Black Bears as Indicators for River Restoration:
Interpreting the hairs of bears to study salmon restoration

Abstract

The population and feeding locations of black bears along the Elwha River are subject to change upon removal of two dams from the Elwha River. With the re-introduction of salmon to the ecosystem, bear response to this change could have far reaching effects on several parts of the ecosystem. Nutrients from salmon may be dispersed away from the river by bears, affecting plants and animals throughout the watershed. Increased nutrients might also contribute to changes in bear body size or population growth. Researchers with the U.S. Geological Survey (Kurt Jenkins), National Park Service (Patti Happe) and Lower Elwha Klallam Tribe (Kim Sager-Fradkin) are studying the hairs of black bears in a collaborative effort to document baseline patterns of black bear distribution and nutrient sources in the Elwha River watershed prior to dam removal.

A young black bear shows its strength and ability to climb trees. Photo by Dave Manson, Olympic National Park

Introduction

The majority of the Elwha watershed is missing what some people think is its keystone species: pacific salmon. In the 90 years since the Elwha Dam has blocked passage of salmon, the entire ecosystem has changed and adapted to accommodate their absence. Olympic black bears, who may have traditionally feasted on protein-rich salmon, are one of the many animals in the Elwha that stand to benefit from salmon restoration. In order to understand the impact of the dam removal on the ecosystem, wildlife biologists from two federal agencies and a local Tribe are working together to study black bear populations and their current food sources in the watershed.

Removal of the dams is expected to change several components of the Elwha River Ecosystem. How bears will respond to these changes is unknown. Evidence suggests that bears are distributed along the watershed in conjunction with ripe berries and other edible food (Sager-Fradkin et al. In press). Black bears spend April-June in the lowlands of the Elwha Valley where they forage on the new green growth of grasses, sedges, and herbs, and scavenge upon carcasses of deer and elk that did not survive the winter. In July-September black bears drift upslope to mountain meadows in the high country where they feed primarily on the berries of huckleberry plants. During autumn (October-November) bears occasionally return to the river basin, but they are also frequently found in mid-elevational forests and shrub fields where late-season berries and green growth are still available. Black bears den in the winter months of November-April during which time they are sustained largely by the stores of fat they have accumulated during summer and fall. Researchers speculate on how the restoration of a new food source in the river, salmon, might change these bear migration patterns.

As an omnivore, a bear searches for a mix of foods including young plants, berries, insects, and meats." Photo by Roger Hoffman, North Cascades National Park

Studying populations of large wild animals, like black bears, is always a challenge for scientists. Traditional methods based on capture, collaring, and tagging techniques are stressful and dangerous for both bears and biologists. Although these techniques have provided very useful baseline information, there are less expensive and less invasive methods that are more suitable to monitoring long-term changes in bear populations. New techniques based on an analysis of DNA and stable isotopes in the hair of bears are helping scientists study bears with less

impact to the animal.

Through DNA analysis of hair, scientists are able to identify individual bears by their genotype, thus providing a more accurate view of which bears are using the Elwha River. This type of information could lead to an estimate of the minimum number of bears using the river valley seasonally. Another test, called stable isotope analysis, allows researchers to determine important components of bear diets. After bears consume the stable isotopes of nitrogen and carbon from plants and animals, those same isotopes are assimilated into the tissue of the bear and can been seen in their hair (Hilderbrand et al. 1996, Robbins et al. 2004).

The ratio of stable isotopes nitrogen-14 and nitrogen-15 indicate where an animal has eaten on a food chain; from producers to consumers. The ratio of stable isotopes carbon-12 and carbon-13 determines whether the animal has eaten terrestrial or marine food sources. Together, these nitrogen and carbon signatures can tell researchers if a black bear has consumed marine-derived consumers, such as salmon, terrestrial-derived consumers, such as deer or elk, or terrestrial producers, like huckleberries.

