

Dear students,

You are all very lucky to live in this special place. The South Park area is one of the most unique places in Colorado. We have plants found no where else in the world; wildlife most people only see on TV; Native American history; historic ranches and working ranches; historic gold and silver mines and current mining; and 14,000 foot mountains. All of these things make South Park so special that the U.S. government designated South Park as a National Heritage Area. A National Heritage Area is like a National Park but even better because we get to live inside the park. Certain areas within the South Park National Heritage Area are so special that we must take extra care to make sure they are well protected; one of these places is the High Creek Fen. This groundwater-fed wetland is the highest quality example of this type of wetland in all of South Park. This fen has plant species that are only found in a few places in the world. It also has nine rare aquatic and semi-aquatic macroinvertebrates not found at any other fen of similar type.

The National Heritage Area needs your help! Because the High Creek Fen is so special we want to make sure that it is not being impacted by visitors. You will collect data and take pictures to document what you see at the fen. Every year students like you will collect the same data, so we can see if the fen changes over time. Take pride in protecting your National Heritage Area.

Jara Johnson

Reading:

You are about to take a deeper look at stream health and read the tale that bugs (benthic macroinvertebrates) have to tell you as you perform a greater service of setting up a Silverheels Middle School monitoring program at the High Creek Fen. You will need to interpret the data you collect.

In the United States, clean drinking water is a right, not a privilege. It was not that way prior to 1974. Let's look at what constituted the criteria for clean drinking water through the ages, and apply it to a scenario you could encounter today.

Scenario: *You are in a drop camp, out far from home. Your water bags sprung a leak and are empty. There is a stream nearby, do you drink the water? (Drop camp = you were dropped off at a designated camp site with camping and cooking equipment but no motorized transportation)*

Turbidity - how clear is the water? This was the rule of thumb as far back as 2000 BC. At the fen, you are going to perform a simple turbidity test using a disk at the bottom of a jar you will fill with water. In ancient times you would also smell the water. If the water smelled good but was not clear, then it was filtered. The filter was a cloth bag or a sand trap.

Your stream is relatively clear. Your stream passed that test. Do you drink the water?

As time marched on people noted that even when the water was clear and smelled good it made them sick, sometimes killing many people. During the Middle and Dark Ages, water was thought of as unhealthy and the practice of drinking honey wine (mead) became wide spread. It was extremely weak in alcohol content. The daily allotment was three quarts per day. Mead took 40 days to make, starting with the first step of boiling the water.

Not until 1676, with the invention of the microscope, did the practice of boiling water for drinking become common and much cheaper than making mead or wine.

You have decided to boil your water: Smart thinking. Never consider stream water safe. In Colorado giardiasis and E.Coli are common illness from drinking stream water. Approximately 550-650 cases of giardiasis are reported in Colorado each year, as reported to the Colorado Department of Public Health.

For more information on boiling water to make it safe to drink, read the Center for Disease Control and Prevention's (CDC) Guide to Drinking Water Treatment and Sanitation for Backcountry & Travel Use:

http://www.cdc.gov/healthywater/drinking/travel/backcountry_water_treatment.html

In conclusion:

- Consider water from any outdoor source as contaminated with disease-causing organisms.
- By far the best way to treat water is by boiling it. Bring water to a roiling boil for at least 1 minute, and at least 3 minutes at altitudes greater than 6,562 feet (2,000 meters).

Before you drink that boiled water, there is more to learn. Rachel Carson, an author and scientist, published the book *Silent Spring* in 1962. In the book, Carson took on the chemical industry. At that time society thought, and to some extent still does, if it is sold at the store it is safe. The book focused on the pesticide DDT. <http://www.nrdc.org/health/pesticides/hcarson.asp> "DDT, the most powerful pesticide the world had ever known exposed nature's vulnerability. Unlike most pesticides, whose effectiveness is limited to destroying one or two types of insects, DDT was capable of killing hundreds of different kinds at once. Developed in 1939, it first distinguished itself during World War II, clearing South Pacific islands of malaria-causing insects for U.S. troops, while in Europe being used as an effective de-lousing powder. Its inventor was awarded the Nobel Prize."

"The chemical stability of DDT and its fat solubility compounded the problem. DDT is not metabolized very rapidly by animals; instead, it is deposited and stored in the fatty tissues. The biological half-life of DDT is about eight years; that is, it takes about eight years for an animal to metabolize half of the amount it assimilates. If ingestion continues at a steady rate, DDT builds up within the animal over time." <http://www.chem.ox.ac.uk/mom/ddt/ddt.html> .The half-life of DDT in soil is 75 years. (There is great speculation in the science community that DDT/pesticides are a large contributing factor in the rise in breast cancer).

