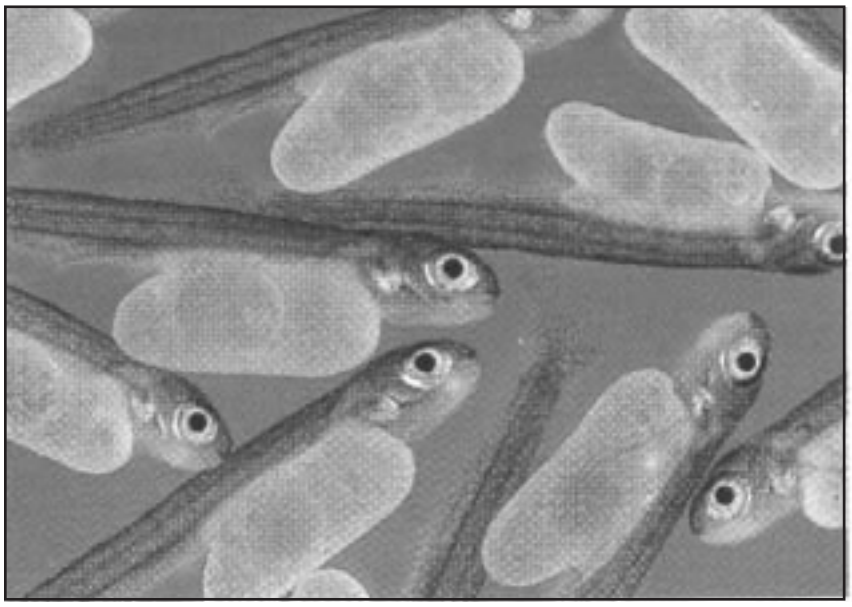
The Salmon Times

March Number 6

Behave Yourself

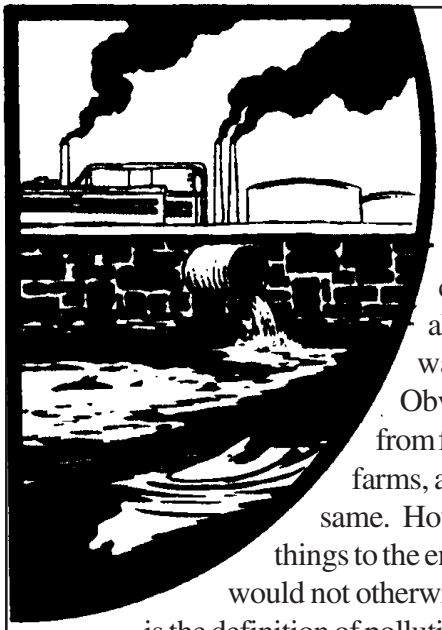


Have our Atlantic salmon been "behaving themselves"? Well, if by "behaving themselves" we mean behaving as they would in nature, then the answer is yes. In their natural environment the newly hatched Atlantic salmon, referred to as alevin at this stage, remain in their gravel redds on the bottom of streams until the spring. A redd provides the alevin with protection from predators, and keeps them from being carried downstream. The alevin in our classroom incubators have been staying in the gravel at the bottom of the tanks, much like the alevin in the streams stay in their redds. The alevin in our classrooms don't have the threat of predators or the current of the river to carry them away, but it would seem that they are still trying to stay out of sight.

Up to this point the alevins' food source, both in the incubators and in nature, has been the yolk sac they emerged from the egg with. But have you noticed that the sac is getting smaller and smaller? Soon the yolk sac will be completely gone and the little salmon will be referred to as fry. The fry will come out from among the rocks looking for their first "real meal". It will be easy to tell when the fry are ready for their first "real meal". The incubator will seem to come alive, with hundreds of little fry swimming up from the bottom. In a stream alevin eat zooplankton, little organisms that float around in the water. To keep the environment as close to a natural one as possible, you may have an opportunity to feed your fry little creatures known as brine shrimp, a form of zooplankton.

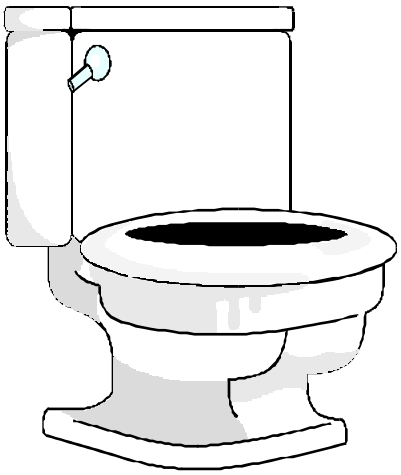
Once the fry emerge from the rocks they are a lot more fun to watch. They also require more care. We all like to eat on a regular basis, right? So do our fry, and they will need to be fed regularly. Since they will be eating regularly, they will also produce more waste. In nature the stream carries the waste away. By using filters in our incubators, and changing the filter cartridges and water every several weeks, we can remove the waste like the stream does.

