# A PLACE-BASED APPROACH TO INVASIVE SPECIES EDUCATION

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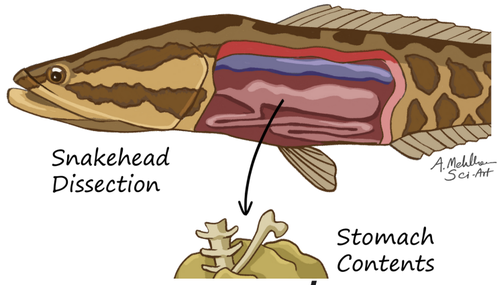
# MY INTERNSHIP

ArcGIS StoryMaps




Illustration/Video

EnLET Educator Resources

**Hungry Hungry Snakeheads: A Diet Analysis Activity**

Developed By: Anna Mehlhorn | Affiliation: Smithsonian Environmental Research Center

**I. Summary**

| Grade Level | Time Required | Keywords |
|---|---|---|
| 9th-12th | about 1 hour | invasive species, genetics |

| Lesson Overview | Learning Objective |
|---|---|
| In this activity, students will complete their own diet analysis using DNA sequences from the stomachs of an invasive fish: the northern snakehead. As they decode these sequences using the National Center for Biotechnology Institutes of Health (NIH), students will build a list of prey items found in the stomach of each fish. Using these lists, students will work in groups and as a class to think about the environmental impacts snakeheads are having on the region. | Students will learn how to use genetics to study animals that live underwater, without ever having to put on a snorkel mask! They will learn that there are genes that all animals have in common, and that genetics which can be used to study diet. Students will also learn how the diets of certain invasive species have noticeable effects on the plants and animals living in Chesapeake Bay environments. |

**II. NGSS Linkages**

| | |
|---|---|
| HS-LS2-2. | Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. |
| HS-LS2-6. | Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. |
| HS-LS2-7. | Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. |

**III. Preparation**

**Teacher Preparation Steps**

1. Using the Teacher Directions and Questions document, familiarize yourself with FASTA formatting, metabarcoding, and some of the prey items your students will be researching. Here you will also find sample graphs and discussion question responses.
2. Save the teacher version of the Sequence Reference Sheet to assist student with the identification of specific sequences as needed. This reference sheet is the answer key - it lists the correct prey item name above each "mystery" FASTA sequence, whereas the Student Reference Sheet lists only the mystery sequence.
3. Either pre-divide the class into groups, or have a plan for dividing the class into groups of two or more. Each group will be assigned one of the 15 snakehead fish to work with.
4. Print copies of the Student Directions and Questions page, or upload it somewhere that is easily accessible to students.

**Background Information**

See: Invasive Spotlight: The Northern Snakehead StoryMap (This is Activity 1)

