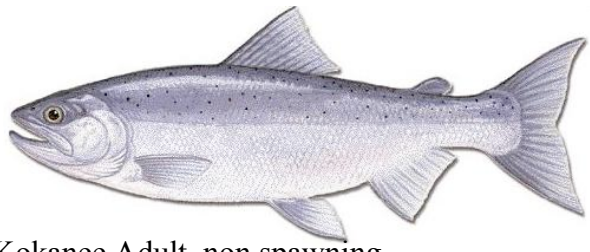
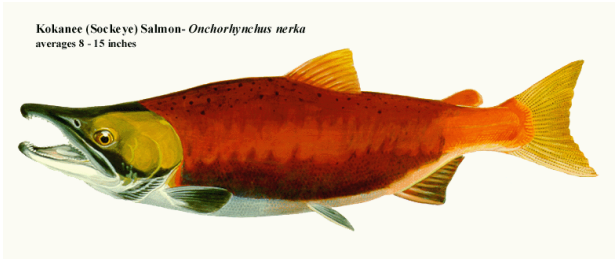
Kokanee Salmon Sheet 1

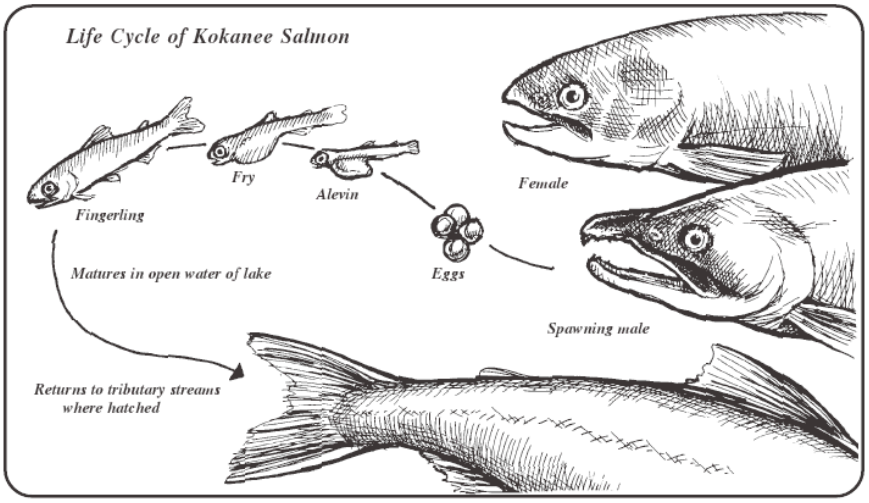
The kokanee salmon (*Oncorhynchus nerka*) is a landlocked variety of sockeye salmon. First introduced to Flathead Lake in 1914, they quickly became widespread in the lake. They are also found in other water sources on both sides of the continental divide in Montana. Kokanee can reach 3-5 pounds, but 1 pound is most common. The size of the fish is dependent upon several factors including population density and the availability of food. They spawn in the fall by either running upstream from their lake or spawning along the shorelines. Kokanee reach sexual maturity in their fourth year and transform greatly prior to spawning. The normally silver colored fish turns smooth-skinned and red colored with a large hooked jaw and teeth on the males. All adults die after spawning and are eaten by eagles, bears and other animals.



Kokanee Adult, non spawning



Kokanee Adult, spawning

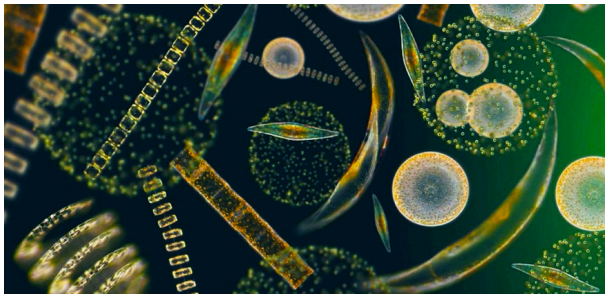


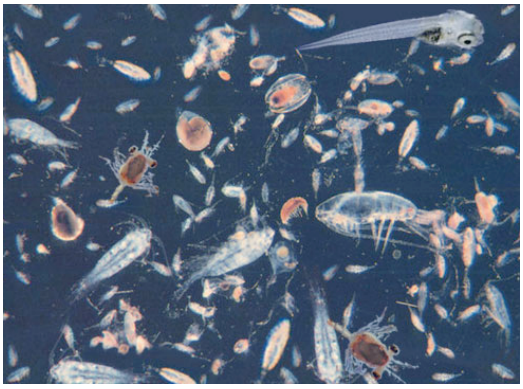
Discussion:

1. List questions posed by your group.
2. What factors might affect the life cycle of a kokanee salmon?
3. The article mentioned that kokanee salmon were introduced to Flathead Lake? What effect might that have had on the native fish in the lake? What are the ethical implications of introducing non-native fish to a water source?