Factories, Bathrooms, Streets and Farms

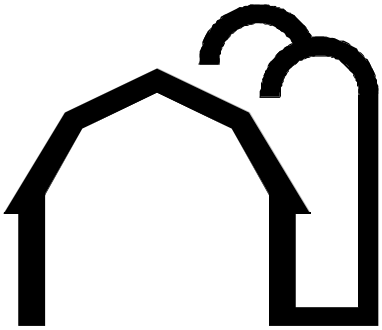


What do all these things have in common? They are all potential sources of water pollution. Obviously, the wastes from factories, bathrooms, farms, and streets are not the same. However, they all add things to the environment that would not otherwise be there, and that is the definition of pollution. Pollution also includes adding more of a natural substance (e.g. salt) to the environment (air, land, water...) than would normally be found there. Either of these kinds of pollution can harm organisms. Although pollution to the land, air, and water all affect our watersheds, we will focus on water pollution, since that can directly affect salmon.

Many factories discharge chemicals and water to streams, river, and lakes. Bathroom waste (sewage) goes to a waste water treatment plant and the treated waste water is discharged to a surface water body. Rain water washes sand, salt, oil, etc... from streets, into a storm water sewer system which eventually discharges to a surface water body. The pollution from these sources is called point source pollution, because the wastes are discharged through pipes that can be seen and pointed to.



There are also sources of pollution that we cannot point to, or tell exactly where they started, because they don't come out of pipes. This type of pollution usually gets into surface water bodies either in storm water runoff (water that flows across the ground surface) which washes it off the land; or through ground water which eventually discharges to surface water bodies. We might be able to tell what type of place the pollution came from (for example, a farm), but not an exact location. This type of pollution is called non-point source pollution. On a farm fertilizers and pesticides are put on crops to protect them and help them grow. When it rains, or the crops are watered, some of the pesticides and fertilizers get washed off the fields and end up in nearby water bodies (streams, lakes, etc...). Some pesticides and fertilizers will also soak down into the ground with the water, and end up in the ground water. In either case it is nonpoint source pollution and it impacts our watersheds. Some other sources of nonpoint source pollution are yards, gardens, parking lots, and landfills (dumps).



Tolerate It

As we mentioned in the February edition of *The Salmon Times*, people used to think that it didn't matter what they put into nearby water bodies because they thought the water could "clean itself". Water does have a good buffering capacity, that is it can break down some pollution and adjust the acid level (pH), but water bodies also have a limit to what they can take. Think of a sponge, it can absorb a lot of water, but once it has absorbed as much as it can hold, can you make it absorb more? (Try it). The same thing happens with rivers and streams. They can only tolerate (hold) so many chemicals, sediments, salts, etc... before the water quality starts to decrease. The effects might be noticeable, like the water getting cloudy or tasting bad; or the water might look fine but have unknown chemicals in it. Sometimes it takes special tests to find out if the water is okay.

Factory graphic from Sport Fishing and Aquatic Resources Handbook, American Fishing Tackle Manufacturers Association

Going To The Source

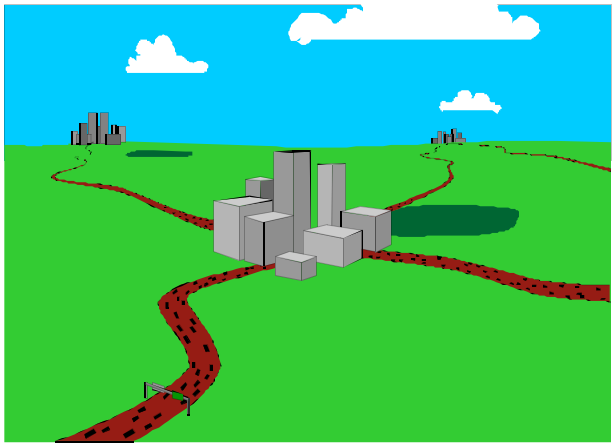
Lets take a look at a few pollution sources in our watersheds.

Factories/Industrial Plants - Many metals, oils, and chemicals are used to make the things we buy in stores. Almost all factories have waste water that results from cooling and washing products (the things they make) and equipment. Small amounts of the substances used to make the products, clean the products, and keep the equipment operating (e.g. oil used to keep parts moving smoothly), often end up in the waste water. This waste water is usually treated to remove the contaminants before it is discharged. The waste water usually ends up in a stream, river, or other surface water body, as point source pollution.

Waste Water Treatment Plants - The majority of waste water entering a treatment plant is sewage (bathroom waste) that comes from homes, offices, apartments, etc... The organic matter in the sewage has a lot of salt, potassium, phosphorus, and nitrogen in it. These things are nutrients to plants and other organisms; but untreated sewage has more nutrients in it than are "good" for a water body. Sewage also contains pathogens (disease causing organisms) that can make people and animals sick. Treatment plants are designed to remove a lot of the organic matter. The more "high tech" systems also treat the water with chemicals to kill the pathogens. After treatment, the waste water is discharged to a surface water body through a pipe.

