly arranged.
Accuracy of Facts	All facts presented in the story are accurate.	Almost all facts presented in the story are accurate.	Most facts presented in the story are accurate (at least 70%).	There are several factual errors in the story.
Focus on Assigned Topic	The entire story is related to the transport and invastion and allows the reader to understand much more about the ANS.	Most of the story is related to the topic. The story wanders off at one point, but the reader can still learn about the ANS.	Some of the story is related to the topic, but a reader does not learn much about the ANS.	No attempt has been made to relate the story to the assigned topic.
Creativity	The story contains many creative details and/or descriptions that contribute to the reader's enjoyment. The author has really used his imagination.	The story contains a few creative details and/or descriptions that contribute to the reader's enjoyment. The author has used his imagination.	The story contains a few creative details and/or descriptions, but they distract from the story. The author has tried to use his imagination.	There is little evidence of creativity in the story. The author does not seem to have used much imagination.
Spelling and Punctuation	There are no spelling or punctuation errors in the final draft. Character and place names that the author invented are spelled consistently throughout.	There is one spelling or punctuation error in the final draft.	There are 2-3 spelling and punctuation errors in the final draft.	The final draft has more than 3 spelling and punctuation errors.
References and Note Cards	Five or more references & note cards are included in the proper format and without errors.	Five references and cards included. Format lacking or erroneous information reported.	3-4 references and/or note cards included in the proper format and without errors.	Less than 3 references included.

Lesson 3 (6-8)

SOUTH DAKOTA'S AQUATIC most (UN)wanted

South Dakota Content Standard(s):

7.S.2.1 Students are able, given a scenario, to predict the consequence(s) of human activity on the local, regional, or global environment.
7.L.2.1 Students are able to use specific strategies to clarify interpretation or understanding.
7.S.1.1 Students are able to recognize that audience and purpose influence speech format in exposition and persuasion.
8.S.2.1 Students are able, given a scenario, to offer solutions to problems created by human activity on the local, regional, or global environment.
8.S.1.1 Students are able to choose a specific format based on audience and purpose.
8.S.1.2. Students are able to develop clear and organized presentations.

Assessment Strategies:

Students are assessed on their completion of the worksheet and quality/thoroughness of poster.

Learning Objective(s):

The learner will identify SD Aquatic Nuisance Species (ANS) and the ways in which they affect the ecosystem and recreation of particular areas in South Dakota.

Grade Level: 7^{th} & 8^{th}

Time Required:

1-2 class periods (depending on student research time)

Materials/Technology Needed:

Poster Paper
Art Supplies
Computer/Internet Access

Background Information:

According to the EPA (1990) an aquatic nuisance species is a "nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." Aquatic nuisance species can be introduced accidentally or purposely. According to the South Dakota Game Fish and Parks the characteristics that allow aquatic nuisance species to thrive are that they; produce many offspring, have early and rapid development, adapt easily to the environment and diet, tolerate broad range conditions and are free of natural controls (predation, disease, etc.).

Lesson Description:

Using the South Dakota's "Most (un)Wanted" Theme and Internet resources students will develop posters that represent an individual SD ANS. The posters are graded according to the rubric and will need to include the common and scientific name, species classification, origin, last seen in SD, description and drawing or picture, why wanted, and ways in which it travels. The documents included below are an initial worksheet and poster format for students to follow.

Below is a list of optional internet resources:

- SD Game Fish & Parks Website:
http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx
- Aquatic Nuisance Species:
http://www.aquaticnuisance.org/index.php
- Classification (public entry and review site)
http://www.wikipedia.org
- National Invasive Species Information Center
http://www.invasivespeciesinfo.gov/index.shtml
- Invasive and Exotic Species
http://www.invasive.org
- Minnesota Department of Natural Resources
http://www.dnr.state.mn.us/invasives/index.html

Enrichment:

If the school has a website, have students develop a web page for each species researched to improve education of their peers.

Bibliography/Resources:

SD Game Fish & Parks Website:
http://www.sdgfp.info/Wildlife/AquaticNuisance/WhatIsAnAquaticNuisanceSpecies.aspx

Lesson Created By: Elizabeth Johnston, Flandreau School District

SD Most (un)Wanted ANS worksheet: Lesson 3(6-8)

Name: _____ Period: _____ Date: _____

Common Name: _____

Scientific Name: _____

Classification:

Kingdom: _____

Phylum: _____

Class: _____

Order: _____

Family: _____

Genus: _____

Species: _____

Origin:

_____

_____

Last seen in SD:

_____

_____

Why is it dangerous? (Wanted for):

_____

_____

How does it travel?/How can it be prevented?:

_____

_____

Picture/Drawing and Description:

_____

_____

_____

SD Most (un)Wanted ANS Poster Format: Lesson 3(6-8)

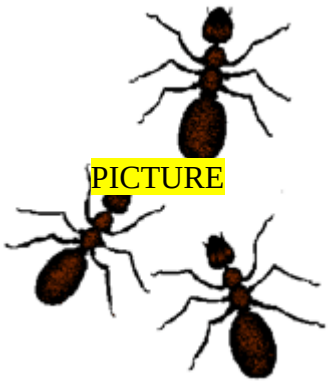
South Dakota's Most unWanted

AQUATIC NUISANCE SPECIES *SCIENTIFIC NAME*

Aliases: common name

Classification
- Kingdom:
- Phylum:
- Class:
- Order:
- Family:
- Genus:
- Species:

Origin:



PICTURE

Wanted for: problems caused

Mode of Travel:

Prevention:

Description

Last Seen: current SD location(s)

Lesson 4 (6-8)

Aquatic Nuisance Species and the Food Web

South Dakota Content Standard(s):

6.L.3 Analyze how organisms are linked to one another and the environment.
7.L.1.3 Students are able to classify organisms by using the currently recognized kingdoms.
7.N.1 Understand the nature and origin of scientific knowledge.
7.S.2.1 Students are able, given a scenario, to predict the consequence(s) of human activity on the local, regional, or global environment.

Assessment Strategies:

Students may be informally assessed throughout the activity. Formal assessment occurs when grading the worksheet and hearing presentations.

Learning Objective(s):

The learner will:
- Design and Construct a food web.
- Organize and Evaluate information gathered throughout the activity.
- Present theory on ecosystem destruction caused by the addition of an ANS.

Grade Level: 7th Science (may be used to cover/review 6th grade science standards/indicators).

Time Required:

Preparation: 1hour
Lesson: 2 class periods:
- Introduction: ½ class period.
- Food Web Activity: ½ class period.
- Nuisance Species Activity: ½ class period.
- Presentation of findings: ½ class period.

Materials/Technology Needed:

Native species cards prepared prior to class period (requires text or internet resources).
ANS Species handouts (included).
Worksheet (included).

Background Information:

According to the EPA (1990) an aquatic nuisance species is a "nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." Aquatic nuisance species can be introduced accidentally or purposely. According to the South Dakota Game Fish and Parks the characteristics that allow aquatic nuisance species to thrive are that they produce many offspring, have early and rapid development, adapt easily to the environment and diet, tolerate broad range conditions, and are free of natural controls (predation, disease, etc.).

Creation of a food web includes; the use of producers (organisms that produces sugars using the energy from the sun), primary consumers (eating the producers), secondary

consumers (eating primary consumers), and tertiary consumers (eating secondary consumers). It is considered a "web" because some of the consumers may be omnivorous, eating both producers and primary or secondary consumers or may be both secondary and tertiary consumers depending on the diet of their prey.

Lesson Description:

Preparation:

Use the following species (and information and pictures from http://www.sdgfp.info/Wildlife/Education or other resources) to make a card for at least one SD native species in each category (producer, primary consumer, etc.). These are simply examples; other local species may be used. Cards should include the species name, a description, its location in the food chain, and its predators (what it is eaten by) and prey (what it eats). An example is included below.

Emerald Shiner
Small fish.
Primary or secondary consumer (depending on prey).
Eats: Algae, insects, small crustaceans.
Eaten by: Any larger fish.

Producers (native aquatic plants and algae):

1. Algae.
2. Floating plants: Duckweed, bladderwort.
3. Submerged plants: Elodea, baby pondweed.
4. Emergent plants: Water lily, cattails (narrow and broad leaf), pennywort.

Primary Consumers (Herbivores):

1. Small Fish: Emerald shiner, black bullhead (when feeding on algae).
2. Zooplankton/Plankton, crustaceans.
3. Insects (dragon flies, water spider, etc).
4. Crayfish.
5. Snails.

Secondary Consumers (carnivores or omnivores):

1. Emerald shiner, bullhead (when insects and crustaceans are prey).
2. Walleye.
3. Smallmouth bass.
4. Bluegill.
5. Brown or brook trout.
6. Snakes.

Tertiary Consumers (typically carnivores, can be omnivores (humans))

1. Northern pike.
2. Birds: Eagle, pelican, crane.
3. Mammals: raccoon, mink, otters.

Print one of the included aquatic nuisance species handouts for each group of 3-4 students. (The addition of the ANS can be the same species for all groups or a different species for each group).

Introduction: Prior to the activity students should explore the following terms: food web, producer, herbivore, omnivore, carnivore, primary consumer, secondary consumer, tertiary consumer, native species, and invasive/nuisance species. Their prior understanding of these terms will aid in discussion and writing during the activity. With the discussion of the terms it is helpful to have students brainstorm examples of organisms that would fit each category and practice making food webs with some of the plants and animals around the school.