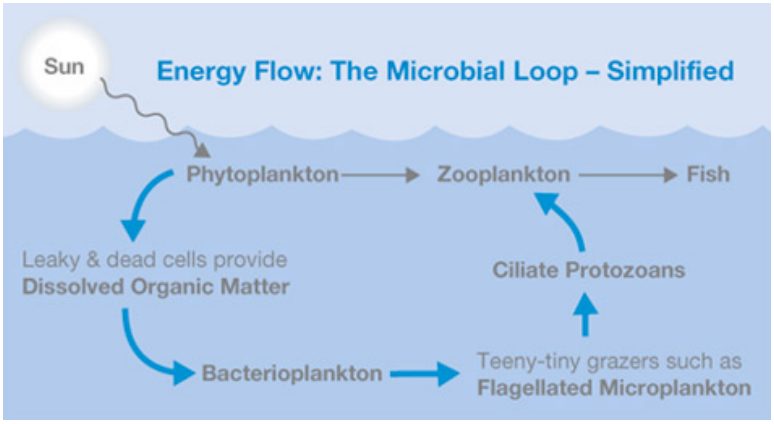
Kokanee Salmon Sheet 2

Kokanee salmon feed on plankton, small organisms that live in the water. Plankton are divided into group based on their type. Phytoplankton are plants, zooplankton are animals and bacterioplankton are composed of bacteria and archaea. When mixed together in the water they are generally referred to as plankton. In areas where there is abundant plankton, kokanee salmon can quickly overpopulate. The fish are also very sensitive to water temperature and often school at certain depths in lakes. Prior to 1986, the population of kokanee salmon in Flathead Lake was abundant, but people began to notice reduced numbers after that time.





Microscopic images of photoplankton (left) and zooplankton (right).

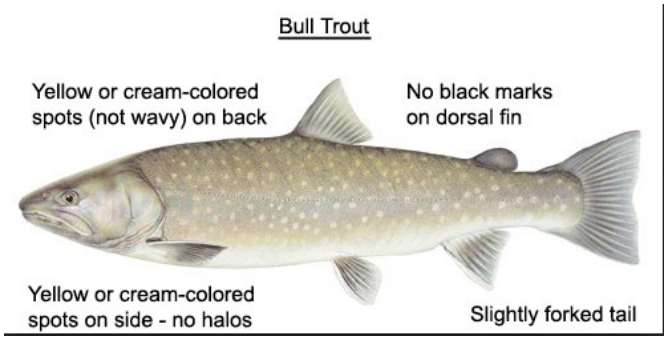


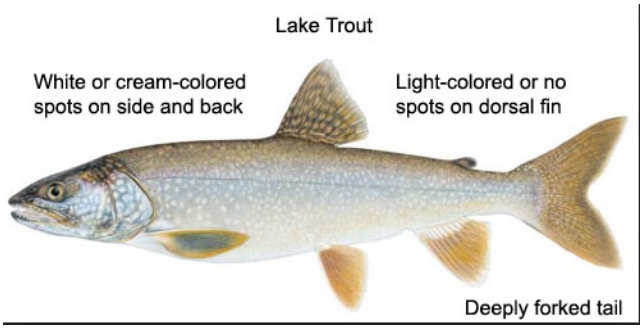
Discussion:

1. List questions posed by your group.
2. What are your initial reactions to the causes of the kokanee population dropping after 1986?
3. As student scientists, what investigations would you conduct to determine the cause of the kokanee population drop in Flathead Lake
4. What additional information do you need to know?

