



## **Fish Wheels**

Lawrence Hall of Science

*This activity outline was developed for use in a variety of informal venues. By design, it provides the content, pedagogy and strategy necessary for implementation by both the novice and experienced informal educator. It is expected that this outline will be adapted and improved upon by the user. We welcome your feedback!*

### **Synopsis of the Activity**

Learners make fish adaptations wheels that allow them to examine different body structures (mouth shape/position/teeth, body shape, tail shape, and coloration patterns) and how their variations allow fish to be successful in their habitats. Based on this information, learners make predictions about the behavior and habitats of fish throughout the aquarium.

### **Audience**

This activity is meant for a general audience. Younger learners will need some help putting together their fish wheels.

### **Setting**

This activity can be set up in front of any size tank in an aquarium and then visitors can continue to make observations throughout the aquarium.

### **Activity Goals**

- To engage the learner to think about the organism as if they were a biologist studying it.
- To engage visitors to interact with aquarium exhibits.
- To encourage learners to actively observe fish in aquariums and to make explanations based on evidence.
- And through observations of body structure and coloration, draw some conclusions about the fish's behavior and habitat (especially its movement, what it eats, strategies for defense, and where it lives in the water column).

### **Concepts**

- Investigating the observable structures and behaviors of fish can provide a lot of information about how the fish lives and moves in its habitat.
- Biologists can make predictions about fish's behaviors and habitat based on their tails, bodies, mouths and coloration.
- There is a connection between body structures and their function.

### **Ocean Literacy Principles**

Principle 5: The ocean supports a great diversity of life and ecosystems.

5.c. Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.

5.e. The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

### **Materials**

- Card stock
- Brass brads (4/fish wheel)
- Scissors
- Exacto knife

- Print out of Fish wheels and Fish body (print at 90% size: To do this, go to “Page Setup” under “File” and change the scale to 90%) (attached)
- Print out of Fish Wheels Directions (attached)
- Print out Fish Adaptations Charts (attached)

### **Prep Section**

- Set out materials for making fish wheels (brads/fasteners, fish wheels, fish body, scissors)
- Set out directions for making fish wheels
- Set out one completed fish wheel model for visitors to see end product

### **Procedure and set up**

- Make copies of fish body and fish wheels on colored card stock
- Use an exacto knife to cut out the holes for each of the wheels on the fish body (This part is tricky to do on the museum floor because childproof scissors don’t cut the small holes very well. It’s easier to just cut the holes out ahead of time). The holes should be cut in the two shapes above each of the body parts listed on the fish (mouth, body, tail, and camouflage).
- Make one complete fish wheel for visitor model.
- Collect brass brads/fasteners and scissors

### **Guiding Questions**

The questions used by the facilitating educator are the key to this activity. The intent of the questions is not to barrage the learner with one after another or to get them to respond with a known (or unknown) fact, but rather to get them to observe fish and generate their own ideas. Examples of guiding questions to focus the learner on different aspects of fish body structures are provided below. In the first part the questions are broken up into two groups, initiating questions and follow-up questions. Often facilitating the observation of the fish can be achieved by pairing an initiating question with one or more follow up questions. The order of these questions is not necessarily a suggested order.

(As you read through the questions you may run across some in each group that you would put into the other category. That is fine, these are meant to start you thinking about how to initiate an interaction and then continue the discussion with the learner.)

#### Initiating Questions:

- Have you seen any of these fish before? Where did you see it?
- What is it doing?
- Do any of the fish look the same? How are these fish the same/different?
- What do you notice about its body/tail/mouth position/teeth/mouth size/coloration?
- How do you think it protects itself?
- What do you notice about how it’s eating?

#### Follow up questions:

- What makes you think that?
- What’s your evidence?
- How might you test that?
- Do you notice any similarities between this fish and the others in the tank? How are they different?
- How can you tell?