Food Web Activity:

- Divide Students into groups of 3-4 individuals.
- Hand out one card from each category (producer, primary consumer, etc.) to each group.
- Have the groups arrange the cards in order from producer to tertiary consumer.
- Students should record their food web on the included Data and Conclusions worksheet.

Aquatic Nuisance Addition:

- For a second day of class, have students reconstruct their food webs with the cards using their data sheet)
- Give each group an aquatic nuisance species handout.
- Students have 5 minutes to read and learn about their ANS.
- Students will add the nuisance species to the food web in any of the following ways:
    - By replacing one or more organisms previously existing in the food web.
    - By being added to the food web.
    - Decreasing overall population numbers of organisms in the food web.

Discussion and ANS Impact

- Students should evaluate the impact of adding the ANS to their food web. Did it affect any of the native species? Is it possible for the ANS and all of the natives to survive? If the introduced ANS eliminates the producer, will it also affect other organisms in the food web? If it eliminates the primary consumer, will it affect other organisms in the food web? These questions may be posed as part of a discussion to aid students in the response to the statement in the worksheet.

Enrichment:

Have students explore the loss of energy in the food chain. (Tertiary consumers must consume several secondary consumers, which consume several primary consumers, which consume many producers.)

Have students read the book Silent Spring by Rachel Carson, a prominent female scientist. The text explores the effects of DDT on the ecosystem and food web. It describes the build up of toxins through the food chain.

Bibliography/Resources:

SD Game Fish & Parks Website:
http://www.sdgfp.info/Wildlife/AquaticNuisance/WhatIsAnAquaticNuisanceSpecies.aspx

Native Aquatic Plants: http://aquaplant.tamu.edu/database/index.htm

Additional information for Didymo:
http://www.mddep.gouv.qc.ca/eau/eco_aqua/didymo/didymo-en.pdf

Documents:

ANS Handouts (additional information on each of the ANS used can be found on the SDGF&P website in the resources section).

Lesson Created By: Elizabeth Johnston, Flandreau School District.

ANS: New Zealand Mud Snail

Picture:

Description: Grow to about 5mm in length and have brown or black cone-shaped shells that twirl to a point.

Kingdom: Animalia
Predators: Sometimes eaten by fish (including Brown Trout) but "These fish gain little energy from the snails, however, because studies have shown that the snails are capable of passing through the digestive canal of trout alive and intact" (Aquatic Nuisance Species.org).
Consume: They decompose animal and plant matter, and eat bacteria, and algae.
How spread: Can be spread by any type of water users including both people and animals. It only takes one to produce an infestation. They can also survive for a long period of time out of water.
Original Location: New Zealand
Why is it a problem? They reproduce quickly (by asexual reproduction) and mass in high densities, and consume algae and compete with other native invertebrates for food sources, which can cause problems throughout the entire food chain. In its native environment it is not a problem because the population is regulated by a unique parasite.
Current SD Location: Has not been reported in South Dakota, but it is a species to watch out for since it has infested waters as close as Minnesota.

ANS: Rusty Crayfish

Picture:

Description: They can be separated from native crayfish by their large black tipped claws and the rusty spots on the back of their torso.
They range from 2-8 inches long.

Kingdom: Animalia
Predators: Eaten by large fish (these fish prefer to consume the native crayfish as the claws are less dangerous).
Consume: Clip and consume aquatic plants, detritus, other crayfish, juvenile fish, sunfish, and fish eggs.
How spread: They are spread by anglers using them as bait. Since females carry fertilized eggs, it only takes one to cause a problem.
Original Location: They originated from waters in Illinois, Indiana, and Ohio.
Why is it a problem? They can force out or completely replace native crayfish. They can destroy plant bed abundance and diversity.
Current SD Location: The Rusty Crayfish has not been reported in South Dakota, but it is a species to watch out for since it has infested waters all around South Dakota including Wyoming, Minnesota, Iowa, and Nebraska.

ANS: Common Carp

Picture:

Description: They are gold/green in color with large scales, along with two barbells that hang from the rear of their upper lip. They can reach up to 4 feet long and weigh over 60lbs.

Kingdom: Animalia
Predators: Larger fish, birds, people.
Consume: Omnivorous, will eat almost anything encountered. Can exist on a vegetarian diet of water plants, but will also consume insects, crustaceans (snails & mussles), and dead fish.
How spread: Easily mistaken for, and used as baitfish when they are juveniles. Have also been intentionally stocked in some waters. .
Original Location: Originates from Asia and Eastern Europe.
Why is it a problem? These fish are highly adaptive, prolific spawners, quickly outgrow potential controls by predation, and compete with native fish for food resources, which includes native snails and mussels.
Current SD Location: They can be found in most bodies of water throughout South Dakota.
Picture/Description

ANS: Eurasian Water Milfoil

Picture:

Description: They produce small red flowers on top of the water in mid-summer. They have about twice as many leaflet pairs (12-21) compared to native version(5-10).

Scientific name: *Myriophyllum spicatum*
Kingdom: Plantae
Predators: Water veneer moth, fish.
Consume: Producers (make own sugars from sun energy).
How spread: Reproduces by fragmentation, plant fragments easily transported in live wells, bilge water, and on boat trailers.
Original Location: Originates from Europe, Asia, and Northern Africa and was introduced into North America in the 1940's.
Why is it a problem? Forms dense stands of vegetation in the water column and thick mats at the surface, shading out native vegetation and reducing oxygen levels during decomposition. This dense vegetation also takes away from recreational activities.
Current SD Location: Currently found in Lake Sharpe, a reservoir on the MO River.

ANS: Didymo

Picture:

Description: Microscopic diatom, attaches to the streambed by a stalk, which have a rough texture similar to wet wool. It is tan, light brown, and whitish that has clumps of ropy strands, a rough cottony feel and fibrous. Doesn't feel slimy like other algae.

Scientific name: ***Didymosphenia geminata***
Kingdom: Protista *
* Some sites show the kingdom as chromalveolata as part of a 2006 discussion to include an additional kingdom to the 5 kingdom system.
Consume: Producer (makes sugars from sun's energy); uses plant stalks for growth and survival.
How spread: Didymo can stick to anything (boats, fishing gear, and wading gear) it touches and be transported without the proper removal.
Original Location: Originates in Europe, Asia and parts of North America.
Why is it a problem? It can form in large masses driving out food sources for other plants and animals. It has been a leading problem for the decline of Brown Trout in Rapid Creek.
Current SD Location: Rapid Creek in Pennington County in the Black Hills.

ANS Food Web Data and Conclusions Worksheet: Lesson 4 (6-8)

Name: _____ Period: _____ Date: _____

Use the space below to diagram the food chain you developed for the 4 organisms in your ecosystem:

What organism did you receive as your aquatic nuisance species? _____

Is this species a producer or consumer? How do you know? _____

_____

Use the space below to show and describe the changes that resulted from adding the aquatic nuisance species to your ecosystem:

Evaluate and respond to the following statement:

> "Aquatic nuisance species do not simply affect the species they eat or compete with for survival they affect the entire food chain."

_____

_____

_____

_____

_____

Lesson 5 (6-8)

ANS: What Can I Do?

South Dakota Content Standard(s):

7.S.2.1 Students are able, given a scenario, to predict the consequence(s) of human activity on the local, regional, or global environment.

7.W.1.4 Students can summarize and paraphrase information from references to compose text.

Assessment Strategies:

Students are formally assessed by rubric and completion of the worksheet and game.

Learning Objective(s):

The learner will develop a document persuading recreational waterway users to work on preventing the spread of aquatic nuisance species.

Grade Level: 7th

Time Required: 1-2 class periods.

Materials/Technology Needed:

Art materials (including paper that can be folded into a brochure).
Computer/internet access.
Rubric (included).
Worksheet (included).

Background Information:

According to the EPA (1990) an aquatic nuisance species is a "nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters." Aquatic nuisance species can be introduced accidentally or purposely. According to the South Dakota Department of Game, Fish and Parks the characteristics that allow aquatic nuisance species to thrive are that they produce many offspring, have early and rapid development, adapt easily to the environment and diet, tolerate broad range conditions, and are free of natural controls (predation, disease, etc.).

Lesson Description:

Students will be designing a "call to action" brochure to teach recreational waterway users about how they can help to prevent the spread of aquatic nuisance species. Describing the impact of ANS and showing pictures/describing some of the results of ANS infestation can introduce the lesson. Additionally allowing students to review the rubric will prepare them for the assignment.

Students must first become experts on the subject. Allow them to surf the following resources to answer the questions provided on the included worksheet.

- SD Department of Game, Fish & Parks Website: http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx
- Aquatic Nuisance Species:

http://www.aquaticnuisance.org/index.php
- Classification (public entry and review site)

http://www.wikipedia.org
- National Invasive Species Information Center

http://www.invasivespeciesinfo.gov/index.shtml
- Invasive and Exotic Species

http://www.invasive.org
- Minnesota Department of Natural Resources

http://www.dnr.state.mn.us/invasives/index.html
- Stop Aquatic Hitchhikers! Campaign

http://www.protectyourwaters.net/

Once they have completed the worksheet have them play the "Who Wants to Be a Fish Biologist" game on the "Stop Aquatic Hitchhikers" campaign website (http://www.protectyourwaters.net/cgi-bin/whowants/whowantstobe.cgi) until they get to the You Won screen showing that they answered all questions correctly.

After becoming experts, have students work in groups of 2-3 (or this can be done alone if group work is discouraged) to design a campaign brochure. Regularly remind students that they are graded according to the rubric so be sure to check it over often.

