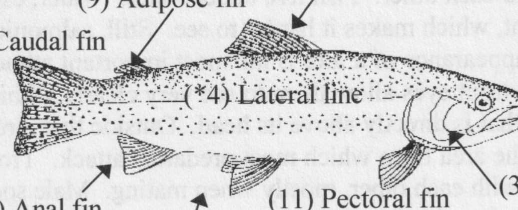
The Trout Body and How It Works

Part of the reason people like to fish for trout and salmon is that they are considered beautiful. Much of their beauty has a functional root. Their torpedo-like shape, muscles, and fins are all arranged so that trout can slice through the water. That way, they can swim facing upstream with a minimum of water resistance. Conserving energy minimizes the risk of predation (by birds and mammals) that trout face every time they come to the surface to feed.

Refer to the **The Trout Body (p. 49)** as you go through the features. The features with stars (*) are sensory organs. There is more information about them in the next section.



A trout uses its **mouth** to eat; trout usually suck their food up, instead of engulfing it like bass do. Trout also use their mouths to feel things, and sometimes males use their jaws for fighting over mates. They do this around spawning time, when they have developed big (1) **kypes**, the hooked portion of the lower jaw. Trout investigate potential meals by smelling with their (*2) **nares**, much like our nostrils, or by looking at them with their ***eyes**. A trout's pupil is slightly triangular, rather than a perfect circle. This helps give it a larger field of vision. All trout breathe through their **gills**. They open their mouths wide to draw water through. Gills work much as our lungs do; they have lots of surface area for exchanging the oxygen they need for the carbon dioxide their body cells produce as waste. Lake-dwelling trout also use **gill rakers** to feed on microscopic creatures called zooplankton. Rather than gulping them up in their mouths, their gills pick the zooplankton up when the water rushes through them. The gill rakers pick the food up off the gills so the trout can swallow them. Gills are very delicate (never touch them if you are going to release the fish), so they are covered by a hard plate called the (3) **operculum**. Since trout have gills instead of lungs, their lungs have been modified into a **swim bladder** (not shown), a long, skinny, air-filled sac. The swim bladder allows a fish to float at a desirable level without constant effort. The (*4) **lateral line** is a special sense organ that runs all the way from the operculum to the tail. In addition to excretion through the gills, a trout uses its (5) **vent** to excrete extra water or salts (if it lives in fresh or salt water, respectively). The vent is also the outlet for eggs or milt during spawning.

Trout have six different kinds of fins. Four are single fins, two are paired. The biggest fin is the tail, or (6) **caudal fin**. It provides a "push" to start moving and acts like a rudder for steering. The caudal fin has many **fin rays**, the bony spikes that give fins shape. The other three unpaired fins are the (7) **dorsal fin**, the (8) **anal fin**, and the (9) **adipose fin**. "Adipose" just means that this is a fatty fin without rays. All unpaired fins are used for swimming power and stabilization. The two sets of paired fins are the (10)

pectoral fins and the (11) **pelvic (or ventral) fins**. Both sets are used like brakes, and the pelvic fins help with up-and-down movement. Students can get used to these terms with **Activity #10, Trout Fill-In (p. 51). Activity #11, Color a Trout (p. 53)** gives kids a chance to be creative. They can draw the markings of their favorite trout, or they can make up a fanciful new one.

Trout Senses

A question to keep in mind throughout this topic is, "How is water a different medium from air? How do things look, sound, taste, smell, and feel differently under water?"

Humans are very visual creatures. Sight is generally is our primary way of recognizing food, shelter, and each other. Fish live under water. Water, especially if moving or dirty, scatters light, which makes it harder to see. Still, salmonids do most of their foraging by sight; the appearance of a lure is the most important attractant (or repellant). The position of a trout eyes allow them to see very clearly within a circular area called the **Snell Circle** that is directly above its head. Outside that circle, they can't see much, but they can see the area from which most predators attack. Trout also use visual cues to communicate with each other, mostly when mating. Male sockeye salmon, for example, turn bright red when they're ready to spawn.

Trout vision has some major limitations. If the water is murky, or if it's dark, or if trout need to detect something outside their limited field of vision, they compensate with other senses. If an aquatic habitat is a disadvantage for vision, it is an advantage for smell. A sense of smell is the ability to detect tiny particles of different chemicals suspended in a medium, like air or water. Things that aren't "smelly" in the air *are* smelly in the water, because the water transmits chemicals much more effectively.

Fish have big nasal cavities called **nares**. Although the nare openings on a trout's snout look much like our nostrils, they are not quite equivalent. Our nostrils are used for both smelling and breathing, so they are connected to our lungs. Since trout use gills instead of lungs to breathe, the nares are closed sacs that are used only for detecting odors. They do this job very well: salmon can smell certain chemicals on human hands at 1 part per 80 billion (like ¼a teaspoon in an Olympic pool). Trout also use smells to communicate with each other; females use chemicals called pheromones, in the mucus on their skin, to tell males when they're ready to spawn.

Fish also have a sense organ, called the **lateral line**, unlike anything humans possess. It is a "distant touch" sensor that detects pressure waves, or vibrations. The lateral line is what allows a fish to maintain its position in a school without bumping into other fish. Look closely at a fish, or at a good drawing of one, to see the lateral line. It is visible as a line of special cells (called neuromasts) that run all the way from head to tail. Use **Activity #12, Which Side Are You on? (p. 55)** to help compare and contrast the lateral line with our sense of hearing, and to apply students' new knowledge of trout biology to fishing tactics.

