When Exotic Becomes Invasive:

Lionfish in the Northern Gulf of Mexico

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This lesson plan explains how to use two activities in conjunction with the presentation, "When Exotic becomes Invasive: Lionfish in the Northern Gulf of Mexico". The two activities include the Lionfish Dissection Puppet and the game board called, *Lionfish Invasion!*

The lionfish dissection activity demonstrates how invasive species can impact the dynamics of a habitat through predation. Students perform a gut-content analysis of a lionfish "puppet" and discover which native species are being consumed. Students record data and identify stomach contents of the lionfish. This hands-on experience mimics procedures that researches at the Dauphin Island Sea Lab perform to understand predation of lionfish in the northern Gulf of Mexico.

The *Lionfish Invasion*! game involves the students in the management aspects of the lionfish invasion. They become "reef keepers" and face many challenges associated with lionfish population growth. This exciting game highlights the adaptations, behaviors and other characteristics that make the lionfish a prime example of an invasive species and ideas about developing species management practices.

When Exotic Becomes Invasive

Lionfish Dissection Puppet - Gut Content Analysis

Subject: Life Sciences

Grade Level: Middle School

Time Required: 45 minutes

Standards:

Next Generation Science Standards

5-Ls2.A, MS-LS2.A: Interdependent Relationships in Ecosystems

MS-LS2.C, HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience

MS-LS4.D: Biodiversity and Humans

Ocean Literacy

Principle # 6 - The oceans and humans are inextricably interconnected.

Learning Objectives:

- Learn the definition of an invasive species.
- Identify characteristics that make the lionfish an invasive species.
- Explore ideas of how people may influence invasion species.
- Analyze data collected to determine what effects lionfish predation has on a native reef community.

Background Information:

Invasive species are exotic or non-native species which have been introduced into a new ecosystem and have a negative effect upon the natural balance of that ecosystem. Ecosystem dynamics can be thrown off balance when the introduced species; lacks predators, has high consumption rates, competes with native species for food or space, or is a vector for pathogens or parasites. Most introductions of invasive species is linked to man-made pathways, either intentional or unintentional.

Lionfish are one of the most aggressive aquatic invaders of the Atlantic Ocean, Gulf of Mexico and Caribbean Sea. They are native to the Indian and Pacific Oceans and were brought to North America for the Aquarium pet trade. The first release of lionfish into the Atlantic Ocean is believed to be from a release off of the coast of South Florida in 1985. They were first discovered in the Northern Gulf of Mexico in 2010. The most recent discovery of the invasive lionfish was off the coast of Brazil in 2014.

Lionfish are voracious piscivores and their predation of native reef species is a top concern regarding their invasion. They consume crustaceans and other prey that native species of the same trophic level consume. It has also been discovered that they are consuming juvenile species of many popular commercially important fish such as snapper and grouper.

Lionfish are very adaptive to temperature, salinity and habitat. They lack natural predators in the introduced ecosystems and reproduce at rapid rates. These characteristics have enabled their populations to increase and spread.

Organizations and communities are developing management strategies to control the lionfish invasion. Public education, lionfish roundups and creating a potential fishery for the invasive species are some of the most common methods. At the Dauphin Island Sea Lab, current research is underway which offers better understanding of the effects lionfish have on the reef communities in the Northern Gulf of Mexico.

Lionfish Dissection Puppet

Materials:

- Dissection puppets
- Stomach puppets
- Prey species
- Prey identification key
- Data sheets
- Pencils
- Tape
- Scissors

Instructions:

Review background information with students.

Lionfish puppets need to be prepared ahead of time either by teachers or students.

Students:

- Scatter fish around a "reef" in a classroom and have students act as lionfish, eating the species around them. Students then stuff the stomachs and prepare the puppets but they should not dissect the same puppet they have prepared.

Teachers:

- Stuff pieces randomly. Maybe one is empty?
- Throw some partially digested critters into the mix for a more realistic approach.
- You may want to print lionfish out at different percentages to give them different lengths.

Each lionfish has been tagged for data collection. Numbers need to be written on each tag.

Students will open the lionfish to reveal the stomach and then open the stomach to identify contents. The stomach content key can be used to identify which species of fish were consumed. Sometimes prey will be in stages of advanced digestion. Students should try to identify each item and record it as unidentifiable if necessary.

Tag #	# of prey	Snapper	Grouper	Damselfish	Goby	Blenny	Crab	Shrimp
1	5	2		2			1	

Analyze data with the students to find out the percentage of crustaceans, demersal reef fish and commercial fish species consumed. Discuss the species identified in the stomachs and discuss what effects their consumption may have on the native species and biodiversity of the habitat.

In a real lab setting, many other parameters are measured and recorded.