Enrichment:

Have students contact a SD Department of Game, Fish & Parks representative to share their brochure with.
Have students share their brochures at a school event so that their research will benefit their communities.
If the students are in a computer class or regular computer access, have them design their brochures using a computer program.

Bibliography/Resources:

SD Game Fish & Parks Website:
http://www.sdgfp.info/Wildlife/AquaticNuisance/WhatIsAnAquaticNuisanceSpecies.aspx

Documents:

Research Worksheet
Brochure Rubric

Lesson Created By: Elizabeth Johnston, Flandreau School District

Research Worksheet: Lesson 5 (6-8)

Name: _____ Period: _____ Date: _____

When completing the worksheet be sure to document the website and author to validate each of your answers.

1. Name and describe 3 aquatic nuisance species in South Dakota.
   a. _____
   _____
   b. _____
   _____
   c. _____
   _____
2. Give 3 reasons why preventing the spread of the above nuisance species is important.
   a. _____
   _____
   b. _____
   _____
   c. _____
   _____
3. Name and describe 5 ways in which the spread of aquatic nuisance species occurs or can be prevented.
   a. _____
   _____
   b. _____
   _____
   c. _____
   _____
   d. _____
   _____
   e. _____
   _____
4. Go back and ensure that you included the sources of all of your information.
5. Go to the "Who wants to be a fish biologist?" game at http://www.protectyourwaters.net/cgi-bin/whowants/whowantstobe.cgi and tell your teacher when you reach the end of the game.

Brochure Rubric: Lesson 5(7)

Teacher Name:

Student Name: _____

CATEGORY	5-6 points	3-4 points	1-2 points	0 points
Content	The brochure includes at least 5 things people can do to prevent the spread of aquatic nuisance species.	The brochure includes 4 things people can do to prevent the spread of ANS, or one of the 5 things is incorect, invalid, or incomplete.	The brochure includes 3 things people can do to prevent the spread of ANS, or more than one of the 5 things is incorect, invalid, or incomplete.	The brochure includes less than three things people can do to prevent the spread of ANS.
Attractiveness & Organization	The brochure has exceptionally attractive formatting and well-organized information.	The brochure has attractive formatting and well-organized information.	The brochure has well-organized information.	The brochure's formatting and organization of material are confusing to the reader.
Graphics/Pictures	Graphics go well with the text and there is a good mix of text and graphics.	Graphics go well with the text, but there are so many that they distract from the text.	Graphics go well with the text, but there are too few and the brochure seems "text-heavy".	Graphics do not go with the accompanying text or appear to be randomly chosen.
Spelling & Proofreading	No spelling errors remain after one person other than the typist reads and corrects the brochure.	No more than 1 spelling error remains after one person other than the typist reads and corrects the brochure.	No more than 3 spelling errors remain after one person other than the typist reads and corrects the brochure.	Several spelling errors in the brochure.
Sources	Careful and accurate records are kept to document the source and accuracy of 95-100% of the facts and graphics in the brochure.	Careful and accurate records are kept to document the source and accuracy of 94-85% of the facts and graphics in the brochure.	Careful and accurate records are kept to document the source and accuracy of 84-75% of the facts and graphics in the brochure.	Sources are not documented accurately or are not kept on many facts and graphics.

Grades 9-12

An Aquatic Nuisance Species Curriculum for South Dakota

Lessons created for

South Dakota Department of Game, Fish and Parks

by

Andrea Frey
Aberdeen School District

Contents **Page**

Lesson 1 (9-12)

Uninvited Guests – Invasive Species

South Dakota Content Standard(s):

9-12.G.2.2 Students are able to explain how humans interact with their environment.
9-12.G.2.3 Students are able to explain how human migration impacts local and global politics, environment, economies, societies, and regions.
9-12.E.1.2 Students are able to explain how scarcity/surplus affects the basic questions of what, how, how much, and for whom to produce.
9-12.E.1.6 Students are able to explain basic elements of trade and its impact on the U.S. economy. (Implied)

Assessment Strategies:

After students have researched what an ecosystem is and how fragile they have become, have them write a brief essay explaining how globalization has impacted the threat of these invasive species to the U.S. Students need to weigh the benefits and the risks of our global economy and various ecosystems to determine if the benefits to globalization and the spread of invasive species is worth the risk.

Learning Objective(s):

- Students will be able to define key terminology such as biodiversity, ecosystem, species, and habitat.
- Students will differentiate between native species, exotic species, and invasive species.
- Students will identify how invasive species have infiltrated various ecosystems. Students will explain ways that human behaviors have endangered the earth's limited resources.

Grade Level: 9-12

Time Required: Approximately 1 – 1 ½ hours

Materials/Technology Needed:

- An In-Focus projector (or connection to another type of video source, like a TV, that can be shared with the class at one time)
- Computers with Internet access; if Internet access is unavailable, the teacher can print copies of the information from the websites listed under the Bibliography/Resources below for individual student use.

Background Information:

This unit is designed to inform students of the threats coming from aquatic invaders. This lesson of the unit is for students to research key definitions and background information, in order to begin to make the connection between the environment and the economy in SD.

Lesson Description:

To begin this lesson, have a general discussion with students about what types of things they like to do outdoors. You could also take a poll as to how many students like to swim, fish, go boating or water skiing, etc. Lead them into how important the environment is to our own personal enjoyment. Let them know that all of the things that we love about SD's outdoor resources are at risk of being eliminated by a variety of invasive species.

Next, log onto http://www.hotchalk.com (see below under Bibliography/Resources for log-in information) and select the video "Attack of the Bio-Intruders: Invasive Species". This video is only 2 minutes and 24 seconds; it was a segment that aired on NBC Nightly News on 2/8/2006. This segment gives a brief introduction into the things that the students will research for the next part of this lesson.

After the video, students will utilize the Internet to research a variety of web sources listed on http://www.portaportal.com . Students will need to enter ***SDGFP*** for the "guest name" for *Guest Access* in order to access hyperlinked sites to answer questions on the handout "Uninvited Guests – Invasive Species". An answer key will be available for teachers.

NOTE - This worksheet can be modified to accommodate the various ability levels in your class.

As students are wrapping up their research, you can begin to discuss the answers from the web search as an entire class. Or, you could also have students get into small groups to discuss the answers that they found before you move the class into an entire group discussion about their research.

Enrichment:

You could decide to have students read individual articles that each student would summarize and present to the class which would focus on one aspect about biodiversity and invasive species. (See link for a Biodiversity .pdf file that would be great for this.)

Bibliography/Resources:

http://www.hotchalk.com – This is another free resource that teachers can use in their lessons. Individual teachers do need to register with the site; however, it will provide teachers access to lesson plans and other teaching resources for various disciplines. The other helpful resource is that you can access a transcript of the video that you want to watch.

Once you are a registered user of this site, to access the video mentioned in the lesson ("Attack of the Bio-Invaders"), click on the "NBC Video" link at the top right side of the webpage. Next, under the "Subjects" heading on the left side of the page, you need to click on the "Science" link. Then under the "Subjects" heading, you will see a "Topics" section, you need to select "Environmental Sciences". In the middle column of the page you will see a listing of additional sub-topics; from this group, click on the "Protection and Conservation" link. Another new listing will appear in the middle column under the "Protection and Conservation" heading, select the "Invasive Species" option. Once you have done that, there will be 4 different videos that you can select from. The "Attack of the Bio-Invaders" video should be the one listed first. Once you click on it, the video will start playing. You can enlarge the video by clicking on the double rectangle icon at the bottom left portion of the video screen. To return to view the computer screen as "normal" you can press the "Esc" button.

http://www.portaportal.com – This is a free online bookmark site that teachers can create and maintain to allow student access to those bookmarked sites for projects such as this.

Sites listed on Porta Portal for this lesson include:

http://nationalzoo.si.edu/ConservationAndScience/MAB/about/faqs.cfm is a site that is maintained by the Smithsonian *National Zoological Park*. This particular section is called "Monitoring & Assessment of Biodiversity – Frequently Asked Questions".

http://www.nationalgeographic.com/geographyaction/habitats/intro.html is a National Geographic site dealing with the Earth and its habitats.

http://www.dnr.state.md.us/mydnr/askanexpert/nonnative_exotic.asp is a site maintained by the Maryland Department of Natural Resources. This section entitled "Ask an Expert: What's the difference between non-native and invasive species".

http://www.serconline.org/biodiversity/fact.html - is a website maintained by the State Environmental Resource Center of Madison, WI. This site is a biodiversity fact pack providing resources associated to protecting the Earth's biodiversity.

http://alic.arid.arizona.edu/invasive/sub2/index.shtml - this site was created by the University of Arizona and provides a lot of information about many aspects about invasive species, including their interaction with humans and the economy.

Another great resource is a .pdf file called *Biodiversity Connecting with the Tapestry of Life* that can be downloaded from the following website that is sponsored by the Smithsonian *National Zoological Park.*

http://nationalzoo.si.edu/ConservationAndScience/MAB/documents/biotapestry.pdf
This would be a good resource for classrooms that do not have access to the Internet. Printing a few copies of this file (the document is 32 pages long) for students to work on the questions in small groups. Another option would be dividing the document into sections where students would be responsible for presenting certain sections of the document.

