

White Sturgeon: Life History, Life Cycle, and Population Decline

A series of three classroom lessons introducing students to British Columbia's "Dinosaurs of the Deep", their incredible long history and adaptations, and the current threats to their continued existence.

Prescribed Learning Outcome(s) met and Curriculum Organizer(s)

It is expected that students will:

Science 8

Applications of Science

- critique information presented in a variety of media
- use graphs and simple statistics to analyse data
- identify variables responsible for changes in systems

Life Science (Global Ecosystems)

- evaluate how major natural events and human activity can affect local and global environments and climate change

Math 8

Problem Solving

- solve problems that involve mathematics within other disciplines

Statistics and Probability (Data Analysis)

- formulate questions for investigation, using existing data
- display data by hand or by computer in a variety of ways

Social Studies 8

Applications of Social Studies

- identify and clarify a problem, an issue, or an inquiry
- gather and organize a body of information from primary and secondary print and non-print sources, including electronic sources
- interpret and evaluate a variety of primary and secondary sources
- assess a variety of positions on controversial issues
- plan, revise, and deliver written and oral presentations

Overview of Activity:

In this series of lessons, students will learn about the life history, adaptations, current distribution, life cycle, and threats to British Columbia's white sturgeon. Through individual and group activities, students will use their sketching, graphing, reading, and computer skills to answer questions about the sturgeon's biology, and infer reasons contributing to the population decline of these "Dinosaurs of the Deep". Real data on sturgeon populations in the Fraser and Nechako River are used. The lessons are:

- Part A: White Sturgeon Life History
- Part B: White Sturgeon Life Cycle [internet access required]
- Part C: Reasons for White Sturgeon Decline

Estimate of time required:

Number of lessons: 3 lessons

Each lesson requires: 1-2 hours

Can be done: Anytime

☒ Fall

☒ Winter

☒ Spring

☒ Summer

STREAM TO SEA ACTIVITY



Natural Area Required: None - Indoor Activity

☐ Ocean OR ☐ Stream OR ☐ Estuary

Overview of Materials and Resources Required:

Material Available for downloading:

- ☒ Activity Description(s)
 - "Activity Description Part A"
 - "Activity Description Part B"
 - "Activity Description Part C"
- ☒ Student Handout(s)
 - "Student Handout Part A"
 - "Student Handout Part B"
 - "Student Handout Part C"
- ☒ Background Information
 - "Backgrounder: White Sturgeon in British Columbia"
- ☐ Discussion Questions
 - [Included in Activity Descriptions]
- ☒ Evaluation /Assessment Tool(s)
 - "Answer Key Part A"
 - "Answer Key Part B"
 - "Answer Key Part C"

Other Required Material:

- Part A: overhead transparency or 11" x 17" paper
- Part B: computer lab with Internet access
- Part C: 2 basins or yogurt containers, sparkles, dirt, water

Suggested Assessment Activities:

- The student handouts' questions may be done in class or as homework. Answer keys are provided.

Recommended Additional Resources and Optional Enrichment Activities:

- Nechako White Sturgeon Recovery Initiative
www.nechakowhitesturgeon.org
- Upper Columbia White Sturgeon... Helping Hands for Ancients of the Deep
www.uppercolumbiasturgeon.org
- Fraser River Sturgeon Conservation Society
frasersturgeon.com
- Species at Risk Public Registry
www.sararegistry.gc.ca
- Lake Okanagan's Ogopogo
www.strangemag.com/ogopogo.html
www.tourcanada.com/ogopogo.htm

Support may be Available.

Contact your local Stream to Sea Education Coordinator or Community Advisor.

www-heb.pac.dfo-mpo.gc.ca/community/contacts/ec_e.htm

or phone (604) 666-6614 to find out if an Education Coordinator in your area assists with this activity.

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Edited by: Elizabeth Leboe



BACKGROUND: WHITE STURGEON IN BRITISH COLUMBIA

Dwelling in the Nechako, Fraser, Kootenay and Columbia Rivers is a survivor from the age of the dinosaurs - the white sturgeon. This mysterious creature is the largest freshwater fish in Canada, and has existed relatively unchanged for millions of years – surviving volcanic eruptions, ice ages and climatic upheavals. But the white sturgeon are now swimming in a current of change that is taking it to the very brink of extinction. It is ranked as **Critically Imperiled** by the British Columbia Conservation Data Centre and is an **Endangered Species** according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

In the Nechako, the white sturgeon population has dropped from what some scientists believe was a minimum of 5000 fish to less than 500. And the vast majority of those fish are more than 30 years old. Available population estimates for upper Columbia River white sturgeon have ranged between 900 and 1,400 wild fish in the Canadian portion of the basin and 1,500 to 2,000 fish from the Canada-U.S. border to the Grand Coulee Dam in the U.S. Like the Nechako population, almost all fish are greater than 30 years old, suggesting that sturgeon are either not reproducing successfully or that the young are not surviving to adulthood. As sturgeon do not begin spawning until they are 15 to 30 years old, the lack of young sturgeon in the Nechako and Upper Columbia means that an entire generation is already missing. In the Fraser the population is much larger (an estimated 62,000 animals), however, negative changes to habitat, increasing water pollution and changing water temperatures could continue to negatively impact this population.

Acipenser transmontanus, the scientific name for the white sturgeon, translates literally as sturgeon across the mountains. This tremendous fish is only found in two major rivers west of the Rocky Mountains in Canada. Both of these rivers flow in British Columbia – the Fraser (which includes the Nechako watershed) and the Columbia systems. In the lower Fraser River the white sturgeon can be massive, reaching 6 metres in length and weighing more than 800 kilograms. Individuals reaching this size may be more than 100 years old! In the Nechako system where growth is slower, a large sturgeon generally reaches about 3 meters in length. The white sturgeon's long, streamlined body has no scales. Instead, it has bony plates, called scutes, arranged in five rows down its body. With a broad, flattened head, tiny eyes and shark-like tail, is well adapted for feeding on animals found below him. Its toothless mouth is on the underside of its head, and extends out of its body in order to suck up food. White sturgeon also have whiskers, or barbels, located between the snout and the mouth, which help it find edible objects.

Another factor that makes the white sturgeon so unusual is its reproductive habits. The spawning age is around 15 years of age for males, and more than 20 years for females – which is very late for fish. Once mature, females spawn more than once, but only every 4 to 10 years. Both sexes can spawn throughout their life. Sturgeon make up for their delayed and infrequent spawning by producing vast numbers of eggs, from about 700,000 in medium sized females to 3 or 4 million in the largest! It appears that preferred spawning sites have faster currents and rockier bottoms than feeding areas. Females and males spawn together in pairs or small groups where they release eggs and sperm into the fast flowing water. The small, brown eggs quickly sink and stick to the riverbed, where they are relatively safe from predators. Depending on water temperature, the eggs will hatch in 5 to 25 days, releasing larvae with yolk sacs attached, that look a bit like tadpoles. Larvae take about two weeks, to develop into fry – miniature sturgeon complete with long snout and scutes. In the lower Fraser River, juveniles reach about 50 cm by age 5, and then grow about 5 cm per year until the age of 25. Nechako white sturgeon are believed to have a slower growth rate, due to the cooler temperatures, shorter northern summers and differences in the types of foods available.

Adult white sturgeon live entirely on animal matter. As they search for food below them, they primarily use touch and taste, rather than eyesight, to find food. They do this by following an odour,



or simply by drifting in a prime location and waiting for the food to come by. Young sturgeon may snack on larval insects, freshwater clams and snails, while older sturgeon feed primarily on fish, including live adult salmon and even smaller sturgeon.