- Oeteliths are removed and age is determined
- Lionfish are weighed and measured
- Gape width and height is measured
- Stomach contents are weighed individually
- Unidentified stomach contents are tested for genetic identification

Lionfish Invasion! **Board Game**

Materials:

- Printed *Lionfish Invasion!* game board
- Lionfish cut outs (48)
- 4 player pieces (color coded bottle caps or plastic animals)
- die
- cards

Rules:

This game can be played with 2-4 players or 2-4 teams. Begin the game with 2 lionfish game pieces on each reef and player pieces on the "START" square. Place the cards in the center of the board. Roll the die to move spaces clockwise around the board. Do not count start. Each player or team is a "reef keeper" and will win by landing on or passing the "WIN" square without any lionfish on their reef. If you still have lionfish on your reef, continue around the board.

When you land on a square, take the following actions:

Shark Attack: Remove 1 lionfish from your reef.

Baby Boom: Add 2 lionfish to your reef.

Invade: Remove 1 of the lionfish from your reef and invade an opponent's reef or move another player's lionfish.

Release: Add 1 lionfish to your reef.

Research: Roll again.

When you land on the "Card" square, players pick a card from the center.

- Place cards that say "Skip next Baby Boom" or "Skip next Release" on your reef until they are used. You do not skip the square when counting spaces. When you land on that square, you do not receive the lionfish.
- Depending on the length of the game, cards may need to be shuffled and replaced in the center.

Using Plays of the Game to Discuss Educational Aspects:

Baby Boom: Lionfish reproduce at astonishing rates. They mature quickly and release eggs multiple times throughout the year.

Shark attack: In their native range (Indo-Pacific Ocean), lionfish do have a few predators including the grey reef shark. There are hopes that native species of invaded areas will begin to see lionfish as prey.

Invade: This represents the relocation of lionfish to new habitats. Obviously something that happens quickly.

Release: Someone has released an aquarium pet to your reef. Unfortunately this is how the whole invasion began!

Research: Scientists all over are studying lionfish and their impact they are having on the habitats they invade. At the Dauphin Island Sea Lab, researchers study competitive displacement and predation by synthesizing habitats with native reef species and lionfish, analyzing gut content of wild caught fish and monitoring natural and artificial reefs.

Rodeo/Bounty: Many coastal areas and protected marine habitats have community-wide round-ups or rodeos. Many agencies are offering a reward or bounty and offer prizes for the largest lionfish catches.

Spearfishing: This popular sport is one of the only ways to catch lionfish.

Fishing limits - shark and grouper: Two hopeful predators of lionfish. There have been very few reports of large species of grouper eating lionfish in the invaded areas.

Public Education: This is one weapon we have to prevent more releases and create awareness.

Pet shop: Hopefully with enough awareness we can have better regulations about keeping invasive species as pets.

BBQ: Apparently the white flaky meat is delicious.

Resources and References:

Dauphin Island Sea Lab, www.disl.org

Dauphin Island Sea Lab – Discovery Hall Programs, http://dhp.disl.org

Websites:

http://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=963

http://coastalscience.noaa.gov/research/pollution/invasive/

Articles:

Dahl KA, Patterson WF III (2014) Habitat-Specific Density and Diet of Rapidly Expanding Invasive Red Lionfish, *Pterois volitans*, Populations in the Northern Gulf of Mexico. PLoS ONE 9(8): e105852. doi: 10.1371/journal.pone.0105852

Green SJ, Akins JL, Maljković A, Côté IM (2012) Invasive Lionfish Drive Atlantic Coral Reef Fish Declines. PLoS ONE 7(3): e32596. doi: 10.1371/journal.pone.0032596

Ferreira CEL, Luiz OJ, Floeter SR, Lucena MB, Barbosa MC, et al. (2015) First Record of Invasive Lionfish (Pterois volitans) for the Brazilian Coast. PLoS ONE 10(4): e0123002. doi: 10.1371/journal.pone.0123002

Mumby PJ, Harborne AR, Brumbaugh DR (2011) Grouper as a Natural Biocontrol of Invasive Lionfish. PLoS ONE 6(6): e21510. doi: 10.1371/journal.pone.0021510

Schofield PJ (2010) Update on geographic spread of invasive lionfishes (Pterois volitans [Linnaeus, 1758] and P. miles [Bennett, 1828]) in the Western North Atlantic Ocean, Caribbean Sea and Gulf of Mexico. Aquatic Invasions 5(1): S117–S122. doi: 10.3391/ai.2010.5.S1.024

Animated maps:

http://nas.er.usgs.gov//queries/SpeciesAnimatedMap.aspx?speciesID=963

http://nas.er.usgs.gov/queries/FactSheets/LionfishAnimation.aspx

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