Unlined Landfills - Landfills, or what we usually call "dumps", are a significant nonpoint pollution source. For years, trash has been dumped in landfills, covered with dirt, and literally left to rot. When rain enters these

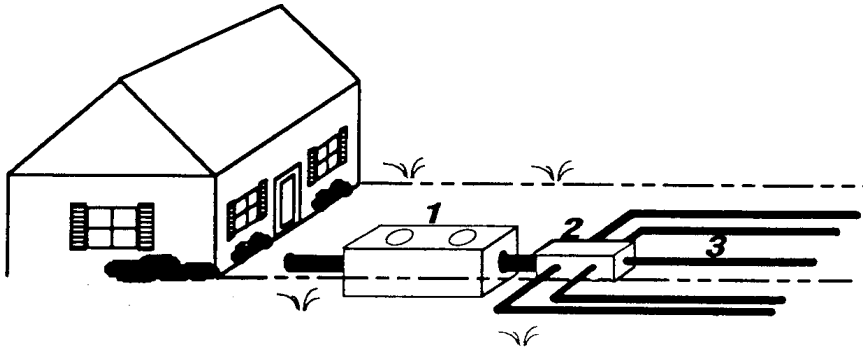
Organic Matter is anything that is alive or was once part of a living thing. Leaves that fall off trees and decaying logs are examples of organic matter.



landfills, moving slowly down through the trash, it causes chemical reactions to take place. Some of these chemical reactions will make new chemicals, and some will change how easy it is for things like metals to dissolve in the rain water. The water will carry some of these metals and chemicals with it as it moves through the watershed.

Lawns and Gardens - Many people put fertilizers and pesticides on lawns and gardens to make them look and grow better. As with farms, a small amount of the fertilizers and pesticides are picked up by rain water and washed into nearby water bodies. The water that soaks into the ground also carries these pollutants down to the ground water. Whichever way these pollutants travel from our lawns and gardens into our watersheds, it is a nonpoint source of pollution and one of the most difficult to pinpoint.

Leaking Septic Systems - Septic systems are private below ground sewage treatment systems. They typically consist of a holding tank, a pump, and a leach field (see diagram on next page). Water from sinks and toilets goes to the settling tank, the solid material settles to the bottom, and the water is then pumped into the leach field. A leach field consists of a series of underground pipes with holes. The water comes out of the pipes in the leach field and slowly moves through the soil. The settling tank and the soil do the job of a treatment plant by removing excess nutrients and pathogens. This is a good way to treat our sewage, unless the septic system isn't working right. In that case, excess nutrients and pathogens enter our watersheds as nonpoint source pollution (since you can't tell which system the nutrients or pathogens have come from).



Septic System: waste goes from the house to the septic tank and then to the leach field.

Dirty Water: No Good For Anyone

We have talked about some of the "Big Time" pollution sources and which pollutants they discharge, now lets look at what some of these pollutants do to the water and to the organisms living in or drinking the water.

Chemical Pesticides: Some of the pesticides that enter streams are eventually consumed by fish or other organisms with their food and water. Plants and animals cannot use these chemicals, but they don't know how to get rid of them, so the chemicals get stored in the fatty tissue of these organisms. Storing these chemicals wouldn't be a problem if there was only a little. But as one organism in the food chain eats another, the chemicals get passed along, and become more and more concentrated. The concentration of chemicals can get so high that it kills the organisms, or keeps them from effectively reproducing. For example, high concentrations of **DDT** (a pesticide) will cause the egg shells of many species of birds to be thin. The shells of these bird species sometimes become so thin that the shells crack when the mother tries to incubate the eggs.

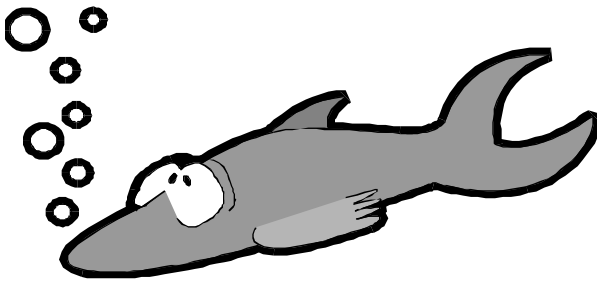
Fertilizers and Excessive Nutrients (human and animal waste): Fertilizers, human waste, and animal waste all contain a lot of nutrients that plants need to grow. At first that sounds good, but when a lot of these nutrients enter a stream, pond, river, etc... at the same place or time it provides a huge food supply and causes a lot of phytoplankton or algae to grow. (This is what is happening when you see a pond covered with what looks like slimy green stuff). When all of these plants begin to die they are broken down by bacteria. Since there are a lot of plants, there are a lot of bacteria. The bacteria use oxygen in breaking down the algae and phytoplankton and the amount of oxygen in the water can dramatically decrease. This drop in the amount of oxygen in the water makes it difficult, or maybe impossible, for other species to live there.

Pathogens: In addition to having a lot of nutrients in them, human and animal wastes also contain many different kinds of pathogens (disease causing organisms). As is the case with pesticides, organisms in the water ingest the pathogens with their water or food. The pathogens might kill the organisms that ingest them, make them sick, or simply be passed along to other organisms.