The reasons for this species' dramatic decline are currently being studied on the Nechako, Upper Columbia and Fraser systems. Contributing factors may include over-fishing prior to the 1994 ban on angling, incidental catches and poaching since then, pollution and changes to the river landscape by human construction. Changes to the level and times of water flows in both the Upper Columbia and the Nechako Rivers and may also have had an important effect on the sturgeon. These changes to water flow are a result of operating reservoirs and the associated management of the flow on these rivers. In the lower Fraser, white sturgeon were nearly driven to extinction in the late 1800's and early 1900's by an aggressive commercial fishery. Gill-netting for salmon in the lower Fraser River until the 1980's may also have had a substantial impact. Although directed commercial fishing has since been halted, the remaining population has been slowly recovering over the past century, but the increased pressures of urbanization continue to be a threat.

All three populations have been studied intensively during the past decade. Some of this work has produced an unwelcome conclusion – both the Upper Columbia and Nechako white sturgeon are in a critical state of decline. Unless something is done, and done soon, the great creatures will likely go extinct. With so many stakeholders involved along each of the rivers, it was imperative all interested parties gather together, to begin working as a team in recovery planning efforts. Recovery initiatives for each of the populations have been created, and each is ultimately responsible for identifying the reasons for white sturgeon decline, and for the design and implementation of habitat protection, restoration and management options. Each group has developed a recovery plan that will help restore each white sturgeon population in Canada. This will take many years to implement, but the hope is that each team will be able to rebuild and maintain the populations until the various causes of the decline can be determined and corrected.

SARA, the Species at Risk Act, has also been set in place to prevent endangered or threatened wildlife from becoming extinct or lost from the wild, and to help in the recovery of these species. If white sturgeon become a listed species under SARA, as a response to COSEWIC having determined that they are endangered, they will be afforded additional protection by making it an offence to:

- Kill, harm, harass, capture or take an individual of a listed species that is extirpated, endangered or threatened;
- Possess, collect, buy, sell or trade an individual of a listed species that is extirpated, endangered or threatened, or its part or derivative;
- Damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species if a recovery strategy has recommended its reintroduction.

SARA is one of the many tools needed to help bring this species back from the brink of extinction. A decision on whether the white sturgeon will be listed under SARA should take place in August 2006. For more information:

- Nechako White Sturgeon Recovery Initiative
www.nechakowhitesturgeon.org
- Upper Columbia White Sturgeon Recovery Initiative
www.uppercolumbiasturgeon.org
- Fraser River Sturgeon Conservation Society
www.frasersturgeon.com/home.html.
- Species at Risk Act
www.sararegistry.gc.ca

NECHAKO RIVER WHITE STURGEON

(*Acipenser transmontanus*)

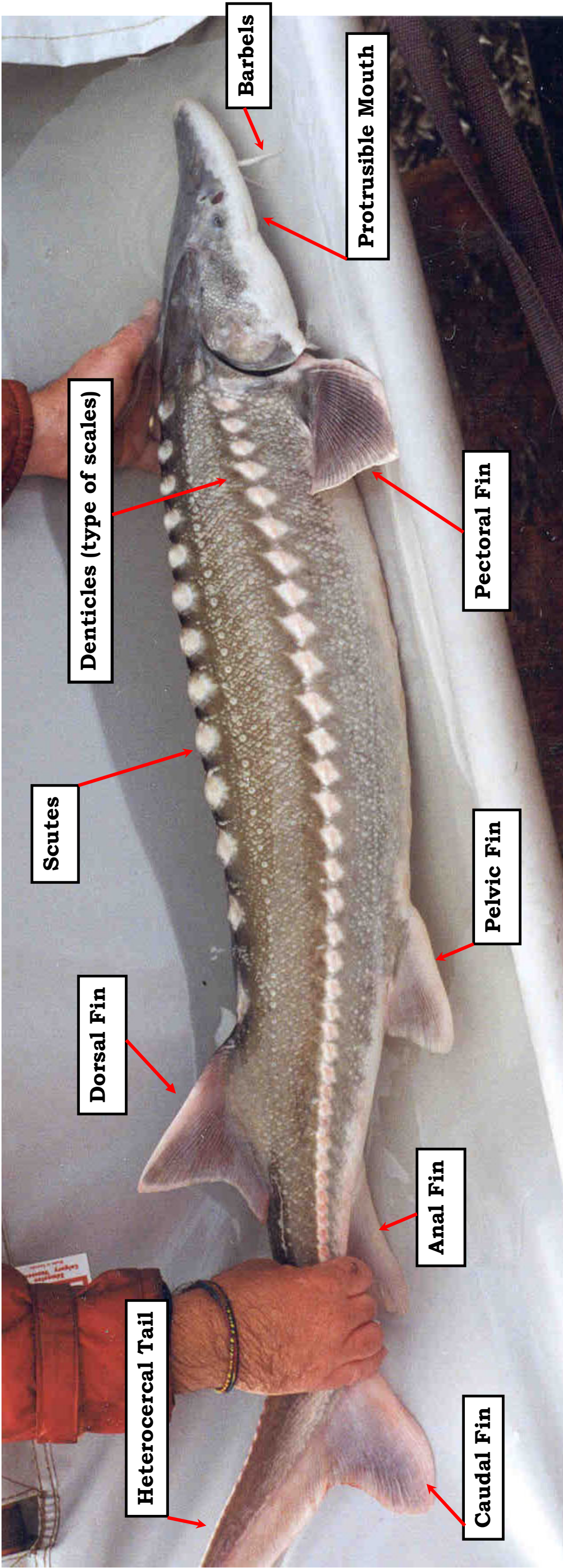


Photo: Nechako White Sturgeon Recovery Initiative

ACTIVITY DESCRIPTION PART A: WHITE STURGEON LIFE HISTORY

Duration: 1-2 hours

Prescribed Learning Outcomes

Applications of Science

It is expected that students will:

- Identify and clarify a problem, an issue, or an inquiry
- Assess a variety of positions on controversial issues
- Plan, revise, and deliver written and oral presentations

Learning Objectives

Students will be able to:

1. Understand that sturgeon are prehistoric fish
2. Explain how adaptations have allowed sturgeon to survive for 175 million years
3. Explain how adaptations have allowed sturgeon to exploit the deep rivers and lakes

Overview of Lesson

Students will brainstorm what they know and what they want to learn about white sturgeon. The teacher will record this information on a “Know-Wonder-Learn” (KWL) chart at the front of the classroom. The students will then work through 3 stations to learn about the life history of white sturgeon, their adaptations, and distribution today. The teacher will summarize what they have learned about sturgeon’s life history and adaptations, while being introduced to subsequent lessons on lifecycle and reasons for decline.

Key Words

- *Acipenser transmontanus*
- adaptation
- anadromous
- anal fin
- barbels
- caudal fin
- denticles
- dorsal fin
- landlocked
- pectoral fin
- pelvic fin
- protractible mouth

Materials

- “Nechako River White Sturgeon” anatomy pictures printed on 11” x 17” paper (two colour print-outs or one overhead).
- “White Sturgeon Anatomy” worksheet (one per student)
- “Adaptations – How White Sturgeon Use Their Environment” student handout (one per student)
- “Dinosaurs of the Deep Background Reading for Students” (one per student)
- “Dinosaurs of the Deep worksheet” (one per student)

Procedure

1. Introduce unit by asking students what they think our new unit is on. Give clues such as “What type of fish has outlived the dinosaurs, is known to eat algae, shellfish, clams, tin cans, and onions?”



2. Fill out a “KWL” chart with students offering what they know about sturgeon. Use the information to create a word web on the board.
3. While stations are self explanatory, a quick walk through of each will ensure they run smoothly. Divide students into three groups, and assign each group to a station. Have students work through each of three stations to learn about sturgeon’s life history, anatomy and adaptations (15 minutes/station).

Station 1: Anatomy

Using the “Nechako River White Sturgeon” picture as a guide, each student fills in the “White Sturgeon Anatomy” student handout.

