**Fun with Herbivorous Fishes**

**Summary**

Students will learn about different types of fishes (ʻiʻa), especially the herbivores (ocean grazers). They will focus on the various adaptations and advancements (structures and functions) that these creatures have evolved for a successful living in their ocean habitats. They will design their own fish that has adaptations suited to its own specific lifestyle, behavior and niche (ecosystem or environment).

**Objectives**

- Students will be confident with the relationship between structure and function in fishes.
- Students will create their own ocean-grazing, and well-adapted fish.

**Materials**

**Fish Adaptations**

Copies of each worksheet per student: Fish Adaptations Diagram, Fish Adaptations Key, and My Fish! Adaptations Worksheet

Crayons, colored pencils, or markers

**YouTube Video Search** – (Optional – see Extension Activities)

Laptop with internet access

Overhead projector/screen

**Making Connections**

This is a great opportunity to address what previous knowledge students have about fishes. While the earlier lessons have not yet covered fishes, they too make up an important component of the ocean grazers. Students can share the types of fishes that they have seen (at the fish market, snorkeling, fishing) and relate this to the next ocean grazer of interest: the herbivorous fishes.

**Teacher Prep for Activity**

Print out the necessary paperwork (My Fish! Worksheet, Fish Adaptation Key, and Fish Adaptations Diagram). Make one copy of each of these per student.

**Background**

Limu are extremely important to the herbivorous animals (a.k.a. ocean grazers) that rely on them as a food source. Grazers include animals such as wana (sea urchins), pipipi snails, myriads fish species, and ‘ōpīhi (limpets). Some of these grazers, such as wana and aʻama, are fairly opportunistic and will eat almost any limu they encounter. On the other hand, most herbivorous fishes tend to be
finicky in their eating habits, preferring the native species of algae to most invasive ones. This has lead to some major examples of invasive algal blooms along beaches in certain parts of Maui and O'ahu. A larger conservation issue arises when the delicate balance of coral and algae is altered because too many of the grazers are removed from the system.

- **FUN FACT:** Huismann and colleagues (2007) share that in any given square meter of reef space, coral reef fishes take over 2,000 bites of limu daily!!
- **FUN FACT:** The word fish is both singular and plural. When scientists are talking about a large group of fish this implies they are all the same species. On the other hand, if scientists are trying to convey a varied fish assemblage (i.e. multiple species), it is more accurate to say fishes.

This unit thus far has included discussion of a variety of ocean grazers (e.g. wana, a‘ama crabs, pipipi snails). Each of these creatures exhibits a different set of structures that allows it to survive from day to day. This diversity is super exaggerated in fish species, as they have had millions of years to evolve. Fish employ a variety of mechanisms for survival (e.g. camouflage, poisonous spines, schooling behavior), especially for defense. However, there are also many structures that reveal the types of prey fish eat. For example, the sharp and hard teeth of a parrotfish (uhu) are used to take massive bites out of coral. This is then ground down into beach sand and spit back out, while the limu is digested. Although uhu are responsible for a large component of our beach sand, they are actually only trying to get to the limu, and the sand they create is only a waste product!

Some of the other herbivorous fishes that live within the coral reef include tangs or “surgeonfishes” like kala, palani, la ‘ipala, kole, paku‘iku‘i, and manini. One interesting thing to note, this family of fishes are called surgeonfish because they have a very sharp, protruding spine at the base of their caudal (tail) fin. There are also a variety of blenny species that are herbivorous, however this fish family tends to be a more inconspicuous component of the reef. Fish watchers (snorkelers and scuba divers) often miss these bottom-dwelling creatures.

There are a variety of books and websites available to learn more about fishes and fish anatomy. In fact, there is a whole discipline of studies focused on it, and people who study fish for a living are called Ichthyologists. Some fishy references are listed below (see Resources). However, the Fish Diagram and Fish Adaptations Key provide a lot of information about the wide variety of distinctive fish structures. In addition, while this lesson plan focuses on the world of ocean-grazing fishes, the 4th-grade Coral Reef Ecology and 5th-grade Open Ocean Fishes PRISM curricula each contain a similar activity that is not limited to the herbivores.