**Materials**

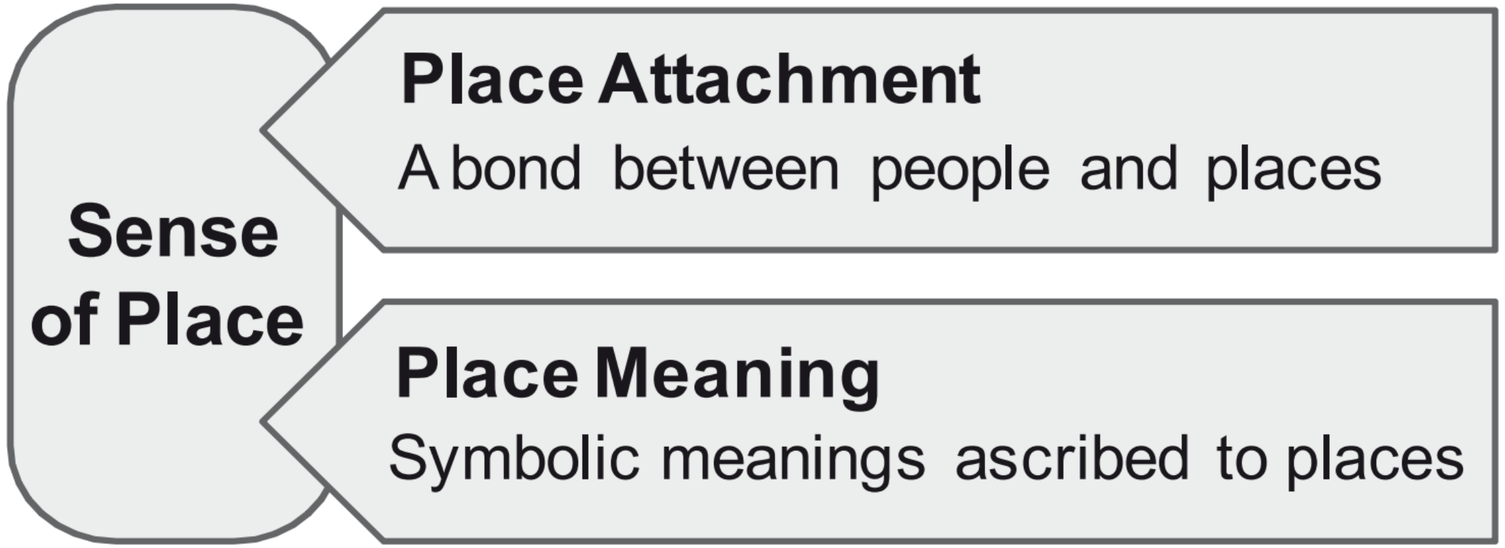
| | | | |
|---|---|---|---|
| Computers/iPads (at least one per group) | ☐ | Graph paper (optional) | ☐ |
| Writing utensils/paper | ☐ | Calculators (optional) | ☐ |

