

## Lesson 4: Student Handout

### 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. They usually build up in the fat of organisms. The mother's milk of mammals has lots of fat in it.

The build up of toxins in organisms is called **bioaccumulation**.

**Persistent toxins are also known as Persistent Organic Pollutants (POPs).**

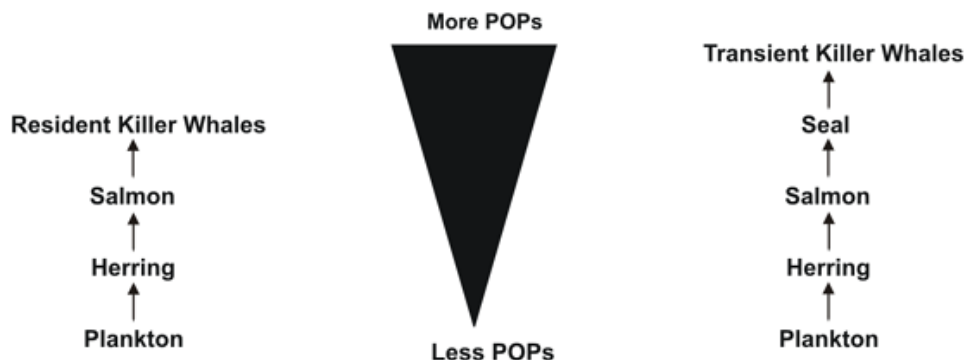
Persistent toxins can cause the following problems:

- 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.

We may use toxins on land, but they go through the soil to the groundwater and into the ocean. All persistent toxins eventually end up in ocean food chains.

The diagram below shows what bioaccumulation means for killer whales. Transient killer whales would have 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.



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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

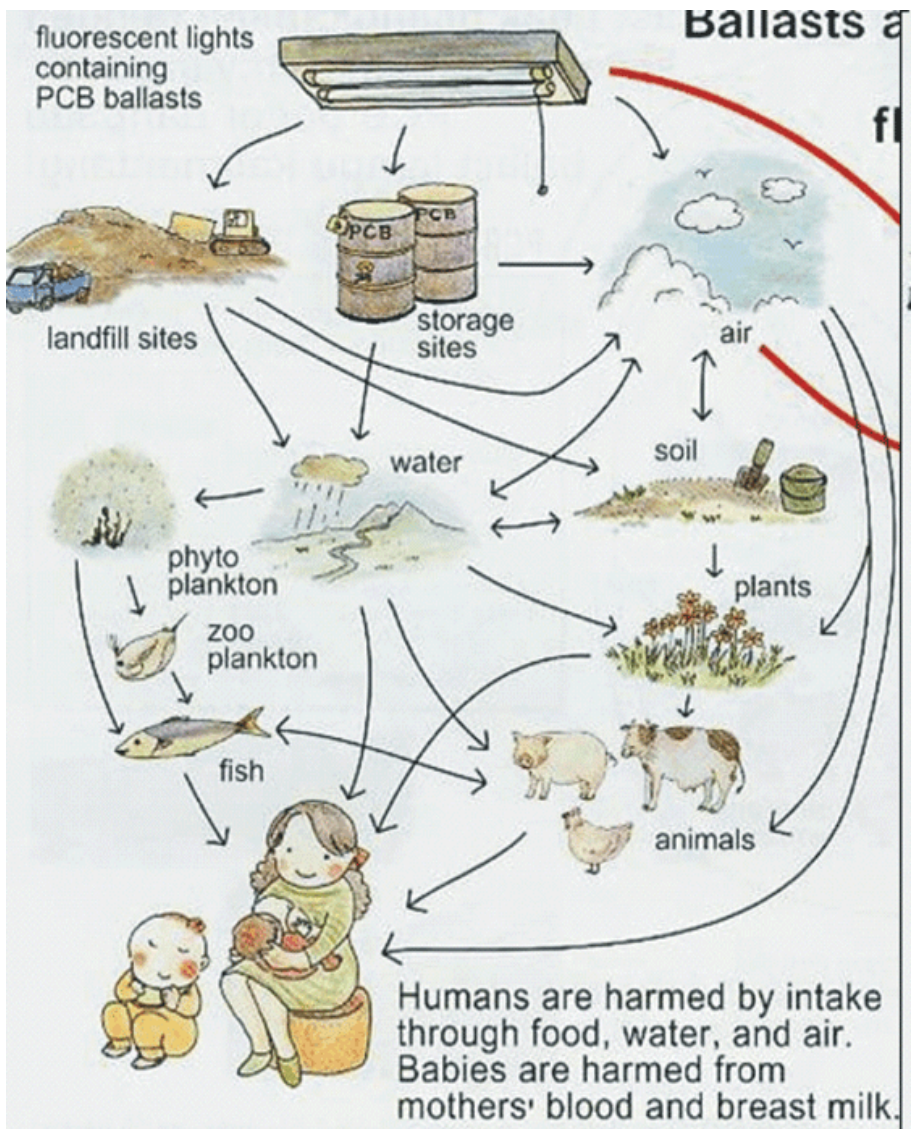
#### Persistent Chemicals in the Food Chain

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. They were not tested for their long-term effects before they were put to use.