A biologist pours blood onto a log in the middle of a hair snagging station. When a bear smells the blood, it will investigate the site by crawling over or under a strand of barbed wire that is strung around the perimeter of the site and leave a sample of its hair caught in a barb (see barbed wire above the yellow arrow in above photo, and the clump of hair in photo below). Photo by USGS

Methods

For two years, Kim Sager-Fradkin headed up the field team collecting samples of hair from bears along the Elwha River during spring and fall seasons (when the bears are not in the high country, nor denning). Because bears don't readily volunteer hair samples to biologists, Sager-Fradkin and the field team established a network of hair snagging stations up and down the Elwha River. These hair snagging stations are spaced every 2.5 kilometers from where the river flows into the Strait of Juan de Fuca up the Valley about 64 kilometers to Camp Wilder. The spacing between hair snagging stations is less than the distance across the average bear's home range, so every bear using the valley lowlands is likely to encounter at least one hair snagging station.

A clump of hair pulled from a black bear when it climbed over a strand of barbed wire. The hair can be analyzed to tell us the unique identity of the bear, whether the bear was male or female, and what the bear has been eating. Photo by USGS

To create hair snagging stations, researchers wrapped two separate strands of barbed wire around the perimeter of 3-5 trees, forming a small corral about 5 meters across. The strands of barbed wire are approximately 35 and 65 cm above ground, designed to catch the hairs of both small and large bears. In the middle of each corral the researchers simulate a site where a cougar might have killed and cached deer or elk to eat later, and that a bear is likely to investigate for food. Because cougars often pile branches atop their kills, the biologists simulate kill sites by piling branches in the center of the corral and by pouring upon it a strong scent attractant with the odor of rotting animals. The scent lure is a mixture of fermented cattle blood, sodium citrate solution to prevent coagulation, glycerin to preserve smell, and a small amount of skunk essence, beaver castor, or shellfish oil. Interested bears crawl under or over the barbed wire to investigate the scent, and in doing so barbs catch and hold one or more clumps of hair. Bears visiting these hair snagging stations are not rewarded with food so are not likely to return to a site repeatedly.

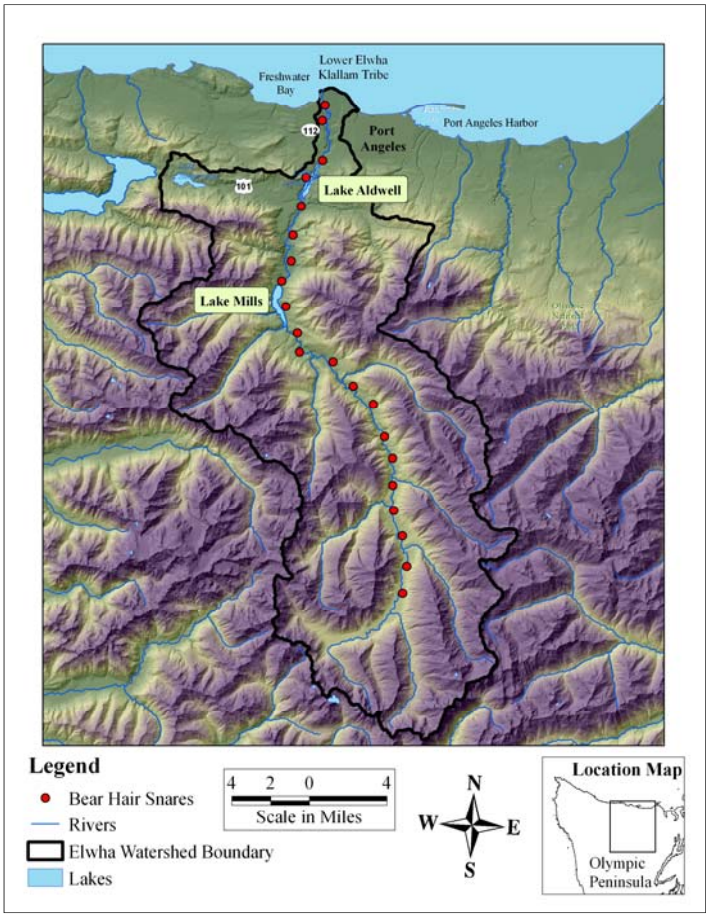
The corrals were established in the spring of 2006 and have been operated for 6 weeks between April and June and another 6 weeks between September and November each year since their establishment. Researchers visit the hair snagging stations every two weeks during the sampling sessions to collect hair samples and pour new scents into the corral. The hair samples are carefully pulled from the barbs using

tweezers and placed in small collection envelopes to preserve the DNA material. The team will continue collecting samples of bear hair through the fall of 2008 at which time they will have replicated their study for three complete spring and fall seasons.