Lesson Plans


EnLET

Environmental Literacy Educator Training

# WHAT IS SENSE OF PLACE?

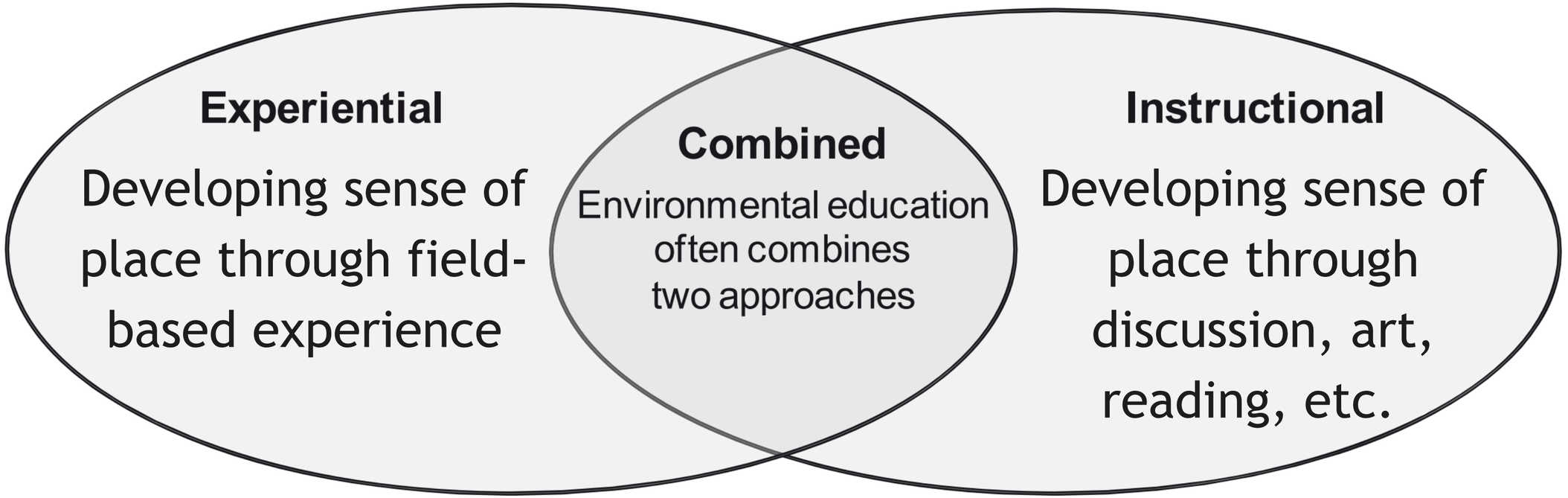



**Place Attachment:** To what degree is the place important?

**Place Meaning:** What makes the place important?

Kudryavstev et al., 2011

# HOW DO YOU FOSTER A SENSE OF PLACE?



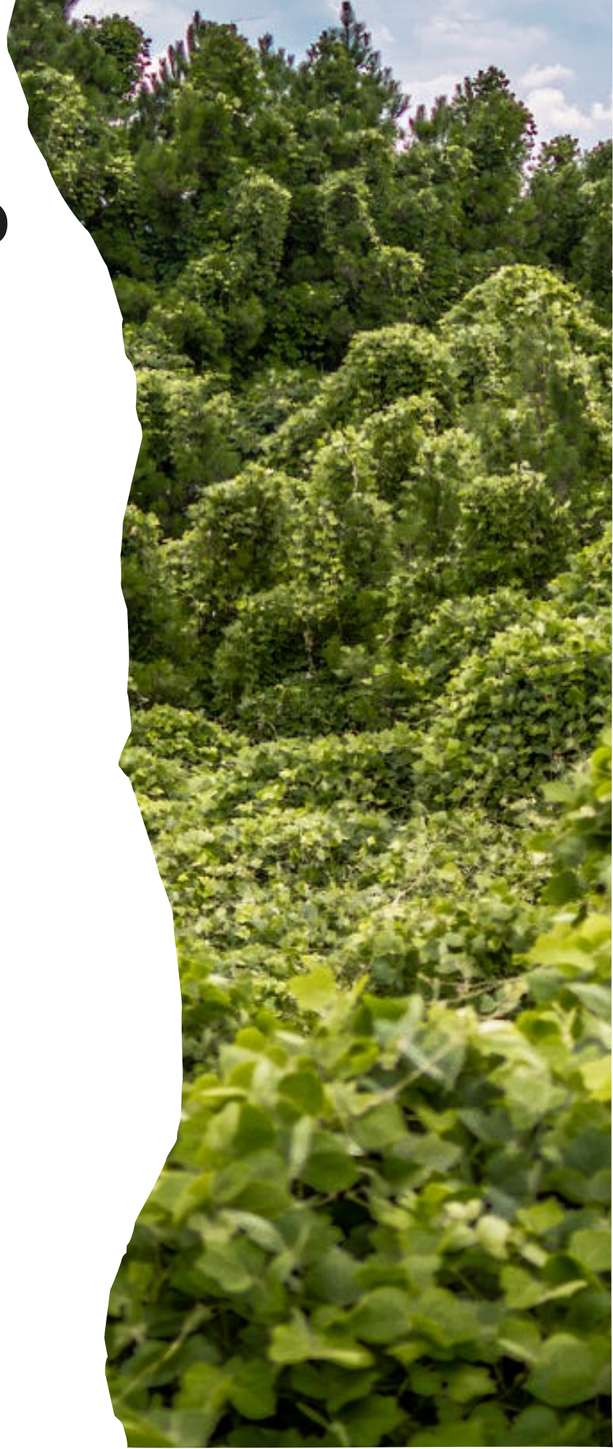

- Teacher Workshop Activities

- StoryMaps
- Documentary Video
- Lesson Plans

# WHAT IS AN INVASIVE SPECIES?

An introduced species that causes harm in a place where it has not evolved to live.

