What's For Lunch?
Exploring Food Webs of the Chesapeake Bay

Coastal and Estuarine Ecology and Management

Virginia Master Naturalist Basic Training Course

Acknowledgements: This activity is adapted from a lesson plan written by Matthew Whalen, Virginia Institute of Marine Science, College of William & Mary as part of the Partnership between Educators and Researchers for Enhancing Classroom Teaching (GK-12 PERFECT), 2011.

Overview
This lesson plan is intended to serve as an interactive activity to accompany a presentation on coastal and estuarine systems during the Virginia Master Naturalist basic training course for volunteers.

Objectives
- Become familiar with common flora and fauna found in coastal and estuarine habitats in Virginia
- Evaluate how some threats, such as invasive species, pollution, and overharvesting, may impact Chesapeake Bay food webs.
- Appreciate the complexity and connections found within a real estuarine food web.
- Be able to determine the position and role of humans in estuarine and marine food webs.

Leader Instructions
1. This activity is ideally done after the trainees have had the Ecological Principles class, so that they are familiar with terms such as trophic levels, producers, and food webs. An understanding of the use and direction of arrows to denote energy flow in food webs is important.

2. Introduce the activity: Explain to the class that overall goal of the activity is to build a food web of the Chesapeake Bay. Describe the materials for the activity before handing them out.

3. This activity utilizes a jigsaw design in which students first learn in small groups and then tie their findings together as a class to make something larger. Divide the class into five groups and provide students with the organism card collection (pages 11-25) for their group number. Explain that

Materials
1. A whiteboard or large piece of white paper taped to the wall
2. Dry-erase markers or other drawing utensil
3. Large sheets of paper
4. "Who eats whom?" data table (1 per participant)
5. Pictures of each organism, laminated or printed on cardstock

Other Resources
- Coastal and Estuarine Ecology and Management multimedia presentation
- Background readings

Time
30-45 minutes, depending on level of discussion

each student team should create a food chain or food web using all the organisms in their group. The students should arrange the organism cards on a large sheet of paper and connect the pictures using arrows to show the direction of energy flow (e.g., from prey to predator, or from producer to herbivore. Cannibalistic species such as the blue crab may have arrows looped back to themselves. See Figure 1.) Students use the "Who Eats Whom" handout (pages 4-10) as reference for the origin and target of each arrow. Allow approximately 10 minutes for the teams to assemble their food webs.

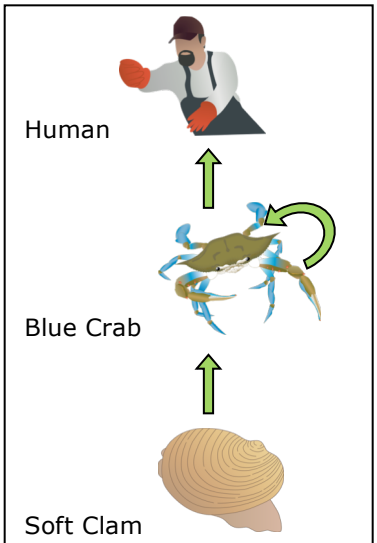
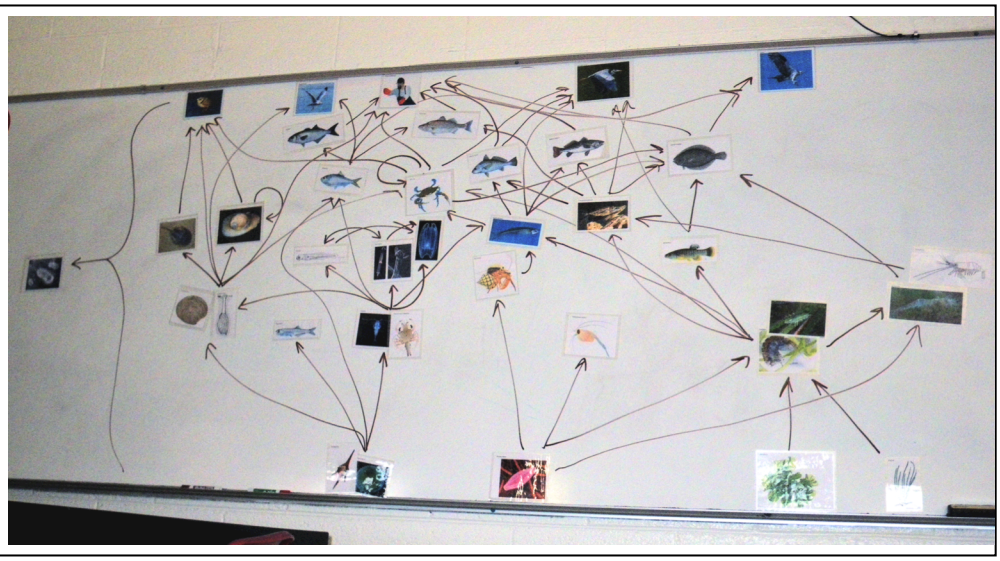


Figure 1. Example food chain of consumers that includes an apex predator and cannibalism. Images from http://ian.umces.edu/imagelibrary/

4. Have the teams present their organisms and food webs to the class. Allow approximately five minutes for this sharing step.

5. Now, choose one team's food web to begin construction of the "master food web." Have students place their organism cards on the white board or chalk board and draw in food web arrows with a dry-erase marker. If you do not have access to a white board or chalk board, tape a large (at least 6'x4') piece of butcher or craft paper to the wall, tape the organism cards to it, and draw the arrows on the paper. NOTE: You may need to help reposition the organism cards on the board to make sure you have enough room for all teams' organisms.