During winter, hair samples are sent to a laboratory for DNA and stable isotope analysis. From each hair sample, the genetics lab has been asked to confirm the species of animal from which the hair came (just to confirm that the sample is from a black bear), the gender of each animal, and the unique genotype of each animal sampled. Although no samples have yet been sent to the stable isotope laboratory, they will be asked to determine the ratios of stable isotopes of nitrogen and carbon.

Expected Results

Laboratory DNA analysis will determine the species, gender, and unique genotype of individual bears sampled at the hair snagging stations. The research team is currently pouring over the early returns from the first year of DNA analyses, so results are not available at this time. The research team has learned that not every hair sample collected contains DNA that is of sufficient quality to identify individual bears. Consequently, it is not clear yet whether the researchers will be able to determine how many bears use the Elwha Valley. Even if they're not able to estimate the total population of bears using the Elwha lowlands, they will be able to estimate indices of population density. An index of a population is easier to measure than the actual population size, and it provides useful information because the index is related to population size and is useful for monitoring. In this case the researchers will be able to estimate the frequency of bear visits to the bear snagging stations and the total number of uniquely identified individual bears visiting the stations. The researchers will also be able to map and compare visitation rates between the spring and fall seasons, and for different areas of the Elwha Valley (i.e. the lower Elwha river below the dams and the upper Elwha river above the dams). Finally, the researchers will be able to determine if it is primarily males or females that use the Elwha lowlands during the spring and fall seasons.



Map of the Elwha River and the network of hair snagging stations. Map by the Lower Elwha Klallam Tribe

Isotopic signatures of bear hair will be used to establish a baseline of how much salmon or other marine resources currently contribute to the diets of bears in the Elwha. This will provide a baseline measure of the current use of salmon by bears to compare to future values after salmon have returned to the Elwha River.

Discussion

Seasonal movement patterns of bears may be altered with readily available salmon. Additionally, if salmon become a reliable source of food for bears in the Elwha Watershed, bears may respond with increased body masses or increased population size (Hilderbrand et al. 1999). Bears are currently located on mountain meadows during the late summer and fall, the period of time when salmon are expected to occur in greatest numbers in the Elwha watershed. Researchers anticipate that bears may change their seasonal movement patterns to accommodate this high-energy, protein-rich food source by spending more time along the river during late summer and fall. Other wildlife are also expected to feed on the restored salmon populations. Mink, otter and other medium sized carnivores may demonstrate changed population and migration patterns. Combined, these changes may have far reaching effects on the entire ecosystem. Once salmon have been re-introduced to the ecosystem, researchers can repeat the methods reported here in order to answer these basic questions.

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Glossary

Consumers- Organisms that are not able to produce their own food and must eat other organisms.

Food Chain- A series of organisms linked together in the order in which they feed on each other

Genotype- the unique genetic constitution of an organism

Home Range- The primary area used by an animal during a given period of time. Most often, researchers look at the area used by animals 95% of the time. If researchers were to analyze the home range of an 8th grade student during the course of a school year, the home range would probably include the student's home, school, soccer or baseball practice and games, band practice and performances, dance practice and performances, trips to the store, etc.

Index (plural indices)- A method for monitoring populations by counting individual animals or their sign (i.e. hair, scat). Because it it difficult to count every individual in a population of wild animals, biologist can generally survey for animal sign over time (i.e. over multiple years) and get an idea of whether a population is increasing, decreasing, or staying the same in size. It is generally accepted that an index of animals or their sign is directly related to the density of that population of animals.

Keystone Species-- a species that has a disproportionate effect on its environment relative to its abundance. Such species affect many other organisms in an ecosystem and help to determine the types and numbers of various others species in a community.

Producers- An organism that produces their own food from simple substances such as water, carbon dioxide, or nitrogen.

Restoration- The process of restoring something to an unimpaired or perfect condition.

Signatures- The proportion of carbon, nitrogen, sulfur, or other nutrients in an animal's diet. A bear that eats salmon will have a high nitrogen and high carbon signature, while a bear that eats grass will have a log nitrogen and low carbon signature.