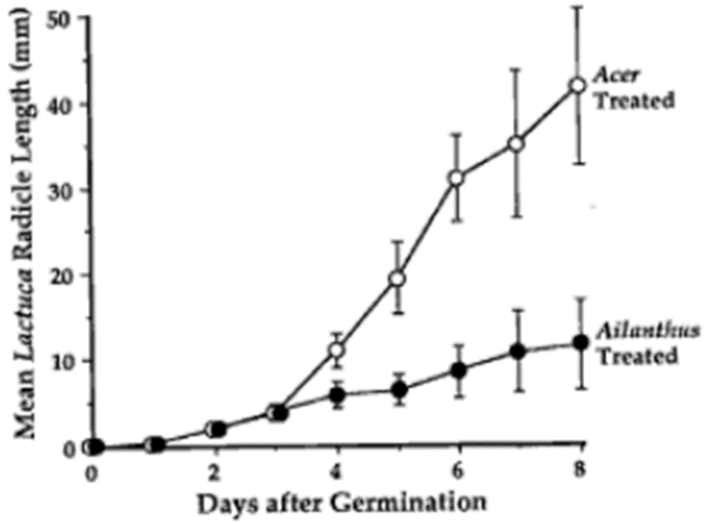
- **Environment** - extinction and biodiversity reduction
- **Economy** - costs US government over $21 billion per year
- **Human health** - invasive pathogens or disease vectors



# TREE OF HEAVEN ACTIVITY

## BACKGROUND INFORMATION

- Fast-growing invasive tree
- Inhibits germination and growth of surrounding plants = **ALLELOPATHY**




Maple leaf extract

Tree of heaven extract

Lawrence et al., 1991

- What does this mean for <u>biodiversity</u>?

# TREE OF HEAVEN ACTIVITY
## EXPERIMENTAL DESIGN

**EXPERIENTIAL LEARNING**

### SWEETGUM TREE
(NATIVE GROUP)

X 3

### TREE OF HEAVEN
(INVASIVE GROUP)

X 3

# TREE OF HEAVEN ACTIVITY
## DATA COLLECTION

**EXPERIENTIAL LEARNING**

**STEP 1:** DOWNLOAD PLANT ID APP

iNaturalist

CALIFORNIA ACADEMY OF SCIENCES

NATIONAL GEOGRAPHIC

seek by iNaturalist

PictureThis

**STEP 2:** SCAN UNKNOWN PLANTS IN YOUR PLOT

**Example: Virginia Creeper →**

**STEP 3:** RECORD SPECIES NAME AND APPROXIMATE COUNT ON DATASHEET

**Tree of Heaven Biodiversity Activity**

Name(s): _____

Plot Number: _____ Invasive/Native (circle one)

| No. | Species | Count (Approximate) | Notes |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

# WORKSHOP ACTIVITY - ANALYSIS

## SHANNON-WIENER SPECIES DIVERSITY INDEX

**EXPERIENTIAL LEARNING**

$$H' = -\sum_{i=1}^{S} (p_i) \ln p_i$$

### Species Richness

Total species count

### Species Evenness

Proportion of individuals in a single species compared to total number of individuals

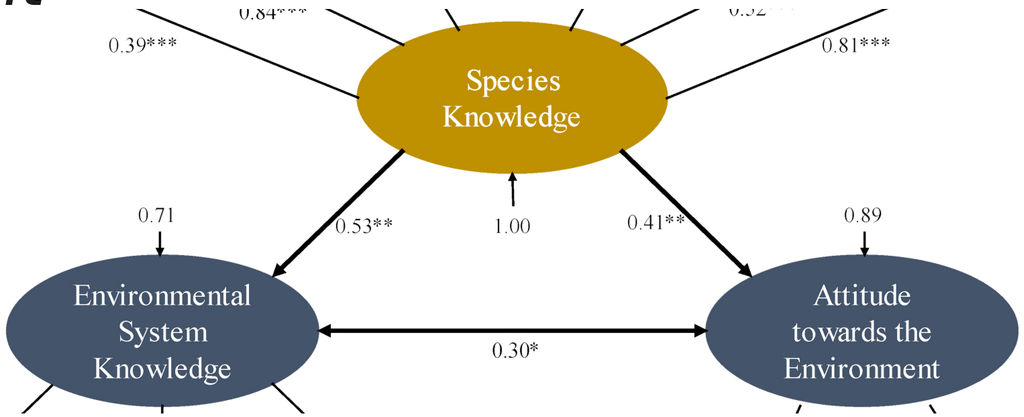
| H' = Shannon Diversity Index | Sweetgum (Native) | Tree of Heaven (Invasive) |
|---|---|---|
| | 0.990489665 | 0.6631445237 |

