Stream to Sea Intermediate

# Student Handout: Lesson 1
# Natural History of British Columbia's Killer Whales

Killer whales (or Orca) are the biggest members of the dolphin family. They are toothed cetaceans and are extremely intelligent and social animals.

They were named killer whales as they were all thought to be killers of other whales. Their scientific name *Orcinus orca* also reflects misunderstanding as it loosely translates into "hell creature".

Killer whales can be found in all marine waters of the world but more often in colder seas. All over the world, populations of killer whales have developed different lifestyles depending on the geography and food availability of their area.

We know what we do about killer whales because of the work of Dr. Michael Bigg. Back in the 1970s, it was believed that there were thousands killer whales in British Columbia and that they should be shot because they were eating too much salmon. Killer whales were also being captured for aquariums. Dr. Bigg found a way to tell killer whales apart so that they could be counted accurately. He did this using the whales' saddle patch and dorsal fin. He catalogued the animals and proved that people were often seeing the same killer whales again and again. There were only hundreds of them, not thousands. His work led to stopping the shooting and capture of killer whales.

**"Cetacean"** is the name for the group of mammals that are whales, dolphins and porpoises.

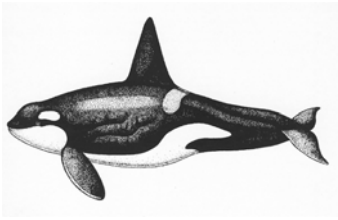
Remember that **mammals**:

- Are able to keep their internal temperatures constant (they are homeothermic)
- Give birth to fully developed young
- Nurse their young
- Have lungs

Most mammals have hair that traps air for warmth. Cetaceans do not have hair but blubber for warmth. Hair would not work to keep them warm since hair cannot trap air in the water. The hair would actually slow them down!

## The Different Populations of Killer Whales in British Columbia

Once he could study killer whales as individuals, Dr. Bigg also found out that there were different kinds. We now know that there are 3 different kinds (**eco-types**) of killer whales in the waters of British Columbia that do not mate with one another. They have different diets and distinct behaviour and culture.



The three eco-types of killer whales are **offshores**, **transients** and **residents**. There are two resident populations in British Columbia: northern residents and southern residents. None of these populations mate with one another even though their ranges overlap. Their different languages stop them from mating between populations. Since they do not mate with one another, on average, they look different. For example, transients have more pointed dorsal fins and offshores appear to be smaller animals.

Not much is known about the offshores yet as they are not often seen close to the coast of British Columbia.

Transients feed on marine mammals. They do not eat fish. They have to be very quiet because their marine mammal prey can hear them and recognize that the

sounds of transients mean they are in danger. Transients therefore also dive longer and do not travel in big family groups.

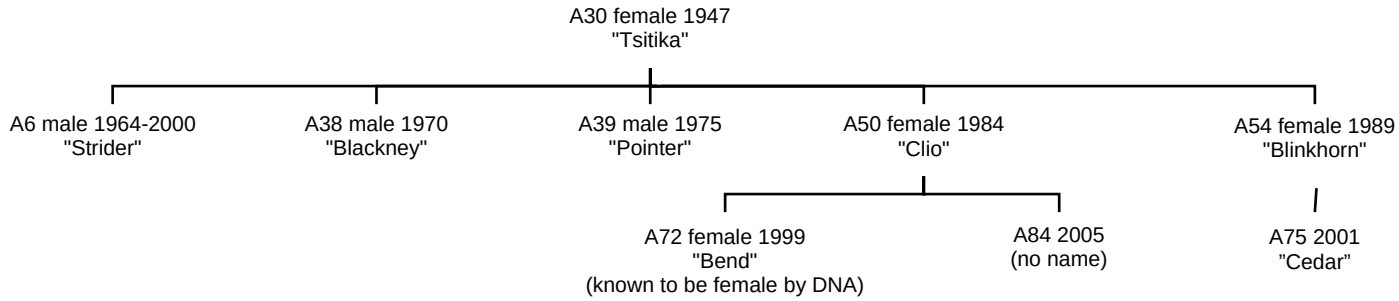
Resident killer whales feed on fish. In fact, about 98% of their diet is salmon. They do not eat marine mammals. They can afford to be very vocal since fish cannot hear them. They are very social and often travel in big groups. They have very structured family units called **matrilines** (mother, her offspring and her daughters' offspring). Neither males nor females leave the matriline. They do not mate within the family (they do not interbreed) since they can recognize who is and is not family because every matriline sounds different. If they sound exactly the same, they stay together but do not mate with one another. They mate with animals of the same population that sound different. Mated males and females do not stay together as a family. They stay in their matrilines so that family sounds remain distinct and the system of recognizing otherness remains intact.