Stable Isotopes- A variety of a chemical element (in this case carbon or nitrogen) which is distinguished by a different mass number but shares the same atomic number and chemical properties.

Researcher Biographies

Dr. Kurt Jenkins, USGS, Forest and Rangeland Ecosystem Science Center

As a teen, Kurt Jenkins decided to pursue a career working in the national parks as either a ranger or a biologist. His interests were kindled by his family's long association with Yosemite National Park, and his frequent trips hiking in the Sierra Nevada. An inspirational zoology professor at U.C. Davis and a summer spent working as an undergraduate biological intern at Olympic National Park convinced him that a career in wildlife research in the National Parks was his calling. To pursue his goals he completed graduate degrees with National Park Service research units at Oregon State University and University of Idaho studying the ecology of elk and other large mammals in Olympic and Glacier National Parks. He taught on the faculty at South Dakota State University for a few years before switching to work as a wildlife research biologist with the National Park Service in Alaska. For 18 years Kurt has worked as a wildlife research biologist with the National Park Service and the U.S. Geological Survey providing research in support of wildlife management issues and monitoring programs, with a primary focus on mammalian ecology in the National Parks.

Dr. Patti Happe, NPS, Olympic National Park

Patti's desire to study wildlife stemmed from her childhood walks with her grandfather on his farm, and was cemented on a trip throughout the Rocky Mountains with her grandparents as a teen. Although her career path has always been heading towards that goal, the route was sometimes circuitous, because at the time few women entered her chosen profession. Her undergraduate degree is in Environment Resource Management from Penn State University, Masters in Wildlife Ecology from Oregon State University and PhD in Rangeland Ecology from Oregon State. Patti has worked a variety of jobs, ranging from Environmental Specialist (focusing on mining impact analysis and compliance) to Dairy Science, to her current job as the lead wildlife biologist for Olympic National Park, where she has been for the past 12 years. In this job Patti works on both research and management, and is responsible for all wildlife species in the park, ranging from songbirds, to fisher, elk, spotted owls, bears and bats.

Kimberly Sager-Fradkin, Lower Elwha Klallam Tribe

As a child in Montana, Kim had a love of both animals and the outdoor world that inspired her to want to become a veterinarian. The realization the most veterinarians worked indoors, however, caused Kim to question her ambitions and seek other goals. It wasn't until Kim traveled to Africa in her early 20's that she became enamored with the idea of studying wild animals. An exhaustive search through college catalogues caused her to realize that she could actually pursue a major in Wildlife Biology. She wholeheartedly embarked on this endeavor, attending Humboldt State University and completing her degree in 1996. Kim landed in Port Angeles, Washington in 1999 where she helped develop a black bear management program for Olympic National Park, surveyed for the elusive marbled murrelet, tracked black-tailed deer for the U.S. Geological Survey, and finally settled into a graduate program at the University of Idaho studying black bear distribution patterns in the Elwha Valley. Currently, Kim is a wildlife biologist for the Lower Elwha Klallam Tribe where she spends her time studying everything from otters to elk.

Curriculum Writer's Biography

Suzanne Gray, Science Teacher, Sequim Middle School

At age four, Suzanne sat her parents down and declared herself a "mountain woman". She hasn't turned back. Through middle and high school in both Maine and Washington State she spent countless hours observing pond life and exploring the dry forests on the eastern slopes of the Southern Cascades. She attended Huxley College of the Environment at Western Washington University as an Environmental Education major which allowed her to spend 1/3 of those college years outside of the classroom. After working as an Outdoor Educator for five years, she returned to the classroom (Antioch University New England) for a Master's of Science with a teaching certification. She currently works as a middle school science teacher in Sequim, WA.

Elwha Research Learning Unit

This research summary is a piece of a larger Elwha Research Learning Unit which has been funded by the Research Learning Network and coordinated by Olympic Park Institute. This is one of seven research summaries which capture the diverse and exciting science which is being done in preparation for the upcoming Elwha River dam removals. All seven summaries are examples of the important work which fits together to help us better understand the Elwha River Ecosystem and neighboring Strait of Juan de Fuca. Three of these research topics have been turned into activities which have been designed for us to practice the scientific process by using real research from this inspiring dam removal effort. For the complete learning unit, go to OlympicParkInstitute.org or ElwhaScienceEd.org.

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