Lesson Created By: Andrea Frey, Aberdeen School District

Name: _____

Uninvited Guests – Invasive Species
Lesson 1 (9-12) – Handout

Directions*:** Go to the following website – http://www.portaportal.com. On the right side of the page you will see "Guest Access" in the blank type in ***SDGFP. It will allow you to access the websites that you will need to use to find information to the following questions. You will use the links under the heading of "Uninvited Guests – Invasive Species".

Biological Diversity and Ecosystems

1. According to the National Zoo/Smithsonian Institute website, biological diversity (a.k.a. biodiversity) is the "variety of life on Earth".

   Below – differentiate between the three types of diversity that fall under the topic of biodiversity.

   Genetic diversity –

   Species diversity –

   Ecosystem diversity –

2. What is a species?

3. What is an ecosystem?

4. How does biodiversity affect the Earth?

5. What is the relationship between species diversity and an ecosystem?

6. How has the population explosion impacted biodiversity?

7. The National Zoo/Smithsonian Institute website explains five devastating effects

humans have on our world.

Below, list each effect humans are having on the earth's biodiversity and summarize each of those effects.

1.

2.

3.

4.

5.

Geography Action! Habitats

8. Define habitat.

9. What is the "right stuff" that the Earth contains that allows life to exist?

10. What are the four basic habitat requirements species need to survive?

11. Differentiate between a generalist species and a specialist species.

12. How can the increasing use of technology impact habitats?

Ask an Expert – Species

13. Differentiate between the following types of species:

Native species –

Exotic species –

Invasive species –

Biodiversity Fact Pack

14. A major concern of the disruption of an ecosystem is that it is like falling dominoes, once one species is affected, others will be affected as well. According to the State Environmental Research Center, how much money will it cost to restore the Florida Everglades' biodiversity back to some sense of normalcy?

15. If the Earth's biodiversity is destroyed, what are the implications it will have on future generations?

16. According to this site, explain the economic impact of the spread of leafy spurge infestations in SD during 1991.

17. What is the overall economic impact of invasive species in the U.S.?

18. According to the SDGFP website, “A 2001 Harris poll identified recreational fishing as the top outdoor leisure time activity of Americans” (“Economic Importance”).

    According to the Biodiversity Fact Pack, in 1991 alone, how much money was spent in the U.S. on sports fishing?

Summary –

19. In your own words, explain the relationship between biodiversity, the economy and our current way of life, based on the sources used for this worksheet.

“Economic Importance of Fishing.” [online] 29 May 2008 <http://www.sdgfp.info/Wildlife/Economics/Fishingeconomics.htm>.

Uninvited Guests – Invasive Species
Lesson 1 (9-12) – Handout **Answer Key**

Directions*:** Go to the following website – http://www.portaportal.com. On the right side of the page you will see "Guest Access" in the blank type in ***SDGFP. It will allow you to access the websites that you will need to use to find information to the following questions. You will use the links under the heading of "Uninvited Guests – Invasive Species". Teacher note – the category listed prior to the questions correspond to the web link title found on Porta Portal. You may decide to keep the headings on this worksheet for your classes or you can delete them.

Biological Diversity and Ecosystems

1. According to the National Zoo/Smithsonian Institute website, biological diversity (a.k.a. biodiversity) is the "variety of life on Earth".

   Below – differentiate between the three types of diversity that fall under the topic of biodiversity. ***The answers for the following questions are found on the website titled FAQ about Biodiversity.

   Genetic diversity – The variety of genes in plants and animals and different species. Example – humans similar genetic makeup; however, each person is unique due to their genes.

   Species diversity – The variety of different plants and animals, etc. Differences occur within and between populations of species.

   Ecosystem diversity – The variety of habitats and climates on Earth. It is the interactions between ecosystems and species that sustain life on the planet.

2. What is a species?
   A species is a group or population of similar organisms that reproduce among themselves, but do not naturally reproduce with any other kinds of organisms.

3. What is an ecosystem?
   An ecosystem is any geographic area, including the living organisms that live there and the nonliving parts of the physical environment.
      Energy and matter move through and are stored in the living and nonliving things – it is the interactions between them that make an ecosystem.
      Ecosystems are living places – prairie, jungle, deserts. They have specific living and nonliving components that make them "unique" from other ecosystems.

4. How does biodiversity affect the Earth?
   It helps keep the air and water clean, regulates climates, and provides food, shelter, clothing, medicine, etc. This is what makes life on earth so complex - all of the diversity and the interactions between them.
      *Answer is the last part of the section – What is biodiversity?

5. What is the relationship between species diversity and an ecosystem?

Species diversity keeps an ecosystem going. If a species disappears, an entire ecosystem will be affected.

6. How has the population explosion impacted biodiversity?

There are 6 billion people today, and could increase to 9 – 12 billion over the next 50 – 100 years. The more people – the more resources that they use and that can pose multiple problems for the planet.

7. The National Zoo/Smithsonian Institute website explains five devastating effects humans have on our world.

Below, list each effect humans are having on the earth's biodiversity and summarize each of those effects.

1. Habitat Fragmentation and Degradation – this means humans are moving into and destroying the habitats of species in that particular ecosystem. All species need food and shelter to survive and humans are eroding these natural habitats for their own (selfish) needs.

2. Global Climate Change – This is a topic that is frequently discussed. As the Earth's temperature changes, glaciers melt, ocean levels rise, weather patterns change, diseases increase (like West Nile), etc. These things affect all species.

3. Pollution – All types of pollution erode natural habitats, but one of the most harmful pollutants are chemicals such as pesticides. These chemicals can have unintended consequences, like killing "good" species, getting ingested and infiltrating the food chain.

4. Over fishing, hunting, and poaching – Due to the increase in human population, resources are being used faster than they can be replaced. There is a lot of money that is made from poaching animals. Another major problem is with deforestation and the destruction of natural habitats.

5. Introducing Non-Native Species – As people move, they take species with them. These non-native species have no natural predators so their numbers can multiply quickly. Also natural species have no defense of these new species and often compete for food and living space.

Geography Action! Habitats (by National Geographic)

8. Define habitat.

Habitats are the natural environments of plants and animals. A habitat is a combination of many factors such as: temperature, soil, rainfall, and geographic location.

9. What is the "right stuff" that the Earth contains that allows life to exist?

The "right stuff" includes a combination of air, water, soil, climate and sunlight.

10. What are the four basic habitat requirements species need to survive?

Habitat requirements include: food, shelter from weather and predators, water, and a place to raise young.

11. Differentiate between a generalist species and a specialist species.

A generalist specie can survive in a variety of habitats. They can handle a wide range of climate and vegetation types, and they can adapt to different foods and environment conditions.

Specialist species are not very common. These species can only survive in a small range of habitats. They cannot adapt to different foods, climates, vegetation types and environmental conditions.

12. How can the increasing use of technology impact habitats?

An increase in technology is directly related to an increase in population. People have increased needs for technology which is used for transportation, heating, cooling, industry, agriculture, and forestry. All of these things threaten ecosystems.

Ask an Expert – Species

13. Differentiate between the following types of species:

Native species –

Native species are ones that naturally occur in an ecosystem.

Exotic species –

Are species that do not naturally occur in an ecosystem, but do not necessarily cause problems for native species.

Invasive species –

Are species that do not naturally occur in an ecosystem, but damage the ecosystem by competing for resources native species need to survive. Invasive species can wipe out native species.

Once invasive species are established they are hard to control, and it is often very expensive to deal with.

Biodiversity Fact Pack

14. A major concern of the disruption of an ecosystem is that it is like falling dominoes, once one species is affected, others will be affected as well. According to the State Environmental Research Center, how much money will it cost to restore the Florida Everglades' biodiversity back to some sense of normalcy?

$7.8 billion (*remind students that they not only have to get rid of the invasives, but they need to restore the ecosystem to times prior to the invasion.

15. If the Earth's biodiversity is destroyed, what are the implications it will have on future generations?

First, many existing species will become extinct. If ecosystems are destroyed by invasive species future generations will reduce their quality of life through psychological, emotional, and spiritual effects from ruined forests, beaches, lakes, mountains, and open spaces.

16. According to this site, explain the economic impact of the spread of leafy spurge infestations in SD during 1991.

Leafy spurge caused SD ranchers and landowners were losing $1.4 million per year. This affected the food that beef herds depended on and could have cost

$4.6 million in annual revenues.

17. What is the overall economic impact of invasive species in the U.S.?

    $137 billion per year because they impact everything from habitat to natural cycles, like fire cycles and nutrient and water cycling in native ecosystems.

18. According to the SDGFP website, "A 2001 Harris poll identified recreational fishing as the top outdoor leisure time activity of Americans" ("Economic Importance").

    According to the Biodiversity Fact Pack, in 1991 alone, how much money was spent in the U.S. on sports fishing?

    $16 billion almost twice as much as what was produced by commercial freshwater fishing and the consumption of those fish.

Summary –

19. In your own words, explain the relationship between biodiversity, the economy and our current way of life, based on the sources used for this worksheet.

    Everything on earth is interconnected from a species standpoint. Our economy depends on all aspects of the ecosystems found on the earth; destruction of each ecosystem brings down parts of our economy like – food, entertainment, harvesting resources, science, etc.

"Economic Importance of Fishing." [online] 29 May 2008 <http://www.sdgfp.info/Wildlife/Economics/Fishingeconomics.htm>.

Lesson 2 (9-12)

Attack of the Aquatic Invaders!