**Bigger Diversity Index number (H') = greater diversity**

# HOW DID THIS ACTIVITY PROMOTE PLACE-BASED LEARNING?

**EXPERIENTIAL LEARNING**

- Hands-on outdoor experience
- Familiarized participants with local species
  - *"species knowledge was found to be a highly significant determinant for both environmental systems <u>knowledge</u> and <u>attitude</u> towards the environment"*




Härtel et al., 2023

# NORTHERN SNAKEHEAD

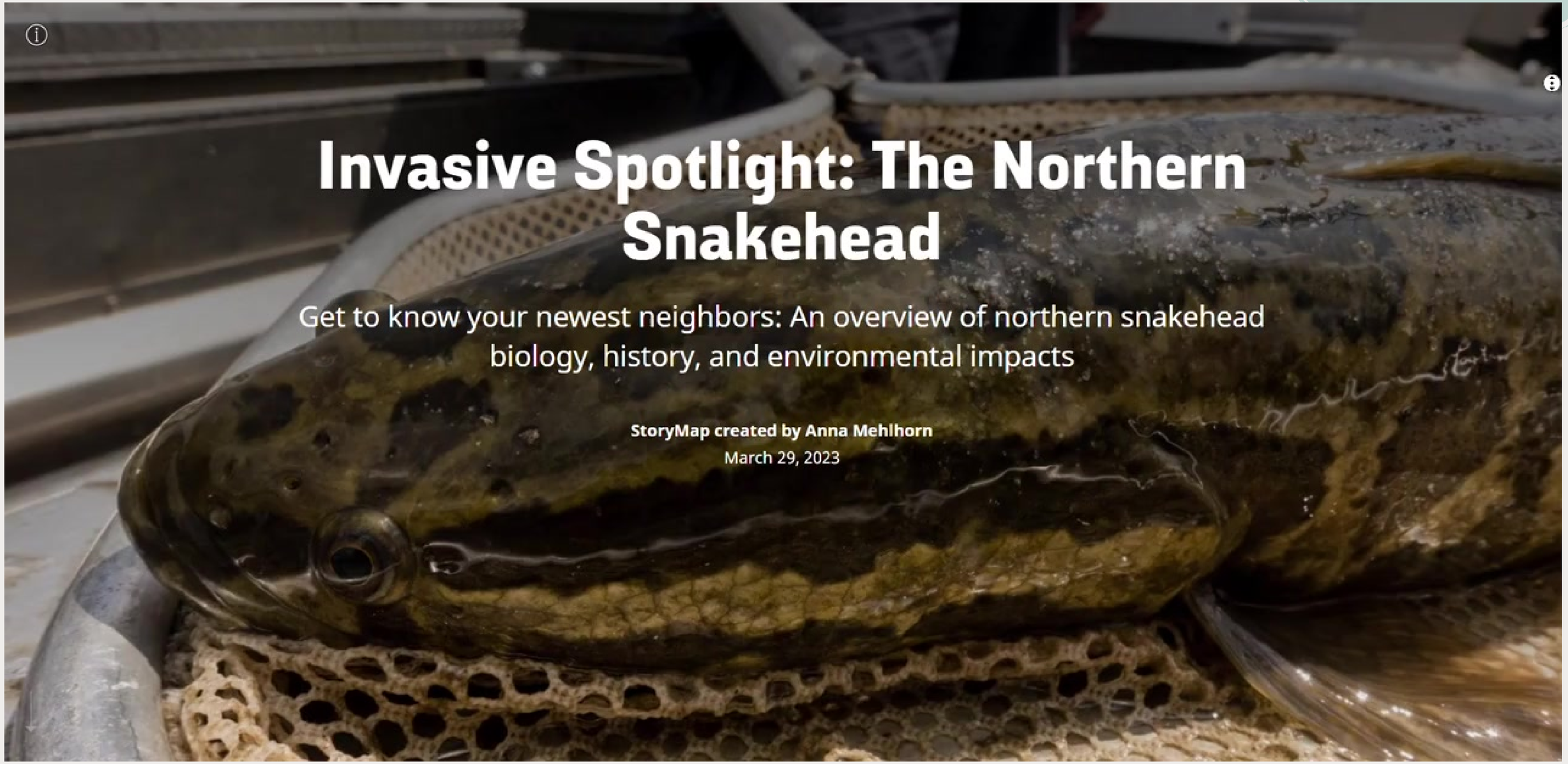
## BACKGROUND INFORMATION

- Introduced to Crofton, MD in 2002
- Large, voracious fish
  - Feed on juvenile native fish