6. Move on to another team. After students begin to draw their arrows, wait to see if they figure out that they need to draw arrows between organisms from the two groups. If not, ask a few leading questions (e.g., "who else on the board eats blue crabs?" to prompt the addition of all arrows suggested by the "Who Eats Whom" data table. The other classmates can participate in this endeavor. Repeat this process until all organism cards are on the board. As the food web is constructed, it will become more and more complex and convoluted. It can be helpful to ask students to point out if and when they think it becomes too convoluted or crazy to easily understand visually. See Figure 2 for a nearly complete food web created by one class. Total Time to build Web: **~ 20 minutes**



7. Lead the class in a discussion about the food web, using the following questions as prompts.

- **What other organisms could we add to the food web?**
  [There are thousands of species of plants and animals in the Chesapeake Bay ecosystem, so there are many possible species that could be added. Even some organisms that are far away from the Chesapeake Bay can have a connection to our food web if another organism travels long distances. For example, ospreys make yearly migrations between North and South America and consume fishes from both hemispheres.

- **What is the ultimate source of energy for our food web?**
  [The sun.]

- **Can you trace the pathway(s) of materials and energy through the food web?**
  [You can choose an example organism (one of the top predators would be a good choice) and ask students to explain where this organism gets materials and energy. Most of the organisms will require oxygen from the air or water, and consumers will get other materials from their prey, which they convert to energy through respiration. This question should lead all the way down to producers and the sun.]

- **What would happen if we start removing species? How could we lose species from the food web?**
  [Examples include disease, overfishing, oil spills, etc.]

- **What would happen if we remove SPECIES X?**
  [Species X can be almost any species in the food web, but it would be good to ask this question for more than one species. For example, picking a primary producer, apex predator, and highly and lowly connected species will yield different answers.]

- **Which species would we consider apex predators? [**Mostly, this will consist of large fishes, birds, and mammals, including humans.]

- **How are humans different from other apex predators?** [One thing the class will likely observe is that humans are predators of more species than most apex predators, i.e., they are more highly-connected.]

- **What could it mean for an ecosystem if humans are highly-connected apex predators?**
  [Something along the lines of, "humans can have large, top-down impacts on ecosystems."]

Materials to Print

Who Eats Whom Data

PRODUCERS		
Organism	**Eats**	**Eaten By**
Phytoplankton (Centric Diatom and Dinoflagellate)		Bay Anchovy Blue Crab Larva Copepod Hard-shelled Clam Menhaden Soft-shelled Clam
Pennate Diatom (These live on the bottom sediments and on eelgrass.)		Amphipod & Isopod Grass Shrimp Hermit Crab Mysid Sand Shrimp
Sea Lettuce		Amphipod & Isopod
Eelgrass		Amphipod & Isopod
DECOMPOSERS		
Bacteria	Almost everything after it dies	Blue Crab Larva Copepod Hard-Shelled Clam Hermit Crab Soft-Shelled Clam

CONSUMERS		
Organism	**Eats**	**Eaten By**
Blue Crab Larva and Copepod	Arrow Worm Bacteria Phytoplankton	Arrow Worm Atlantic Croaker Atlantic Silverside Comb Jelly Fish Larva Grass Shrimp Hard-Shelled Clam Menhaden Mummichog Mysid Sand Shrimp Soft-Shelled Clam
Hard-Shelled Clam		Blue Crab Horseshoe Crab Human Moon Snail Ring-Billed Gull
Soft-Shelled Clam	Bacteria Blue Crab Larva Copepod Phytoplankton	Atlantic Croaker Blue Crab Horseshoe Crab Human Moon Snail Ring-Billed Gull Striped Bass
Mysid (a.k.a. Possum Shrimp)	Blue Crab Larva Copepod Pennate Diatom	Atlantic Silverside Blue Crab Comb Jelly Grass Shrimp Menhaden Sand Shrimp Speckled Trout
Arrow Worm	Amphipod Blue Crab Larva Copepod Fish Larva	Atlantic Croaker Atlantic Silverside Comb Jelly Fish larva Menhaden Mummichog

Organism	Eats	Eaten By
Fish Larva	Blue Crab Larva Copepod Arrow Worm	Arrow Worm Atlantic Croaker Atlantic Silverside Comb Jelly Menhaden Mummichog
Comb Jelly	Arrow Worm Blue Crab Larva Other Comb Jellies Copepod Fish Larva Mysid	Other Comb Jellies
Amphipod and Isopod	Eelgrass Pennate Diatoms Sea lettuce	Arrow Worm Atlantic Croaker Atlantic Silverside Blue Crab Grass Shimp Mummichog Sand Shrimp Speckled Trout
Grass Shrimp	Amphipod & Isopod Blue Crab Larva Copepod Mysid Pennate Diatom	Atlantic Croaker Atlantic Silverside Blue Crab Bluefish Mummichog Speckled Trout Summer Flounder
Sand Shrimp	Amphipod & Isopod Blue Crab Larva Copepod Mysid Pennate Diatom	Atlantic Croaker Atlantic Silverside Blue Crab Bluefish Great Blue Heron Mummichog Speckled Trout Summer Flounder