### **Activity Description**

#### Invitation

Introduce yourself and invite visitors to come over and take a look at some of the fish in the aquarium exhibit. Notice what the visitors are interested in and facilitate a conversation based on their interests.

Some questions to ask to start the conversation include:

- “Are you interested in fish?”
- “Do you have a fish tank at home?”
- “Hey, what do you think that fish is doing?”
- “What do you notice about these fish?”
- “Did you have a chance to see it eat something?”

Encourage the learners to make observations to share their observations with everyone else. You might try: let’s see if everyone can come up with something different they notice about the fish. Color, shape, movement and feeding behavior of the fish are organized into separate sections below so that the facilitator can play off the interests of the visitor

### Diversity of Fishes

- “How are all these fish the same?”
- “In what ways are they different from each other?”
- “Which fish looks the most interesting to you? Why? What makes it interesting?”
- “Do any of the other fish have that same feature?”
- “How many different tail shapes can you find?”
- “How many different mouths (or body shapes or colors and patterns) can you find?”

### Body Parts of Fish

- “What do you notice about the mouths (or tails or shape) of the fish?”
- “Can you find another fish with that same shape of mouth (or tail or body)?”

### Tail Shape and Body Shape

- “How would you describe the shape of the tail (or body)?”
- “How would you describe the tail (or body) shape on the fish that seems to swim the fastest?”
- “Which ones are moving slowly?” “How would you describe their tail (or body) shape?”

*Sometimes it helps to give younger visitors choices or let them draw the shape—does it look more like a V? (make a v-shape with your fingers) or more rounded or square? (hold out your whole hand with fingers together to demonstrate shape). Have the learner show you which one they think it is with their hands. Ask them to find other fish with a tail with that same shape.*

- “Do the fish with the v-shaped tails or the rounded/square tails swim faster?”
- “Do the fish with the torpedo-shaped bodies or the pancake-shaped bodies swim faster?”

### Mouth Shape and Eating

- “How is this fish catching and eating its food? Let’s watch this fish eat and see what it does.”
- What does its mouth look like?
- How do you think that type of mouth might help it to catch food?
- What type of food do you think it eats with that kind of mouth?”

*For younger visitors you might reference other animals that they may have experience with, “What is a sharks’ mouth like? What do they eat? How do you think they eat?” If you’re set up in front of a large aquarium, you can give younger learners pictures of the fish in the tank to sort as they notice similarities within the large aquarium display*

### Coloration Patterns

If visitors notice coloration of the fish, ask them some of these guiding questions:

- What do you find interesting about the color or pattern?
- Do you think this type of coloration might help the fish survive in its habitat?
- How might it help? What makes you think that?

Show the visitors some pictures of the fish in its habitat.

- Do these pictures seem to support your ideas about the color and where it lives? Why or why not?

Is there anything else you notice in the picture?

How could you be surer about the ways that the coloration pattern might help it to survive in its habitat?

**Building the fish adaptations wheel.** Show visitors a completed fish wheel. “You can build a fish wheel so that you can use some of the information you’ve observed here and some of the information biologists have already discovered about fish to help us make predictions about other fish’s behaviors and habitats. When you’re done making your fish wheel you can take it around the rest of the aquarium or use it right here to look at some more fish. Do you want to make one?”

Show visitors the directions for making their fish adaptations wheel. The body structure wheels should be cut along the dotted lines. The fish body can also be cut out. Once the cuts are all made, have the learners place their wheels behind the appropriate windows and attach the wheels to the fish body with the brads.

**Example of using the fish wheel:**

Visitors and docent are observing fish in an aquarium exhibit.

Docent: What are you noticing about this fish?

Visitor 1: It has a tail shaped like a crescent – on the wheel it says this is a lunate tail.

Docent: So what kind of swimmer would it be?

Visitor 1: Well, let’s see, (visitor references fish wheel) it has a lunate tail...so it would be a fast swimmer.

Docent: What do other people think about that?