- What does this mean for Chesapeake Bay food webs?

# SNAKEHEAD STORYMAP

INSTRUCTIONAL LEARNING



# SNAKEHEAD DOCUMENTARY

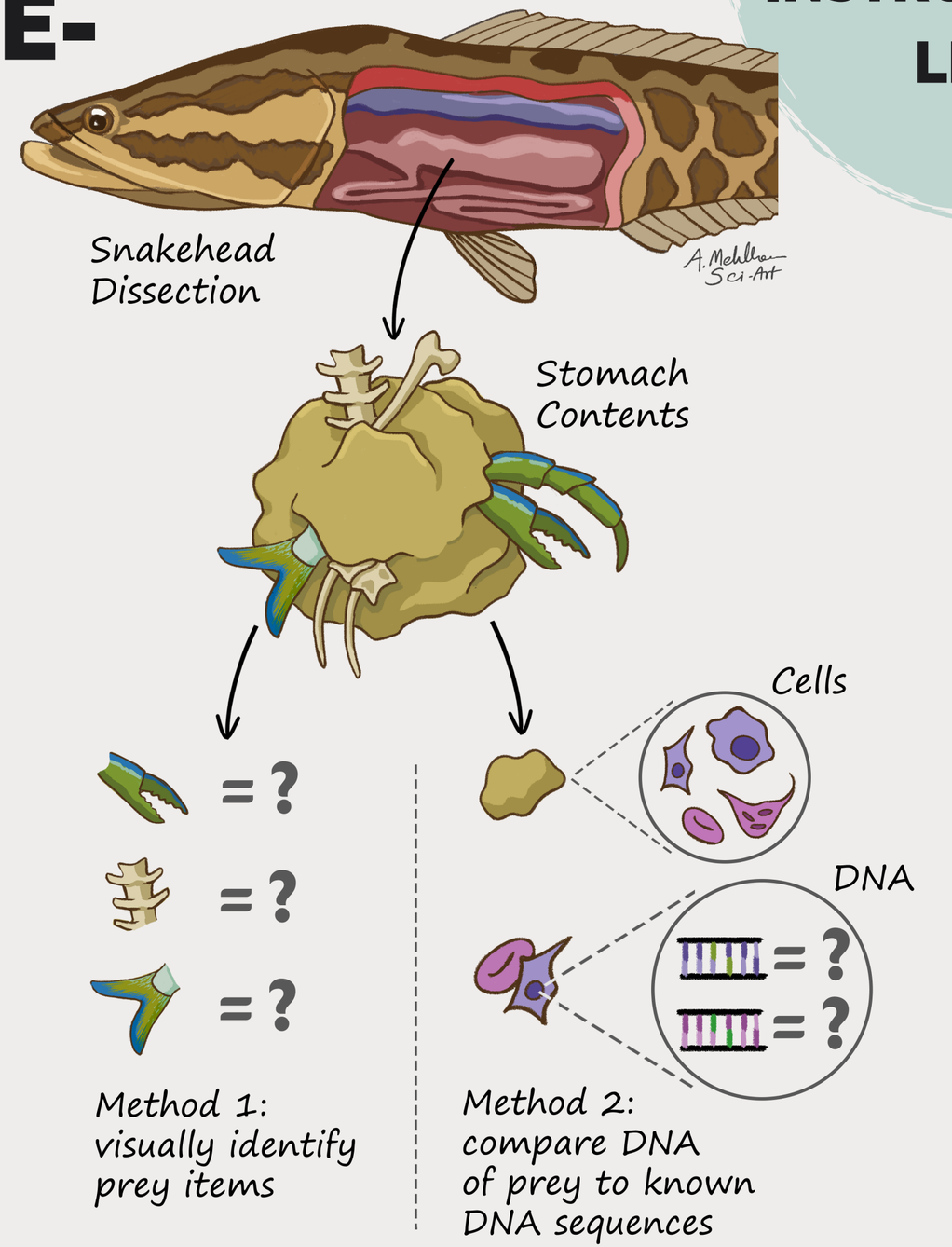
INSTRUCTIONAL LEARNING

# LESSON PLAN EXAMPLE-

## SNAKEHEAD DIET STUDY

INSTRUCTIONAL LEARNING

- Inspired by genetics research in the Coastal Disease Ecology Lab
- Emphasizes:
  - Genetics concepts
  - Graphing
  - Data interpretation

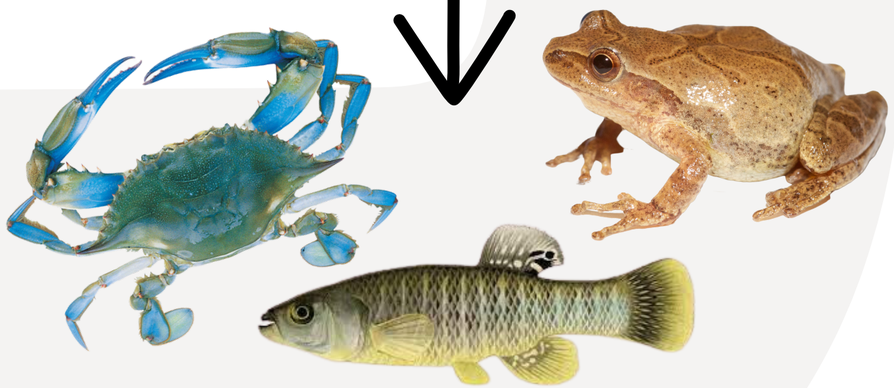


# LESSON PLAN EXAMPLE-
SNAKEHEAD DIET STUDY

INSTRUCTIONAL LEARNING

**"Mystery" Sequences**

**1)** AATCTCTCGTCGTGTTACG
CTCTTCGGGTCGCATCGCA...
**2)** GGTTTCCGTTCTTTCATGA
TCGTCGTGATAAAGACATTG...
**3)** GGATCAGCTCTGGGGAC
AGTAGGCTAGCCATCAGATT...

**Discuss:** what impacts might this diet have on the local environment?

# LESSON PLAN EXAMPLE-
## SNAKEHEAD DIET STUDY

**INSTRUCTIONAL LEARNING**

Smithsonian Environmental Research Center

EnLET Environmental Literacy Educator Training

EnLET Educator Resources

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### Key Definitions

| Invasive Species | Sequence |
|---|---|
| A species that is introduced to a new area and causes harm to human, environmental, and/or economic health. | A special arrangement of nucleotides that are read in the order they occur in DNA. Like words in a book, different arrangements of nucleotides have different meanings. |
| **FASTA Format** | **Nucleotides** |
| FASTA format is the standard for representing DNA sequences in genetics studies. Each sequence starts with a ">" symbol followed by the species name and unique sequence identifiers. | The building blocks of DNA - Adenine (A), Cytosine (C), Thymine (T), and Guanine (G) |

## IV. Procedure

### Step 1

Give the class 15-20 minutes to explore the Snakehead StoryMap. Have a short follow-up discussion about what makes snakeheads an invasive species and why it is important to learn about their diet. Briefly discuss the genetics behind this activity. While students are reading over the StoryMap, split the class into groups of at least two students per group.

### Step 2

Once the class is split into groups, direct students to the blank Student Directions and Questions sheet and the "mystery sequence" Student Reference Sheet. Assign a different snakehead fish (labeled in the reference sheet, snakehead 1-15) to each student group. Give the groups a few minutes to review the directions and sequences.