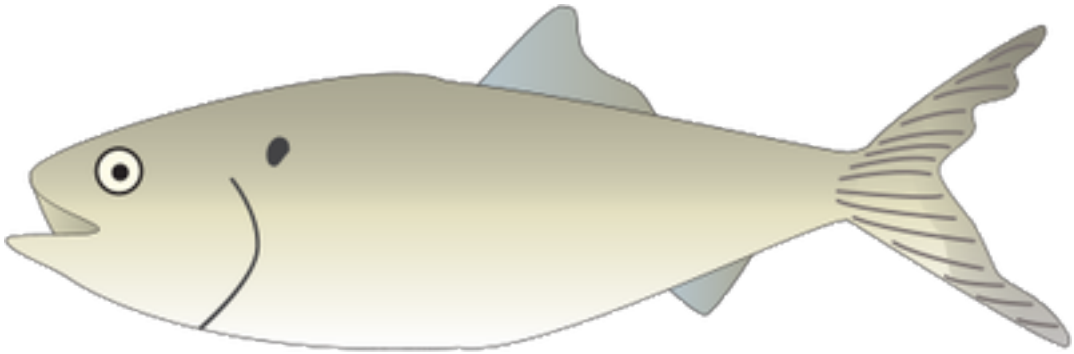
Organism	Eats	Eaten By
Bay Anchovy	Blue crab larva Copepod Fish larva Mysid	Atlantic Croaker Bluefish Ring-Billed Gull Speckled Trout Striped Bass Summer Flounder
Hermit Crab (a scavenger)	Bacteria Dead animals Other Hermit Crabs Pennate Diatoms	Atlantic Croaker Blue Crab Other Hermit Crabs Summer Flounder
Blue Crab	Amphipod & Isopod Atlantic Silverside Other Blue Crabs Grass Shrimp Hard-Shelled Clam Hermit Crab Moon Snail Mysid Sand Shrimp Soft-Shelled Clam	Other Blue Crabs Bluefish Great Blue Heron Humans Piping Plover Speckled Trout Striped Bass Summer Flounder
Horseshoe Crab	Hard-Shelled Clam Sand Shrimp Soft-shelled Clam	Great Blue Heron Piping Plover Ring-Billed Gull
Moon Snail	Soft-shelled Clam Hard-Shelled Clam Other Moon Snails	Blue Crab Other Moon Snails Piping Plover
Menhaden	Blue Crab Larva Copepod Fish Larva Phytoplankton	Bluefish Human Osprey Speckled Trout Striped Bass

Atlantic Silverside	Amphipod & Isopod Arrow Worm Blue Crab Larva Copepod Fish Larva Grass Shrimp Mysid Sand Shrimp	Blue Crab Bluefish Great Blue Heron Hermit Crab Ring-Billed Gull Speckled Trout Striped Bass Summer Flounder
Mummichog	Amphipod & Isopod Arrow Worm Blue Crab Larva Copepod Fish Larva Grass Shrimp Sand Shrimp	Bluefish Great Blue Heron Hermit Crab Speckled Trout Striped Bass Summer Flounder
Atlantic Croaker	Amphipod & Isopod Arrow Worm Bay Anchovy Blue Crab Larva Copepod Fish Larva Grass Shrimp Hermit Crab Sand Shrimp Soft-Shelled Clam	Bluefish Great Blue Heron Human Osprey Striped Bass
Striped Bass	Atlantic Croaker Atlantic Silverside Bay Anchovy Blue Crab Menhaden Mummichog Soft-Shelled Clam	Human Osprey

Organism	Eats	Eaten By
Striped Bass	Atlantic Croaker Atlantic Silverside Bay Anchovy Blue Crab Menhaden Mummichog Soft-Shelled Clam	Human Osprey
Bluefish	Atlantic Croaker Atlantic Silverside Bay Anchovy Blue Crab Grass Shrimp Menhaden Mummichog Sand Shrimp	Human Osprey
Speckled Trout	Amphipod & Isopod Atlantic Silverside Bay Anchovy Blue Crab Grass Shrimp Menhaden Mummichog Mysid Sand Shrimp	Human Osprey
Summer Flounder	Atlantic Silverside Bay Anchovy Blue Crab Grass Shrimp Mummichog Sand Shrimp	Human Osprey
Piping Plover	Blue Crab Horseshoe Crab Moon Snail	

Organism	**Eats**	**Eaten By**
Ring-Billed Gull	Atlantic Silverside Bay Anchovy Hard-Shelled Clam Horseshoe Crab Soft-Shelled Clam	
Osprey	Atlantic Croaker Bluefish Menhaden Speckled Trout Striped Bass Summer Flounder	
Great Blue Heron	Atlantic Croaker Atlantic Silverside Blue Crab Horseshoe Crab Mummichog Sand Shrimp	
Human	Atlantic Croaker Blue Crab Bluefish Hard-Shelled Clam Menhaden Soft-Shelled Clam Speckled Trout Striped Bass Summer Flounder	