Not all killer whales in the world are resident, transient or offshore types. They have lifestyles that suit the prey and geography of their area.

*Sources:*
*The work of Dr. Michael Bigg; Dr. John Ford; Graeme Ellis and Dr. Lance Barrett-Lennard*

### The A30 Matriline

Whales are assigned names by the Wild Killer Whale Adoption Programme after the calves have been sighted for 2 years in a row. This is done because the death rate can be high in the first years of killer whale calves' lives.




## Questions

1. What is the relationship between A30 and A75 in the matriline example?

2. Even though A6's body has never been found, how is it known that he is dead?

3. Why isn't it known whether A75 is male or female?

4. Why can resident killer whales afford to travel in large groups and be very vocal?

5. Why can't transient killer whales be highly vocal animals that travel in large groups?

6. How are residents able to recognize if they are closely related to other killer whales?

Bioaccumulation: A Case Study
of British Columbia's Killer Whales

## Student Handout: Lesson 2
## Killer Whale Food Chains and Food Webs

An **ecosystem** is defined as a group of organisms interacting with one another and with the non-living factors (light, soil, temperature, water) in their environment.

**Predators** are animals that eat other animals. **Prey** are the animals that get eaten by predators. **Producers** are organisms that can make their own food. Plants are the main producers; they trap energy from the sun and store the energy in the form of sugar. This process of light energy getting trapped in the bonds of the sugar molecules in called photosynthesis. **Consumers** are organisms that get energy from eating other organisms. Types of consumers:

a) **Herbivores** eat only producers (plants)

b) **Carnivores** eat other consumers. Carnivores are predators (e.g., transient killer whales) that eat prey (e.g., seals)

c) **Omnivores** eat producers and consumers

d) **Decomposers** are consumers that feed on dead organisms. Bacteria and fungi are decomposers. They "clean up" by turning dead organisms back into nutrients in the ecosystem. They are different from scavengers like eagles and hermit crabs because decomposers grow in or on the dead or waste matter taking the nutrients directly into their cells. This is how they recycle nutrients in the environment.

### Food Chains

A food chain is a model that shows how energy stored in food passes from organism to organism. The arrows show the flow of energy; they point from what is eaten to what eats it. Here is an example:

| Phytoplankton → zooplankton → herring → salmon → seals → transient killer whales |
|---|

In the example, the food chain shows that zooplankton get energy by eating phytoplankton; herring get energy by eating zooplankton; salmon get energy by eating herring; seals get energy by eating salmon; and transient killer whales get energy by eating seals.

Producers are always at the beginning of a food chain since they are the only organisms that can make their own food from the sun's energy. Remember, phytoplankton are plants so they are producers! Usually, food chains are drawn with the producer at the bottom or beginning of the chain. Remember, the direction of the arrows is really important as they show the transfer of energy; they show which way the food goes.

The consumers that eat the producers are the **first order consumers** (or primary consumers). The consumers that eat these consumers are the **second order consumers** (or secondary consumers) and so on.

### Food Webs

A food web is a model that shows the interactions between food chains. It is a combination of many different food chains that shows the inter-relationships between many producers and consumers in an ecosystem.

## Questions

1. Draw a food chain for resident killer whales:

2. In the food chain for resident killer whales:
   a) Circle the producer(s)
   b) Put a check mark above the consumers
   c) Put a square around the prey of salmon
   d) Put a star over zooplankton's predator

3. Draw a food web for the following organisms in the space below: Herring; salmon; zooplankton; phytoplankton; transient killer whale; humans; resident killer whale; harbour seal.
   Hints: Seals eat herring and salmon and so do we. Very few of us eat seals so do not include this link. Transients do not eat humans!