Station 2: Adaptations

Using the “Nechako River White Sturgeon” picture as a guide, each student completes the questions on the “Adaptations – How White Sturgeon Use Their Environment” student handout.

Station 3: Dinosaurs of the Deep

Using the “Dinosaurs of the Deep: Background Reading for Students” handout, students complete the “Dinosaurs of the Deep Worksheet” and hypothesize why sturgeon never went extinct.

Evaluation

1. Review with students:
 - “White Sturgeon Anatomy” Worksheet
 - “Adaptations - How White Sturgeon Use Their Environment”
 - “Dinosaurs of the Deep Worksheet”
2. In their groups, students can present to the class the hypothesis they derived on why sturgeon were able to survive during a time when many other species became extinct (question 12 from “Dinosaurs of the Deep Worksheet”).

Extension Activity: Demystifying Ogopogo.

At one time, Loch Ness in Scotland was heavily populated with sturgeon. Okanagan Lake is famous for its Ogopogo. Acting as detectives, students use the following websites to help uncover if Ogopogo is really a sturgeon. If computer time is unavailable students could use books instead.

www.strangemag.com/ogopogo.html

www.tourcanada.com/ogopogo.htm

STUDENT HANDOUT PART A:
ADAPTATIONS – HOW WHITE STURGEON USE THEIR ENVIRONMENT

1. The sturgeon's mouth resembles a vacuum hose. Where in the river would you expect to find sturgeon feeding? Think about where their mouth is placed.
2. Barbels are flesh-like whiskers found between the mouth and the snout. The barbels help the sturgeon detect food. Think about how cats use their whiskers and what senses you use when you eat. What senses do you think the barbels use?
3. The sturgeon's scutes are like a razor; these bony plates are razor sharp. In fact, biologists who handle sturgeon often receive many cuts on their hands. Scutes act like armour. Why would this be important to sturgeon? And at what period in their life history do you think the scutes are the most important?
4. Like other prehistoric fish, sturgeon do not have scales, but denticles. Denticles are scale-like plates found along the skin of the sturgeon, which give the skin its roughness. If you rubbed your hand along their skin one way it would feel smooth; rubbing it the other way would feel very rough. How would this feature help a sturgeon survive in a watery environment?
5. Why do you think white sturgeon are called white?
6. The type of colouring white sturgeon have is called counter-shading. Counter-shading means that a fish is dark top and light below. How is the white sturgeon in the picture coloured?
7. How do you think counter-shading would camouflage white sturgeon in the river?



STUDENT HANDOUT PART A: DINOSAURS OF THE DEEP - BACKGROUND READING FOR STUDENTS

Evolution

Fish first appeared over 500 million years ago, and sturgeon first appeared approximately 175 million years ago. Today, these “dinosaurs of the deep” remain relatively unchanged. While many of the Earth’s first fish have gone extinct, and many more have evolved to become the first vertebrates, sturgeon have remained relatively unchanged. These characteristics include: a cartilaginous skeleton; fine-grained skin with scale-like plates (denticles); torpedo shape; upturned tail fin; mouth set far back on the underside of the head; a blunt nose; and bony scutes. Sturgeon are well-adapted bottom feeders. They use their protractible tube mouth like a vacuum to suck up whatever they come across on the river bottom. Because sturgeon spend much of their life in the dark depths, their eyes are very small and their eyesight poor. To compensate, they have developed highly sensitive whiskers or barbels to help locate prey.

Life Cycle

Sturgeon are anadromous fish, they can spend all or part of their adult life cycle in salt water returning to fresh water to spawn. Historically, white sturgeon on the lower Columbia River spent much of their life in the ocean, feeding in the rich marine environment, and then returning to the rivers to spawn. Scientists believe that white sturgeon on the upper Columbia River did not historically migrate to the ocean like the sturgeon of the lower Columbia. However, scientists do believe that the sturgeons’ movements have been greatly affected within the upper Columbia Basin by the development of numerous hydroelectric dams, and today they are effectively a landlocked species spending no time in the ocean.

Distribution

There are 29 species of sturgeon found throughout the world. All of these species are found in the Northern Hemisphere including Europe, Asia and North America. Of the 9 species found in North America, two are located on the West Coast. These include both the green sturgeon (*Acipenser medirostris*) and the white sturgeon (*Acipenser transmontanus*). *Acipenser transmontanus*, or “sturgeon beyond the mountains”, are found in three major drainages: California’s Sacramento River; the Columbia River; and the Fraser River. In British Columbia, spawning populations of white sturgeon occur in three rivers: the Fraser; the Nechako; and the Columbia/Kootenay.