Visitor 2: Yep. My fish wheel says it also swims long distances because the tail is good for that too.

Docent: Is there any other evidence that it is a fast swimmer?

Visitor 2: Yes it has a body shape (called fusiform) that is also good for fast swimming.

Docent: Where do you think it may live then?

Visitor 2: Well, its body has countershading, and it can swim really long distances. It might live in the open ocean?

Docent (directed at Visitor 1): What do you think?

Application and Generalizing

Show visitors pictures of other fish not in your display area. You might ask some of the following guiding questions and encourage visitors to use their fish wheels to find a possible answer:

“Which of these fish do you think might swim the fastest?”

“What makes you think that?”

“What do you think this fish might eat?”

“What makes you think that?”

“Where do you think this fish might spend most of its time?”

“What makes you think that?”

What could you say about the color pattern on a fish and where it might live?

“What would you say about the shape of a fishes tail (or body) and how fast it swims?”

You might tell visitors that biologists make these same types of observations about fish features and use their observations to make predictions about where fish live and whether they are fast or slow swimmers.

After visitors have participated in the activity for several minutes, have them tell a newcomer what they observed and what they are thinking about. Encourage them to engage with each other.

Challenge the visitors to use the new information they've gained from their fish observations to make new observations and draw conclusions about the behaviors and habitats of other fish in the aquarium. Encourage them to come back to tell you what they discovered. Suggest that visitors keep their observations in mind the next time they visit an aquarium or friend's house and observe their pet fish.

**Notes:**

Role of educator:

- Try to adopt the role of “guide on the side” rather than “sage on the stage.” Rather than simply imparting information, be a facilitator of learning and co-investigator, seeking evidence and explanations alongside the visitors.
- Engage visitors in investigating fish themselves.
- Invite visitors to come over and look at the fish in the tank and then engage them in a discussion of the fish and their body structures and behaviors.
- Use the discussion map:

- Ask a broad question
- Listen to responses and thinking
- Ask for evidence or explanations
- Ask for alternative opinions or ideas
- Restate or review visitor's ideas
- Ask a question leading back to the main topic

Questioning:

- Try to ask more broad questions with multiple possible responses that encourage higher level thinking, rather than focused questions with single answers.
- Care needs to be taken not to badger visitors with questions. Give room for exploration and for visitors to make observations, think, wonder and discuss amongst themselves.

Dealing with new visitors:

- After they have been there for several minutes, have visitors tell a newcomer what they observed and what they are thinking about. Encourage them to engage with each other.
- Have them view other tanks/trays and make comparisons between tanks/trays.

**Related Activities/Extensions/Modifications**

Design a fish to live in a habitat that you create. Remember to include all the adaptations for survival that it needs.

**Background**

Fish are one of the most successful of the groups of animals with backbones—the vertebrates—and consist of over 50% of all the living vertebrate species. In addition to being one of the most numerous groups, they are also among the most diverse. The incredible variety of forms and behavioral adaptations for survival seen in fish are a reflection of the complex and diverse habitats available to them in their ocean and freshwater homes.

The tremendous diversity in fish is the result of numerous adaptations since fish first evolved over 500 million years ago. The interplay of these adaptations has shaped fish in countless ways, but each form or shape has evolved to allow fish to successfully feed, swim, escape predators, and reproduce in their habitat. These adaptations can be grouped into categories of size, shape of body and tail, coloration patterns, location of mouth and size of teeth and gill rakers. Close observation of these fish adaptations can lead to predictions about their behavior and choice of habitat within ocean or freshwater environments.

The shape and position of fish fins are related to their body shape and the location of the center of buoyancy of the fish. The differences between fish in their fin shape and location are adaptations for their habitat and behaviors and are reflected in their locomotion and maneuvering abilities. For example, the lower part of the tail fin in bottom dwellers such as rays is usually reduced, but it is enlarged in the flying fish, which may use it to help them jump out of the water. Other examples of adaptations include the dorsal fin of remoras, which is modified as a sucker to allow it to hitchhike on sharks, and the dorsal fin of anglerfishes, which attracts prey to its large mouth.

