

Learning about how temperature effect young salmon

When should you see development?

How are your eggs doing? You won't see much at first. If you were able to look inside the eggs, you would see cells multiplying inside. Remember from your knowledge of the life cycle that the first distinct features you'll be able to see with your naked eye are two black dots; these are the eyes developing. By knowing the stages of the lifecycle and monitoring the water temperature they are in you can predict when you should see different stages.

When will we expect to start seeing eyes?

This is a great question and is also a great math exercise for you and your students. Before we go into the math let me discuss a little background information so you can understand and explain the math. The rate of development (or growth) of your salmon eggs can be determined by the water temperature in your aquarium. The warmer the water temperature in your aquarium, the faster your salmon eggs will grow. The reverse is also true: the colder the water temperature, the slower the salmon eggs will grow. Unlike your students' growth rate, you have control over the rate your salmon will grow. This is also how the growth rate is controlled in hatcheries.

Since water temperature is one of the primary factors which affect the salmon's growth at this stage, we don't want your salmon to grow too fast (water is too warm) or too slow (cold). Salmon require cold, clean, oxygenated water to survive. If you keep your aquarium too cold, your aquarium will freeze. If your aquarium is too warm (exceeding 15 degrees Celsius) your salmon will grow too fast. Too fast of growth can cause defects, death, and increases in biological waste. This increases the number of required water changes that are needed to be performed. Changes in water temperature that occur too quickly or fluctuate too widely can also damage your salmon growth. When altering the temperature in your aquarium, major fluctuations in temperature should be avoided and you should avoid changes greater than 1 or 2 degrees Celsius per day.

What is an ATU and how do I calculate it?

Now you know how temperature affects salmon growth, but that still doesn't help you predict when your eggs are going to develop into the other stages of the life cycle. In order to calculate growth rate and determine if your salmon are developing properly, you must measure the temperature of

the water in your tank daily. This daily temperature measurement can be added up over a period of days to describe the cumulative effect of temperature over time, a unit of measure is known as an accumulated thermal unit (ATU).

Example: If your tank is at 1 degree Celsius all day then your thermal unit (TU) for that given day is 1. If the next day your tank is at 2 degrees Celsius, then your TU for that given day is 2. To calculate your ATUs, simply add each daily TU. So far your ATUs would be 3. [Note: You can calculate ATUs in Fahrenheit but it is much easier in Celsius. The formula to convert Fahrenheit temperatures to Celsius is: $C = \frac{5}{9}(F - 32)$.]

Your calculated ATU will now enable you to determine the growth rate of your salmon and when to expect different stages of development. The table below describes the expected number of ATUs for important life cycle stages:

Accumulated Thermal Units (ATUs) required to reach important embryonic developmental stages in coho salmon.		
STAGE	ATUs (°C)	ATUs (°F)
To Eyed Stage	220	396
To Hatch	400-500	720-900
To emergence	700-800	1260-1800

Have your students help you keep track of TUs. I have attached a calendar to help you keep track on a daily basis. If you prefer, you may instead keep track in the table form that I have also attached. No matter how you decide to do it, it is important to track of your TUs on a daily basis so you can see if your salmon are developing properly.

Using the information you learned about ATUs to estimate when you should see each stage occur. You can manipulate the temperature to avoid major holidays or school breaks.