1



Tracey Saxby, IAN Image Library, http://ian.umces.edu/imagelibrary/

Menhaden

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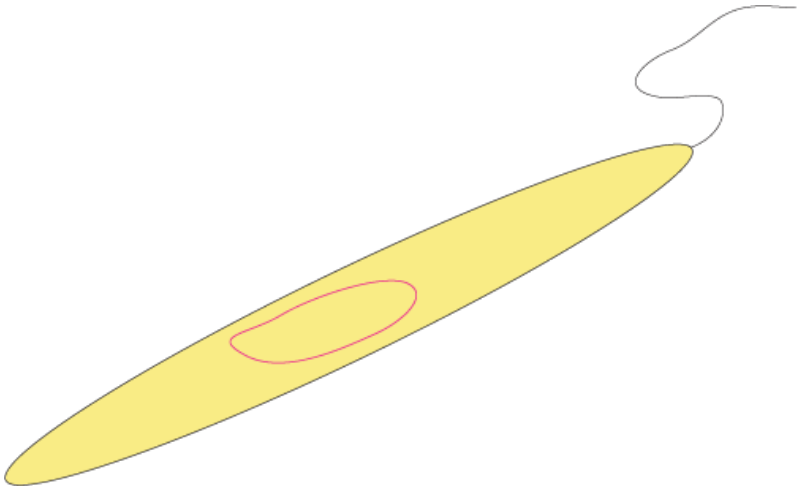

Bacteria

Ian Hewson, IAN Image Library, http://ian.umces.edu/imagelibrary/

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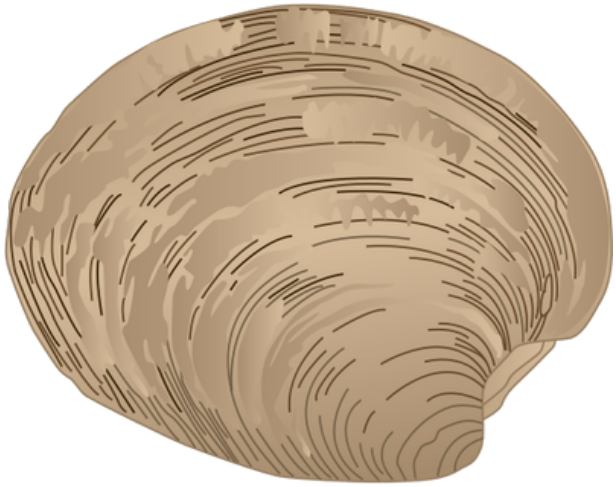

Hard-shelled Clam

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1

Moon Snail

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Ring-billed Gull

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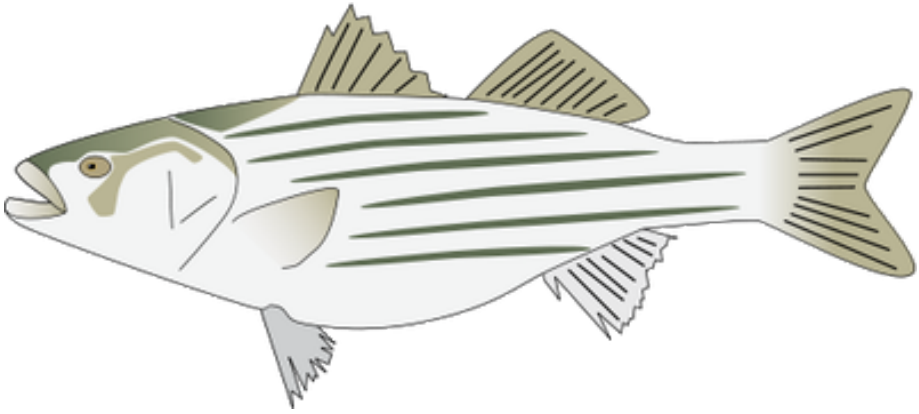

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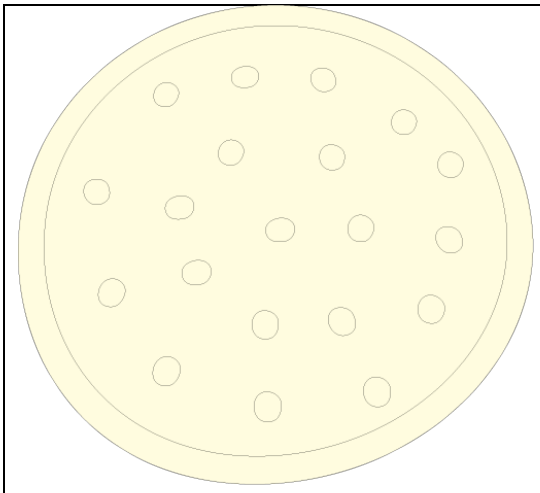
Jane Thomas, IAN Image Library, http://ian.umces.edu/imagelibrary/

Striped Bass

1



Centric Diatom

Diana Kleine, IAN Image Library, http://ian.umces.edu/imagelibrary/

1

Sand Shrimp

Freshwater and Marine Image Bank, University of Washington. Public Domain.

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Blue Crab Larva (Megalopa)

Chip Chenery, IAN Image Library, http://ian.umces.edu/imagelibrary/

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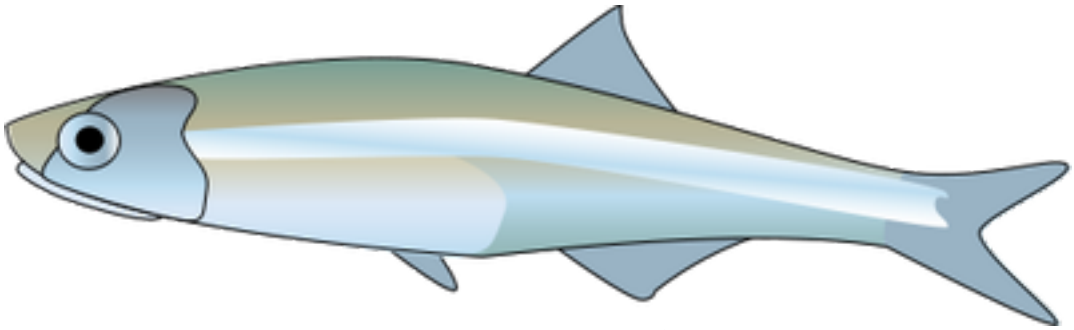