**Vocabulary**

- **Barbels** – The long, whisker-like, paired appendages that extend from certain fish species’ mouths and are used to detect food (by feel and taste). They are present in a variety of carp (e.g. goldfish), catfish, goatfish (weke), and some sharks.

- **Caudal fin** – The tail fin of a fish. The shape of a species’ caudal fin tells a lot about their life history (see Fish Adaptations key). For example, a rounded tail might suggest that the fish doesn’t swim long distances, but instead needs high maneuverability. Other caudal fin shapes include lunate (moon-shaped) and forked and everything in between.

- **Compressed** – A fish that is laterally compressed such that snorkelers can barely see it if it is swimming straight at them, but it may be quite apparent from the side. This is a typical body shape for many herbivorous reef fishes (e.g. manini, yellow tang).
**Dissection** – The process of disassembling something (usually a dead animal) for the purpose of learning about its anatomy, and to aid in understanding relationships between structures and functions. Also known as “anatomization.”

**Dorsal fin** – The fin on the topside of any fish.

**Forked tail** – A particular shape of caudal (tail) fin that allows for short bursts of speed.

**Gills** – An anatomical organ present in numerous aquatic organisms, such as fishes, which is used to extract oxygen from the water column.

**Gutting** (a fish) – The process of removing the insides (guts) of a fish to be used for food. Like dissection, but with the purpose of making the fish servable.

**Ichthyology** – The study of fish and fishes; a branch of zoology (study of life) that focuses on fish.

**Lateral Line** – A sense organ in fishes that runs in a line down the length of their bodies. Individual receptors in the lateral line, called neuromasts, allow for the detection of water movement nearby the fish (i.e. fish can sense the direction of local currents and movements of neighbor fishes.

**Lunate tail** – A particular moon-like shape of caudal (tail) fin that allows for very fast swimming over large distances but makes turning “on-a-dime” quite difficult.

**Pectoral fin** – The fins on the side on marine creatures (e.g. fish, marine mammals) that usually extend from their gill plates (operculum). A great conspicuous example of pectoral fins are those of the Humpback Whale: [http://ps3029.k12.sd.us/State/Humpback_Whale_underwater_shot.jpg](http://ps3029.k12.sd.us/State/Humpback_Whale_underwater_shot.jpg)

**Rounded tail** – A particular shape/type of caudal (fin) in fishes that allows greater maneuverability and moderate speed. This can be seen within Tetradontidae (“four teeth”) family members such as pufferfishes.

**Procedure**

**Activity 1. Fish Adaptations (1 hour)**

A discussion can be started with the class by asking them:

- “Who can share one type of herbivorous fish (i.e., ocean grazer)?” *Some answers may include parrotfish (uhu), yellow tangs (la‘ipala), or Convict tangs (manini).*
- “What types of structures might an ocean-grazing fish display?” *For example, a small mouth to pluck bite-size limu pieces, or camouflage/striping to hide within limu patches.*

1. Pass out a Fish Adaptations Diagram to each of the students.
2. Go over each of the structures one by one (e.g. caudal fin types) and talk about potential functions of these specific designs.
3. Talk about any new vocabulary terms not covered by the above discussion on fish structures. *This part should take about 10 minutes.*
4. Ask students to speculate about the functions of various morphometric (shape) types.
5. Place a copy of the Fish Adaptations Key on an overhead projector (if possible) and compare the class thoughts with the ones provided on the Key.
6. Ask students:
   • How do the functions of structures differ (from what they expected)?
   • Does this seem right? Wrong? Why?
   *This latter section should take about 20 minutes.*

7. Introduce the My Fish! project and pass out the appropriate worksheet. Be sure to tell
   students that they will be designing an herbivorous (ocean-grazing) fish.

8. Allow them to use their imagination and be creative BUT stay within something that makes
   sense. Some questions the teacher might pose include:
   • Should an ocean grazer have sharp predator teeth?
   • Should a nearshore species have a lunate tail (for long migrations)?