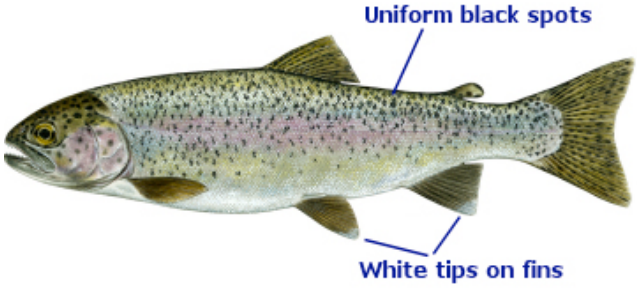
Kokanee Salmon Sheet 3

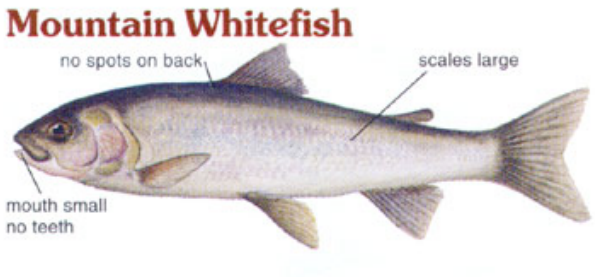
The five primary game fish in Flathead Lake include two native species: bulltrout and cutthroat trout. The nonnative fish are lake trout, kokanee salmon and lake/mountain whitefish. Since data collection began, scientists have seen distinct periods of domination by fish species. Prior to 1920, the native bulltrout and cutthroat dominated Flathead Lake. From 1920 to 1984, kokanee salmon was the most abundant, with an estimated population of 2.3 million in 1984. During the time of kokanee domination, all other species existed in the lake, but the lack of deep water food sources kept the lake trout population down. Since 1984, lake trout have dominated. Scientists found that captured lake trout between 1980-1988 had eaten kokanee as their main diet and after 1989, their diet consisted of whitefish.





Cutthroat Trout





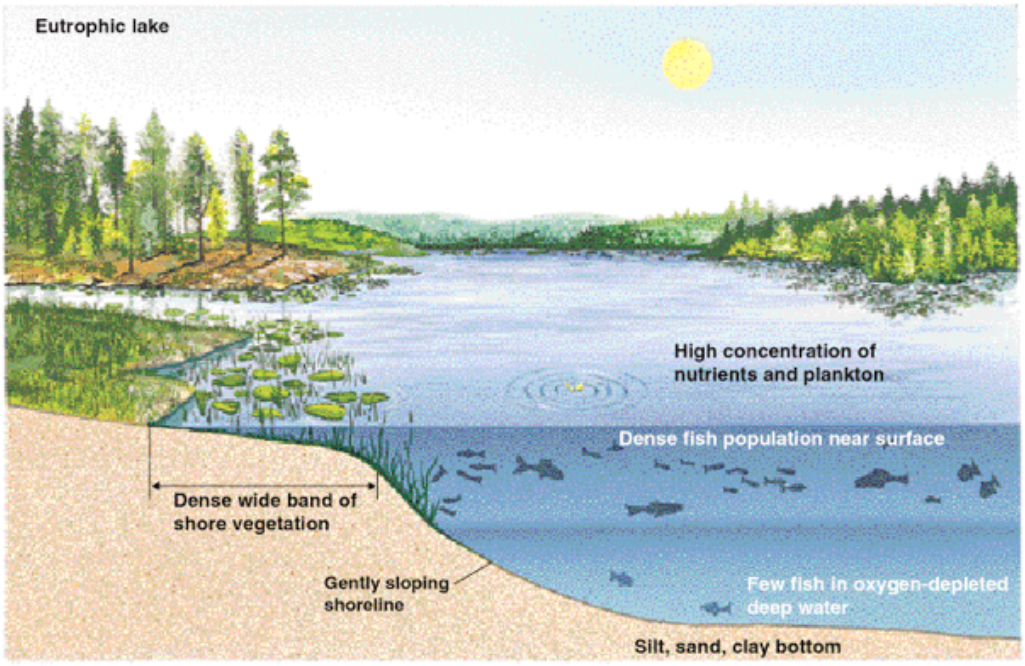
Discussion:

1. List questions posed by your group.
2. What is the impact of predation of lake trout on kokanee salmon?
3. What other factors could have lead to the decrease of kokanee salmon in Flathead Lake?
4. What additional information is needed to adequately explain the difference in life span?
5. As student scientists, what reasons might you have for the rise in lake trout population after 1984?

Kokanee Salmon Sheet 4

Since 1977, the waters of Flathead Lake have seen a 30% increase in algae growth. Proposed mining in the North Fork of the Flathead threatened water quality. More people moved into the area, creating more pollution. Towns around Flathead Lake banned phosphate detergents around this time as well. Phosphate detergents have been shown to increase nutrient levels in water and lead to algae growth. In addition, scientist have noticed a 2 degree Celsius temperature rise in Flathead Lake since 1977.