Oil, Chemicals and Heavy Metals: Like the other pollutants, oils, chemicals, and heavy metals get ingested by the organisms that live in or use the water. These pollutants can have a lot of different effects on organisms and, unfortunately, they can all be toxic (kill the organism). Oil doesn't even have to get into the organism in order to harm it. For example, oil can get in the gills of fish and suffocate them. Ducks and other waterfowl can be injured or killed when oil gets on their feathers. The oil sticks their feathers together and ruins the natural oil coating that protects the birds from the water and cold temperatures.

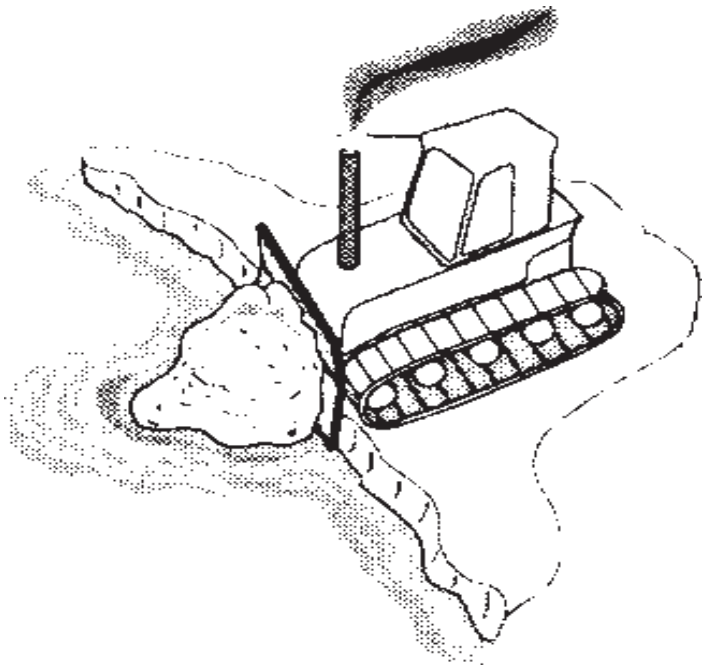
Progress

That all sounds pretty depressing! But here are two good facts - (1) the pollutants entering our watersheds have been greatly reduced over the past twenty years, and (2) you can keep the progress going. We're not done yet!



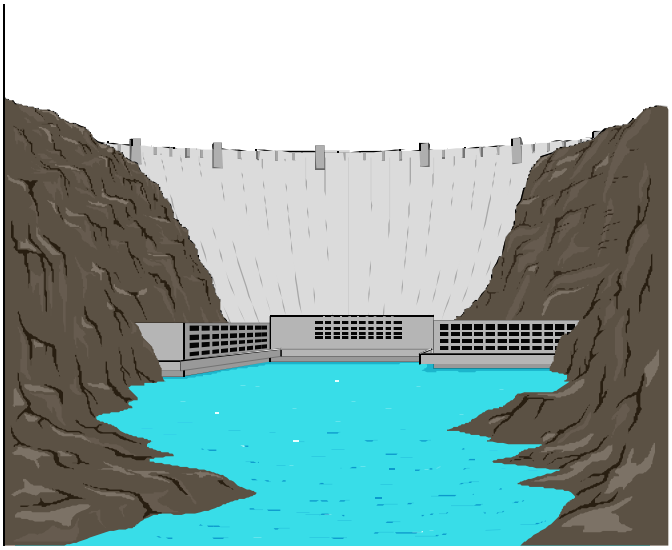
Septic system graphic from Massachusetts Dept. Environmental Protection

Turning Up the Heat



Many factories use water from streams, rivers, or lakes, to cool machinery. They then return it to the surface water body at a higher temperature than when it was pumped out. This addition of heated water (or sometimes cooled water) is called thermal pollution. There is often a drastic change in the water temperature and it can cause thermal shock in many organisms. Thermal shock is just what it sounds like: shock caused by a temperature change. It can cause organisms to temporarily stop breathing or eating, and can even kill some organisms.

Two other things happen as the water temperature increases: 1) it holds less oxygen, and 2) it holds more chemicals. If a temperature increase reduces the amount of oxygen in the water, where is it going? Pure oxygen is a gas unless it is under a lot of pressure. The oxygen in water is combined with other things that keep it in the water. When the temperature goes up, there is more energy in the water which the oxygen uses to break free and go into the air as a gas. This is a problem for the fish and other organisms living in the water because it's hard to "breath"! Have you ever been on the top of a really high mountain? The air up there has less oxygen, and you have to breath faster (harder) to get enough oxygen. In the same way, the organisms in the water have to breath faster to get enough oxygen when there is less in the water. All that breathing leaves them less energy for other things, like escaping from predators. That's a problem!



The second change that occurs when the temperature of the water increases is that the water can hold more chemicals. There are many scientific reasons why this happens but what it all boils down to (no pun intended) is that chemicals will dissolve more easily in warm water than cold. (Try dissolving salt in both warm and cold water. Which one holds more?) This means that when a factory adds heated water to a river, the water can hold more chemicals. Unfortunately, just because the water can hold more chemicals doesn't mean the organisms can tolerate more chemicals!