South Dakota Content Standard(s):

9-12.G.1.1 Students are able to use resources, data services, and geographic tools that generate and interpret information.
9-12.G.2.2 Students are able to explain how humans interact with their environment.
9-12.G.2.3 Students are able to explain how human migration impacts local and global politics, environment, economies, societies, and regions.
9-12.E.1.2 Students are able to explain how scarcity/surplus affects the basic questions of what, how, how much, and for whom to produce.
9-12.E.1.6 Students are able to explain basic elements of trade and its impact on the U.S. economy.

Assessment Strategies:

Students will be given a quiz where they need to write an explanation analyzing how ANS infestations have affected different parts of the country. In their explanations, students must include changes to the ecosystem and economic consequences. (Depending on your class, you can decide how in depth their answers need to be.)

An additional question for the written quiz could be that students need to explain what globalization is and how globalization has contributed to ANS problem. Students will need to justify if participating in a global economy is worth the risk – especially considering that a main cause of spreading ANS occurs through agricultural and industrial raw material imports. (This could lead into students evaluating our own production of agricultural products and looking for more industrial raw materials within the U.S. This is definitely a higher level question.)

Learning Objective(s):

- Students will explain at least three different types of aquatic nuisance species found in the U.S.
- Students will explain how each of the different types of aquatic nuisance species entered the U.S. and how each has spread.
- Students will identify at least three problems that each of the aquatic nuisance species have caused.
- Students will explain the impact aquatic nuisance species has on the economy.

Grade Level: 9-12
Time Required: Approximately 1 – 1 ½ hours

Materials/Technology Needed:

- An In-Focus projector (or connection to another type of video source, like a TV, that can be shared with the class at one time).
- Computers with Internet access; if Internet access is unavailable, the teacher can print copies of the information from the websites listed under the Bibliography/Resources below for individual student use.

Background Information

This lesson of the unit will focus students on specific examples of aquatic nuisance species and their impact on various regions of the U.S.

The opening for this lesson is a video dealing with northern snakehead fish that have been caught in the Chicago River. The concern is that these fish eat other species and can destroy established fish communities, like large mouth bass. Because these fish destroy natural ecosystems, it is feared that the snakehead fish will make its way into Lake Michigan and the Illinois River – from there, the snakehead fish could be hard, if not impossible to control, potentially affecting a multi-billion dollar sport fishing industry.

The remainder of the lesson will deal with three other examples of ANS that have greatly impacted the U.S.

**Make sure that students understand that Aquatic Nuisance Species can be referred to as Aquatic Invasive Species as well.

Lesson Description:

To begin this lesson, review with students the interconnection that ecosystems have with society and our economies.

Next, log onto http://www.hotchalk.com (see below under Bibliography/Resources for log-in information) and select the video "Growing Snakehead Fish Population Has Biologists and Fisherman Worried". This video is only 1 minute and 28 seconds; it was a segment that aired on NBC News on 10/16/2004. This segment gives a brief introduction into the things that the students will research for the next part of this lesson. After the video, briefly discuss and explain to students that they will be researching a variety of aquatic nuisance species that have appeared in the U.S. and what the impact has been in those areas.

After the video and brief discussion, students will utilize the Internet to research a variety of web sources listed on http://www.portaportal.com. Students will need to enter ***SDGFP*** for the "guest name" for *Guest Access* in order to access hyperlinked sites to answer questions on the handout "Aquatic Nuisance Species". An answer key will be available for teachers. This portion of the lesson will focus primarily on Zebra Mussels and the sea lamprey invading the Great Lakes, and Purple Loosestrife, found all over the U.S. Students will learn specifically what each of the aquatic nuisance species is, where it came from, how it was spread, and what the implications of these aquatic species have been.

NOTE - This worksheet can be modified to accommodate the various ability levels in your class.

After students have completed their online research, discuss as a class. This will lead into the next lesson.

Enrichment:

Students could do individual (or small group) research on one of the above named ANS examples and present their findings to the class either in a formal presentation like PowerPoint, a mock "ask an expert" segment that might be found on TV, it could be a presentation to a state legislative committee about the problem and why funding needs to be available for education, prevention, and control of ANS.

This would be a good opportunity to co-teach this lesson with a biology teacher, and even

a language arts teacher.

The next lesson will deal with specific ANS threats that South Dakota is facing.

Bibliography/Resources:

http://www.hotchalk.com – This is a free resource that teachers can use in their lessons. Individual teachers do need to register with the site; however, it will provide teachers access to lesson plans and other teaching resources for many different disciplines. The other helpful resource is that you can access a transcript of the video that you want to watch.

Once you are a registered user of this site, to access the video mentioned in the lesson ("Growing Snakehead Fish Population"), click on the "NBC Video" link at the top right side of the webpage. Next, under the "Subjects" heading on the left side of the page, you need to click on the "Science" link. Then under the "Subjects" heading, you will see a "Topics" section, you need to select "Environmental Sciences". In the middle column of the page you will see a listing of additional sub-topics; from this group, click on the "Protection and Conservation" link. Another new listing will appear in the middle column under the "Protection and Conservation" heading, select the "Invasive Species" option. Once you have done that, there will be 4 different videos that you can select from. The "Growing Snakehead Fish Population" video should be the one listed last. Once you click on it, the video will start playing. You can enlarge the video by clicking on the double rectangle icon at the bottom left portion of the video screen. To return to view the computer screen as "normal" you can press the "Esc" button.

http://www.portaportal.com – This is a free online bookmark site that teachers can create and maintain to allow student access to those bookmarked sites for projects such as this.

Sites listed on Porta Portal for this lesson include:

http://www.sdgfp.info/Wildlife/AquaticNuisance/WhatIsAnAquaticNuisanceSpecies.aspx
This site is maintained by the SD GFP. The definition of ANS is concise and easy to understand.

http://www.nature.org/initiatives/invasivespecies/features/art21255.html and

http://www.nature.org/initiatives/invasivespecies/about/?src=search these links are maintained by The Nature Conservancy and provide good background information about ANS.

http://www.pbs.org/strangedays/episodes/invaders/experts/aquaticinvaders.html
This site is a joint project between PBS and National Geographic. Strange Days is a series that has been running on PBS. The video version of the episode entitled "Invaders" would also be good to incorporate into this lesson.

http://www.anstaskforce.gov/soc.php This is a site maintained by the ANS Taskforce. This site provides information about individual ANS found in the U.S.

http://www.anstaskforce.gov/impacts.php This portion of the ANS Taskforce deals with the impacts associated with individual types of ANS found in the U.S.

http://gf.nd.gov/fishing/ans-animals.html This is the site for the North Dakota Game and Fish Department that details invasive aquatic animals.

http://www.dnr.state.mn.us/invasives/index.html This is the site for the Minnesota Department of Natural Resources and provides information on a variety of ANS.

http://alic.arid.arizona.edu/invasive/sub2/index.shtml - this site was created by the University of Arizona and provides a lot of information about many aspects about invasive species, including their interaction with humans and the economy.

Lesson Created By: Andrea Frey, Aberdeen School District

Name: _____

Aquatic Nuisance Species
Lesson 2 (9-12) Handout

Directions*:** Go to the following website – http://www.portaportal.com. On the right side of the page you will see "Guest Access" in the blank type in ***SDGFP. It will allow you to access the websites that you will need to use to find information to the following questions. You will use the links under the heading of "Aquatic Nuisance Species".

1. In your *own* words, define aquatic nuisance species (ANS).

2. What are the characteristics that make aquatic nuisance species unique?

3. What are some ways that ANS are spread?

4. How are *natural* species numbers controlled? What makes ANS such a problem?

5. How much chaos have ANS caused for the various ecosystems found in the U.S.?

6. Why do ANS pose such a threat to our freshwater ecosystems?

7. How has our global society affected the spread of ANS?

8. How has the amount of imports into the U.S. changed since the mid-1960s?

9. How much has the U.S. increased the amount of imports of agricultural products and industrial raw materials since the mid-1960s?

10. (Challenge Question) Every economic decision involves trade-offs. In regard to the increase in imports to the U.S., make a list of trade-offs involved in making the decision to increase the import of certain goods. (Hint – think beyond the online articles.)

11. (Challenge Question) An externality is an unintended consequence that occurs from some type of decision/action. What externalities of global exploration (over the centuries) occurred? Why did it occur?

Specific ANS Examples in the U.S.

For this part of your research, you will be looking at a few of the most prominent ANS infestations in the U.S.

Zebra Mussels

1. Where did the Zebra Mussel originate from?

2. How was the Zebra Mussel introduced to U.S. waters?

3. Where had the Zebra Mussel initially been introduced?

4. What impacts have Zebra Mussels had in the Great Lakes ecosystem?

5. How have zebra mussels caused problems for cities around these infested waters?

6. How much does it cost to control and monitor Zebra Mussels in the Great Lakes area?

7. Why are Zebra Mussels so difficult to control?

Sea Lamprey

1. Where did the Sea Lamprey originate?

2. How harmful is the Sea Lamprey in the Great Lakes (or any waterway) ecosystem?

3. How much does it cost to control and monitor the Sea Lamprey in the Great Lakes area?

4. What method has been used to control the Sea Lamprey population in the Great Lakes? Have those efforts been successful?

Purple Loosestrife

1. Where did Purple Loosestrife originate?

2. How was Purple Loosestrife introduced to U.S. waters?

3. Where is Purple Loosestrife found in the U.S.?

4. How does Purple Loosestrife affect an ecosystem?

5. How is Purple Loosestrife controlled?

6. Why is Purple Loosestrife so difficult to control?

Aquatic Nuisance Species
Lesson 2 (9-12) Handout Answer Key

Directions*:** Go to the following website – http://www.portaportal.com. On the right side of the page you will see "Guest Access" in the blank type in ***SDGFP. It will allow you to access the websites that you will need to use to find information to the following questions. You will use the links under the heading of "Aquatic Nuisance Species". *Teacher note – many of these answers can be found on multiple websites – I have listed a couple of areas where the answers may be found.