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Bay Anchovy

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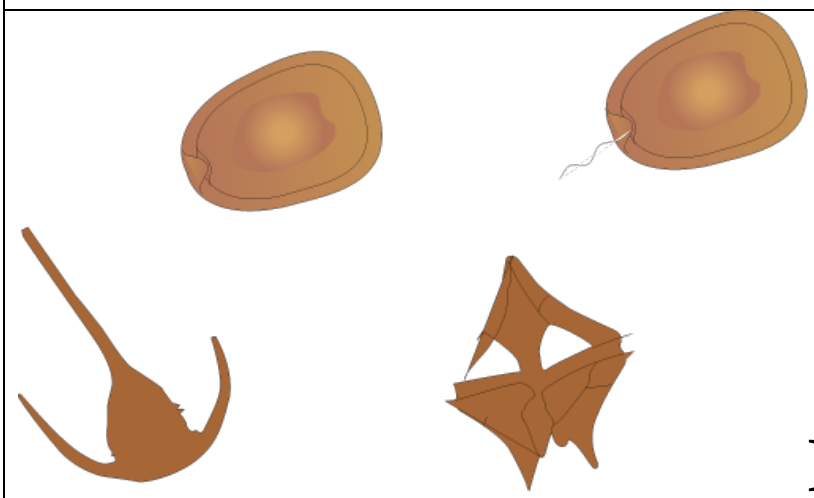

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Dinoflagellate

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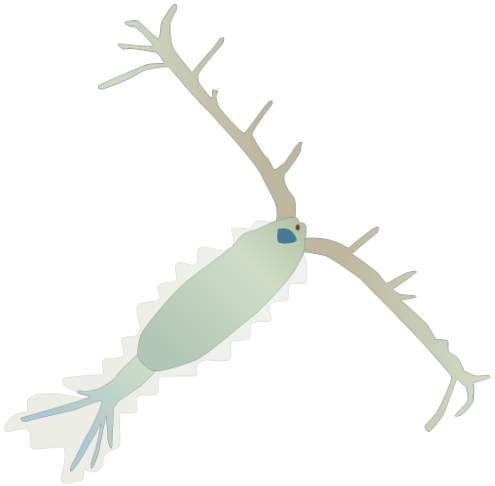

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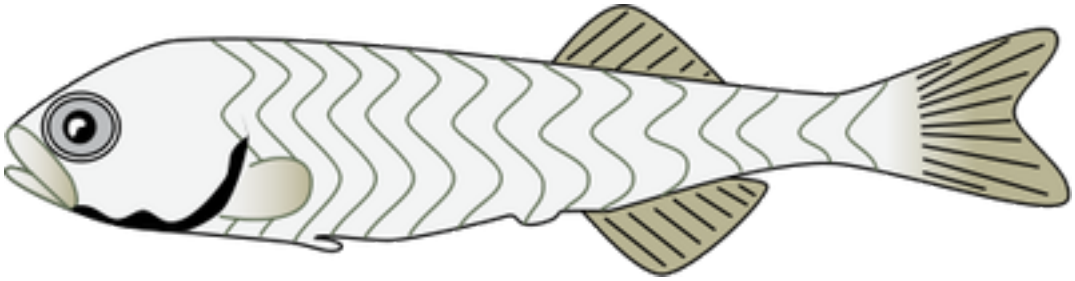
Copepod



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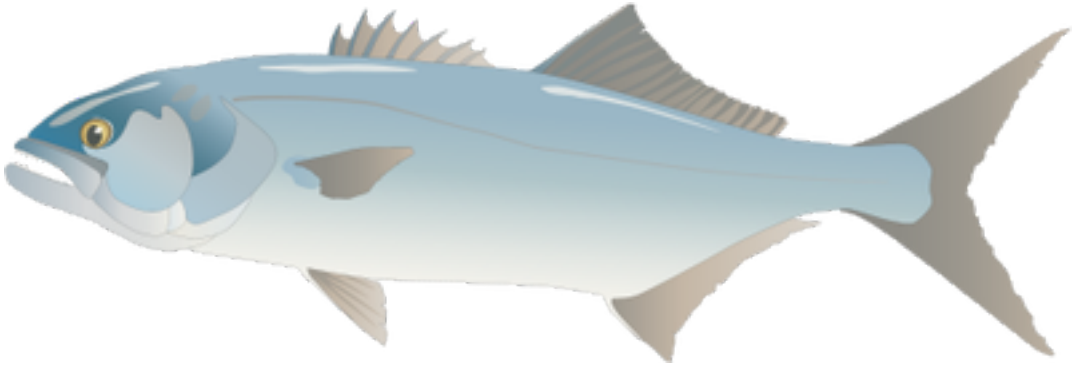
Fish larva



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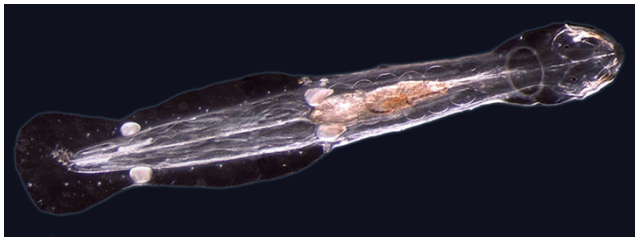
Bluefish