DDT kills mosquitoes that could carry disease. PCBs can conduct electricity, they insulate, they don't burn and they don't corrode. They were used in everything from electrical lights to paint and printing ink.

Look at the diagram to see how chemicals like PCBs move into and through the food chain. *Diagram: Japan Offspring Fund; Stop PCB – end the sources of PCB pollution worldwide. jof@niffy.ne.jp*

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!



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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 shells of large birds were too weak so that they would be crushed by the weight of the adults. Then the chemicals were tested and 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. (Source: Chemical Trespass).
- Of 300,000+ chemicals used in N. America, about 400 are “emerging chemical contaminants” (ECC) and can bioaccumulate. 75% have not been studied. (Source: Derek Muir, Environment Canada, Feb 2008).
- There is a new group of chemicals that are 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 also are fire retardants just like PCBs were. There are at least 15 alternatives to their use that do not bioaccumulate. Europe has banned most PBDEs. North America has not.

#### **PBDE = polybrominated diphenyl ethers**

*The "PBDEs" are a group of fire-retardant chemicals that contain the chemical bromine and stop fires. They have been proven to be persistent organic*

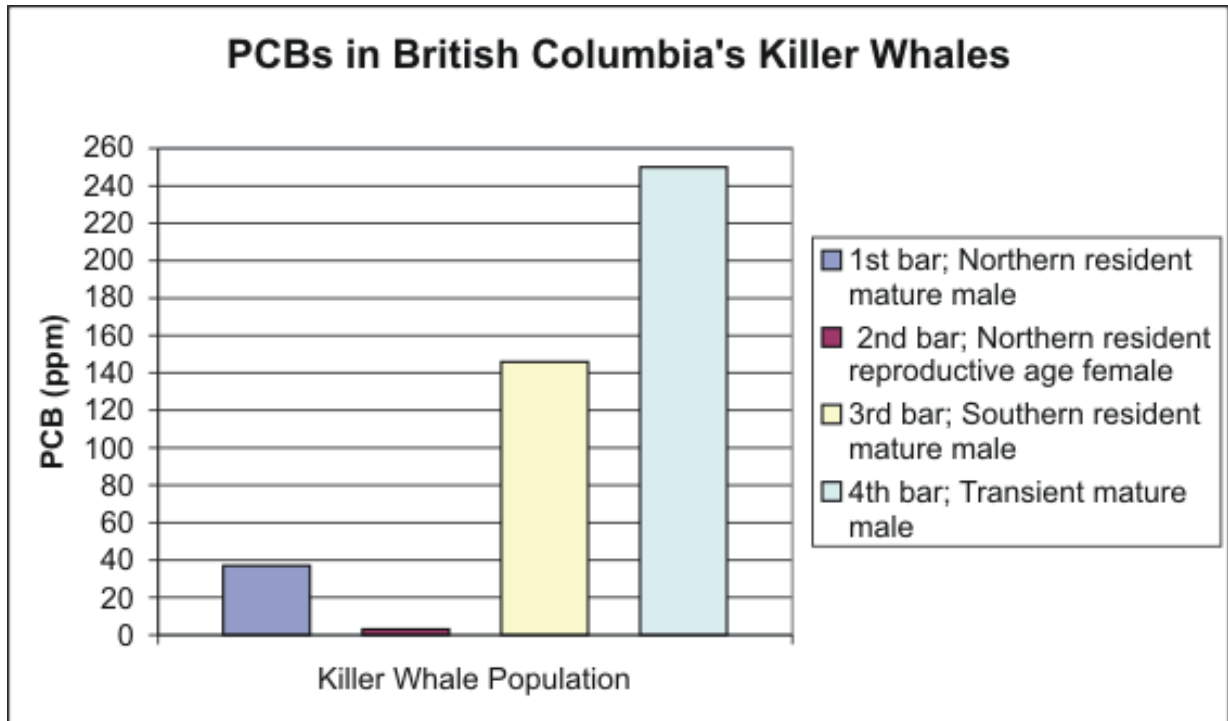
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*pollutants and are found in furniture, televisions and computers.*

#### 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

1. 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		

2. 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?

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3. A level of 16.5 ppm causes immune system problems in harbour seals (Source: Oceana). Which killer whale populations are above this level?
4. A level above 50 ppm, is considered toxic waste by Canadian guidelines (Source: Oceana). Which killer whale populations are above this level?
5. 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?
6. 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?
7. Knowing what you do now about toxins in killer whales, explain why males might live much shorter lives.
8. 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?
9. Summary: For each topic, mark the one that is most likely to have more toxins

<b>Type of Killer Whale:</b>	<input type="checkbox"/> Resident	<input type="checkbox"/> Transient
<b>Gender:</b>	<input type="checkbox"/> Male	<input type="checkbox"/> Female
<b>Birth Order:</b>	<input type="checkbox"/> Firstborn calf	<input type="checkbox"/> Not firstborn calf
<b>Range:</b>	<input type="checkbox"/> Near big cities	<input type="checkbox"/> Further away from cities