Catching Some Rays:

Another Source of Thermal Pollution

Imagine that you are at the side of a creek, with trees hanging out over the water from both sides. Then imagine that all the trees are cut down from both sides of the creek to build houses or condominiums. Has the amount of sunlight reaching the water surface changed? Yes, more sunlight is now reaching the water surface. The more sunlight that reaches the water surface, the more heat the water will absorb and the higher the water temperature will be. This is another type of thermal pollution caused by human activity. This change in the water temperature will change which organisms are able to live in a stream, river, or lake.

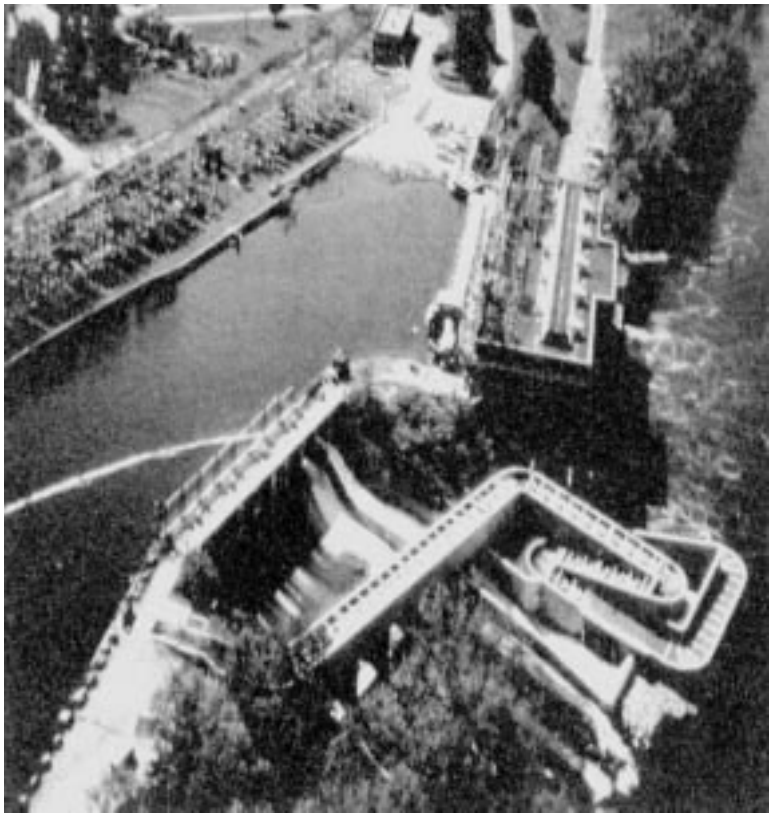
Connections:

Human Activities, Watersheds, and Atlantic Salmon

Although the majority of this issue of *The Salmon Times* has been devoted to a discussion of water pollution, that is not the only impact human activities have had on watersheds nor is it the primary cause of the decline of the Atlantic Salmon. The top three causes for the decline of the Atlantic salmon, in order of importance, are (1) dam construction and stream alteration, (2) over fishing, and (3) water pollution.

We have already talked about the third reason, water pollution, and the general effects it has on organisms. It is clear that water pollution is not good for fish but which pollutants have had the greatest impacted is unknown.

Overfishing, the second reason for the salmon decline, occurs when so many fish are caught that the number of fish born each year is less than the number of fish taken. In the case of salmon, the big ocean fisheries were primarily the source of overfishing, not individual fisherman along the rivers. Steps have been, and are being, taken to control overfishing of salmon.



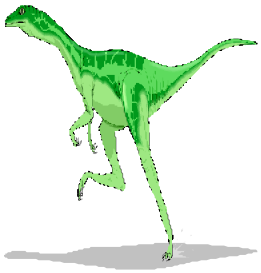
Major Reasons for Salmon Decline:

Dams
Fishing
Pollution

The top reason for the decline of the salmon was dam construction and stream alteration. A dam, as you may know, is a structure that blocks a river channel, allowing a controlled amount of water through to the downstream side, and backing up the rest of the water behind the dam. Dams are huge physical barriers to both upstream and downstream migration. Many dams now have fish ladders, fish lifts, and/or downstream bypasses but they were not all built that way. Originally most dams simply prevented the salmon from reaching their spawning grounds, thereby reducing salmon reproduction. Dams also posed a real physical threat to the survival of salmon migrating downstream. Salmon instinctively follow the strongest current when migrating up or down stream. At a dam the strongest current usually leads to a turbine (a mechanism with gears that capture the energy of the moving water). Many salmon, in following the current, died by getting caught in these turbines. The construction of downstream bypasses has greatly reduced the number of salmon getting caught in turbines.