2

Jane Hawkey, IAN Image Library, http://ian.umces.edu/imagelibrary/

Osprey



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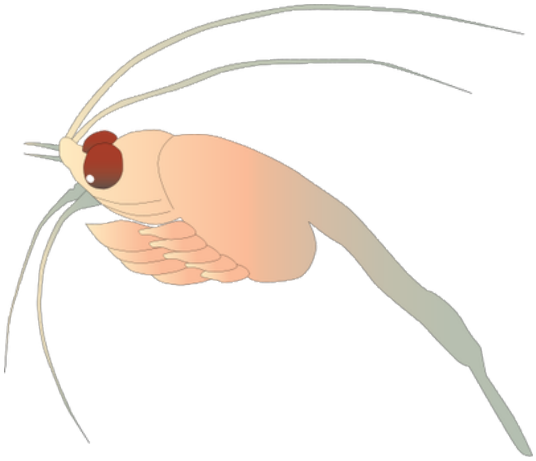
2

Arrow worm



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Mysid (possum shrimp)

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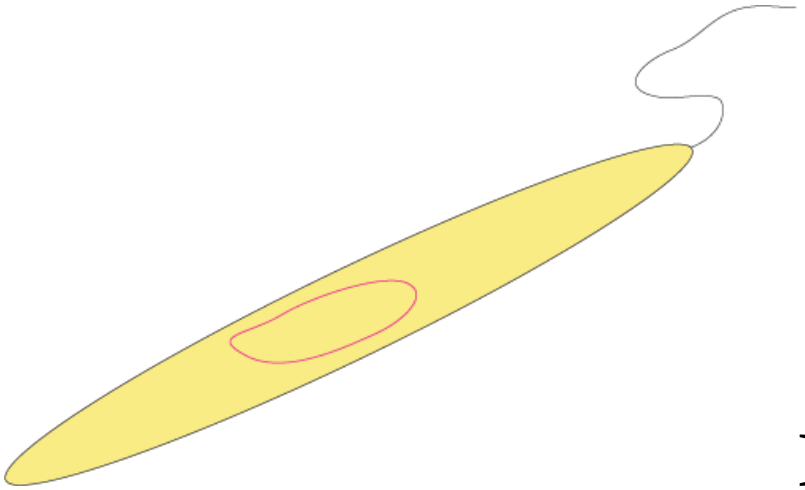

Bacteria

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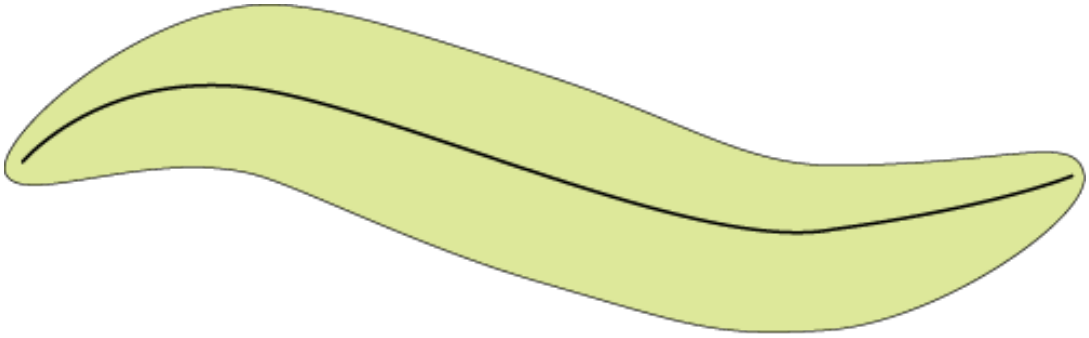

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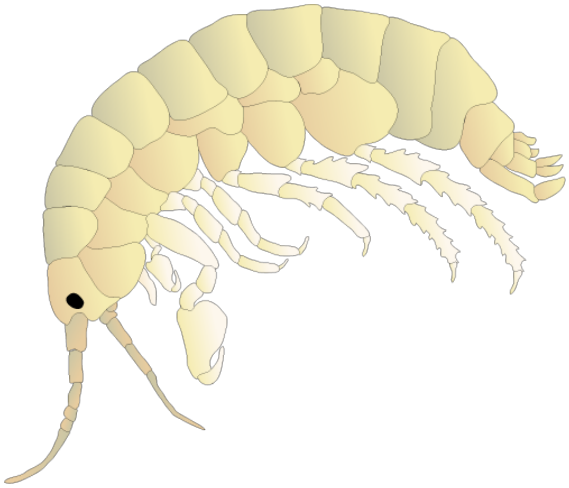
Pennate Diatom

3



Amphipod

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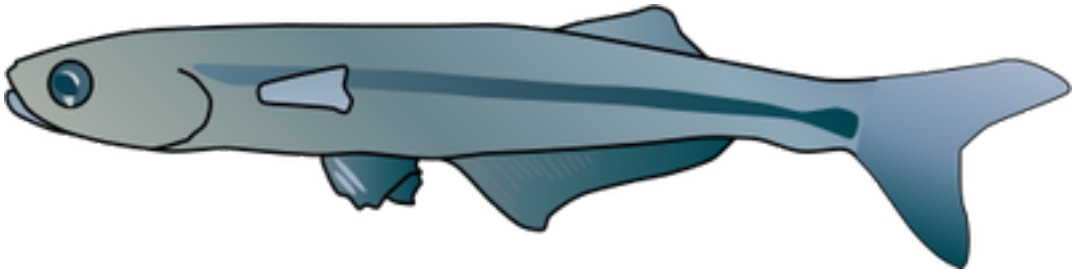
Great Blue Heron