4. How many food chains are there is this food web?

5. Describe where the decomposers would be in this food web.

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## Student Handout: Lesson 3
## SARA and Threats to Killer Whales

### Killer Whales in Trouble

In 2001, the Committee on the Status of Endangered Wildlife in Canada determined:

- Southern resident killer whale are 'endangered'
- Northern resident killer whales are 'threatened'
- Transient killer whales are 'threatened'
- Offshore killer whales are 'of special concern'

The transient population and both resident populations are listed in Schedule 1 of the Species at Risk Act (SARA), Canada's law to protect wildlife species from becoming extinct.

Southern resident killer whales travel in both Canadian and American waters. In November 2005, America also listed this population as 'endangered' according to their laws.

### Questions

1. What are some possible threats to all British Columbian killer whale populations?

2. Why might transient killer whales be more disturbed by noise?

3. Why might southern resident killer whales be in more trouble that other BC killer whale populations?

# Student Handout: Lesson 4
# Bioaccumulation and Killer Whales

## What is bioaccumulation?

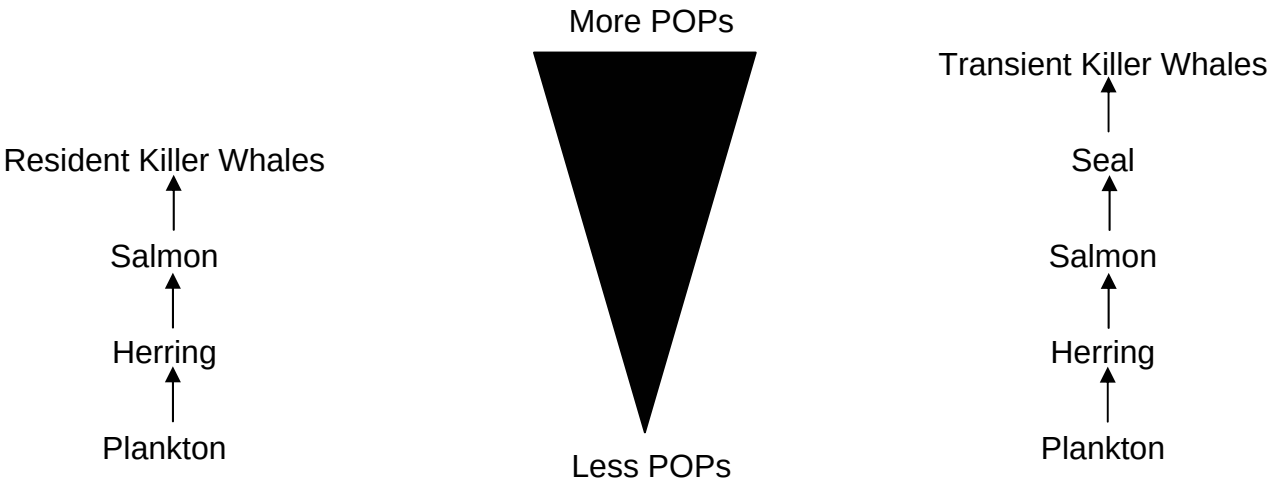
Many chemicals we use in our daily lives are toxic. Toxic chemicals include pesticides, engine products and many household cleaners. Most toxins are made by humans; they do not occur naturally.

Some of these toxins are **persistent**. This means that they do not break down and as a result they build up in the food chain, usually in the fat of organisms. The mother's milk of mammals has lots of fat in it. Persistent toxins are also known as Persistent Organic Pollutants (**POP**s). The build up of persistent toxins in the food chain is known as **bioaccumulation**.

Persistent toxins can cause the following problems:

- Reproductive failure
- Birth defects
- Immune system disorders (cancers and weakness to disease)
- Behaviour and learning disorders
- Death

The more toxins an organism has, the greater its problems. The diagram below shows what bioaccumulation means for killer whales. Transient killer whales contain more persistent toxins because they are higher in the food chain than resident killer whales. Since resident killer whales and seals are both 4th order consumers, if they had the same range, it would be expected that they would have the similar levels of persistent toxins.




We (humans) may use toxins on land, but they can travel through the soil in groundwater into waterways and into the ocean. All persistent toxins eventually end up in ocean food chains. It is not only local sources of toxins that affect killer whales. Persistent toxins accumulate in cold countries like Canada by evaporating and condensing again and again (this is known as global

distillation). It has been proven that it only takes 5 to 10 days for toxins to come from as far away as Japan into British Columbia's waters.