9. Give them sufficient time to complete their drawing and list the different reasons (i.e.,
   functionality) for each of the structures, the overall body shape and its coloration.
   *The My Fish Activity should take about 25 minutes to complete.*

10. If time allows, share drawings with the class – individually or as a gallery walk.

One food-for-thought question might be: How might a fish help plants? *(They could potentially
distribute their spores to a new location or they could tend a territory of algae or “algae garden”
to keep other herbivores from using this resource).*

**Assessments**

Students’ work on the My Fish Adaptations worksheet can be used as a measure of their individual
grasp of fish adaptations (in terms of the relationship between structure and function). When the
class is done with this assignment, ask several students to share their MyFish creations and to tell a
little story about what type of habitat it lives in (e.g. surface-dweller, bottom-feeder, open-ocean
rambler, limu patches), and what type of swimming it exhibits such as: slow and maneuverable
(rounded), quick and flexible (forked), or long-distance and speedy (lunate). Ask students, “What
does their body type/shape say about their lifestyle?” and see what their responses are. Lead them
to respond to their own questions by thinking out the answers and talking to classmates. The
phrase, “Ask three before you ask me” might be relevant here (for assignment rules and for
hypotheses about fish structure and function).

**Resources**

Fish Adaptations

- [http://www.geocities.com/Athens/Atrium/5924/fishadaptations.htm](http://www.geocities.com/Athens/Atrium/5924/fishadaptations.htm)

Marine Fishes of Hawaii

- [www.coralreefnetwork.com/marlife/fishes/fishes.htm](http://www.coralreefnetwork.com/marlife/fishes/fishes.htm)

Importance of Coral Reefs

- [http://oceannworld.tamu.edu/students/coral/coral4.htm](http://oceannworld.tamu.edu/students/coral/coral4.htm)

Other resources

- EnchantedLearning.com see “fish”
- [http://en.wikipedia.org/wiki/Fish](http://en.wikipedia.org/wiki/Fish)
Extension Activities

YouTube Video Search (30 minutes)

This activity includes the use of the internet. Therefore, the teacher would need to make sure that computers are available beforehand (preferably the use of one laptop with an overhead projector to show the screen to the whole class). In addition, many DOE schools have blocked websites such as YouTube.com from loading with their internet provider. The teacher might check this out ahead of time to make sure this activity will work in the classroom. If this activity is possible, then the teacher needs to check out the potential YouTube videos (for relevance and appropriateness). There are a variety of links that come up when you search “Fish Dissection” or “Fish Anatomy” or “Gutting a Fish,” but some are too long, or vague, or gory for 3rd graders. Keep in mind that when viewing these videos as a class the teacher can always fast-forward to the interesting parts.

YouTube is a great resource for fish anatomy videos. Some good links include:

- Fish Anatomy Part One: [http://www.youtube.com/watch?v=jTZc6-Rb4W0](http://www.youtube.com/watch?v=jTZc6-Rb4W0)
- Fish Anatomy Part Two: [http://www.youtube.com/watch?v=yPUAN4HdXuE](http://www.youtube.com/watch?v=yPUAN4HdXuE)
- Fish Dissection Pictures: [http://www.youtube.com/watch?v=f3Z8dwUDP14](http://www.youtube.com/watch?v=f3Z8dwUDP14)

1. Break students into groups with computers (or set-up the projector in front of the class).
2. Review new vocabulary words that might come up with this activity (e.g. dissection, gutting) and make sure students know some of the videos might be a little vivid.
3. Play several of Fish Dissection videos to show students the diversity of fish morphology types in the sea.
4. Stop and take the time to ask, answer and discuss questions.

Culture/Art/Math/Literature Connections

If time and resources allow, the Gyotaku (fish print) lesson would be a great opportunity to give students some hands-on experience with fish anatomy in the classroom. More information can be found at the Mixed-Plate Biology website (Hawaiian Style – Lessons in Gyotaku): [http://www.accessexcellence.org/AE/ATG/data/released/0276-LenoreKop/description.php](http://www.accessexcellence.org/AE/ATG/data/released/0276-LenoreKop/description.php)

Ask parents to bring in any extra whole fishes and students to bring in white t-shirts to make these permanent clothing articles (be sure the paint used is appropriate for cloth and will last through the rinse cycle). Otherwise, if done on paper, have the students label the different fish structures (and see if they know what the type of basic body shape, caudal fin, and coloration their fish samples imply about their lifestyles and habitat types).