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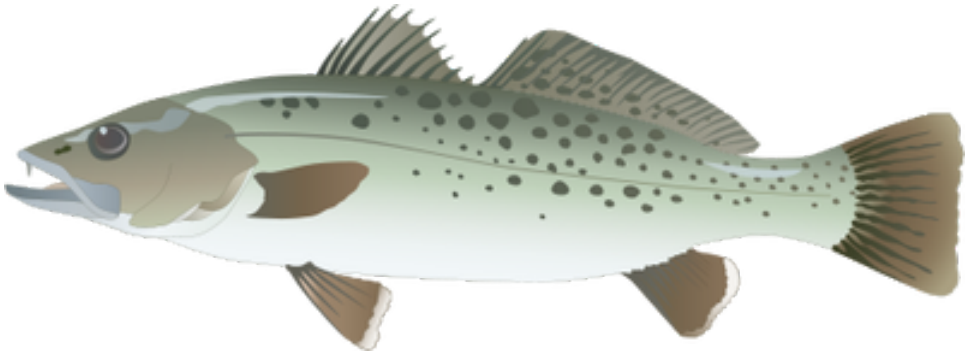
Atlantic Silverside



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Speckled Seatrout

3

Hermit Crab

Sander Scheffers, IAN Image Library, http://ian.umces.edu/imagelibrary/

3

Human

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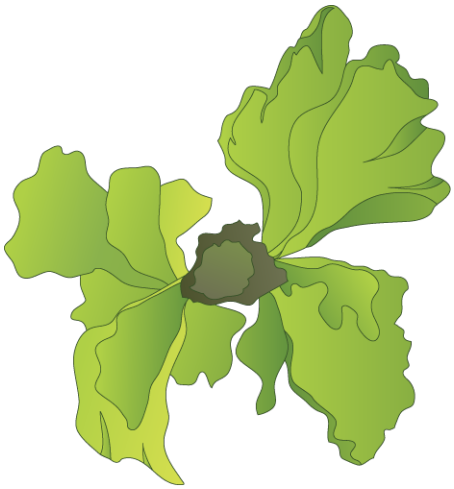

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Sea Lettuce

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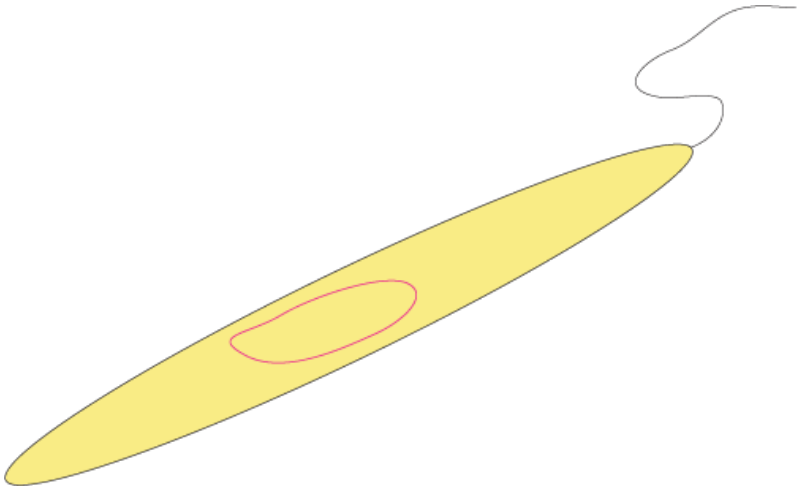

4

Bacteria

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4

Isopod

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Soft-shelled Clam

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Blue Crab

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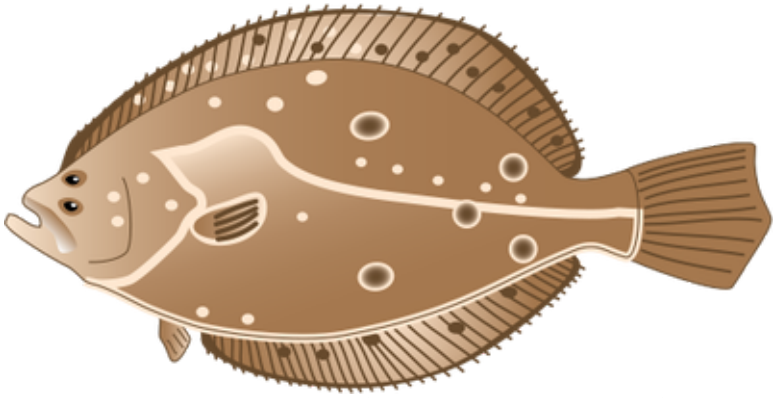