Life Cycles

Understanding the details of trout and salmon life cycles is essential if we are to protect them. Certain life stages are especially vulnerable to disturbances, and dams and other physical barriers can be particularly deadly to migratory species. Many trout, and some landlocked salmon, spend their whole lives in fresh water. Others are born in fresh water and later migrate into salt water, before returning to fresh water to spawn. This type of life cycle is called **anadromy**. It will be explained in detail in the second part of this section.

The Basic Trout Life Cycle

Depending where they live, trout will reproduce at different times of the year. Two to four weeks before spawning, male trout ready themselves by undergoing a set of physical changes. Colors become more intense (i.e. a sockeye's red color or a brook trout's brilliant fins). A mature male also develops a **kype**, a hooked lower jaw with strong teeth. Closer to mating time, the female starts searching for a good site to build her **redd**, or nest. She will deposit her eggs in clean gravel that has quality water flowing through it, so that they get plenty of oxygen. When a female has found a suitable site, she uses her fins to cut her redd. She hovers over the site, scooping out a little depression. Then a male swims up beside her. Sometimes, **competition** between the males is fierce. They display their size and strength, and sometimes even bite each other. In addition to staving off other males, they need to impress the females they want to mate with. They do mating dances while the females work on the redds. Interrupted females will sometimes slap at over-eager males. When a female is ready, her mate swims up alongside her, and she releases her eggs while he releases his **milt**, which fertilizes the eggs. The female covers the eggs with gravel. Females usually repeat this process two or three times with different males, at different sites. This takes place over a couple of days.

Eggs develop and hatch as they incubate. About halfway through the incubation period, tiny trout come out of the eggs. The trout are not yet free-living; they still feed on attached egg sacs instead of foraging. This stage is called the **alevin.** Eggs and alevins are particularly vulnerable to environmental disturbances, because they cannot leave the redd to escape. Sudden sedimentation, e.g. from a big storm, can smother the young. **Anchor ice** (ice that forms on the bottom, rather than floating to the top) or very warm water can also kill the growing trout. Alevins stay in the redd until the egg sacs are digested. They then become **fry**. This process can take a long time, especially in very cold water. For fall spawners, it can take 8 or 9 months for fry to emerge.

Different species mature at different ages. Brook trout grow up in 1 or 2 years, but cutthroats need 3 or 4 years. What would be some advantages of a shorter life cycle? (Having a better chance of reproducing before being eaten.) A long one? (A chance to grow larger, and thus produce more offspring at one time.) When these full-grown trout get ready to spawn, the cycle starts all over again.

We'll talk at some length about migration between fresh and salt water later, but many non-anadromous salmonids still migrate. For a movement to be a true migration, it must be a cyclical movement with three elements: a fixed time period, the involvement of most of the fish in a population, and a definite destination. Many salmonids migrate from lake to stream (or the reverse), or from shallow to deep water (or the reverse). They might do it to feed, or to move from warmer to cooler water (or vice-versa). Some of these trips are quite substantial, but they are nothing compared to …

The Sea-run Life Cycle: Lifestyles of the Fat and Anadromous

Before you go into the details of the anadromous life cycle, it might be helpful to pose the question, "Why be anadromous?" Migration can be dangerous; any coordinated movement exposes fish to intense predation (e.g. grizzly bears feeding on Alaskan salmon). There must be some great reward in the ocean to make it worth the risk.

The anadromous life cycle begins with eggs in a redd. The eggs hatch into **alevins**, tiny trout which can swim but cannot leave the redd. Alevins are nourished by an attached yolk sac. As they use up the yolk sac, they grow into **fry**, which feed more or less as adults do, and emerge from the redd. Anadromous fish usually spend 1-4 years in the lake or stream they were born in before migrating out to sea. When they are almost physically mature enough for the trip, they lose their parr marks and turn into **smolt**. Their colors change so that they will be camouflaged in the sea instead of in fresh water. Smoltification changes both appearance and body chemistry, since keeping salts and water in balance works differently in salt and fresh water.

Smolt migrate downstream into the sea, where they spend 2 or 3 years. There is much more food in the ocean than there is in freshwater habitats. While in the ocean, salmon mostly eat tiny shrimp-like creatures called krill (just like blue whales do). Anadromous fish attain their adult size while in the ocean. Because there is so much food in the ocean, anadromous fish get much bigger than landlocked ones. A "big" landlocked rainbow trout weights about 5 pounds. Sea-run rainbows, called steelhead, are genetically near-identical, but they often weigh 25 pounds. A female salmon will lay approximately 1000 eggs for each kilogram she weighs, so there is a direct correlation between body size and fertility.

When salmon are nearly ready to spawn, their colors change to mating shades, and they adjust their physiology for a return to fresh water. Most mature salmon migrate back to the streams in which they were born, but scientists do not completely understand how they find their way home. Salmon definitely use the current and their sense of smell to find their way upstream, but exactly what odors they recognize is not known. It may be the smell of landlocked relatives or the unique chemical composition of the bedrock and runoff. Whatever smells salmon use as cues, it is clear that pollution in the native stream can be very damaging, since any change in chemistry equals a change in smell.

Migration can be very hazardous. Predators, diseases, and changing stream flows all pose obstacles. In addition, human development creates hazards with dams, pollution, development, and overfishing. From a redd of 1000 steelhead eggs, an average of only 1 individual survives to return to the home stream and spawn once. The trip itself is exhausting; salmon leap over waterfalls that would be impossible for an unhealthy fish to surmount. Some fish, like the Pacific salmon, spawn only once before dying. Their bodies decompose and enrich the streams in which their young are developing. All trout and char, and the Atlantic salmon, are capable of migrating and spawning 2 or 3 times. The typical lifespan of an anadromous trout is 3 to 7 years.