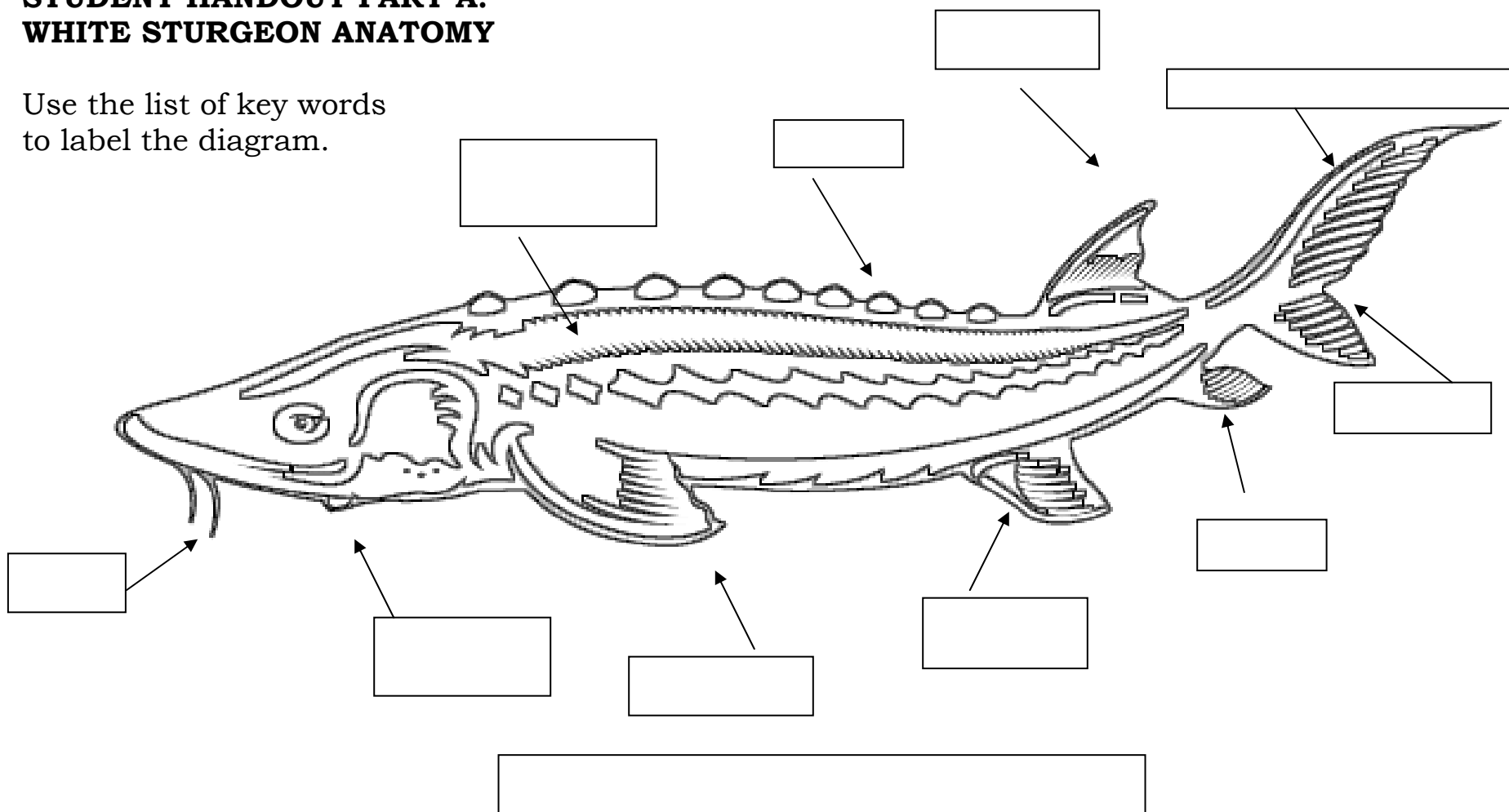
**STUDENT HANDOUT PART A:
DINOSAURS OF THE DEEP WORKSHEET**

1. When did sturgeon first appear on the time line?
2. When did dinosaurs first appear on earth?
3. Sturgeon are anadromous. What does this mean?
4. Draw a picture of where you might find a sturgeon living.
5. Why have sturgeon taken advantage of the deep rivers and lakes?
6. Sturgeon can grow up to 6 meters long. Do you think a fish this size has predators? Why?
7. Name one similarity that sharks and sturgeon share.
8. What is “counter-shading” and why is it an advantage?
9. Name one similarity that crocodiles and sturgeon share.
10. Give one reason why you think crocodiles, sharks and sturgeon have survived to present day?
11. What were possible events that caused the dinosaurs to go extinct?
12. A paleontologist is a person who studies species that existed long ago. Often, paleontologists use fossils to help discover where certain animals lived, what they ate, and how they survived. Sturgeon are considered “living fossils”.
As a paleontologist, develop a theory with your group about why sturgeon were able to survive during a time when many other species became extinct.



STUDENT HANDOUT PART A: WHITE STURGEON ANATOMY

Use the list of key words
to label the diagram.



KEY WORDS

Acipenser transmontanus
Caudal fin
Heterocercal tail
Protrusible mouth

Anal fin
Denticles
Pectoral fin
Scutes

Barbels
Dorsal fin
Pelvic fin



ANSWER KEY:

ADAPTATIONS – HOW WHITE STURGEON USE THEIR ENVIRONMENT!

1. The vacuum hose resembles a sturgeon's mouth. Where in the river would you expect to find sturgeon feeding? Think about where their mouth is placed.
Sturgeon are bottom feeders, which means they find most of their food on the bottom of the river.
2. Barbels are flesh-like whiskers found between the mouth and the snout. The barbels help the sturgeon detect food. Think about how cats use their whiskers and what senses you use when you eat. What senses do you think the barbels use?
Barbels detect the odour of food for sturgeon.
3. The razor represents the sturgeon's scutes. These bony plates are razor sharp. In fact, biologists who handle sturgeon often receive many cuts on their hands. Scutes act like armour. Why would this be important to sturgeon? And at what period in their life history do you think the scutes are the most important?
Scutes are sharpest when sturgeon are young. This is important because they are much smaller fish at this time and the scutes help make them unappetising to other fish.
4. Like other prehistoric fish, sturgeon do not have scales, but denticles. Denticles are scale-like plates found along the skin of the sturgeon, which give the skin its roughness. If you rubbed your hand along their skin one way it would feel smooth; rubbing it the other way would feel very rough. How would this feature help a sturgeon survive in a watery environment?
Denticles help protect sturgeon from other fish.
5. Why do you think white sturgeon are called white?
Because of the white on their stomach.
6. The type of colouring white sturgeon have is called counter-shading. Counter-shading means that a fish is dark top and light below. How is the white sturgeon in the picture coloured?
The sturgeon is light to dark grey above and white below.
7. How do you think counter-shading would camouflage white sturgeon in the river?
Because sturgeon are bottom feeders they spend a lot of time near the bottom of the river where it is dark. Their dark colour helps them blend in down here. As well, if there are fish below them in the river the light colour of their underside helps them blend in the light filtering through the water.

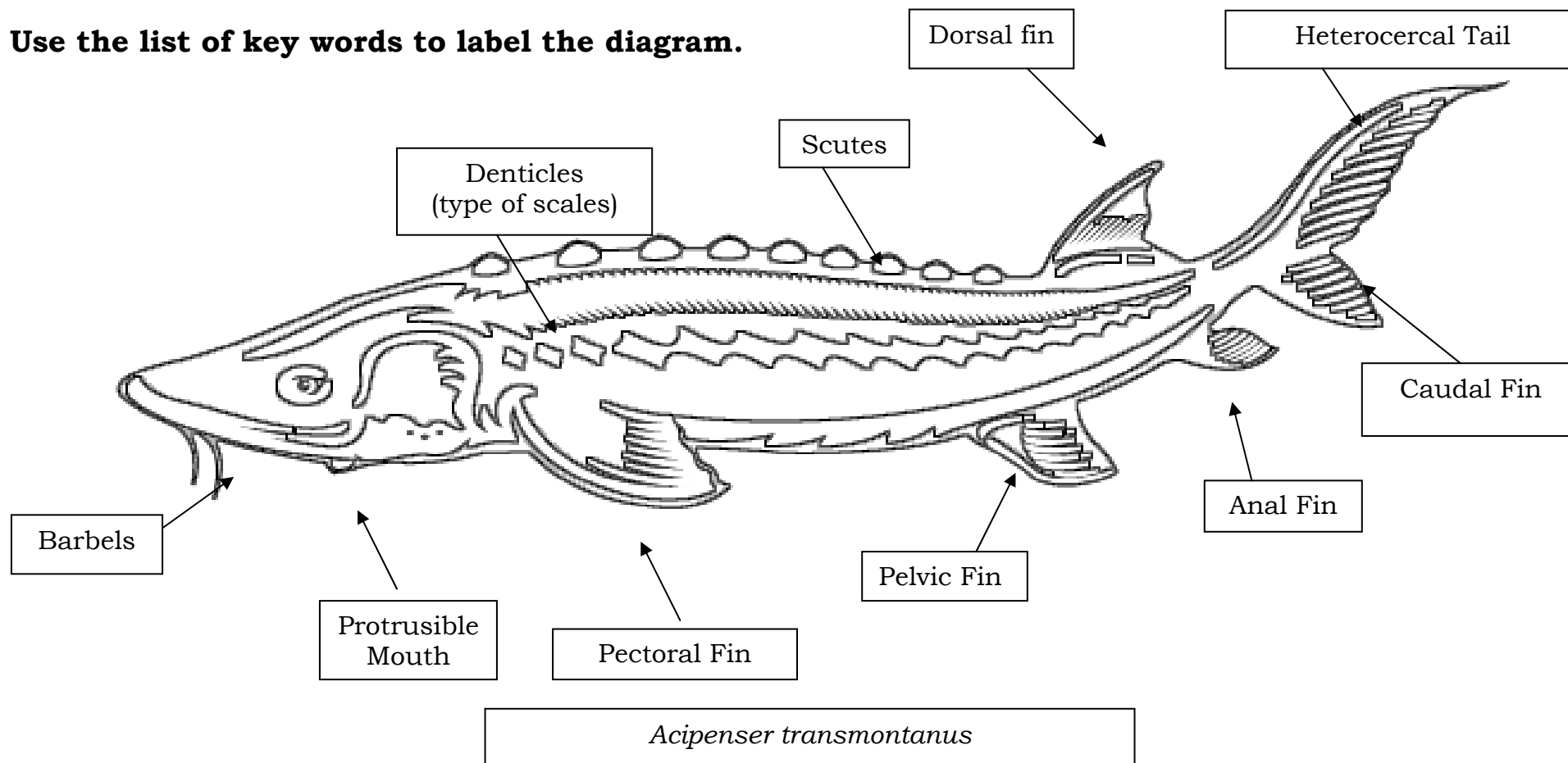
ANSWER KEY:

ADAPTATIONS – DINOSAURS OF THE DEEP TIMELINE

1. When did sturgeon first appear on the time line?
175 mya
2. When did dinosaurs first appear on earth?
325 mya
3. Sturgeon are anadromous. What does this mean?
Anadromous means they can live in both marine and fresh water.
4. Draw a picture of where you might find a sturgeon living.
5. Why have sturgeon taken advantage of the deep rivers and lakes?
There is an abundance of habitat because of the number of deep rivers and lakes in the Northern Hemisphere. As well there are few other species that have adapted to living in deep water habitat which has ensured the sturgeon have very little competition.
6. Sturgeon can grow up to 6 meters long. Do you think a fish this size has predators? Why?
Sturgeon are only predated on during their egg and larvae stage, by the time they are a few years old they have no predators other than humans.
7. Name one similarity that sharks and sturgeon share.
Denticles
8. What is “counter-shading” and why is it an advantage?
Counter-shading is when a fish is dark on top and light below. To a fish swimming above a shark, the shark blends into the waters dark depths. To a fish swimming below a shark, the shark blends into the light filtering through the water above.
9. Name one similarity that crocodiles and sturgeon share.
Generalists
10. Give one reason why you think crocodiles, sharks and sturgeon have survived to present day?
They are all generalists, allowing them to take advantage of whatever food was available.
11. What were possible events that caused the dinosaurs to go extinct?
There are various theories why the dinosaurs went extinct: an exploding star, the earth's collision with a comet, global warming, a giant solar flare, and a meteor hitting earth.
12. A Paleontologist is a person who studies species that existed long ago. Often paleontologists use fossils to help discover where certain animals lived, what they ate, and how they survived. Sturgeon are considered living fossils.
As a paleontologist develop with your group a theory why sturgeon were able to survive during a time when many other species became extinct.
[Answers will vary].

STUDENT HANDOUT: WHITE STURGEON ANATOMY

Use the list of key words to label the diagram.



KEY WORDS

Acipenser transmontanus
Caudal fin
Heterocercal tail
Protrusible mouth

Anal fin
Denticles
Pectoral fin
Scutes

Barbels
Dorsal fin
Pelvic fin



ACTIVITY DESCRIPTION PART B: WHITE STURGEON LIFE CYCLE

Duration: 1-2 hours

Prescribed Learning Outcomes

It is expected that students will:

- gather and organize a body of information from primary and secondary print and non-print sources, including electronic sources
- interpret and evaluate a variety of primary and secondary sources
- critique information presented in a variety of media

Learning Objectives

Students will be able to:

1. identify white sturgeons developmental stages
2. navigate several sturgeon related website
3. compare the lifecycle of the sturgeon to kokanee salmon

Overview of lesson

Through a review of one or two internet sites, students will be introduced to the white sturgeon's and (by way of comparison) the kokanee salmon's lifecycle life cycles. Applying what they have learned, students will complete a related Venn diagram and question sheet.

Materials

- "White Sturgeon Life Cycle – Background for Students" (one per student or one overhead)
- Access to a computer lab
- "Fact Finding Mission" worksheet (one per student)
- "Life Cycles of Nechako White Sturgeon and Kokanee Salmon" Venn diagram (one per student)
- "Upper Columbia White Sturgeon" website
www.uppercolumbiasturgeon.org.
- "Kokanee Salmon Heritage Project" website [optional]
www.livinglandscapes.bc.ca/thomp-ok/kokanee-salmon/index.html

Key Words

- broadcast
- fin ray
- hatch
- juvenile
- larvae
- otoliths
- redd
- spawning
- substrate
- turbidity
- velocity

Procedure

1. Provide students the "White Sturgeon Lifecycle – Background for Students" handout. Have them read it, and then review topics and key words with the class.
2. Computer Lab:
 - a) Students go to the "Upper Columbia White Sturgeon" website and click on "Biology and Life History Tour". Using information from this website, have students complete the "Fact Finding Mission" worksheet of questions on the life cycle of white sturgeon.
 - b) Have students fill in the "Life Cycles of Nechako White Sturgeon and Kokanee Salmon" Venn diagram comparing the lifecycle of both the white sturgeon and the



BC White Sturgeon: Life History, Lifecycle and Population Decline

kokanee salmon. Direct them to the “Kokanee Salmon Heritage Project website if information about Kokanee salmon is required (click on “Table of Contents”, then “Life Cycle”).

3. Review answers with the class for the two worksheets.
4. Discussion: Ageing white sturgeon
 - a) Discuss the following questions:
 - **It is expensive and difficult to determine the age of fish; why do we bother?** –
It helps biologists determine how many fish are spawning, if young fish are surviving, if the population is ageing etc.
 - **How are most fish aged?**
Their scales
 - **How are white sturgeon aged?**
Their fin ray
 - **Why would white sturgeon not be aged using their otolith?**
Unlike kokanee salmon that die after spawning, white sturgeon do not. As a result, it would not be possible to remove this bone (the otolith) without killing the fish.
 - **Why is it important for scientists to know how old a fish is?**
By knowing how old a fish is, scientists can find out if young fish are surviving and how old a species can get.
 - **Why do you think fish in the lower Columbia River grow larger than fish in the upper Columbia River?**
Fish in the lower Columbia have access to the ocean where there is more food.

Evaluation

1. Review with students:
 - “Fact Finding Mission” Worksheet
 - “White Sturgeon Kokanee Salmon Venn diagram



STUDENT HANDOUT PART B: WHITE STURGEON LIFE CYCLE - BACKGROUND READING FOR STUDENTS

Life Cycle

Because sturgeon live so long, they reach maturity at a much later age than most species. In both the Nechako and Upper Columbia, female sturgeon reach maturity around 30 years of age, while males reach maturity during their teens to mid 20s. Mature sturgeon spawn between May to July when the water temperature is between 14-18°C. The following are important components to a high-quality spawning site:

- substrate - clean stones, not sand
- water velocity - swift flowing, such as near rapids or below waterfalls or dams
- depth – deep water
- turbidity - sediment in the water provides cover for eggs and aids in their dispersal

While a single female can produce several million eggs, they do not spawn every year; instead, they spawn every 4 to 5 years. Whether a female spawns depends on having an adequate spawning site and the proper water temperature. If conditions are unfavourable, she will reabsorb her eggs and miss spawning that year. Unlike female kokanee salmon that dig redds (nests), female sturgeon broadcast (release) their eggs into water; one or more male sturgeon fertilize these eggs. Once the eggs are fertilized they sink to the bottom of the river where they adhere to plants and rocks. There is no care provided to the eggs or young sturgeon by adult fish. Eggs hatch between 7 and 10 days (cooler temperatures cause them to hatch later) into tadpole-like larvae. Larvae live off their yolk sac for the first 12 days and then start to feed on aquatic insects and zooplankton. After 20 days, larvae change into juveniles, resembling their parents with a full set of scutes, and fins. White sturgeon are vulnerable throughout their egg and larvae stage. In areas of poor habitat they are susceptible to predation and lack of food. Less than 0.1 percent of juveniles survive past their first year.