1. In your *own* words, define aquatic nuisance species (ANS).
   An aquatic nuisance species is one that is a non-native and threatens the natural ecosystem. These species can overtake the resources needed by native species. ANS can also threaten recreational, commercial and agricultural that depend on those infested waters.
   (SD GFP Aquatic Nuisance Species webpage or Invasive Species webpage from University of Arizona)

2. What are the characteristics that make aquatic nuisance species unique?
   They produce many offspring; they have early and rapid development; they adapt easily to different environments and diets; they tolerate a broad range of conditions; and they are free of natural controls.
   (SD GFP Aquatic Nuisance Species webpage or Invasive Species webpage from University of Arizona)

3. What are some ways that ANS are spread?
   Some are spread accidentally, while others are spread intentionally.
   The three most common ways they are spread is through trade, agriculture, and transport.
   (ANS Threats by The Nature Conservancy webpage)

4. How are *natural* species numbers controlled? What makes ANS such a problem?
   Natural species populations are controlled by natural means like predators and food supply.
   Natural species cannot defend against ANS because ANS reproduce quickly and can overtake a habitat.
   (ANS Threats by The Nature Conservancy webpage; SD GFP webpage; Invasive Species webpage from University of Arizona)

5. How much chaos have ANS caused for the various ecosystems found in the U.S.?
   Invasive species cost the U.S. economy approximately $120 billion per year.
   Also, species are at risk of becoming extinct; no habitat or region is immune for invasive threats.
   (ANS Impacts by The Nature Conservancy webpage)

6. Why do ANS pose such a threat to our freshwater ecosystems?
   They are often difficult to detect, before it is too late; various water intakes have been damaged by ANS; waterways are clogged with plants that make boating and other recreational activities un-enjoyable; some ANS prey upon natural species which are

becoming endangered.
(ANS Impacts by The Nature Conservancy webpage)

7. How has our global society affected the spread of ANS?
As people move - so do ANS, some people like a particular plant or enjoy certain species of fish and they accidentally get into new habitats; others are caused by being brought into a new area due to trade and shipping.
(PBS Strange Days website)

8. How has the amount of imports into the U.S. changed since the mid-1960s?
Imports have increased from $192 billion in 1965 to $3.3 trillion in 1990.
(PBS Strange Days website)

9. How much has the U.S. increased the amount of imports of agricultural products and industrial raw materials since the mid-1960s?
These imports have increased from $55 billion in 1965 to $482 billion in 1990.
(PBS Strange Days website)

10. (Challenge Question) Every economic decision involves trade-offs. In regard to the increase in imports to the U.S., <u>make a list</u> of trade-offs involved in making the decision to increase the import of certain goods. (Hint – think beyond the online articles.)
*Some trade-offs include: American industry/agriculture for cheaper international products, reduced quality, cannot regulate standards as easily, increase in trade deficit, etc. – many more can be added.

11. (Challenge Question) An externality is an unintended consequence that occurs from some type of decision/action. What externalities of global exploration (over the centuries) occurred? Why did it occur?
When people move from one place to another they often take native plants or fish with them – not realizing that it would cause problems (people would take these things because they liked them). With global exploration, borders have been taken down – making places more accessible, which has caused ANS to travel with people, on ships, and in/on goods.
The spread of ANS can be quite easy – release of ballast water from ships, seeds on clothing or other products, etc.
(PBS Strange Days website as one resource)

Specific ANS Examples in the U.S.

For this part of your research, you will be looking at a few of the most prominent ANS infestations in the U.S.

<u>Zebra Mussels</u> (*There are multiple sources for this information – many of the sites are noted on Porta Portal.)

1. Where did the Zebra Mussel originate from?
   Eastern Europe, western Asia, Black and Caspian Sea drainages

2. How was the Zebra Mussel introduced to U.S. waters?
   A Caspian Sea tanker released ballast water, into the Great Lakes
      Ballast water is the water that is used in "empty" (or near empty) ships to increase their stability.

3. Where had the Zebra Mussel initially been introduced?
   From Lake St. Claire near Detroit

4. What impacts have Zebra Mussels had in the Great Lakes ecosystem?
   They reproduce rapidly and in large numbers, they don't have many natural predators in their new habitat (birds like ducks); they cover rocks that walleye use for spawning, they consume small zooplankton that are needed by small game fish; large numbers of zebra mussels can strain an entire lake of plankton needed by native species, etc.

5. How have zebra mussels caused problems for cities around these infested waters?
   Because zebra mussels produce rapidly, they can clog water intake systems, and can affect hydroelectric company equipment which cost a lot of money to unclog.

6. How much does it cost to control and monitor Zebra Mussels in the Great Lakes area?
   $30 million dollars a year for control and monitoring

7. Why are Zebra Mussels so difficult to control?
   Rapid population growth, zebra mussels produce microscopic larvae that can move through filters that are used to stop them from spreading – so it makes them virtually impossible to stop, the larvae can attach themselves to boats, trailers, misc. equipment and can spread virtually undetected.

Sea Lamprey

1. Where did the Sea Lamprey originate?
   In the Great Lakes after the opening of the Welland Canal in 1929.

2. How harmful is the Sea Lamprey in the Great Lakes (or any waterway) ecosystem?
   They are a major factor in the collapse of lake trout populations if not controlled, one sea lamprey can kill 40 lbs. of fish in its adult lifetime.

3. How much does it cost to control and monitor the Sea Lamprey in the Great Lakes area?
   $12 - 16 million annually (ANS Impacts from ANS task force website and Invasive Species – MN DNR website)

4. What method has been used to control the Sea Lamprey population in the Great Lakes? Have those efforts been successful?

They have employed chemical control methods that have been effective in stopping 90% of the populations.

Yes they have worked, but are again threatening fishery restorations.

Purple Loosestrife

1. Where did Purple Loosestrife originate?

Europe

2. How was Purple Loosestrife introduced to U.S. waters?

NE coast of the U.S. in the early 1800's in ballast and brought as an ornamental plant.

3. Where is Purple Loosestrife found in the U.S.?

In 42 states

4. How does Purple Loosestrife affect an ecosystem?

It displaces native wetland plants and is not suitable for cover, food or nesting areas.

5. How is Purple Loosestrife controlled?

One way is by hand pulling while the plant is flowering, but before it turns to seed. It can be cut. A biological control – a loosestrife eating beetle – can be used. Herbicides can be used, but must be used carefully to not affect nearby vegetation.

6. Why is Purple Loosestrife so difficult to control?

The seeds are easily spread by humans, wetland animals, and moving water.

Lesson 3 (9-12)

Aquatic Nuisance Species (ANS) - Not in My Ecosystem!

South Dakota Content Standard(s):

9-12.G.1.1 Students are able to use resources, data services, and geographic tools that generate and interpret information.
9-12.G.2.2 Students are able to explain how humans interact with their environment.
9-12.G.2.3 Students are able to explain how human migration impacts local and global politics, environment, economies, societies, and regions.
9-12.E.1.2 Students are able to explain how scarcity/surplus affects the basic questions of what, how, how much, and for whom to produce.
9-12.E.1.6 Students are able to explain basic elements of trade and its impact on the U.S. economy.

Assessment Strategies:

- Grade brochure based off criteria listed in the attached rubric.
- Students will need to present their ANS topic to the rest of the class, following a sample presentation rubric that has been provided.

Learning Objective(s):

- Students will identify specific ANS species that are making their way into SD.
- Students will create a brochure identifying a particular ANS threatening SD.
- Students will include in their brochure a picture of the ANS, basic information about what the species is, how it got here, where it is currently found in SD waters, and identify the risks associated with that type of ANS infestation.
- Students will be able to explain that when an ANS infiltrates one watershed that all of the other tributaries are now threatened.
- Students will present their ANS topic to the rest of the class.

Grade Level: 9-12

Time Required: Approximately 1 ½ - 2 hours

Materials/Technology Needed:

- An In-Focus projector (or connection to another type of video source, like a TV, that can be shared with the class at one time) or a TV with DVD/VCR.
- Computers with Internet access; if Internet access is unavailable, the teacher can print copies of the information from the websites listed under the Bibliography/Resources below for individual student use.
- A printer (color would be nice, black/white will do)
- White and/or colored construction paper
- Miscellaneous art supplies

Background Information

This lesson of the unit will focus primarily on specific ANS threats to SD. Some of the threats are around SD, but have only recently been found in SD waters. Others are ANS that are found in a variety of areas across the state. Some of these threats include:

Didymosphenia Geminata “Didymo”, Eurasian Watermilfoil, Curly Leaf Pondweed, Brittle Naiad, Asian Carp (4 types), European Rudd, Tamarisk “Salt Cedar”, Purple Loosestrife and Zebra Mussels (which were already researched in the last lesson, but would be great for an ELL student or student on an IEP).

