Fishy Tales: Growth Change in Scales

Material adapted from:
Forecasting the Future, Stephen-Birch Aquarium Museum: "A Fishy Tale"
Canadian Wildlife Federation, Wild Education: "Fish Ways"
Creek Connections: "How Old is that Fish?"

Introduction:

As with tree rings, which add a layer each growing season, fish scales have annual rings. Year marks called "annuli", can be detected on many scales by skilled scale readers and the spacing between annuli gives an indication of the particular conditions the fish encountered during a period of growth. Therefore, an increase or decrease in growth is reflected in the scales of a fish. Therefore, fish sometimes serve as bioindicators of the health of waterways by tracking their growth.

A fish keeps most of its scales for its entire life, but some scales are lost and replaced. Discarded scales drift downward and accumulate in sediments. These collections of scales serve as records of environmental change. In this activity students will study fish scales to identify changes in the environmental conditions experienced by a fish.

Objectives:

Students will be able to:

- Describe the different features of fish scales, circuli, annuli, radii and focus
- Examine scales for evidence of growth change in fish
- Understand environmental factors that affect the growth of fishes.

Ocean Literacy Principles

This activity support:

- Essential Principle #1: Earth has one big ocean with many features

Materials:

At least one large, or selection of, fish/fish skin with scales intact
Beakers or jars
Water
Tweezers
Dish Detergent
Paper Towels
Microscope Slides
Microscopes
Masking Tape
Writing Materials
Rulers
Color pencils/crayons

Handouts/Transparencies:

Scale Transparency
Student Handout

Procedure

1. Explain that some living organisms keep a record of their age in some of their body structures. These structures change their growth patterns as a result of annual changes in the environment of the organism.

2. Explain a change in the abundance of food affects fish growth, whereby changes in currents and strength/direction of the wind move fish toward or away from food-rich areas. Water temperature can also affect food availability.

3. Have students brainstorm the annual environmental fluctuations that could cause changes in the growth pattern of a fish. Examples include:

    - Warmer water temperatures in summer
    - Less light in winter
    - More biological activity leading to more available food in summer, etc.

    Upon completing the list, have students hypothesize which season a fish would grow the most.

4. Show the **Scale Transparency** and have students note the position of the focus of the scale, the circuli and the annuli. Provide students with a copy of the **Student Handout**.

5. Divide the class into groups with one piece of fish/fish skin per group. Have the students scrape away a few scales with the tweezers. Instruct some students from each group to soak the scales in a small jar or beaker of warm water to which a few drops of dish detergent have been added. By stirring the water vigorously, they can remove much of the mucus and other materials from the scales.

6. Have students remove the scales from the water solution and blot them dry on a piece of paper towel. Students can mount a scale for observation by placing it between two microscope slides and wrapping masking tape around each end of the slides to flatten it and keep it in position.

7. Have students observe the scale they prepared and sketch an illustration of what they see, labeling the visible structures using the Idealized Fish Scale handout. Students should also try to determine the age of the fish by counting the annuli.

Wrap Up Discussion

From Student Handout:

- Assume the idealized scale above came from a fish that grows best in warmer

waters and that one degree of temperature leads to 1mm growth difference. The average water temperature of this fish's habitat was 11°C in the last season before you removed the scales. Suggest an average water temperature for the season prior. Could fish be used as a bioindicator of climate change?

Outer ring = 4mm, ring before that (season prior) = 2mm
Growth difference = 2mm less than most recent season
If 1°C = 1mm growth difference, then temp was 2°C lower
Therefore average water temp in season prior was 9°C (11°C-2°C)

As indicator of climate change, fish are not so reliable because there is no way to tell whether a fish experienced an overall change in climate. We can only tell that some condition or conditions changes. This change might have been due to either altered location or altered conditions in the same location. In studying climate change, we are most interested in measuring how conditions changed in the one location. Scales from fish that live in the same area their whole life would be most useful.

- We have assumed your observed scales came from a fish that spent all of its life within one geographic area. How would your scales look different if the fish migrated from one area to another? Do your scales indicate that the fish may have migrated?

If scales indicate the fish was subject to a wide ride of fluctuating water tempertatures, the fish could very well have migrated. Circuli on the scale would be irregular in width and inconsistent with distance from focus (i.e. not so ring shaped). In contrast, circuli that is gradual and unidirectional would be indicative of no migration and therefore more useful in determining any climate change.

- What factors would cause a fish to grow slower?

Decrease in food supply, decrease in metabolic rate that results from cooling water temperatures, stress from pollution, stress from spawning

- What factors would cause a fish to grow faster?

Idea water temperatures, lack of competition, and an abundant food supply

- Summarize the use of fish as bioindicators.

<u>Teacher Notes</u>

1. Scale samples can be taken from a live fish and the fish can be released without harm; scales will grow back. A dead specimen may be obtained from an angler or purchased from a fish market. The aging process is particularly clear on lake whitefish, which may be purchased with scales intact

2. Occasionally a false annulus will form on scales due to lack of food, high temperatures or reduced oxygen levels. It can usually be identified because the circuli rapidly become closely packed. In a true annulus, the circuli usually close gradually and seem to "cut over" one another.

Extensions

1. If different species of fish are available to use, have students compare different scales. Have students research each species in terms of location, migration habits and affinity for certain water temperatures. Have the students evaluate whether the scale features correlate with this information.

Vocabulary:

Annuli
Heavy lines that can be seen on a fish scale. These are actually numerous curculi bunched very close together, indicative of periods of environmental stress or decreased metabolism. Annuli generally occur during winter months. Counting the number of annuli on a scale will determine the age of the fish.
Bioindicator
An organism that can be analyzed to indicate ecosystem health
Circuli
These are the concentric lines apparent when looking at a scale under a microscope. Used to determine growth in fish, the spacing between line indicates environmental conditions in the fish's habitat. Large gaps in circuli indicate favorable environmental conditions and a plentiful food supply
Ctenoid
These types of scales overlap and allow greater maneuverability because the scales can slide over one another as the fish bends. They have a spiny or comb-like posterior margin. These cover most bony fish.
Cycloid
Similarly to ctenoid scales, these also overlap, but have a smooth posterior margin in contrast. Both Cycloid and ctenoid scales grow proportional to the fish.
Focus
The central point of a fish scale
Ganoid
These scales have a rhombus shape and are connected by peg and socket joints. Gar, bowfin, paddlefish and sturgeon exhibit this scale pattern
Placoid
These scales form from a rectangular base that exists under the skin. Spines project from this base to the surface and point posteriorly. Sharks, skates, and rays are common species with placiod scales, making their skin rough to the touch
Radii
Lines of scale radius, stretching out from the focus of the scale
Scales
The overlapping series of hard plates that cover a fish's body