Ageing Sturgeon

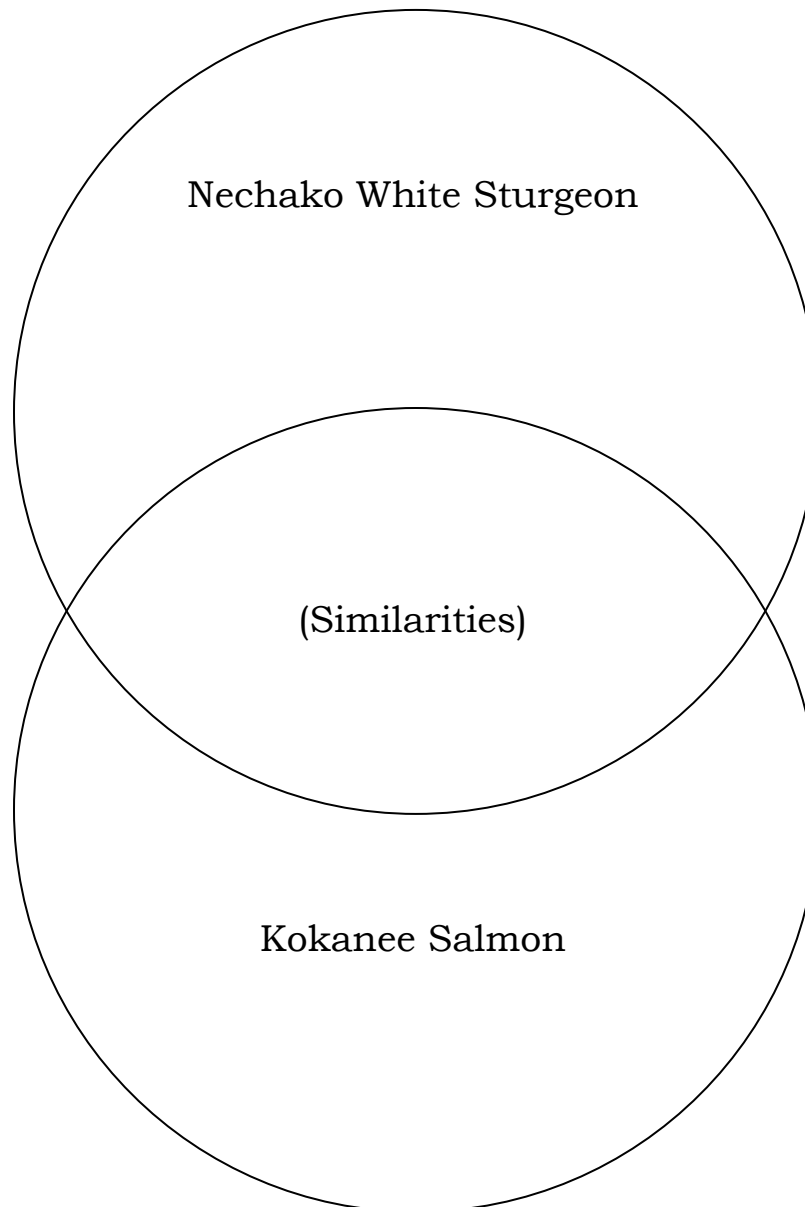
Because a sturgeon does not have scales, scientists use a small piece of a sturgeon's pectoral fin to determine its age. The rays are finger-like pieces of bone that give a fin its strength. Like the rings of a tree, layers are added each year to a ray. These layers can be counted to provide the sturgeons' age. As for a tree, the space between the layers shows how fast the sturgeon is growing.

To provide consistency, sampling of the fin ray is always done in the same place and in the same way. A small section of the left pectoral fin ray is cut using a hacksaw blade. Once this is done a scalpel is used to completely remove the sample from the rest of the fin. Finally, using a jeweller's saw the sample is cut into 4 to 6 cross sections. Cross sections are mounted onto slides which can be viewed under a microscope. Because fin rays are external, they are susceptible to physical damage, if this is the case, the same procedure would be done on the right pectoral fin.

To a large extent food supply and temperature determine growth rates. Scientists have learned that sturgeon in the lower Columbia River with access to the ocean grow larger and at a more constant rate, than the fish that live in the upper Columbia River, with no access to the ocean. Fish in the Nechako have even slower growth rates than those in the upper Columbia.

STUDENT HANDOUT PART B:
LIFE CYCLES OF NECHAKO WHITE STURGEON AND KOKANEE SALMON

Name	Subject
Teacher	Date



STUDENT HANDOUT PART B: FACT FINDING MISSION

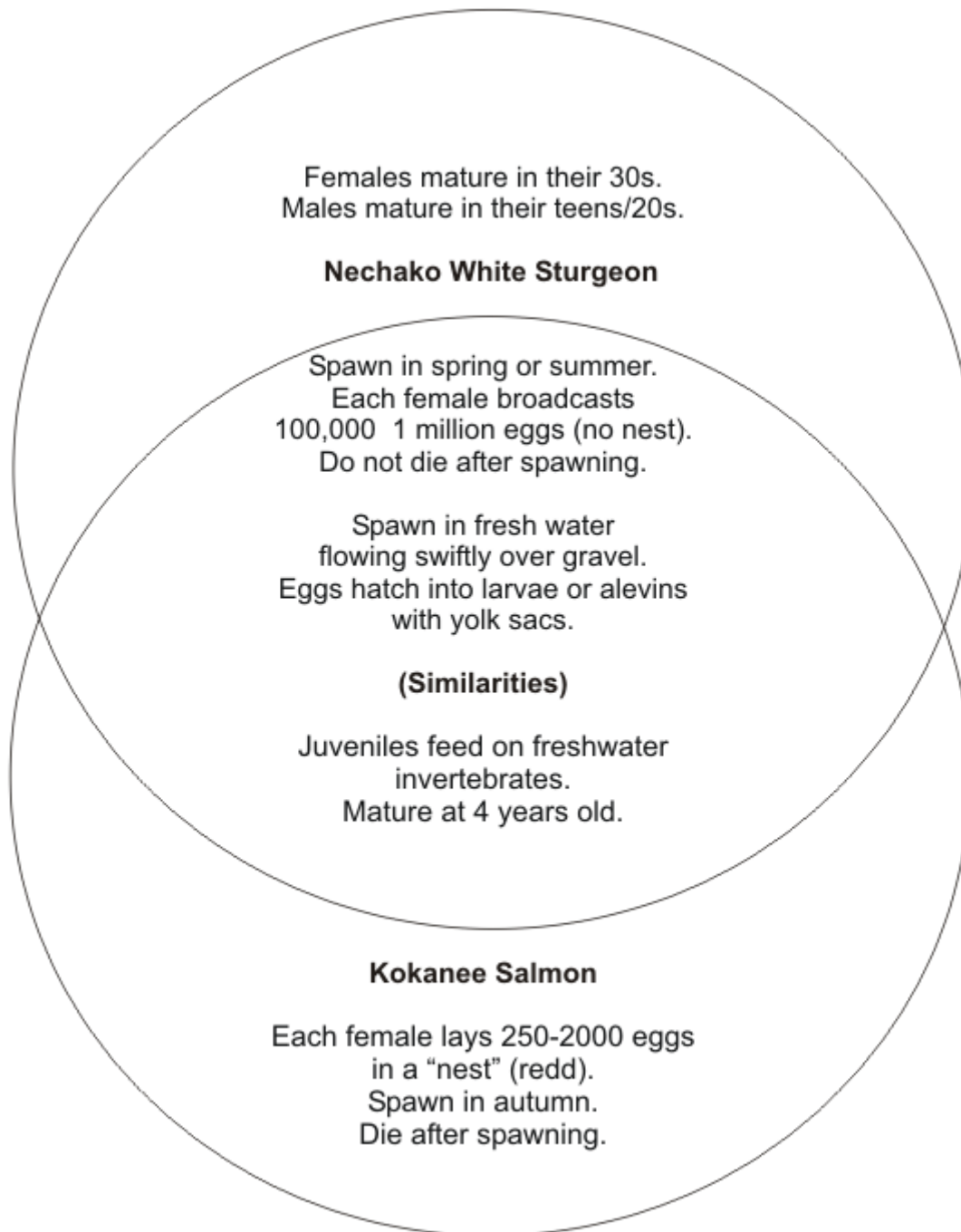
You have just been hired by the Department of Fisheries and Oceans (DFO) to study white sturgeon! Before you head for the Columbia River you need to gather some facts on the white sturgeon's life cycle. Fortunately, you know exactly where to look, **The Upper Columbia White Sturgeon** website www.uppercolumbiasturgeon.org. By using the *Biology and Life History Tour*, you will be able to answer the questions below.