The good news is that DDT has been banned in the United States since 1972. The bad news is it was not banned worldwide until 2002, and is being phased out. DDT evaporates and comes down in precipitation. Most of you know the story of the Bald Eagle - the weakened shells and dead chicks, and finally their rebounding population after DDT was banned. It makes one wonder about other chemicals that cause anthropogenic (originating in human activity) water pollution—pesticides, herbicides, industrial waste and organic compounds.

How do you know if some of that stuff is in your steam? The bugs will tell you. You have now decided to not only boil the water, but also to do a quick check on the benthic macroinvertebrates. Where are you going to look? Benthic means bottom, macro means visible to the naked eye and invertebrates is without a backbone. You are going to look under rocks, under twigs, in leaves and grass in the water.

Thank you for being part of the fen monitoring process. I hope you leave this experience with some valuable life lessons and lots of new questions.

Keystone, Indicator, Flagship and invasive species.

Reading:

Keystone species are species that exert great influence on an ecosystem compared to their abundance. Sea otters are an example of a keystone species. A hundred years ago, they were hunted extensively for their furs, and are currently on the Endangered Species list (at risk of becoming extinct). We like to think that the environmental movement is a 'modern movement,' but notice the dates in this reading.

“Topic; How the Sea Otter Kept the Coastal Fish Population Safe

What Causes It; In the 1700-1800s, on the coast of California, the sea otter was hunted for its sleek, beautiful fur. It was also killed by fishermen who thought they were eating too many of the fish they wanted to catch. The sea otter were hunted almost to extinction.

Without the sea otter, fishermen began to see changes in the ecosystem. Sea otters are one of the few animals that can eat sea urchins. When the otters disappeared, the sea urchin population grew very quickly. Soon there were more sea urchins on the California coast than ever before. Sea urchins eat kelp. Now that there were so many more sea urchins, they ate up all the kelp beds. The kelp beds are very important to many fish as a place to have their young. This set off a chain reaction. With the otters gone and the sea urchins numbers growing quickly, the kelp beds began to disappear. Then the fish, with no safe place to spawn, began to disappear. In just a few years, the fishermen noticed that the fish were suddenly gone.

How Does It Affect Us; Killing off the sea otter had the opposite effect they had hoped. They didn't know the sea otter actually helped protect the fish populations by eating sea urchins. The sea otter is a keystone species for its ecosystem.

What Has Been Done to Fix It; In 1911, a treaty was passed to protect the sea otters from hunting. This was called the International Fur Seal Treaty. In some areas the sea otters came back. The sea urchins in those areas were brought back into control. Their kelp beds recovered and the fish population came back too. This is an example of how a keystone species is interconnected with a whole ecosystem.”

<http://www.exploringnature.org/db/detail.php?dbID=7&detID=77>

Flagship species:

- A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause.
- By focusing on, and achieving conservation of that species, the status of many other species that share its habitat, or are vulnerable to the same threats, may also improve.

- Flagship species are usually relatively large, and considered to be 'charismatic' in western cultures.
- Flagship species may or may not be keystone species and may or may not be good indicators of biological process. <http://www.worldwildlife.org/>

Examples are the bald eagle, prairie dog, wolf and the polar bear. The bald eagle was the animal that generated public support for the banning of DDT. The bioaccumulation of DDT was not just confined to the bald eagle. It affected all birds of prey: gulls, terns, cormorants, herons, osprey, falcons and eagles. DDT almost exterminated the peregrine falcon. It affected songbirds such as the red robin as well. Brown pelicans were one of the first birds observed to have eggshells cracking in the nest and few chicks hatching.

Spotlighting the national bird got the public's attention. The nightly news was teaching viewers about food chains and how these chemicals move up the food chain—through bioaccumulation—with a picture of the bald eagle in the background. Good science and the use of a flagship species quickly halted the use of the chemical DDT. (That does not mean pesticides are not still killing birds.)

A few words of caution: The use of keystone, flagship, and indicator species is an exciting, evolving field with many scientific hypotheses to test. Science is an exact field. The test must be repeatable with the same results. The next two examples are from Encyclopedia Earth.

“While the concept has excited international initiatives to identify indicator species, in practice, identifying potential indicator species is hard work. The organism's presence, absence or abundance must be linked to an environmental condition in a scientifically-sound manner to justify its use as a conservation practitioner's proxy. As the old adage goes, “correlation does not equal causation.” A case in point: it was widely believed (and highly publicized) that a worldwide decline in frogs was an indication of global climate change. The decline, however, seems to be the result of many factors that vary locally. Thus, it remains unclear what environmental or other changes are indicated by declines in frog population.”