*Source: Dr. Peter Ross' research*

## Persistent Chemicals in the Food Chain

How can it be that we allow these chemicals to go into the environment and build up in the food chain? We made mistakes in the past with chemicals like the pesticide DDT and PCBs. People thought these were "super chemicals", great inventions that solved problems (DDT kills mosquitoes; it was used to kill bugs that might be carrying disease. PCBs conduct electricity, insulate, don't burn and don't corrode; they were used in everything from electrical lights to paint and printing ink.) These "super chemicals" were not tested for their long-term effects before they were put to use.

Look at the diagram to see how chemicals like PCBs move into and through the food chain.

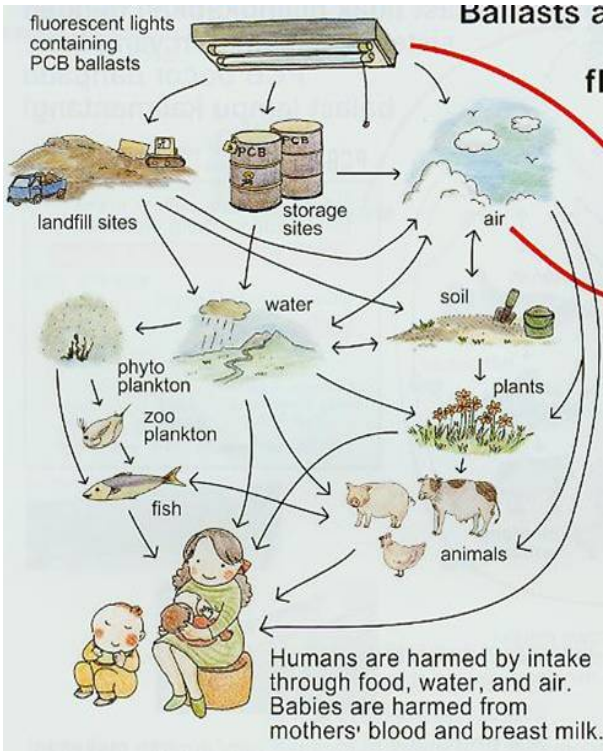



Diagram: Japan Offspring Fund
www.tabemono.info/english

The table below shows more of these persistent toxins. These are known as the "Dirty Dozen". Notice that 9 of these 12 toxins are pesticides!

| Persistent Organic Pollutant (POP) | Pesticide | Industrial Chemical | By-product |
|---|---|---|---|
| Aldrin | √ | | |
| Chlordane | √ | | |
| DDT | √ | | |
| Dieldrin | √ | | |
| Endrin | √ | | |
| Heptachlor | √ | | |
| Mirex | √ | | |
| Toxaphene | √ | | |
| Hexachlorobenzene | √ | √ | √ |
| PCBs | | √ | √ |
| Dioxins | | | √ |
| Furans | | | √ |

After years of using these chemicals, animals in the food chain started having problems. For example, with DDT, the egg shells of large birds were so weak that they would be crushed by the weight of the adult birds. When the chemicals were tested, it was discovered that they bioaccumulate.

## So we learned our lesson right?

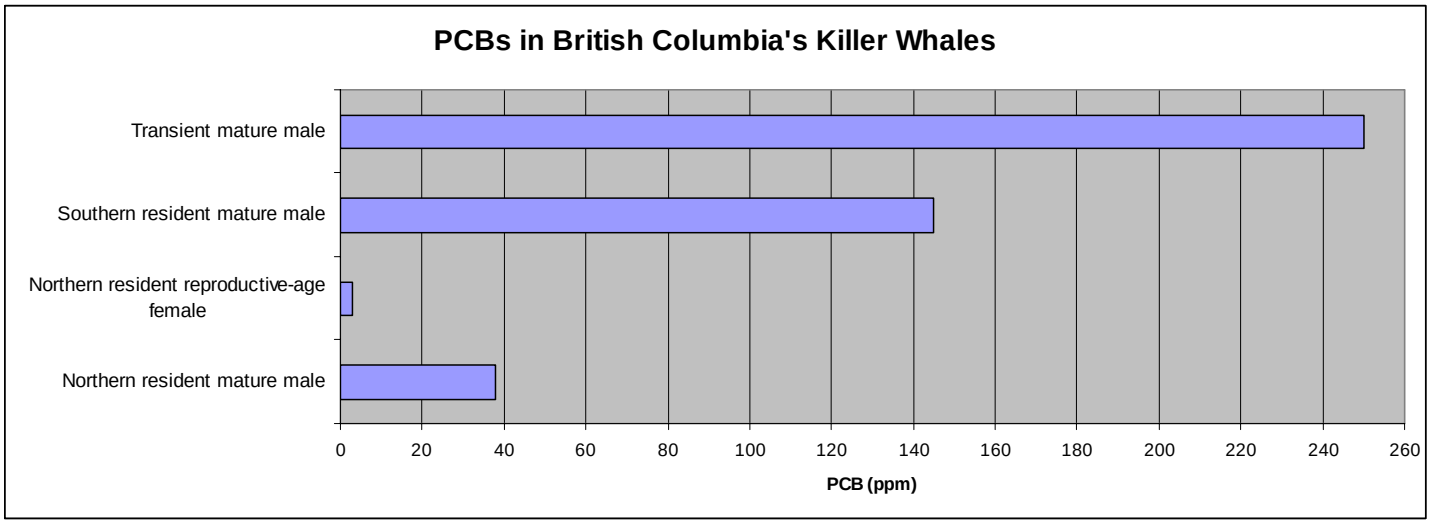
No. We have definitely not learned our lesson.