1. Females mature at ____ years, and males at ____ years.
2. Spawning sturgeon look for sites that have these 4 things:
 - a) _____ c) _____
 - b) _____ d) _____
3. Female salmon dig redds (nests) for their eggs, what do white sturgeon do?
4. Why do you think that female sturgeon deposit such a large number of eggs?
5. If conditions are not right, a spawning female will reabsorb her eggs and try spawning the next year. Why is this a good adaptation?
6. The eggs that are laid are sticky, why might this be?
7. How long does it take for the eggs to hatch?
8. Young sturgeon larvae look like a _____?
9. Why is it important that young larvae be able to drift downstream?
10. Where in the river do young sturgeon feed?
11. Name 3 things that sturgeon eat:
 - a) _____ b) _____ c) _____
12. Why are sturgeon called "dinosaurs of the deep"?



ANSWER KEY PART B:
LIFE CYCLES OF NECHAKO WHITE STURGEON AND KOKANEE SALMON

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ANSWER KEY PART B:
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1. Females mature at 30 years, and males at 15-20 years.
2. Spawning sturgeon look for sites that have these 4 things:
 - a) *substrate*
 - b) *water depth*
 - c) *water velocity*
 - d) *turbidity*
3. Female salmon dig redds (nests) for their eggs, what do white sturgeon do?
Broadcast their eggs.
4. Why do you think that female sturgeon deposit such a large number of eggs?
It increases the chances of some eggs surviving.
5. If conditions are not right, a spawning female will reabsorb her eggs and try spawning the next year. Why is this a good adaptation?
She doesn't waste her energy: if conditions aren't right for spawning, they are not right for healthy egg development.
6. The eggs that are laid are sticky. Why might this be?
The stickiness helps eggs adhere to the river bottom, so they are not flushed downstream.
7. How long does it take for the eggs to hatch?
7-10 days.
8. Young sturgeon larvae look like a tadpole.
9. Why is it important that young larvae be able to drift downstream?
Drifting downstream helps larvae find food, and avoid predators by locating hiding places.
10. Where in the river do young sturgeon feed?
On the bottom
11. Name 3 things that sturgeon eat:
 - a) *amphipod*
 - b) *mysids shrimp*
 - c) *small fish*
12. Why are sturgeon called "dinosaurs of the deep"?
Because they are so old and have changed little over 175 million years!



ACTIVITY DESCRIPTION PART C: REASONS FOR WHITE STURGEON DECLINE

Duration: 1-2 hours

Prescribed Learning Outcomes

It is expected that students will:

- use graphs and simple statistics to analyze data
- critique information presented in a variety of media
- identify variables responsible for changes in systems

Learning Objectives

Students will be able to:

1. create a bar graph showing the depleted numbers of white sturgeon in the Nechako River
2. understand 2 possible reasons for the decline of sturgeon stocks
3. understand how hydroelectric dams trap sediment

Overview of Lesson

Students are introduced to possible reasons why this species is in decline and is endangered. Students work individually to graph real data on the sturgeon population in the upper Nechako River. Using what they have learned from their graphs, students are able to infer events that could be contributing to sturgeon decline. Impacts of hydroelectric dams are examined in more detail through a demo done by the teacher. (This can also be a student led experiment)

Key Words

- bio-accumulation
- dikes
- extirpated
- hydroelectric dam
- mortality
- population
- reservoir
- sediment load
- turbidity

Materials

- “Reasons for White Sturgeon Decline - Background Reading for Students” (one per student)
- “Decline of White Sturgeon in the Nechako River” worksheet (one per student)
- graph paper (one sheet per student)
- 2 basins or yogurt containers, sparkles, dirt, water (one set for the teacher)
- “Population Assessment “ graph (overhead)

Procedure

1. Graphing exercise (bar or line graph)
 - a) Students use the raw data provided in the “Decline of White Sturgeon in the Nechako River” worksheet to create a bar graph showing the actual numbers of white sturgeon in both the lower Fraser and Nechako rivers.
 - b) Have students interpret the graph, looking at actual and predicted numbers for different age classes. They can then talk about some of the reasons why there are so few young fish.
2. Hydroelectric dam experiment (demonstration or in pairs or small groups)



- a) Fill the two basins or yogurt containers with water. Explain that one represents river water, now impounded in a reservoir behind a dam and the other one represents the water in the lower river below the dam.
- b) Add dirt to the water of the “reservoir” basin and stir the water.
- c) With students watching the water, pour water from the “reservoir” basin into the “lower river” basin
 - **What does the water flowing out of the upper basin (reservoir) look like?**
Clear.
 - **What is the water in the lower river basin like?**
Cloudy, turbid.
 - **What happened to the sediment?**
It flowed into lower river basin
 - **How do you think clearer water affects sturgeon?**
Clear water provides clean, healthy habitat.
- d) Now sprinkle sparkles into the lower river basin. These sparkles represent pollution occurring along the lower half of the Nechako.
 - **Sprinkles represent pollution. What happens to it?**
Pollution sinks to the river’s bottom.
 - **Where do sturgeon eat?**
From the bottom of the river.
 - **Sturgeon are located where in their food chain?**
At the top.
 - **Do you think they would be affected by pollution?**
(Answers will vary)

Evaluation

1. Correct graph using overhead.
2. Review with students:
 - “Decline of White Sturgeon in the Nechako River” worksheet

Extension Activity

Have students work in pairs to create a reservoir and river using yoghurt containers.

STUDENT HANDOUT PART C: REASONS FOR WHITE STURGEON DECLINE BACKGROUND READING FOR STUDENTS

The upper Nechako white sturgeon population is in trouble: White sturgeon are in danger of becoming extinct. The Committee on the Status of Endangered Wildlife in Canada describes white sturgeon as **endangered**. Provincially, they are **red-listed** (a critically imperiled species). The reasons for this decline in their numbers are mostly human-related and have occurred within the past 125 years (remember these fish have been on Earth for 175 million years).

The following is a list of possible sources of stress to the Nechako white sturgeon population. Human-related threats to white sturgeon are cumulative, and include:

1. Hydroelectric dam construction

- Dams have changed water quality and quantity. Because of decreased turbidity in reservoirs behind dams, the water is clearer. Clear water may make it more difficult for young sturgeon to hide from predators.
- Dams have reduced water flow and water temperature, which can have a possible negative impact on spawning. White sturgeon prefer to spawn in fast moving water.

2. Predation

- It is possible that changes to the river, including sediment load and water clarity, have increased the number of predators that feed on white sturgeon eggs and other vulnerable life stages.

3. Decrease food

- There may be less of the food preferred by juvenile sturgeon available today than there was historically because of changes to the river.

4. Industrial and municipal pollution

- Pollution can have a negative effect on water quality, which may cause a decrease in sturgeon survival and reproduction.
- Because white sturgeon can live to be over 100 years old, they tend to concentrate chemical contaminants such as copper, zinc and heavy metals in their flesh. This is known as “bioaccumulation”.

5. Over-fishing

- Humans historically captured sturgeon for roe (eggs, caviar), meat and large ‘trophy’ fish. It is now prohibited to fish for white sturgeon.

6. Altered channel structure

- Changes in the amount of water and the speed at which it travels have redistributed bottom sediments in the river. Research is needed to see how such changes have restructured the flood plain habitat required for adult white sturgeon spawning, feeding and juvenile rearing habitats.