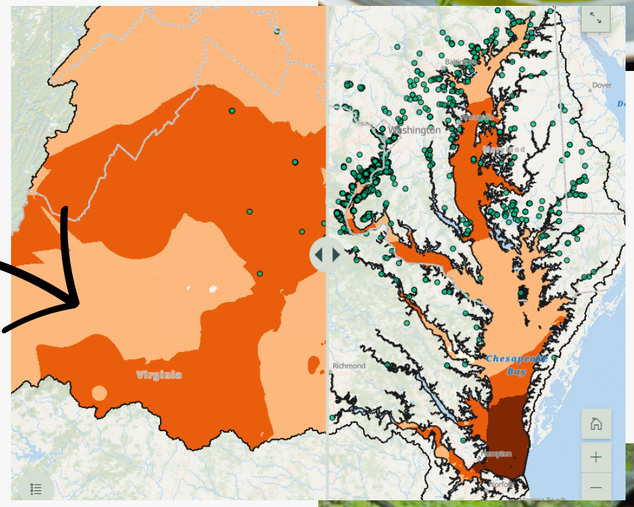
### Step 3

Demonstrate to the class, using the first sequence on the Student Reference Sheet, how to copy the sequence and paste it into the Nucleotide BLAST program. Direct them to the website through Google or through the snakehead StoryMap. Copy and paste the first sequence where you see: **"Enter Query Sequence / Enter accession number(s), gi(s), or FASTA sequence(s)."** Scroll down and click the blue **BLAST** button. The first sequence should produce the following result: *Rhinoptera bonasus*.

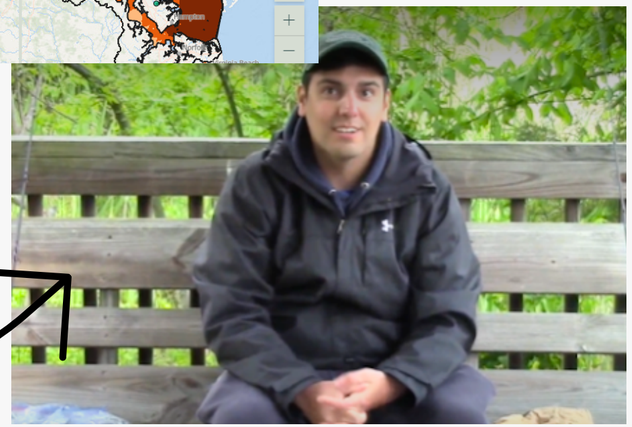
# HOW DO THESE SNAKEHEAD PROJECTS PROMOTE PLACE-BASED LEARNING?

- **Actionable ideas** - approachable (and fun!) ways to help manage snakeheads locally
  - Fishing/Identifying
  - Cooking

- **Maps and images** - easier to make connections to familiar locations and imagery




- **Class Discussion**
- **Storytelling** - *"Place meanings can be articulated and reproduced through media independently of the actual location"*



Giaccardi and Palen 2008: Malpas 2010

# WHY IS THIS IMPORTANT?

"WE CANNOT WIN THIS BATTLE TO SAVE SPECIES AND ENVIRONMENTS WITHOUT FORGING AN EMOTIONAL BOND BETWEEN OURSELVES AND NATURE—FOR WE WILL NOT FIGHT TO SAVE WHAT WE DO NOT LOVE."

**STEPHEN JAY GOULD**

# REFERENCES


Giaccardi, E., and L. Palen. 2008. The social production of heritage through cross-media interaction: Making place for place-making. International Journal of Heritage Studies 14, no. 3: 281–97.

Härtel, T., Randler, C., & Baur, A. (2023). Using Species Knowledge to Promote Pro-Environmental Attitudes? The Association among Species Knowledge, Environmental System Knowledge and Attitude towards the Environment in Secondary School Students. Animals, 13(6), 972.

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# THANK YOU!

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MERRILL FOUNDATION
ALISON CAWOOD
ANNA DAVIS
KATRINA LOHAN
PATRICK MCCABE
ZACK MILLS
LIZ ANDERSON
PUBLIC ENGAGEMENT TEAM