Dams have two other impacts on Atlantic salmon, impacts that may also affect other forms of aquatic life. As water slows down and collects upstream of a dam, sediment settles to the bottom. A stream may start out with a gravel bottom but will change as the gravel gets buried by the silt and sand. Salmon will not spawn in this type of habitat. Dam operators periodically vary the amount of water flowing through a dam and therefore, through a river channel. A salmon may build a redd downstream of a dam when flows are high and there is a lot of water. However, if a dam operator decides to decrease the amount of water flowing through a dam, what was once a perfectly healthy redd of salmon eggs may end up above the water line during a period of low flow.

Extinction is Forever



You probably know that there will never again be a live brontosaurus, woolly mammoth, or sabre tooth tiger. They are extinct, gone forever. But did you know that hundreds of species of plants and animals have become extinct over the last few hundred years?! That's right! Most of them have become extinct due to human activities! We have (mostly unknowingly) destroyed the habitats of hundreds of organisms, leaving them with no place to live and/or no food to eat. Human activities have also contaminated the water and/or food supplies of many organisms, causing their decline and ultimate extinction.

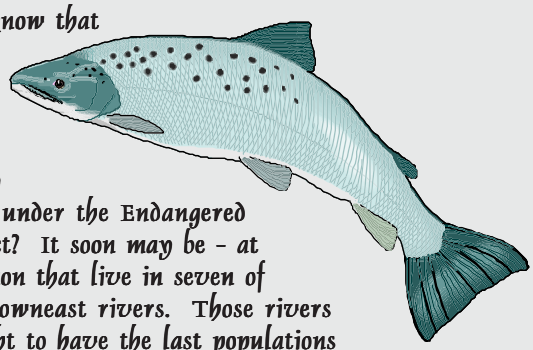
The peregrine falcon, a powerful bird of prey, fell victim to DDT (pesticide) contamination begining in the mid-1900's. Now, thanks to the efforts of many to control pesticide use, the falcon is making a strong comeback.

Peregrine Falcon

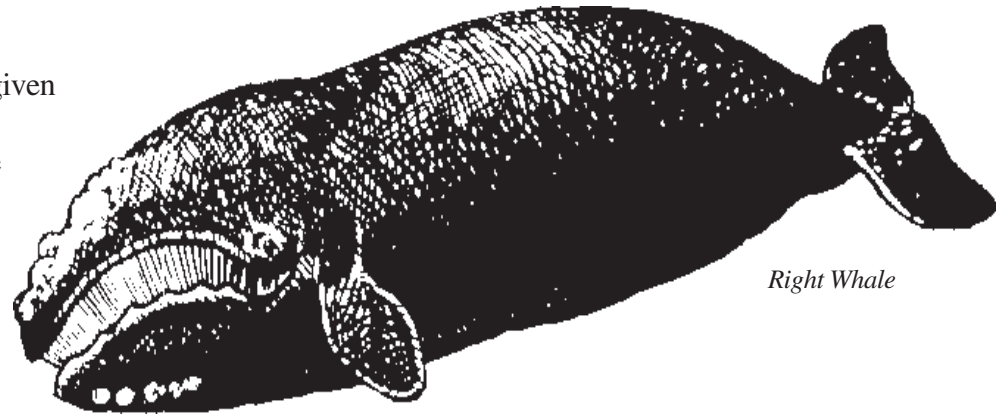
Nothing can be done to bring back those species that are already extinct, but steps can be taken to keep more species from becoming extinct. Species that haven't yet disappeared, but face great peril, are called either threatened or endangered. These terms are used and defined in the Endangered Species Act of 1973, which among other things, gives the U.S. Fish and Wildlife Service and National Marine Fisheries Service the responsibility to protect and manage threatened and endangered species. An endangered species is one that is at risk of becoming extinct in the very near future. A threatened species is one with a lesser risk of extinction in the short term, but one which is likely to become endangered if nothing is done to deal with the problems threatening it in the first place. Action is needed in either case, to prevent permanent loss of these plants and animals.

Are Salmon Endangered?

Did you know that the Atlantic salmon is not currently protected under the Endangered Species Act? It soon may be – at least salmon that live in seven of Maine's downeast rivers. Those rivers are thought to have the last populations of truly wild salmon in New England.



Do you know how the Right Whale got its name? It was given that name because it was the "right whale to hunt!" People made a lot of money selling whale blubber and oil. So many whales were killed that the right whale is now endangered.

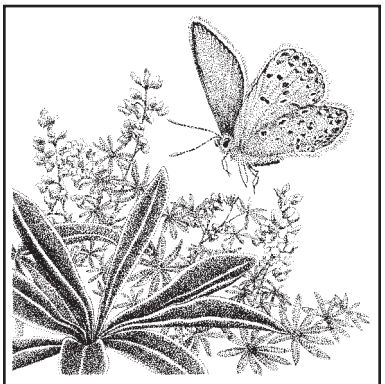


Right Whale

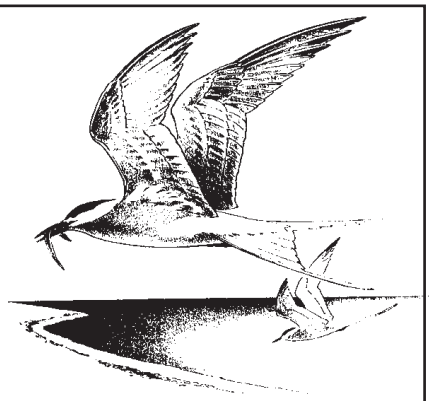
Right In Your Backyard

How many of these threatened and endangered species from New England do you recognize?