Additionally, the teacher can implement a fish theme when teaching new math techniques (multiplication tables, division, fractions … etc.). For example, if a fishing boat caught 42 pounds of mahimahi and they need to divide it equally between all the six crew members, then how much fish would each person bring home? Seven pounds. Also, the teacher or parents could pick up some books about local fishermen lore or Hawaiian mythology from the library to read for a literature connection.
**Fish Adaptions Key:**

(Table modified from http://www.geocities.com/sseagraves/Adaptationsinfish.doc)

<table>
<thead>
<tr>
<th>Structure</th>
<th>Adaptation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jaws/Mouth</td>
<td>Large mouth and sharp teeth</td>
<td>Carnivorous fish (ie. eats other smaller fishes)</td>
</tr>
<tr>
<td></td>
<td>Suction-cup-like small mouth</td>
<td>Herbivorous fish (makes it easier to bite pieces of limu)</td>
</tr>
<tr>
<td></td>
<td>Sharp beak</td>
<td>Corallivores (ie. allows fish to eat chunks of coral)</td>
</tr>
<tr>
<td></td>
<td>Bottom-feeder</td>
<td>Mouth angled upwards allows fish to quickly attack and bite prey above it</td>
</tr>
<tr>
<td></td>
<td>Barbels</td>
<td>Fish uses these structures to feel and sense prey in the sand</td>
</tr>
<tr>
<td>Caudal Fin</td>
<td>Forked tail</td>
<td>Allows for quick short bursts of speed</td>
</tr>
<tr>
<td></td>
<td>Rounded tail</td>
<td>Allows for greater maneuverability and moderate speed</td>
</tr>
<tr>
<td></td>
<td>Lunate tail</td>
<td>Allows for very fast speed over long distances</td>
</tr>
<tr>
<td>Body Type</td>
<td>Fusiform</td>
<td>Streamlining allows for quick movement</td>
</tr>
<tr>
<td></td>
<td>Round</td>
<td>Makes it hard to eat them – especially with all the spines; slow swimmer</td>
</tr>
<tr>
<td></td>
<td>Eel-like</td>
<td>Creature lives hidden among the rocks</td>
</tr>
<tr>
<td></td>
<td>Compressed (flattened side- to-side)</td>
<td>Makes them harder to see from the front and behind</td>
</tr>
<tr>
<td></td>
<td>Flat/Depressed</td>
<td>Makes them difficult to see from top to bottom; creature lives and feeds on the ocean bottom</td>
</tr>
<tr>
<td></td>
<td>Torpedo</td>
<td>Allow for very fast swimming</td>
</tr>
<tr>
<td>Eyes</td>
<td>Both on the same side of their head</td>
<td>Fish lies flat on the ocean bottom and has a depressed or flat body type</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>Fish lives in the nearshore (shallow) environments</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>Fish lives offshore in deeper habitats</td>
</tr>
<tr>
<td>Coloration</td>
<td>Camouflaged</td>
<td>Lives in areas similar to its coloration (rocks/seaweeds … etc.)</td>
</tr>
<tr>
<td></td>
<td>Counter-shading (ie. darker on the top side and lighter on the bottom)</td>
<td>Fish swims in blue water (open ocean) and is less visible to predators from both above and below</td>
</tr>
<tr>
<td></td>
<td>No markings</td>
<td>Lives in open water environments</td>
</tr>
</tbody>
</table>
My Fish! Adaptations

______________________________ (name of your fish)

Jaw Type: _____________________________________________

What does this mean about my fish? (habitat, behavior, etc.)

________________________________________________________________________________

Body Type: ____________________________________________

What does this mean about my fish? (habitat, behavior, etc.)

________________________________________________________________________________

Caudal Fin Type: ________________________________________

What does this mean about my fish? (habitat, behavior, etc.)

________________________________________________________________________________
Fish Adaptations!

- JAWS/MOUTH:
  - bottom-feeder
  - nornotore
  - perch

- LATERAL LINE:
- DORSAL FIN:
- CAUDAL FIN:
- PECORAL FIN:
- ANAL FIN:
- OPERCULUM (gill cover):
- PELVIC FIN:
- MOUTH

- BODY TYPES:
  - flat
  - compressed
  - eel-like
  - torpedo

- CAUDA FIN:
- BEAK
- BARBELS
- Lunate
- Forked
- Rounded