“It [indicator species] can be used in many ways and scientists are learning from their mistakes. One example of the use of indicator species is the spotted owl as an indicator of old growth habitat. However, this owl was at the heart of the timber industry v. environmentalist controversy over old growth forests in Oregon and Washington, USA. At the time it was believed that spotted owl habitat was limited to the big, tall trees and standing dead wood found only in very old and mature forests (though now it is clear that spotted owl habitat is much more widely distributed)”. The description of the spotted owl explains how it is an indicator, but also mentions its role in a conservation issue, making it a flagship species.

http://www.eoearth.org/article/Indicator_species”

Invasive species are any species of insect, animal, plant or pathogen not native to that ecosystem and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

The zebra mussel is an example of a freshwater aquatic invasive species. Zebra mussels are bivalves (they have 2 shells). They are small – only about one inch long. Zebra mussels are native to Eastern Europe and Western Asia, but were discovered in the Great Lakes region of the United States in 1988. Scientists believe the mussel came to the U.S. in the ballast water of ships traveling from Europe to the U.S. Ballast water is water that ships have in their hull to help them stay stable when travelling. Ships dump this water when they take on a large load.

Since the zebra mussel's arrival in the late 1980s, it has quickly spread into major rivers and other bodies of water in the country. At first, the zebra mussel spread when barges would travel throughout major rivers. Now zebra mussels are mainly spread through recreational boating and fishing.

Zebra mussels have several negative environmental and economic impacts. They have eliminated native mussel populations in some places because they attach themselves to the native mussels, which prevent the mussel from being able to function. Zebra mussels also filter about one liter of water a day. With such a large number of zebra mussels in an area, they often filter out so much algae that there is not enough left for the aquatic species that eat algae. Zebra mussels attach to the inside of water pipes and continue growing and reproducing in the pipes until they are completely clogged. They are also extremely difficult to remove from surfaces, like boats and other hard surfaces. (Frequently Asked Questions About the Zebra Mussel. U.S. Geological Survey.)

http://fl.biology.usgs.gov/Nonindigenous_Species/Zebra_mussel_FAQs/zebra_mussel_faqs.html

Indicator species are species whose presence, absence, or relative wellbeing in a given environment is a sign of the overall health of its ecosystem. By monitoring the condition and behavior of an indicator species, scientists can determine how changes in the environment are likely to affect other species that are more difficult to study. The science of indicator species is still evolving.

Indicator plants can be used to detect soil composition. For example, locoweed can be used to determine the presence of selenium in the soil. "Some of these plants can accumulate this element to large concentrations, and they can be poisonous to livestock, causing a syndrome known as "blind staggers" or "alkali disease." [The most important selenium-accumulating plants in North America are in the genus *Astragalus*, of the legume family.] There are many species in the legume family, with 25 species that can accumulate up to 15 thousand ppm (parts per million) of selenium in foliage. *Astragalus* can emit selenium-containing chemicals to the atmosphere, which gives the plants a distinctive and unpleasant odor.]

<http://science.jrank.org/pages/3553/Indicator-Species.html>

I used this as an example of a plant because every few years there is a report of some young adults smoking or eating locoweed for the high or the supposed health benefits. They go to

sleep and never wake up. They die from selenium poisoning. The CDC (Centers for Disease Control and Prevention) has tracked selenium poisoning cases to health supplements. They state that selenium is a trace mineral; we need at minimum 55pg/d and at maximum 400pg/d in our diet, which we get from meats, nuts, vegetables and grains. Logic says if the leaf holds 15,000 parts per million of selenium, finding a dosage lower than 400 parts per gram is extremely hard. On the flip side selenium deficiencies are linked to poor health—higher cancer rates, heart disease etc.

While the indicator plants are poisonous, the grain crops grown in the soil high in selenium are beneficial. South Dakota has some of the highest soil concentrations of selenium in the United States. Farmers are selling their wheat crops to European markets at higher than average prices. You will not ingest too much selenium when it is coming from a food source. When it is in a supplement form, however, it is difficult to know the potency of the dosage you are ingesting. Locoweed is poisonous because it takes up very large amounts of selenium, but the grasses and food crops growing in the same soil are not toxic because they do not take up nearly as much selenium as locoweed.

<http://www.sdwheat2.org/files/Farmhomeselenium307.pdf>

The High Creek Fen has rare plants that indicate the richness and uniqueness of the fen.

Macroinvertebrates as indicator species have been studied extensively. You are going to watch a short movie created by middle school students about macroinvertebrates and how their presence and abundance can indicate whether or not a stream is healthy. You will be filling out a worksheet as the movie progresses. There are built-in stopping spots in the film that give you time to answer the correlating questions.