Lesson Description:

Students of all ages love movies and it is fun to implement segments into class discussion. To begin this lesson, the teacher could play a scene from *Finding Nemo.* With a DVD copy of the movie the scene would be #9 “The Tank Gang”. (If you are using a VCR copy of the movie, the video time counter would begin at 25 minutes 11 seconds and run until 27 minutes and 03 seconds.) After showing this scene, students should discuss the following questions:

- Why were the fish “afraid” of Nemo after he mentioned that he was from the ocean? (To them Nemo was “contaminated”)
- How did the “Tank Gang” deal with the situation? (they “cleaned” him)

Then turn the discussion toward the situation SD, and other states, are facing regarding ANS with the following question:

- If this worked for the “Tank Gang’s” situation in the movie, would it work on a larger area, like a lake or a river? Why or Why not?
  - The point of this question is to show students that once an invasive species is introduced to a body of water, some native defenses can fight against the new invader; however, after a while the ANS multiplies to a point where the native species is overcome and can no longer fight off the ANS.

For the next portion of this lesson, you can break students into small groups (2-3 students each) or if you have a small enough class, you could have students work individually. Pass out the brochure assignment requirement sheet (click here for attachment). Explain to the groups, or individuals, that they will research a particular ANS which will be assigned to them. They will need to find the information required on the assignment sheet. Their presentation of their research can take shape of a brochure; but you could also implement other “Foldable” shapes (see Dinah Zike information under the “Resources” heading).

Students will utilize the Internet to research various web sources listed on http://www.portaportal.com. Students will need to enter ***SDGFP*** for the “guest name” for *Guest Access* in order to access hyperlinked sites to find the answers necessary to meet all of the requirements associated with the brochure.

**Students may use additional sources after they have utilized the ones from Porta Portal.

After students have completed their research, make sure students have all of the materials in order to complete their brochure. Again remind students to make sure that they follow the requirements (attached here).

Student brochures can be handmade, they can be created with Microsoft Publisher, or they can go to the following website from Read Write Think which has an interactive brochure that students can create a brochure online. That website is http://interactives.mped.org/view_interactive.aspx?id=110&title

Students will present their specific ANS to the rest of the class. After all of the

presentations have been completed, use a transparency of the rivers and lakes in SD and have students explain that once an ANS infiltrates one watershed that all of the other tributaries are now threatened.

Enrichment:

After the student(s) presentations, the class could create a "master" map of SD showing all ANS distributions so far.

Students could also research their ANS topic to see what states in the region are dealing with and what type of threat neighboring waters (from other states) pose to SD waters.

Teachers could request someone from SDGFP to come and discuss the issues of ANS in SD.

Students could create different types of "Foldable" (other than a tri-fold/brochure style foldable). There are many examples of Foldables in the bibliography information provided and there are examples of Foldables online as well.

Bibliography/Resources:

Finding Nemo. DVD. Walt Disney Pictures, 2001.

http://www.portaportal.com – This is a free online bookmark site that teachers can create and maintain to allow student access to those bookmarked sites for projects such as this.

Sites listed on Porta Portal for this lesson include:

http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx - This site provides specific information about current ANS threats to SD. Once a student selects a specific ANS from the right side of the page, they will get a photo of the species, miscellaneous information about the species, and there are distribution maps for ANS in SD and a distribution map for the US.

http://www.dnr.state.mn.us/invasives/index.html This is the site for the Minnesota Department of Natural Resources and provides information on a variety of ANS.

http://gf.nd.gov/fishing/ans-animals.html - This is the site for the North Dakota Game and Fish Department that details invasive aquatic animals.

http://gf.nd.gov/fishing/ans-plants.html - This is the site for the North Dakota Game and Fish Department that details invasive aquatic plants.

Dinah Zike's High School Economics Reading and Study Skills Foldables. The McGraw-Hill Companies: New York. (**No date listed on this book.)

http://interactives.mped.org/view_interactive.aspx?id=110&title Is from the website Read Write Think and is connected with the unit called Brochure Writing for Audience and Purpose. This would be a great lesson to collaborate with an English or a computer teacher.

Kuhn, Daryl. "Element Brochures." Science Scope October 1996 22-25. 16 Jun 2008.

<http://faculty.harker.org/rajis/science/project/elementbrochure/Element%20Brochure%20Project.pdf>.

This resource is what I modeled my sample brochure from.

http://www.rcampus.com –This is a free resource for teachers. It allows you to

browse a collection of rubrics that have already been created, or you can create your own. This site does require you to register if you want to modify an existing rubric or create one from scratch. A basic rubric to grade this project from is one built by username - lisamarieford rubric code J5786.

Lesson Created By: Andrea Frey, Aberdeen School District

SD Aquatic Nuisance Species Threats
Brochure Requirements: Lesson 3 (9-12)

You will be creating a brochure based on a particular aquatic nuisance specie that is threatening SD waters. Your topic will be one that you have randomly drawn. Here are the requirements for the project:

Format:

- Your brochure will be printed on an 8x11 piece of paper.
- The paper will be folded in 3
- There should be information on all 6 folded sides.
    - See the sample brochure as to what information is required on each page.
- Your brochure should be visually appealing – utilizing *at least* 3 images.
- Your information should be based on factual information gathered from research.
- The brochure is to inform your audience (in this case your classmates) about your assigned aquatic nuisance species.
- REMEMBER – you must cite all information and images used in your brochure following MLA format.
    - For citation format – go to www.citationmachine.net
- All fonts should vary in size and color, but remain easy to read.
- Pay attention to the amount of white space in your brochure. There is a fine line of what is an appropriate amount of white space – too much, could use more information or graphics. Too little white space – appears cluttered.

This is where you will include introductory information about your ANS.

- You need to explain what your ANS is
- Explain where it came from

Fold Line

The back cover should include your name and the names of people in your group. Include the class name and period or block.

Also include the date that this project was completed

**Remember:

- Is your information easy to read and understand
- Is your brochure attention grabber? Consider color, font, font size, etc.
- Double check spelling and grammar!!!

Fold Line

This will be your cover page.

1. You will need to create a creative title introducing your aquatic nuisance specie
2. You must include the common name for your species and the scientific name
3. You should also include a picture of your aquatic nuisance specie

*This sample brochure was modeled after an article found in the October 1996 issue of *Science Scope* by Daryl Kuhn.

On-line citation information –

Kuhn, Daryl. "Element Brochures." Science Scope October 1996 22-25. 16 Jun 2008 <http://faculty.harker.org/rajis/science/project/elementbrochure/Element%20Brochure%20Project.pdf>.

In this portion of the brochure, you need to:

- Explain how this ANS is spread.
- Explain why this particular ANS is such a problem (what does it do?).

Fold Line

In this space of your brochure you will need to include a distribution map of where your ANS has already affected SD waters.

(You will find this information on the SD GFP website.)

Fold Line

On this side of the brochure include ways that people need to do in order to stop the spread of this type of ANS.

You could use words and images for this.

Lesson 4 (9-12)

SD We Have a Problem!
Dealing with ANS

South Dakota Content Standard(s):

9-12.G.1.1 Students are able to use resources, data services, and geographic tools that generate and interpret information.
9-12.G.2.2 Students are able to explain how humans interact with their environment.
9-12.G.2.3 Students are able to explain how human migration impacts local and global politics, environment, economies, societies, and regions.
9-12.E.1.2 Students are able to explain how scarcity/surplus affects the basic questions of what, how, how much, and for whom to produce.
9-12.E.1.6 Students are able to explain basic elements of trade and its impact on the U.S. economy.
9-12.C.1.5 Students are able to describe the state, local, and tribal governments with the emphasis on their structures, functions and powers.

Assessment Strategies:

Students will create a list of pros and cons for various ways that ANS are prevented and controlled. Students would write a page on which method they feel would be the most successful control method with the least amount of negative effects.

Students will receive a scenario of a new ANS infestation in SD waters and using their list of methods and pros and cons of each, students will need to justify which method would be best to prevent or control that particular ANS before it becomes out of hand. (**Higher level assessment)

Learning Objective(s):

Students will research what other states have done to deal with various ANS infestations.

Students will list potential trade-offs associated with each control method.

Students will decide the best means of controlling the spread of a variety of plant and animal ANS.

Grade Level: 9-12

Time Required: Approximately 2-1/2 hours

Materials/Technology Needed:

Computers with Internet access; if Internet access is unavailable, the teacher can print copies of the information from the websites listed under the Bibliography/Resources below for individual student use.

Background Information

Students will need to refer back to all of the previous research that they have conducted about different types of ANS and then research various methods of controlling and/or managing various ANS infestations.

Lesson Description:

First, review from the last lesson as to what kind of ways states have tried to control and monitor Zebra Mussels, Sea Lamprey, and Purple Loosestrife (chemical methods, recommended cleaning methods for boats, etc.)

For the next part of the lesson, you can have students independently research various methods used to control ANS; or you could have students work in small groups researching one specific control method. I have listed some resources of how states have gone about controlling a particular ANS on the Porta Portal site; however, I would suggest that students use online databases (like E-Library or ProQuest) provided on the SD Library site to find additional resources so they can look at all angles about the method so they can add to their pro/con list.

Some methods are: chemical, mechanical, biological, electric barriers, education, tightening regulations (i.e. bait restrictions in WI), and so on.

**Some of this research could easily be an advanced student task. It depends on your class as to how detailed you would like them to go with their research.

Depending on the class, you could come up with different scenarios where a certain type of ANS (that they have studied) is invading SD. Students could work alone or with a small group where they would take their list of various prevention/control methods and the list of pros and cons that they created for each option and try to figure out which prevention/control method(s) would be the best to implement. Each group would need to justify to the rest of the class why their plan would work the best.