7. Rooted aquatic plants

- Reductions in the speed of the river’s current, along with municipal nutrient loads, have greatly increased the numbers of rooted aquatic plants in the Nechako River. This increase in plant life can suppress oxygen levels, change water chemistry, and



increase sedimentation. These are all factors that could have a negative influence on white sturgeon spawning and survival rates.

An interesting note – it is hard to kill an individual white sturgeon, but easy to threaten their continued population as a whole. Adult individuals themselves have low mortality rates because: they have no predators (with the exception of humans); they are at the top of their food chain; they are opportunistic feeders (going where the food is); and they have easily adapted to low oxygen levels found in our deep cold lakes. However, as a population, they are very sensitive to disturbances during the egg and larval stages. While spawning has been recorded, young fish are seldom found, indicating they are not surviving to adulthood. Because there are only an estimated 500-600 adult white sturgeon left in the upper Nechako River system, it is expected with no intervention that this population will be “extirpated” (locally extinct) within the next 25 years.

STUDENT HANDOUT PART C: DECLINE OF WHITE STURGEON IN THE NECHAKO RIVER WORKSHEET

There are currently an estimated 571 white sturgeon in the Nechako River. This is too few juvenile fish to support a healthy sturgeon population. If this number is not increased, biologists predict that within the next 40-50 years the Nechako white sturgeon will be extinct.*

1. Using a sheet of graph paper, create a bar graph showing the actual numbers of white sturgeon in both the lower Fraser and Nechako rivers.

Population Assessment (1995 to 1999 data)

Age (years)	Proportion of catch (approximate %)	
	Fraser sturgeon (between headwaters and Hope)	Nechako sturgeon
0-4	1	0
5-9	15	3
10-14	20	2
15-19	14	3
20-24	9	3
25-29	6	5
30-34	5	14
35-39	5	27
40-44	3	15
45-49	2	9
50-54	1	2
55-59	1	4
60-64	1	2
65-69	1	3
70-74	1	3
75-79	1	0
80-84	0.5	1
85-89	0.5	3

2. What percentage of the Nechako sturgeon is likely to be of reproductive age?

* Information taken from the Carrier Sekani webpage, "White Sturgeon of the Nechako."

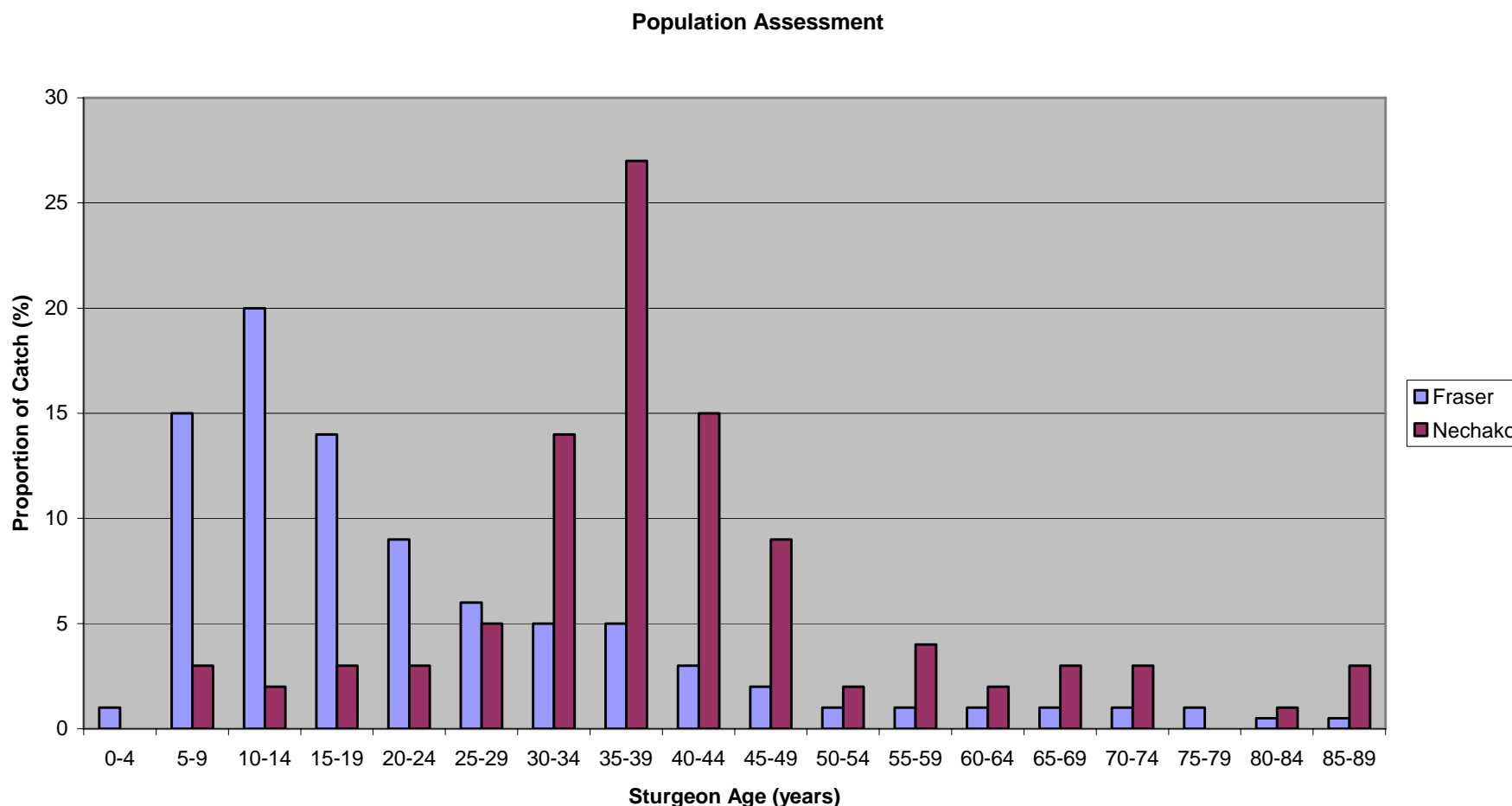
www.nechakosturgeon.org/index.html



3. What percentage of the Nechako sturgeon is between the ages of 30 and 44?
4. What age group is likely to have spawned the 5 to 9 year olds? Why might there be more young sturgeon in the Fraser and more middle-aged sturgeon in the Nechako?
5. Why might there be more young sturgeon in the Fraser and more middle-aged sturgeon in the Nechako?
6. What kinds of human activities might affect sturgeon populations?
7. Judging from the information on the graph, do you think sturgeon spawn every year? Why or why not?
8. Why do you think there is a lack of juvenile sturgeon in the Nechako?

ANSWER KEY PART C:
DECLINE OF WHITE STURGEON IN THE NECHAKO RIVER WORKSHEET

- Using a sheet of graph paper, create a bar graph showing the actual numbers of white sturgeon in both the lower Fraser and Nechako rivers.



2. What percentage of the Nechako sturgeon is likely to be of reproductive age?
42%
3. What percentage of the Nechako sturgeon is between the ages of 30 and 44?
56%
4. What age group is likely to have spawned the 5 to 9 year olds? Why might there be more young sturgeon in the Fraser and more middle-aged sturgeon in the Nechako?
45-49 years old
5. Why might there be more young sturgeon in the Fraser and more middle-aged sturgeon in the Nechako?
Sturgeon in the Fraser are able to reproduce successfully and juveniles are surviving, possibly due to different uses of the river.
6. What kinds of human activities might affect sturgeon populations?
Dam building, agriculture, sport fishers, road building, recreational boating
7. Judging from the information on the graph, do you think sturgeon spawn every year? Why or why not?
No. There is a gap between the ages of each group
8. Why do you think there is a lack of juvenile sturgeon in the Nechako?
Juvenile sturgeon are not surviving, mature sturgeon are failing to spawn.