Fish usually have the streamlined—or fusiform—shape, which is very efficient in the water, but they do show a great range of departures from this typical shape. Each of these departures is an adaptation to a specific way of life, which puts a premium on something other than fast swimming.

### **Vocabulary**

Fish: animals that are typically cold-blooded, covered with scales, and equipped with two sets of paired fins and several unpaired fins. However, some species of fish are lacking one aspect of this definition (e.g., eels have no fins and clingfish have no scales). Fish are abundant in the sea and in fresh water, with species being known from mountain streams (e.g., char and gudgeon) as well as in the deepest depths of the ocean (e.g., gulpers and anglerfish).

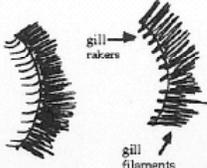
Habitat: a place that has all of the necessities for an organism to live, grow, and reproduce (e.g., food, water, air, shelter)

**Please see attached Fish Adaptations Charts for specific connections between body structure and function.**

## Fish Adaptations Charts

<i>BODY SHAPE</i>		
	DESCRIPTION	EXAMPLE
<p>FUSIFORM</p> 	streamlined and cylindrical; very fast and can swim continuously for long distances	bonita, mackerel, anchovy
<p>DEPRESSED</p> 	flattened from back to belly like a pancake; ambush prey with short bursts of speed; burrows into sand	skates, rays, goosefish
<p>SPHERE</p> 	rounded, globe-like; slow swimmers; may attract prey to them with light and lures	porcupine fish, puffer fish, anglerfish
<p>RIBBON</p> 	snake-like; slow swimmers but easily move through crevices; hide under rocks or in cracks, and ambush prey that comes too near their hideout	wolf eels, monkeyface eel
<p>COMPRESSED</p> 	flattened side to side; sharp, quick turns and very maneuverable; viewed head-on they almost seem to disappear	surf perch, opaleye, halibut, flounder

<b>TAIL SHAPE</b>		
	DESCRIPTION	EXAMPLE
<p>LUNATE</p>  <p>(fastest)</p>	fastest swimmers, maximum speed with minimum effort over long distances	marlin, mackeral, dolphinfish, swordfish
<p>FORKED</p> 	moderately fast, continuous swimmers	anchovy, herring
<p>SQUARED</p> 	very maneuverable, capable of bursts of speed for short distances	rockfish
<p>ROUNDED</p> 	very maneuverable, capable of bursts of speed for short distances	senorita, goby, flatfish
<p>TAPERED</p>  <p>(slowest)</p>	slow swimmers, use body undulations to swim	moray eel

<b>MOUTH, TEETH and GILL RAKERS</b>		
	<b>DESCRIPTION</b>	<b>EXAMPLE</b>
<b>MOUTH ORIENTATION</b> 	<ol style="list-style-type: none"> <li>1. oriented upwards denotes surface feeder or feeds on prey above it;</li> <li>2. downwards suggests bottom-grubber</li> </ol>	<ol style="list-style-type: none"> <li>1. stargazer, stonefish</li> <li>2. sturgeon</li> </ol>
<b>MOUTH SIZE &amp; SHAPE</b> 	<ol style="list-style-type: none"> <li>1. large jaws engulf prey;</li> <li>2. jaws which can protrude suck in prey;</li> <li>3. elongate jaws reach into crevices;</li> <li>4. elongate lower jaw feeds on prey seen above</li> </ol>	<ol style="list-style-type: none"> <li>1. lingcod</li> <li>2. rockfish</li> <li>3. butterflyfish</li> <li>4. halfbeak</li> </ol>
<b>TEETH SIZE &amp; SHAPE</b> 	<ol style="list-style-type: none"> <li>1. fish eaters have pointed, knife-like;</li> <li>2. snails and clam eaters have plate-like grinders and crushers;</li> <li>3. choppers on plants and corals have fused, beak-like</li> </ol>	<ol style="list-style-type: none"> <li>1. barracuda</li> <li>2. bat ray</li> <li>3. parrotfish</li> </ol>
<b>GILL RAKERS SIZE &amp; SHAPE</b> 	<ol style="list-style-type: none"> <li>1. comb-like gill rakers filter food;</li> <li>2. large, coarse gill rakers protect gills when they eat from large prey items</li> </ol>	<ol style="list-style-type: none"> <li>1. anchovy</li> <li>2. lingcod</li> </ol>