For example, one scenario could be: A family is vacationing in SD. For the first day of their vacation they used their two jet skis on Lake Oahe. It was getting late, so they put their jet skis on their trailer – not paying attention that the trailer had some Curly Pondweed stuck between it and the jet ski. The family gets to their second destination, Lake Kampeska in Watertown. The family is excited to meet up with other family members already on their jet skis. As they unload their jet skis from their trailer, the segment of Curly Pondweed also enters the water along with the jet skis. This goes unnoticed until the following spring. What is the best course of action to take in preventing or controlling the spread of this ANS all around the lake?

Enrichment:

Each student could be given the same scenario, write up their justification and then "debate" which method of control is the best solution to deal with the ANS in that scenario.

Bibliography/Resources:

http://www.portaportal.com – This is a free online bookmark site that teachers can create and maintain to allow student access to those bookmarked sites for projects such as this.

Sites listed on Porta Portal for this lesson include:

http://www.northeastans.org/controls.htm - ***This site is where I would have students begin their research. This site takes individual aquatic species and provides information on how to control them. There is a drop-down menu that will give options for chemical,

mechanical, and biological methods. Students will select one of the control methods, and then they will need to read through some of the .pdf files that describe how each method would be used for each ANS listed.

http://www.mass.gov/czm/invasives/prevent/index.htm This site is maintained by the Massachusetts Office of Costal Zone Management. This source provides more educational based efforts in dealing with ANS.

http://www.gf.nd.gov/multimedia/ndoutdoors/issues/2007/may/docs/hunting-exotics.pdf This resource was posted by the ND Game and Fish Department. It is an article that is easy to read and provides straight forward examples of dealing with ANS.

http://www.gf.nd.gov/multimedia/ndoutdoors/issues/2007/june/docs/both-sides.pdf - another easy to read and understand article on dealing with ANS

http://www.gf.nd.gov/multimedia/ndoutdoors/issues/2003/jul/docs/aliens.pdf - Again, another easy to read and understand article on dealing with ANS.

http://www.jsonline.com/story/index.aspx?id=418892 and http://www.ag.auburn.edu/aaes/communications/highlights/winter99/electricfence.html and http://sports.espn.go.com/outdoors/bassmaster/news/story?page=b_fea_bt_0412_news_fisheries_barrier – All three articles discuss using an electric fence to control animal ANS.

Lesson Created By: Andrea Frey, Aberdeen School District

Lesson 5 (9-12)

An Ounce of Prevention. . .

South Dakota Content Standard(s):

9-12.G.1.1 Students are able to use resources, data services, and geographic tools that generate and interpret information.
9-12.G.2.2 Students are able to explain how humans interact with their environment.
9-12.G.2.3 Students are able to explain how human migration impacts local and global politics, environment, economies, societies, and regions.
9-12.E.1.2 Students are able to explain how scarcity/surplus affects the basic questions of what, how, how much, and for whom to produce.
9-12.E.1.6 Students are able to explain basic elements of trade and its impact on the U.S. economy.
9-12.C.1.5 Students are able to describe the state, local, and tribal governments with the emphasis on their structures, functions and powers.

Assessment Strategies:

Students will be graded using a rubric on their creation of either a public service announcement for the TV or the radio, or create a poster alerting people involved in swimming, fishing, and boating in the waters of SD to be vigilant in trying to reduce the threat of spreading ANS between bodies of water in SD, and surrounding states.

Learning Objective(s):

Students will identify ways that South Dakotans (and tourists to the state) can reduce the risk of transporting ANS into our state waters.

Students will create a catchy slogan to help people be mindful of the risks that they are taking by not taking precautions to stop the spread of ANS.

Students will identify how much of an economic impact ANS would have on the SD economy.

Students will explain all of the potential impacts an ANS outbreak would have on the economy of a small town on the Missouri River or a new development on a lake in SD (as an example).

Grade Level: 9-12

Time Required: Approximately 2-2½ hours

Materials/Technology Needed:

- An In-Focus projector (or connection to another type of video source, like a TV, that can be shared with the class at one time).
- Computers with Internet access
- Students may need access to a video recorder, artistic supplies, etc. in order to create their PSA (for TV or radio) or a poster.

Background Information

This lesson of the unit will focus primarily on how SD (and other governmental agencies) plans

on dealing with ANS. Remember the famous idiom by Benjamin Franklin, an ounce of prevention is worth a pound of cure? Well, in the case of dealing with ANS, prevention is the best course of action.

Lesson Description:

To begin this final lesson of the unit, have a class discussion about how important prevention and education are to help protect SD waters from ANS.

Next, show the class a 13 minute video titled "Lose the Hitchhikers or Lose Your Lake" produced by the ND Game and Fish Department. You can access this video at http://gf.nd.gov/multimedia/pubs/ans-video.html

Then, have students access the SD GFP website to research how much revenue SD generates from recreational fishing. They can access this through Porta Portal under the heading "Preventing Aquatic Species from Happening", and then selecting the 1st source titled "Economic Importance of Fishing in SD". This will help show students how important keeping ANS from affecting our waters and dramatically affecting revenue for the state.

Next, students will work in small groups to create a 1 minute video public service announcement (PSA), a 30 second PSA spot for the radio; or a poster that will be displayed at bait shops, hunting/fishing lodges, GFP offices, state controlled boat launches, campgrounds, etc. The PSA or poster must be of high interest to get people using SD's waterways to stop and think about ANS and how to prevent spreading them to other water areas. Click here for project requirements and a sample project grade sheet.

You might have groups focus on different areas for their projects like: cleaning your boat and gear, don't release fish or aquatic plants, notify SD GFP right away if you suspect a questionable species, don't release unused bait into the water – throw it in the garbage, increase fishing license fees to place boat washes at all state maintained boat launches (*this would need SD legislative approval), etc.

Enrichment:

Students could be asked to create a 3 – 4 minute educational video that could be posted online (ex. www.teachertube.com) for other students to use (i.e. like elementary or middle school students).

Or students could be asked to create a 2 – 3 minute special segment that would be featured on the news educating people about ANS and how to stop spreading them to other bodies of water.

Bibliography/Resources:

http://www.portaportal.com – This is a free online bookmark site that teachers can create and maintain to allow student access to those bookmarked sites for projects such as this.

Sites listed on Porta Portal for this lesson include:

http://www.sdgfp.info/Wildlife/Economics/Fishingeconomics.htm This link provides SD revenue figures generated by resident or nonresident fishing.

http://www.nature.org/initiatives/invasivespecies/features/art21231.html and http://www.nature.org/initiatives/invasivespecies/help/ these links are for the Nature Conservancy where they outline what people can do to prevent spreading invasive species.

http://www.sdgfp.info/Wildlife/AquaticNuisance/AquaticNuisanceSpecies.aspx This is a

page from the SD GFP site discussing ways to avoid spreading ANS.

http://www.nature.org/initiatives/invasivespecies/howwework/ this link is to the Nature Conservancy where they outline what their organization is doing to prevent invasive species from spreading.

http://www.100thmeridian.org/boats.asp This is from the 100th Meridian group dealing with boat cleaning.

http://www.habitattitude.net This site is dedicated to informing people of the importance of not releasing fish or aquatic plants that could harm the environment.

http://www.rcampus.com – Again, This is a free resource for teachers. It allows you to browse a collection of rubrics that have already been created, or you can create your own. This site does require you to register if you want to modify an existing rubric or create one from scratch.

A sample rubric to grade a poster for this lesson is one built by username whiteley sara rubric code X54BC.

A sample rubric to grade an audio PSA would be username missmamie rubric code AB97C.

A sample rubric to grade a video PSA would be username missmamie rubric code MB98B.

Lesson Created By: Andrea Frey, Aberdeen School District

Informational PSA Poster Option: Lesson 5 (9-12)

Students that choose to make an informational PSA poster will be graded on the following criteria:

- Attractive layout
    - Good use of color, font size and style, message jumps out at people
    - Posters need to be original work and not copied from other sources.
- Images have typed captions.
- Come up with a slogan that is easy to remember to get your point across.
- Key information about the topic is presented accurately and concisely
- Message needs to be clear about what you are asking people to do regarding Aquatic Nuisance Species.
    - Example: clean your gear, don't flush fish
- Proofread your poster – points will be deducted for spelling and grammatical errors.

Audio PSA Option

Students that choose to make an audio PSA will be graded on the following criteria:

- Script must be typed.
    - Points will be deducted for spelling and grammatical errors.
- Use of descriptive, attention grabbing language.
- Come up with a slogan that is easy to remember to get your point across.
- Key information about the topic is presented accurately and concisely
- Message needs to be clear about what you are asking people to do regarding Aquatic Nuisance Species.
    - Example: clean your gear, don't flush fish
- Audio recording shows good inflection in the speaker(s) voice.
- Use of background music needs to be subtle and not detract from the message.
- Consider the most effective organization and flow of material to gain and keep audience attention.

Video PSA Option

Students that choose to make an audio PSA will be graded on the following criteria:

- Script must be typed.
    - Points will be deducted for spelling and grammatical errors.
- Use of descriptive, attention grabbing language.
- Come up with a slogan that is easy to remember to get your point across.
- Key information about the topic is presented accurately and concisely
- Message needs to be clear about what you are asking people to do regarding Aquatic Nuisance Species.
    - Example: clean your gear, don’t flush fish
- Use of background music needs to be subtle and not detract from the message.
- Visuals need to be appropriate to the message.
- Consider the most effective organization and flow of material to gain and keep audience attention.