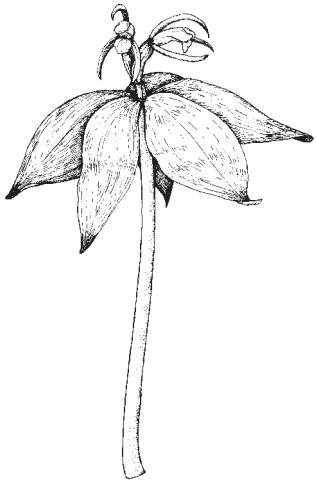
Red-bellied Turtle



Karner Blue Butterfly

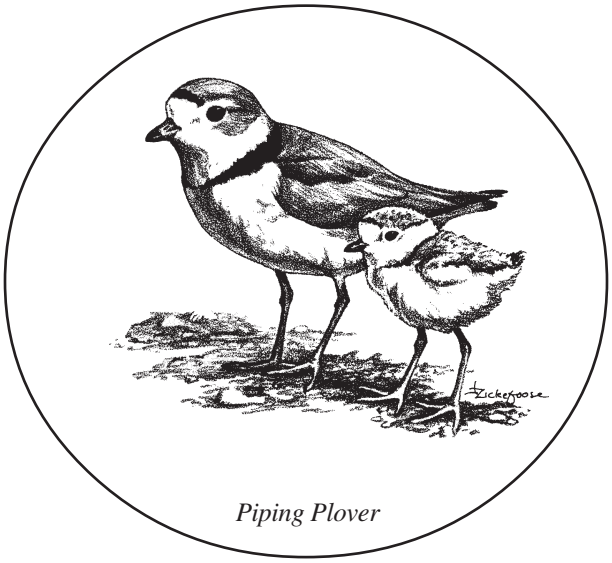


Roseate Tern

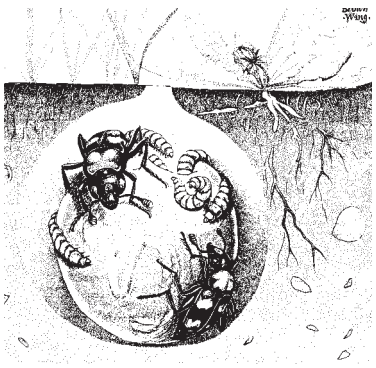


Small Whorled Pogonia

Dwarf Wedge Mussel



Piping Plover



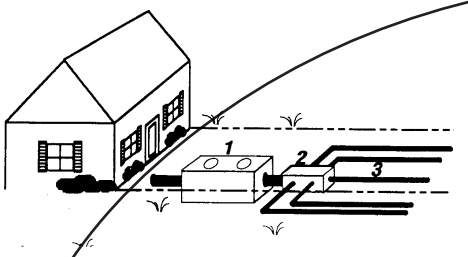
American Burying Beetle

Illustration Credits

Karner blue butterfly, small whorled pogonia (Diana Dee Tyler, USFWS); red-bellied turtle (David Carroll, USFWS); american burying beetle (Kathy Brown-Wing, USFWS); roseate tern (Barry Van Dusen, USFWS); dwarf wedge mussel (USFWS); piping plover (Julie Zickefoose, USFWS)

UNSCRAMBLE THESE POLLUTION WORDS

(SEE WORD LIST ON PAGE 10)



SOURCES OF POLLUTIONS

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R M A S F

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R A M N E T T E T N L A P T

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T S E P I C Y S M E T S S

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T R E I S C F A O

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T A E W S R A T W E

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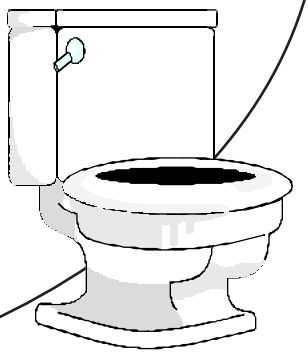
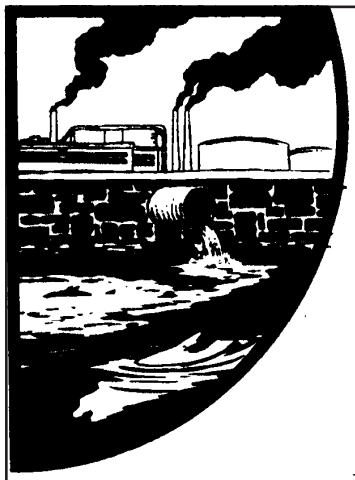
L F I N D S L A L





KINDS OF POLLUTION

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T N P N O I N O C R U O S E

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L M R E T H A L O P L I O N T U