- Many countries still use the chemicals that have been proven to bioaccumulate.
- These chemicals are stored all over the world and are often not properly disposed of.
- Canada and America do not have laws that insist on the testing of new chemicals that are not used in food. In fact, of some 85,000 chemicals used in North America, only 10% have been tested for their environmental effects (Source: Chemical Trespass).
- There is a new group of chemicals that is being produced in North America that has already proven to bioaccumulate. These are the PBDEs, a group of chemicals that are of use to humans because they don't burn. They are fire retardants. There are alternative fire retardants that do not bioaccumulate. Europe has banned PBDEs. North America has not.

PBDE = polybrominated diphenyl ethers
The "PBDEs" are a group of fire-retardant chemicals that contain the chemical bromine. They have been proven to be persistent organic pollutants and are found in furniture, television and computers.

## Persistent Toxins and British Columbia's Killer Whales

Dr. Peter Ross studied the amount of toxins in the blubber of British Columbia's resident and transient killer whales. The blubber samples were used for both DNA and toxin research. The samples were collected by using a retractable dart system that removed a sample the size of a pencil eraser. Dr. Ross' studies are summarized in the chart below; the units of measurement are parts per million (ppm).



**Questions**

Use the "PCBs in British Columbia's Killer Whales" graph to fill in the following table:

| | Northern resident mature male | Northern resident female of reproductive age | Southern resident male | Transient mature male |
|---|---|---|---|---|
| Estimate of amount of PCBs in blubber (ppm) | | 3 | | |

Use the graph and the table to answer the following questions.

1. Researchers found that beluga whales in the St. Lawrence River had PCB loads of about 79 ppm. These animals had malformed skeletons and cancers and their population was severely endangered (*Source: Muir et al*). In ringed seals, a level of 77 ppm causes reproductive problems (*Source: Oceana*). Which killer whale populations are above these levels?

2. A level of 16.5 ppm causes immune system problems in harbour seals (*Source: Oceana*). Which killer whale populations are above this level?

3. A level above 50 ppm, is considered toxic waste by Canadian guidelines (*Source: Oceana*). Which killer whale populations are above this level?

4. In Canada, the action level for PCBs is 2 ppm. This is the amount that is too high for humans to eat food with this level of PCBs. Which killer whale populations are above this level?

5. Approximately how many times greater is the level of PCBs in Northern resident males than Northern resident females of reproductive age? Why do you think the males might have so many more toxins like PCBs?

6. Knowing what you do now about toxins in killer whales, explain why males might live much shorter lives.

7. Approximately how many times greater is the level of PCBs in Southern resident males than Northern resident males? Why do you think the southern residents might have so many more toxins like PCBs?

8. Summary: For each topic, check the selection that is most likely to have more toxins

| | | |
|---|---|---|
| **Type of Killer Whale:** | ☐ Resident | ☐ Transient |
| **Gender:** | ☐ Male | ☐ Female |
| **Birth Order:** | ☐ Firstborn calf | ☐ Not firstborn calf |
| **Range:** | ☐ Near big cities | ☐ Further away from cities |