Thompson and Turk: Earth Science and the Environment, 2/e
Figure 10.28a



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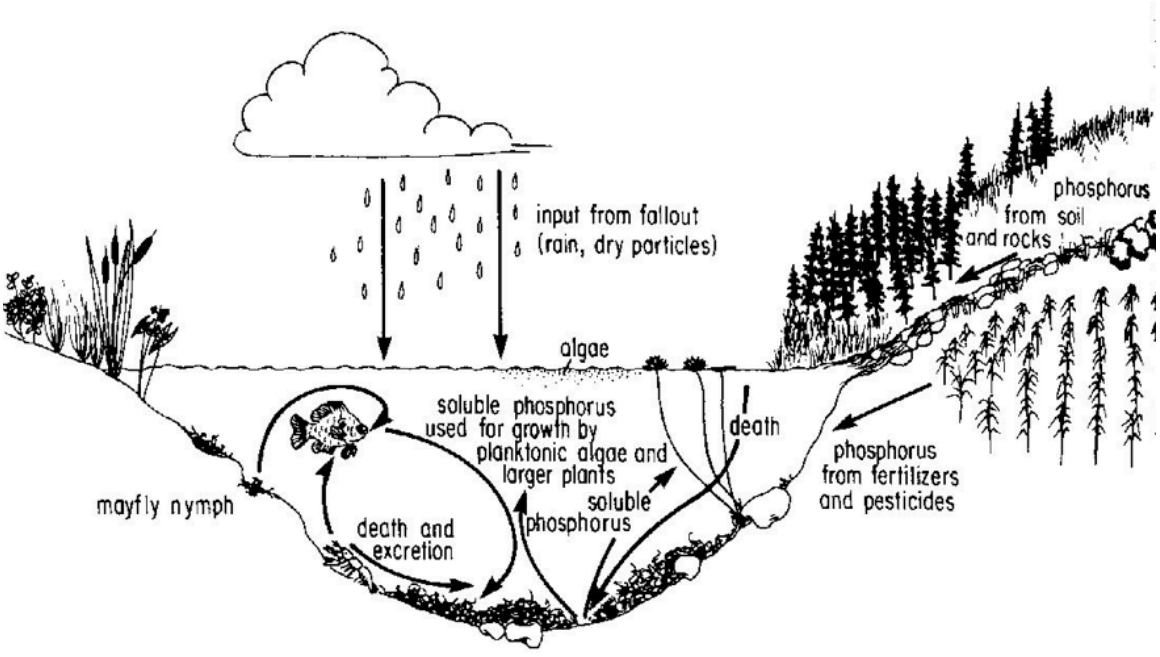

Discussion Questions:

1. List questions posed by your group.
2. What new evidence is presented and does it explain the decrease in the kokanee salmon population?
3. What effect does phosphate have on the food supply in Flathead Lake?
4. As scientists, what investigations would you conduct to determine the cause of the kokanee population drop?
5. What possible explanations are there for the reduced population size? List all that come to mind.
6. What additional questions does this information raise?

Kokanee Salmon Sheet 5

In the early 1980s, the opossum shrimp (*Mysis relicta*) were introduced to Swan, Ashley and Whitefish Lakes as a method to increase the kokanee salmon population. Because of the interconnected water systems and the fact that aquatic animals travel on boats, fishing gear, etc., the shrimp made their way into Flathead Lake.

Mysis relicta (up to 2.5 cm in length)

Mysis relicta stay on the lake bottom during the day and migrate to the surface at night, taking advantage of the colder, deeper waters. As they move to the surface, they bring along other plankton, moving the food source from the depths to nearer the surface, benefitting the fish that live in shallower water. After *Mysis relicta* was introduced, it was discovered that many of the cladcoeran and copepod populations, types of zooplankton, decreased. Since the introduction of the opossum shrimp, the population of bulltrout and cutthroat trout have also declined, leaving the lake trout the predominant specie in Flathead Lake.

Discussion Questions:

1. List questions posed by your group.
2. What new evidence is presented and does it explain the decrease in the kokanee salmon population?
3. What effect did the introduction of *Mysis relicta* have on the fish population in Flathead Lake?
4. You now have all the pieces to tell the story of the loss of kokanee salmon in Flathead Lake…can you complete it?
5. What additional questions does this information raise?

Kokanee Salmon Assessment

Based on the Kokanee Salmon Case Study, please respond to the following:

1. Provide evidence that you engaged in the Science & Engineering Practice of Asking Questions in science.

2. How was the case study an example of systems & system models?

3. Provide evidence that through the case study you were constructing explanations and designing solutions.

4. Provide evidence that through the case study you were analyzing and interpreting data.

5. Based on the case study, write a claim-evidence-reasoning example that summarizes the reason there are no longer Kokanee Salmon in Flathead Lake (HS-LS4-5).

Scoring Rubric:

3: Student meets expectations and shows advanced thinking about the concept

2: Student provides evidence that is reasonable, clearly stated, addresses each point

1: The statement is somewhat unclear, not clearly described, simplistic or shows little thought

0: The statement is very unclear or incorrect, not related to the question, problem or concept