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E W A G S E

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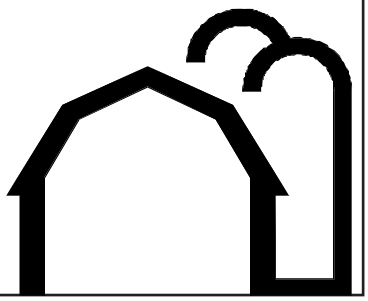
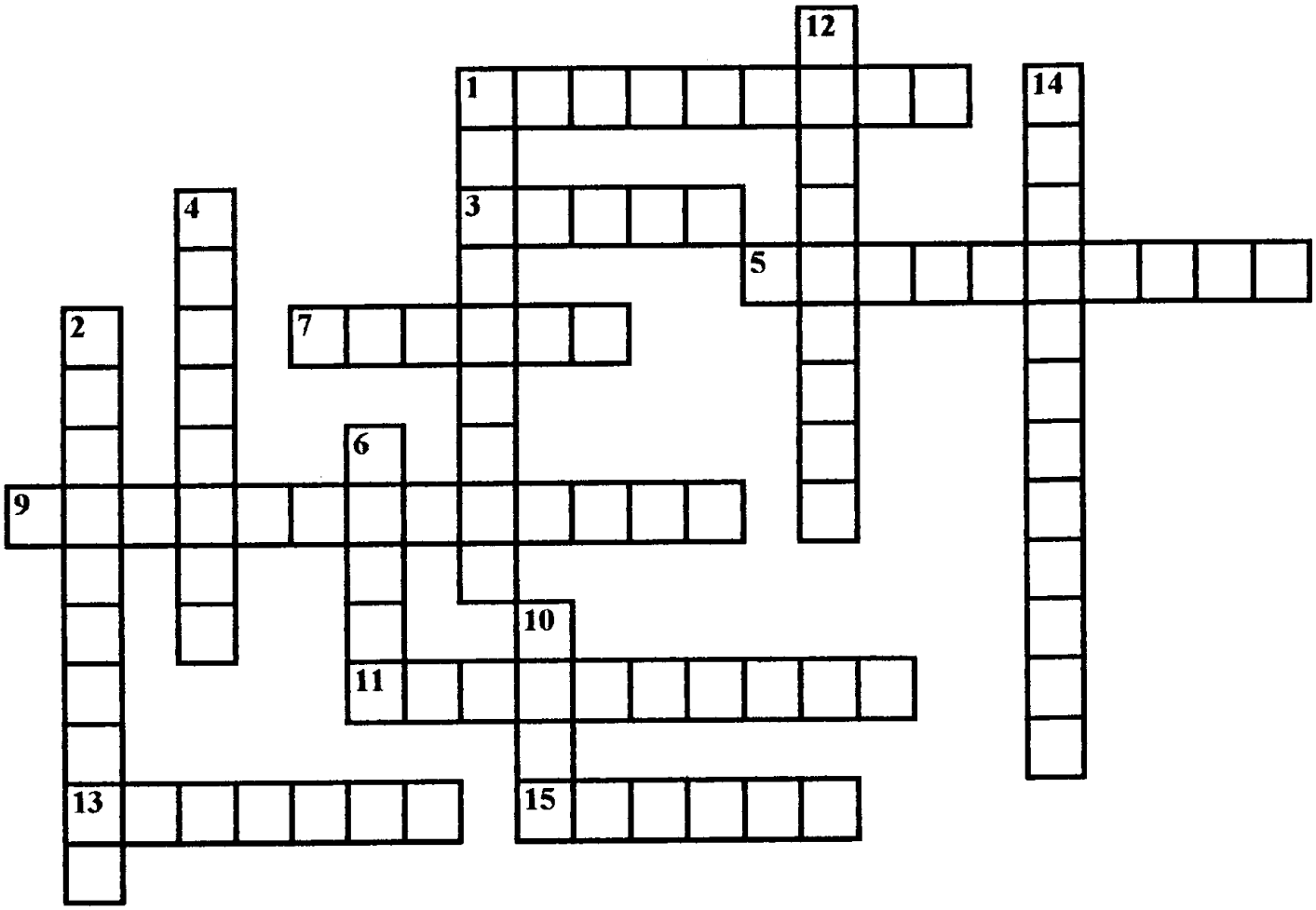
T I P O N O R U C S E



What You Know About Pollution



ACROSS

1) Factories, farms, streets, and homes are all potential sources of this.
3) A word used to describe substances that can kill you.
5) A step below endangered.
7) Overland flow of water into a river or stream.
9) Tiny plants that float in the water and sometimes make it look green.
11) The right whale is an _____ species.
13) A plant or animal species that will never be seen again is _____.
15) Where pollution starts.

DOWN

1) Organisms that can cause disease.
2) Something that helps a fish get around a dam.
4) You did this to your food and water yesterday.
6) A lot of this organism grows when nutrients are added to a water body.
10) A structure that holds back water in a river.
12) When a factory puts the water they used back into a river they _____ it.
14) When a water body is polluted it is described as this.

Un-Scramble Word List

septic systems	thermal pollution	sewage
landfills	treatment plants	point source
farms	nonpoint source	
factories	waste water	