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Summer Flounder

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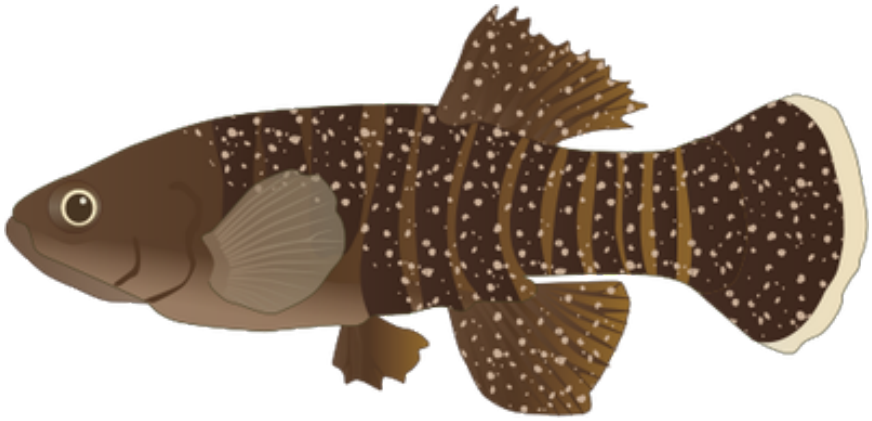

Mummichog

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4

Human

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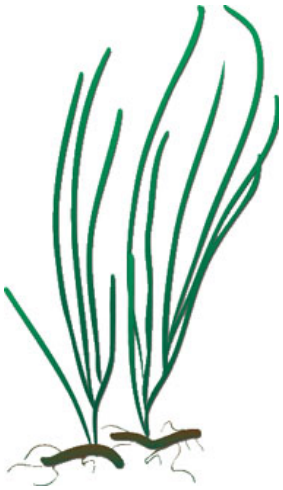

5

Eelgrass

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5

Isopod

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Grass Shrimp

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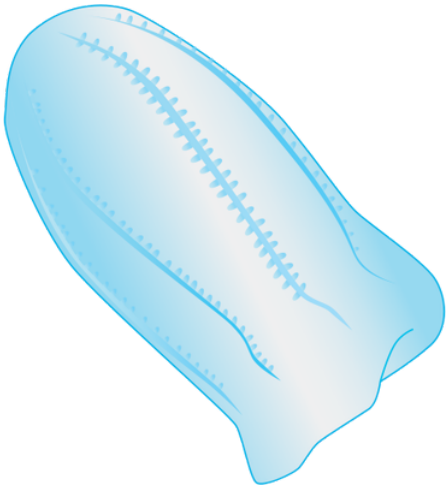

Comb Jelly

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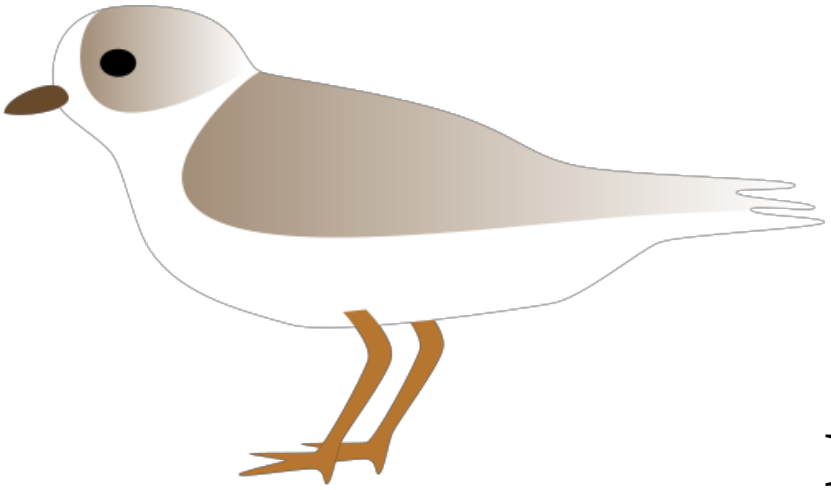

Piping Plover

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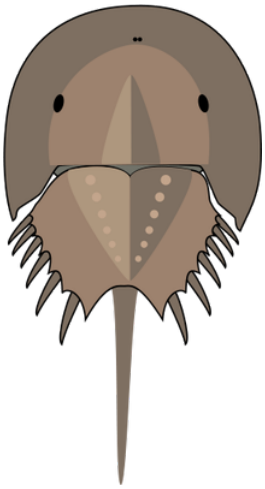

Horseshoe Crab

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5

Atlantic Croaker

National Oceanic and Atmospheric Administration, Public Domain

5

Soft-shelled Clam

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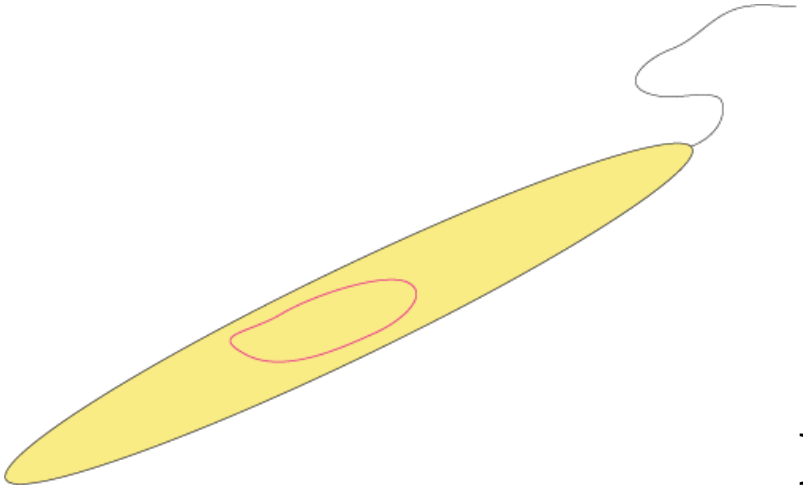

Bacteria

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