<b>COLOR PATTERNS</b>		
	<b>DESCRIPTION</b>	<b>EXAMPLE</b>
<b>CAMOUFLAGE</b>	match surroundings to blend in and hide	halibut, cabezon
<b>DISRUPTIVE COLORATION</b> 	spots, stripes, and patches of color breakup and diffuse the actual outline  often spend time in groups so that it is hard to tell where one fish ends and another begins	kelpfish, sergeant-major
<b>COUNTER-SHADING</b> 	dark back and lighter belly hides fish from predators as sunlight penetrates from above  usually live in open water	anchovy
<b>ADVERTISING</b> 	1. warning to stay away from poisons or spines; 2. attract mates, defend territories 3. clean other fish	1. lionfish 2. California Sheephead 3. señorita
<b>DECEIVING</b> 	1. false eyespots confuse predators into attacking the wrong end or miscalculating size/shape of fish; 2. fish resembles objects of no interest to enemies; 3. fish mimics something: that is (a) helpful (like a cleaner) or (b) dangerous (like a poisonous seasnake.)	1. Big Skate, butterfly fish 2. stonefish, sargassum fish 3. (a) blenny, (b) snake-eel

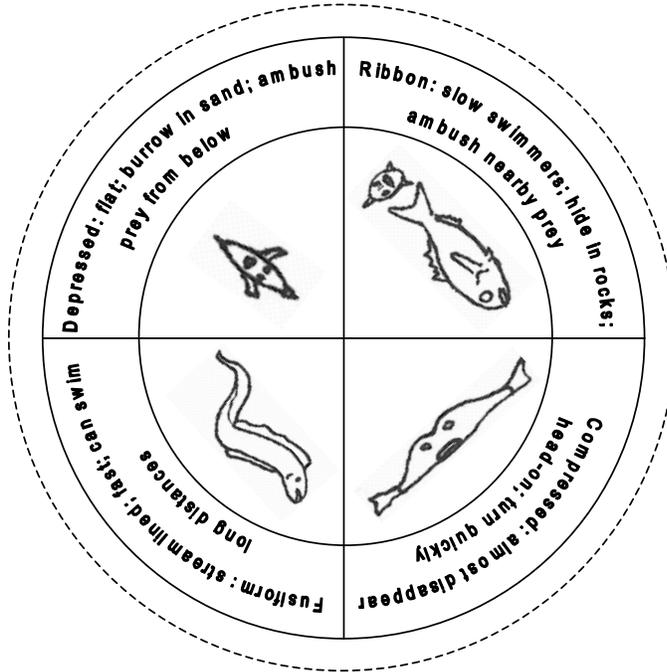
## Fish Wheels Directions:

1. Cut out outline of fish body.
2. Cut out fish wheels on the dotted lines.
3. Use brads/fasteners to make a hole in the center of each fish wheel.
4. Use brads/fasteners to make a hole in the fish body at each of the 4 dark dots between windows.
5. Place fish wheels behind the appropriate windows on fish body.
6. Poke brads/fasteners through the holes you've made in the body and the wheels and tighten brads/fasteners.

Tail Shape:



Body Shape:



Mouth shape:



Color Pattern:



