Spring 2013

The Planet, 2013, Spring

James Rogers
Western Washington University

Huxley College of the Environment, Western Washington University

THE PLANET

THE RECOVERY ISSUE SPRING 2013

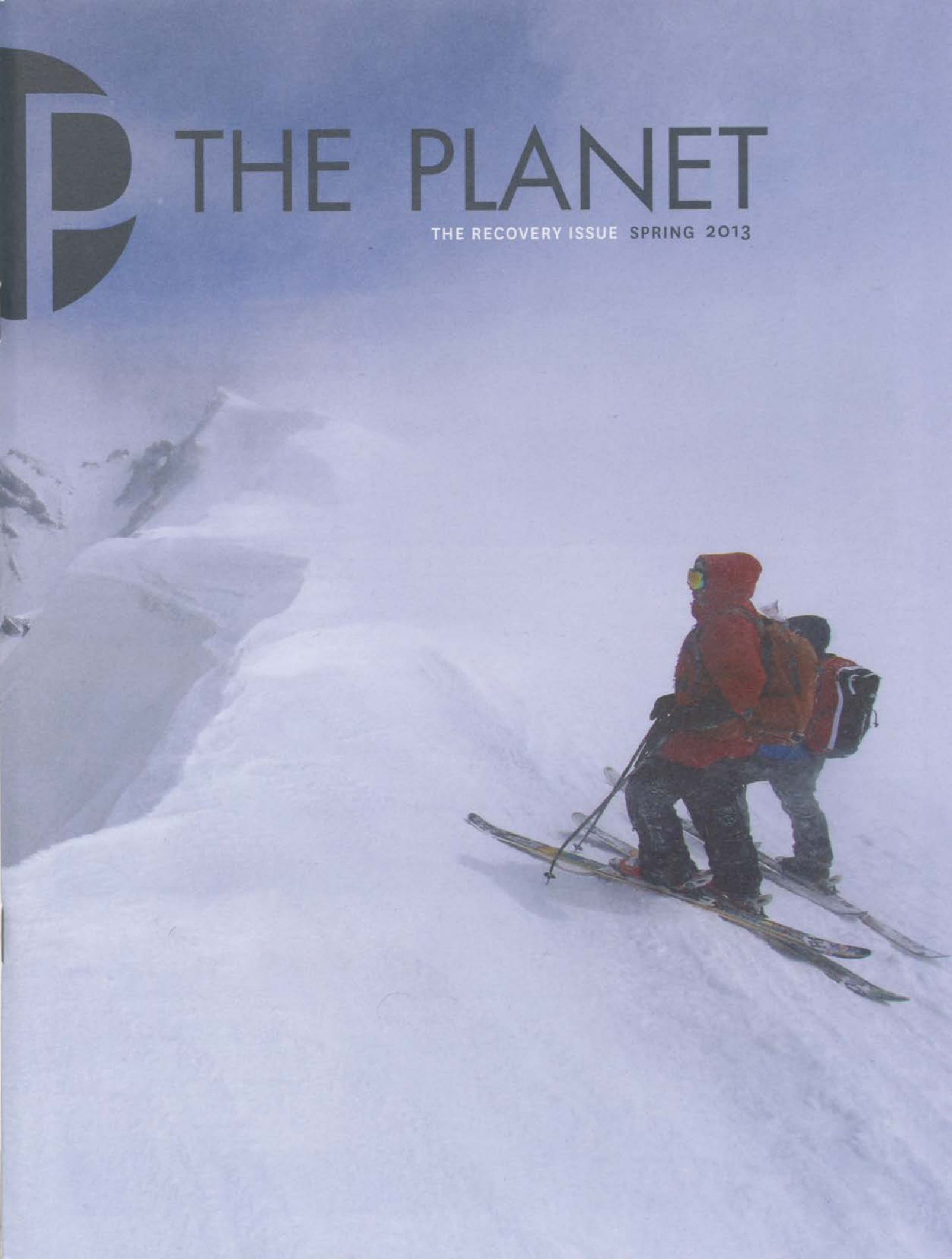

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photo - tim seguin

DEAR READER,

This spring issue focuses on the word recovery.

But, I should mention that at the beginning of each quarter at The Planet, one of the first things we tell new writers is to scrutinize their use of words like recovery. This is because, as any of you dedicated readers out there may have noticed, we try to avoid these kinds of words or take the time to back them up with facts when they are in a story.

We do this because words like recovery, health, disaster and sustainability are not scientific measurements of how truly "recovered" or "disastrous" something is. Really these words tell us very little about their subject. They are inherently ambiguous.

For instance, how is a healthy ecosystem defined? By what standards is it "healthy?" Is it healthy by the standards of one specific animal? You could claim deer populations are flourishing, but this might mean predator populations are at an all time low. Alternatively, are we only considering a system healthy by human standards? Or are we only considering it unhealthy by human standards? A disastrous event for humans could be normal or even beneficial to the health of an ecosystem in the long run.

Confusing, right?

But there is some beauty in the ambiguity of a word like recovery. It lends itself to many unique issues and as a theme allows us to encapsulate many subjects including threats to increasing wolf populations, cleanup of mercury at the Georgia-Pacific site, the use of fungi for remediation and even the de-extinction of lost giants like the mammoth.

Consider the many implications of the word recovery in the stories that follow and take the time to interrogate words like recovery in the future because these words are more complex than we give them credit for.

Enjoy.

James Rogers
Editor-in-Chief

CORRECTIONS:

The Planet Magazine strives for accuracy and will correct any factual errors promptly and courteously. In the Winter 2013 Policy issue, there was an error in "Coal Controversy." The proposed Cherry Point coal terminal will cover 1,500 acres, not 15,000 acres

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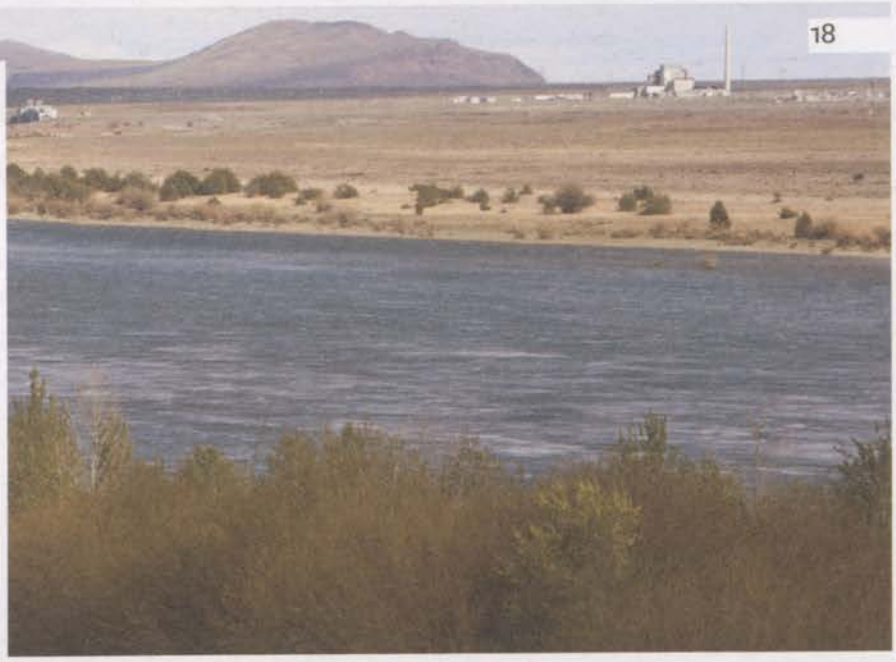


FEATURED STORIES:

ABOUT *THE PLANET:*

THE PLANET MAGAZINE is the quarterly student publication of Western Washington University's Huxley College of the Environment. We are dedicated to environmental advocacy through responsible journalism.

This issue of The Planet is printed on Mohawk Via uncoated bright white paper. It is made from 30% recycled content. Mohawk is a certified Women Owned Business Enterprise and is the first U.S. paper mill to offset 100% of its electricity with windpower renewable energy credits. It is also the first U. S. premium paper mill to shift toward carbon neutral production. Basically, they are environmental superheroes. We are proud to support them.

ON THE COVER:

The summit of Mount St. Helens at 8,365 ft. Pictured are Olin Wimberg and Eric Parker.

The 50 mph winds let up just in time for me to snap this shot.

-Jasper Gibson

FROZEN*FOOTPRINTS*

STORY JULIAN THEBERGE | **PHOTOS** TIM SEGUIN

Deep in the shivering heart of eastern Siberia, two scientists, a father and son, are bringing the ancient mammoth ecosystem back to life. Each step of their growing herd of herbivores could bring humanity closer to amending the largest human-caused extinction in history and mitigating a source of greenhouse gas emissions.

ABOUT 2.6 MILLION TO 11,700 YEARS AGO, in the geological period referred to as the Pleistocene epoch, colossal ice sheets advanced and retreated in the northern latitudes. Migrating herds of mammoth grazed in the grassy-tundra ecosystem. But, 13,000 years ago, humans got smart. The ancient Clovis people, named for their innovative spears, were now able to kill large game like mammoths, saber-tooth cats, giant rabbits and huge sloths more readily and in large numbers.

Throughout Siberia, the animal extermination caused the grassy tundra to collapse. According to Russian scientist Nikita Zimov in a 2009 Geophysical Research Letter, when the ecosystem changed, 1,000 gigatons of carbon was released into the oceans and atmosphere. Now humans are changing the climate again and the melting soils in the Northern Siberian plains could release up to 500 gigatons of carbon, accelerating climate change.

Zimov is now the director of his father's project called Pleistocene Park. The park's goal is to keep the permanently frozen Arctic soil — permafrost — cooler with the hopes of reducing greenhouse gas emissions by simulating or recreating the conditions before humans eradicated the large herbivores, Zimov said.

During the last 40,000 years, the soil has been accumulating carbon from the atmosphere. However, the permafrost is no longer frozen year-round. As the soil thaws, carbon is released into the atmosphere. Average temperatures in the Arctic are increasing, causing more greenhouse gases to be emitted, continuously accelerating climate change, Zimov said.

Pleistocene Park's strategy for lowering Arctic emissions is to use large grazing animals to keep the permafrost cooler, Zimov said.

Without large animals, half a meter of soft snow acts as a heat insulator from the cold air. The air temperature is negative 45 degrees Celsius, but in the soil, the temperature is much warmer — around negative 7 degrees Celsius, Zimov said. Even though the soil is still bitter cold by common standards, the permafrost must stay frigid.

However, when animals trample the snow, it is packed into just 10 centimeters and loses its insulating properties. Under the soil where animals have walked, the temperature cools to negative 25 degrees Celsius — a 20-degree drop. Eventually more animals will be added to the land, further crushing the snow and lowering the temperature, Zimov said.

By trampling the snow, the permafrost will remain frozen. Carbon in the soil will stay put, and greenhouse gasses will not be released, he said.

The park could also indirectly affect climate change through the alteration of the landscape's color. Forests are dark so they absorb

"Eventually more animals will be added to the land, further crushing the snow and lowering the temperature."

TOP: *Large portions of North America and Eurasia were once home to mammoths. This mastodon, whose skeleton was reconstructed at the Burke Museum of Natural History in Seattle, is a relative of the mammoth. Nikita Zimov, director of Pleistocene Park, believes the absence of megafauna on the landscape may be affecting our climate in surprising ways.*

BOTTOM: *By compacting snow and reducing its capacity as a thermal insulator, large animals may facilitate the preservation and expansion of permafrost in Siberia. (Photo Illustration)*

heat, just like a black shirt on a hot day. Tundra grassland is covered in snow during winter and reflects heat from the sun. Instead of trapping heat like the forest, the grassy tundra reflects it back into the atmosphere. This is a direct and quick way to slow a heating atmosphere, Zimov said.

Pleistocene Park has been through many struggles, but Zimov is determined to see it through. Eventually he wants to open the gates and let the park extend naturally. Even though it would be difficult, he wants to see the forest turn back into grassy tundra, he said.

"Why set yourself small goals?" Zimov said.

Andy Bunn, Huxley College of the Environment associate professor and scientific collaborator with Zimov, said it is unrealistic to believe the project could change all the boreal forest — which accounts for 15 percent of ecosystems worldwide.

However, if Pleistocene Park successfully changes the carbon cycle, it could open the door for future research projects. It might be 50 years before there is evidence of success or failure, Bunn said.

"Reconstructing mammoth DNA is like running the New York City and Philadelphia phone books through a paper shredder and trying to piece them back together"

Imagine the freezing Arctic version of the African Savanna. Just replace elephants with mammoths, rhinoceros with wooly rhinoceros, gazelle with caribou and lions with sabre-tooth cats.

In the Yakutia region, where the park is located, each square kilometer once contained roughly one mammoth, five bison, six horses and 15 reindeer. It is possible to calculate the density from the type, condition and depth of bone deposits, Zimov said.

To make way for the park, Zimov bulldozed a section of the boreal forest with a tank, Bunn said.

Zimov has amassed a herd of Yakutian horses, musk oxen, reindeer and moose acquired from across Russia. Currently, the population of herbivores is not high enough to maintain the grassland. He hopes to buy more musk oxen and eventually Canadian bison, Zimov said.

Even though Zimov will not rely on mammoth cloning projects, they could aid the long-term success of his project, he said.

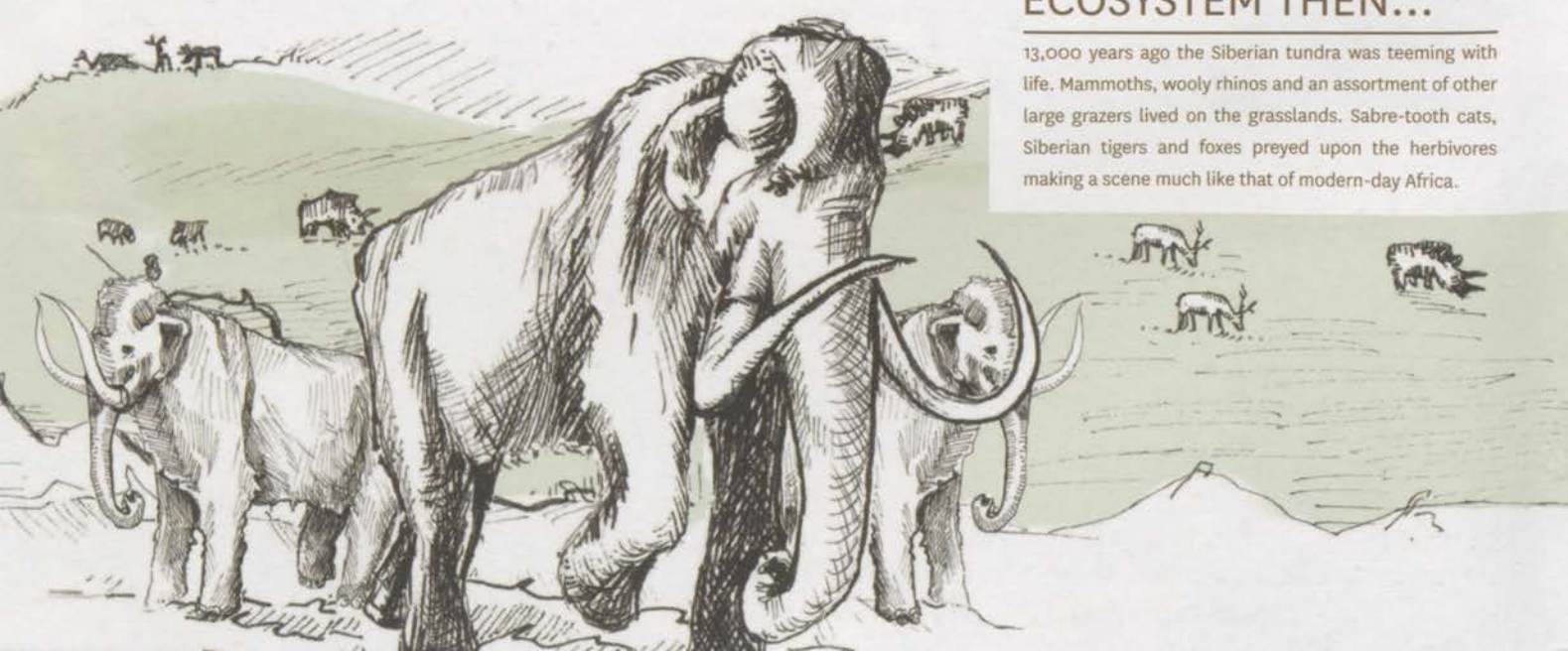
At an independent TED talk on de-extinction, Hendrick Poinar said the process would involve reconstructing DNA from a flash-frozen mammoth stem cell and impregnating their closest living relative — the African elephant.

Geneticists may be able to perform this feat in about 15 years. However, it will take longer before a cloned mammoth can live outside free from monitoring. His grandchildren can worry about it, Zimov said.

"[We do not want] one poor animal with a

ECOSYSTEM THEN...

13,000 years ago the Siberian tundra was teeming with life. Mammoths, wooly rhinos and an assortment of other large grazers lived on the grasslands. Sabre-tooth cats, Siberian tigers and foxes preyed upon the herbivores making a scene much like that of modern-day Africa.



ABOVE: *By introducing herds of large animals like bison, horses and reindeer to the Yukatia region of Siberia, Zimov plans to convert forest to grassy tundra and trap greenhouse gases in the soil.*

BELOW: *Zimov hopes that mammoths might soon be brought back from extinction by reconstructing fragmented DNA. He suggested the reintroduction of megafauna might slow the melting of Siberian permafrost. Photo courtesy of Miles Borgen.*

bunch of doctors running after him, making sure he would not get sick or he will not start sneezing," Zimov said.

Stanley Temple, a conservation biologist from the University of Madison and an attendee at the de-extinction conference, said the mammoth project is plausible, but extremely unlikely. Frozen mammoth DNA was exposed to the DNA of other organisms and fragmented into small sections — normally DNA is in one continuous thread.

"It is time to really move away from the hype and move away from the things that grab the media headlines and actually approach this thing in a scientific way," Temple said.

Reconstructing mammoth DNA is like running the New York City and Philadelphia phone books through a paper shredder and trying to piece them back together, Temple said.

Genetic engineers would not only need to put the pieces back together, but they would also have to borrow DNA from Asian and African elephants, Temple said. Splicing DNA from two organisms would make a chimera — neither mammoth nor elephant, but something totally new.

Temple is more interested in using genetic technology for endangered species rather than extinct ones, he said. When the population drops, the diversity of traits decreases. Successful adaptation hinges on a species' ability to change. Recovering species could benefit from artificially adding lost genetic material from their ancestors to kick-start their diversity and survive.

Huxley College of the Environment associate professor Andy Bach said money should be spent on organisms that have a chance, like salmon.

"The mammoths had their chance and they lost," Bach said.

Putting mammoths back in the Arctic also hinges on some large assumptions. According to David Nogués-Bravo in a 2008 Public Library of Science article, mammoth extinction was a combination of climate conditions and human hunting. Archaeological dig sites indicate humans hunted mammoths. However, science has no way of proving that humans were the only cause of mammoth extinction and climatic evidence shows a warming climate may have reduced their habitat.

If climate caused the die-off, mammoths would return to the same situation that killed them, rendering the mammoth restoration project futile, Bach said.

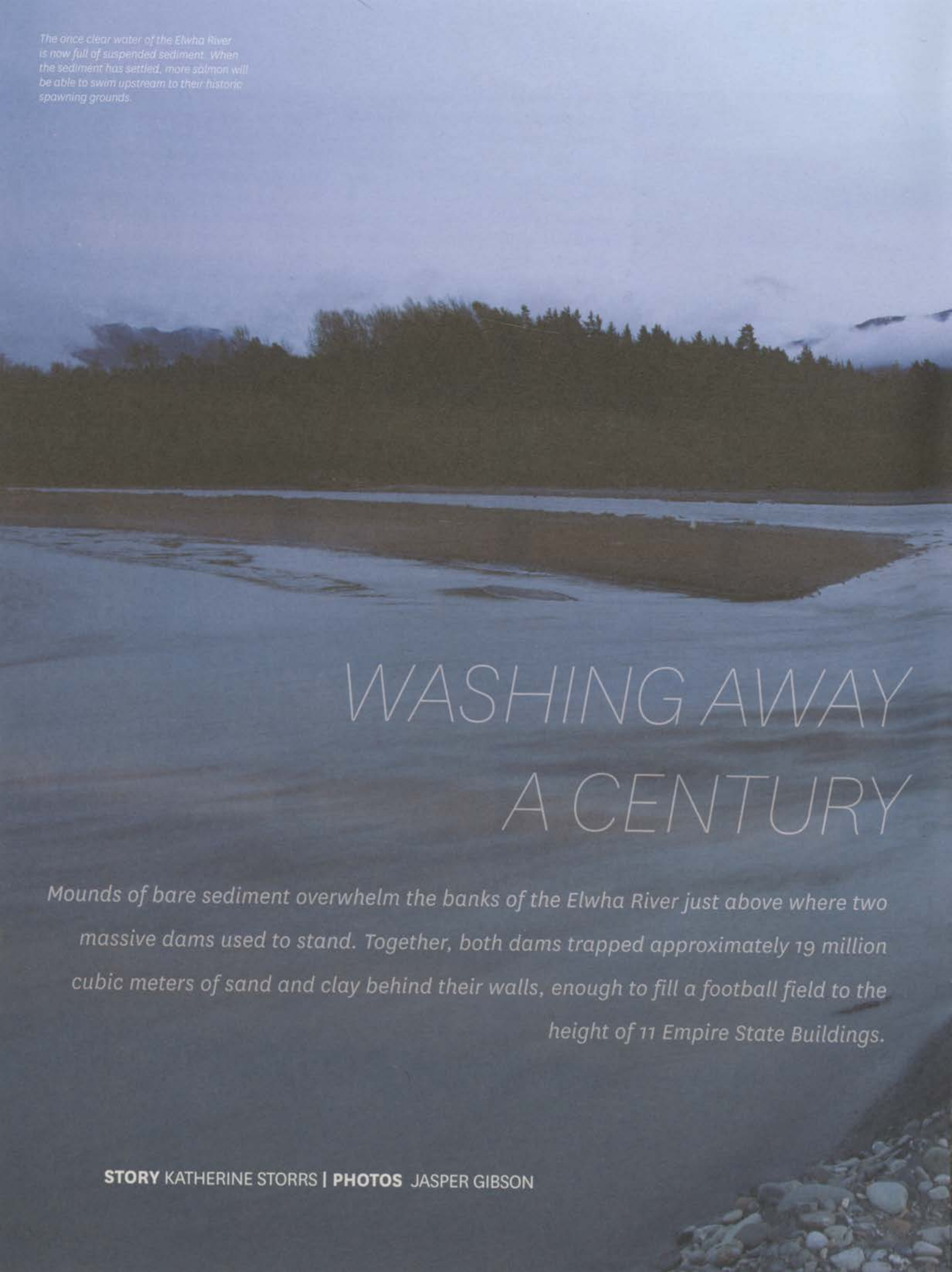
Pleistocene Park has an uncertain future. Big leaps in science and visionaries are always scorned at first, but maybe footsteps in Siberia are a cause for hope.

JULIAN THEBERGE is a junior studying environmental science, communications and music at Western Washington University. After studying, he enjoys rock climbing, art and Zen. His heroes are Albert Einstein, Joseph Campbell and Frank Ocean.

TIM SEGUIN is a senior pursuing a degree in environmental photography through Huxley College and Western Washington University's art department. When he is not in the darkroom, he enjoys snowboarding and birding.

...AND NOW

Reindeer, moose, Yakutian horses, muskoxes and bison already live in the park. Although the animal densities remain lower than in ancient times, Zimov plans to return the steppe ecosystem to its former vitality.



The once clear water of the Elwha River is now full of suspended sediment. When the sediment has settled, more salmon will be able to swim upstream to their historic spawning grounds.

WASHING AWAY A CENTURY

Mounds of bare sediment overwhelm the banks of the Elwha River just above where two massive dams used to stand. Together, both dams trapped approximately 19 million cubic meters of sand and clay behind their walls, enough to fill a football field to the height of 11 Empire State Buildings.

STORY KATHERINE STORRS | **PHOTOS** JASPER GIBSON

THE DESTRUCTION OF THE ELWHA DAM AND Glines Canyon Dam is the largest dam-removal project in U.S. history. The river basin is the ideal learning opportunity for ecologists to study dam removal. As sediment flows through the unleashed waters, scientists can witness the renewal of an ecosystem after 100 years of disturbance.

Most of the Elwha River meanders through the dense, damp forests of Washington's Olympic National Park, federally protected from human influence.

Sediment that accumulated in the reservoirs behind the dams is now being exposed, piling up on the banks of the river and making its way to the mouth.

SEDIMENT AND SALMON

The demolition crew completed the removal of the Elwha Dam in March 2012 and only 40 percent of the Glines Canyon Dam remains. The National Park Service is funding this $325 million dollar project, which should be completed by December 2013, said Barb Maynes, public information officer at Olympic National Park.

"Part of what needed to be examined in the process of determining whether or not to relicense the dams were the full costs, not just the dollars it took to build the dams, but what is the cost in terms of eagles and bears and bugs that eat salmon," Maynes said.

Fish ladders, structures that allow fish to swim upstream past dams, were not included in either dam. The dams restricted salmon to the lower 5 miles of the Elwha River, but they will soon be able to access 70 miles of federally protected habitat for the first time since the dams were constructed.

According to the 2012 State of Salmon in Watersheds report, following the removal of the dams, salmon populations are expected to swell to 300,000, which is 100 times their current size.

"It was expected that dam deconstruction would expose almost 800 acres of lakebed sediment when the reservoirs were drained."

Before salmon populations increase, there is a lot of sediment that needs to make its way through the rivers. This may take a few years, said James Helfield, associate professor at Huxley College of the Environment.

High amounts of suspended sediment in the water, also known as high turbidity, are causing problems for the salmon migrating upstream to spawn. Sediment can get lodged in the gills of fish, causing breathing difficulty, Helfield said.

High turbidity is a short-term effect that will last until the sediment from the lake reservoirs is stabilized on the banks of the river or has moved through the Elwha. It will be deposited onto the riverbed, beaches and estuary or dumped into the Strait of Juan de Fuca.

To reduce the health effects that high turbidity has on spawning salmon, the deconstruction of the dams is halted during "fish windows." These are key times throughout the year that salmon migrate upstream to spawn, Maynes said.

As salmon return to the watershed above the old dam sites, they will bring nutrients from the ocean that will affect vegetation health for up to 2 miles on either side of the river, said Robert Elofson, member and River Restoration Director of the Lower Elwha Klallam Tribe.

These marine-derived nutrients come from the food the salmon eat at sea and are brought back and deposited in the watershed when the salmon spawn and die as a part of their life cycle. Wildlife such as black bears and raccoons help spread these nutrients to the riparian zone, which is the habitat located alongside the river, Helfield said.

"But this project, it is not all about salmon, it is all about restoration," Maynes said.

BANKING ON SEDIMENT

The deconstruction of the Elwha Dam and Glines Canyon Dam drained Lake Aldwell and Lake Mills releasing a vast amount of sediment that is now being introduced into the ecosystem.

According to the 2011 Revegetation and Restoration Plan for Lake Mills and Lake Aldwell, it was expected that dam deconstruction would expose almost 800 acres of lakebed sediment when the reservoirs were drained.

According to the plan, samples of the fine sediments at the reservoirs reveal the lakebeds are lacking organic matter and essential nutrients, including nitrogen and phosphorus.

ABOVE: *Invasive plant species thrive in newly disturbed areas. The National Park Service and Lower Elwha Klallam Tribe aim to discourage invasive plant establishment by planting more than 400,000 native seedlings to outcompete the invaders.*

BELOW: *As the complete removal of the Glines Canyon Dam nears, all that remains of Lake Mills is the meandering Elwha River. The river will continue carving the lakebed, taking with it a century's worth of sediment.*

The bottom of the reservoir was anaerobic, or lacked oxygen, so organic matter such as leaves, needles and logs accumulated instead of decomposing and adding nutrients to the soil as they would in an oxygen-rich environment, Elofson said.

The sediment from the old lakebeds is made up of mostly fine particles such as clay and sand. Fine particles of sediment settle out when they hit slow-moving water in lakes, Helfield said.

This structure of the exposed soil is not conducive for plant growth.

"When it is wet, it is like soupy porridge and when it is dry, it is like concrete," Helfield said. "We have been wondering, what, if anything, can grow on this stuff now that it is been exposed."

According to the 2011 Proceedings of the Elwha River Science Symposium, there is great concern invasive plant species will move in on the new sediment and outcompete native plants because of their knack for growing in disturbed areas.

An invasive species is a non-native organism that can damage human health, the environment or the economy.

"The basic principle behind ecosystem restoration is you just want to try and get your native species in the ground, give them a leg up. Once they get tall enough, so that they can no longer be out-shaded by invasive species, then they have won," Helfield said.

The National Park Service and Lower Elwha Klallam Tribe are working together to revegetate the newly exposed sediment.

According to the Elwha Revegetation page on the National Park Service's website, volunteers will plant more than 400,000 native plants representing 80 species of grasses, herbs, shrubs and trees.

"It is all connected; once the vegetation starts to take root, it will hold sediment in place and there will not be as much sediment washing through the water. Less erosion, less turbidity," Helfield said.

A LIVING LABORATORY

For a scientist, nothing beats getting out of the lab and into the field. The Elwha restoration will serve as an outdoor classroom for scientists of all ages and skill levels to study the restoration of a protected watershed after dam removal.

The Elwha is a great place to learn about the degradation of an entire ecosystem by dams because other influences such as agriculture or deforestation are not an issue, Maynes said.

> *"When it is wet, it is like soupy porridge and when it is dry, it is like concrete."*

Howard Sprouse maintains a laboratory at Peninsula College in Port Angeles, Wash. to study soil repair using fungi and would like to apply it to the Elwha. He has come up with an idea to establish a university program focusing on Elwha restoration. This program would include students from Western Washington University and Peninsula College.

"I am calling it the 'living laboratory,'" Sprouse said.

According to the project proposal, the living laboratory program would give students a chance to gain research experience to supplement their formal education while at the same time adding new research to the field of ecosystem science.

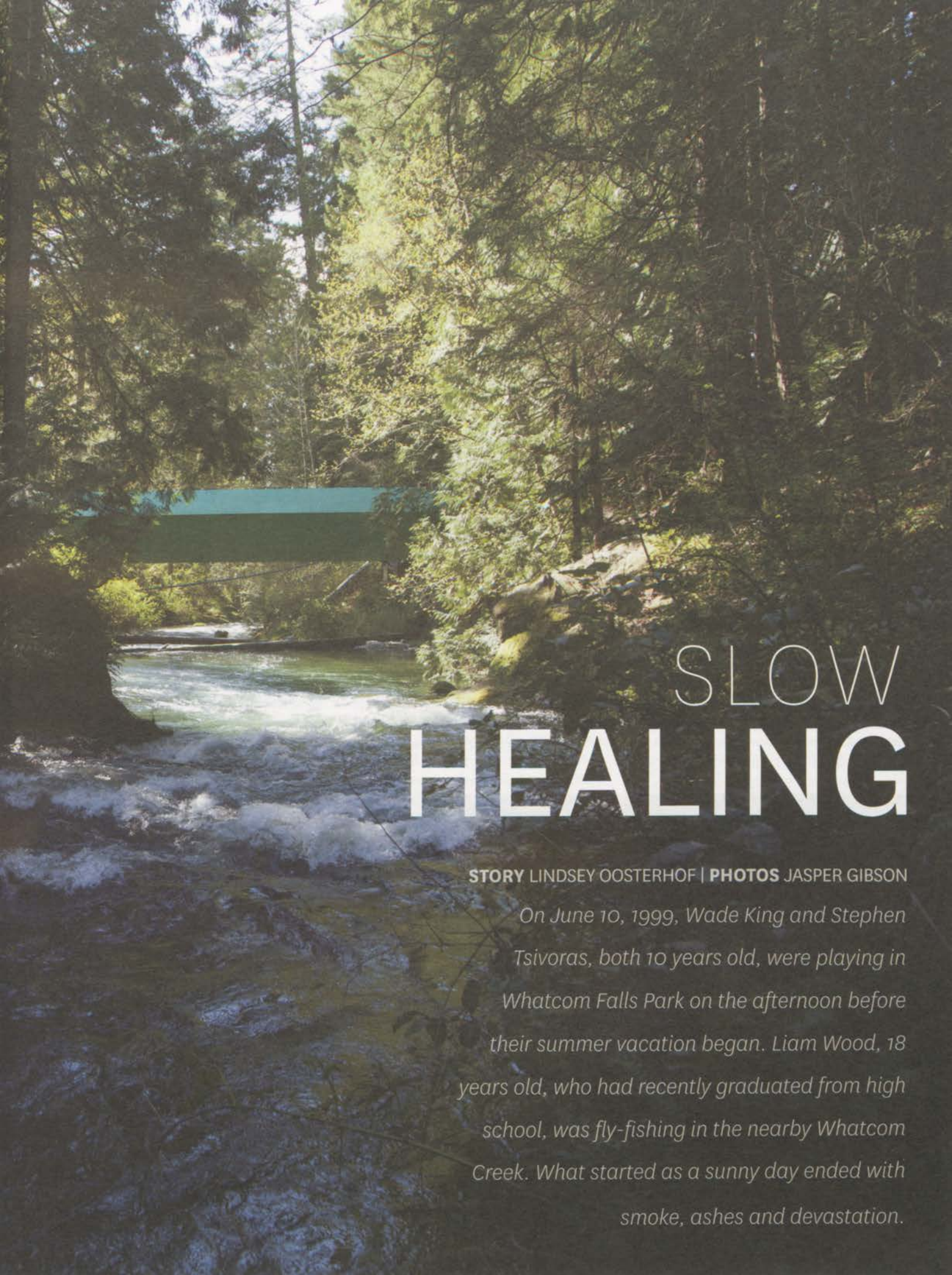
"Academics has always led the way in our knowledge of scientific disciplines," Sprouse said.

He said he believes the restoration at the Elwha addresses topics spanning several different scientific and engineering disciplines.

"If I could leave one thing for everyone," Sprouse said, "it would be to encourage everyone to look at this as an opportunity to participate in what is going to be a long-term process in a landmark restoration effort supporting the greater health of natural ecosystems on planet Earth."

KATHERINE STORRS is an environmental science student at Western Washington University who loves marine ecosystems. She hopes to lead educational kayaking tours to share her love for whales and crabs.

JASPER GIBSON, a sophomore at Western Washington University's Fairhaven College, is an avid outdoor adventure photographer from Sandpoint, Idaho. He studies human connections with nature through visual journalism.



SLOW HEALING

STORY LINDSEY OOSTERHOF | **PHOTOS** JASPER GIBSON

On June 10, 1999, Wade King and Stephen Tsivoras, both 10 years old, were playing in Whatcom Falls Park on the afternoon before their summer vacation began. Liam Wood, 18 years old, who had recently graduated from high school, was fly-fishing in the nearby Whatcom Creek. What started as a sunny day ended with smoke, ashes and devastation.

"Everything was burnt — it was black; there was no green vegetation," Subsits said. "I have never been to a war zone, but that is what I would imagine one would look like."

FOURTEEN YEARS AFTER THE OLYMPIC Pipeline explosion, the families of the deceased continue to slowly heal from the tragedy.

According to a 2006 Land Economics Journal article on the aftermath of the explosion, the Olympic Pipe Line Company's petroleum pipeline ruptured, dumping 229,000 gallons of gasoline, enough to fill about 6,300 bathtubs, into Whatcom Creek. When the gasoline ignited, it led to a series of explosions engulfing a 1.5-mile radius around the creek and sending a smoke cloud 6 miles into the sky.

Joe Subsits, Chief Pipeline Engineer at Utilities & Transportation Commission, said he recalls seeing the aftermath of the accident while working as an inspector for the Department of Ecology.

"Everything was burnt — it was black; there was no green vegetation," Subsits said. "I have never been to a war zone, but that is what I would imagine one would look like."

Wood was the first of three to perish from the explosion. He was overcome by gasoline fumes and drowned in the creek.

Both Wade and Stephen suffered burns on more than 90 percent of their bodies and passed away the following day.

"The night before the accident, [Wade] hit a home run," said Mary King, mother of Wade. "He was smiling at me at every base and I thought, 'keep running Wade, keep running!'"

It was Wade's baseball team's first time winning a game. Growing up, he wanted to be like his older brother who played baseball for Sehome High School. Baseball was Wade's passion, Mary King said.

Through donations from their settlement, the King family helped build Western Washington University's recreation center and named it after Wade to preserve his memory.

The King's have tried to stay connected as their son's friends have grown into adults, but watching them grow up is a constant reminder of losing Wade, Mary King said.

"It is really hard watching these milestones that the other kids are [reaching] and wondering what he would be doing now," Mary King said. "And we will never know."

Prior to the accident, excavating equipment damaged a pipe in Whatcom Falls Park, creating gouges in the pipeline, Subsits said.

Gouges tend to concentrate stress and crack the form of the pipeline every time there is pressure fluctuation. They lead to cracks that become bigger until the pipe eventually fails, Subsits said.

Olympic Pipeline operators were unaware of the damage, he said.

A pressure-release valve in the Bayview terminal in Skagit County had an issue, which caused the valve to close. This shut off the flow of oil, raising pressure in that section of the pipe and leading to bigger cracks, he said.

Olympic Pipeline operators at that time had indications of this type of damage but they did not assess it in a timely manner, Subsits said.

According to the Land Economics Journal article, the public perceived pipelines as more dangerous than usual because the accident dominated the local news for weeks afterward, resulting in decreased property values near the pipeline. The prices of houses were reduced based on the proximity to the pipeline explosion location; houses 50 feet away were estimated to be $9,613 cheaper.

According to a 2007 Whatcom Creek Restoration Project report by the City of Bellingham, the explosion burned approximately 25 acres of vegetation along Whatcom Creek.

"We saw some burnt nests and knew where some hawks had been living," Clare Fogelsong, project manager at Bellingham's Public Works Department said. "Pretty much any bird that did not die from the smoke was incinerated."

All aquatic life within 3 miles was killed as well, Fogelsong said.

On the day of the explosion, a Public Works crew led by Fogelsong worked to build barriers in the creek to catch remaining gasoline.

BELOW: *Mary King holds a scrapbook of her son, Wade King who was one of the three victims of the pipeline explosion. Since the explosion, the Wade family has been active in pipeline safety advocacy.*

PREVIOUS PAGE: *A new section of covering surrounds the pipeline that spans the creek in Whatcom Falls Park where the tragedy occurred. Washington has expanded its pipeline safety programs since the accident.*

RIGHT: *The 1999 Olympic Pipeline explosion engulfed a 1.5-mile radius around Whatcom Creek and sent a smoke cloud 6 miles into the sky. Photo courtesy of Matt Petryni.*

When the crew simply walked through the creek and disturbed the sediment, plumes of gasoline that had been trapped under the sediment were released, resulting in a rainbow sheen on top of the water and the distinct smell of gasoline, Fogelsong said.

Intense cleanup of the creek was done for approximately a year and Fogelsong continues to work on maintaining the creek. After the incident, the Olympic Pipe Line Company and responsible parties paid a $12 million settlement, which allows restoration projects to continue, Fogelsong said.

According to the Whatcom Creek Restoration Project report, the long-term restoration plan included monitoring recovery of damaged resources and actual restoration of the creek through replanting and habitat enhancement.

Since the explosion, representatives from the Olympic Pipe Line Company have worked with representatives from the City of Bellingham to ensure Whatcom Creek returns to pre-accident conditions, Michael Abendhoff, external affairs manager of British Petroleum said.

The creek is nearing the point where no more traces of gasoline are being found, so the work between the pipeline company and the city is gradually stopping.

"Natural biology doesn't run on gasoline," Fogelsong said. "It is poisoning to bio-life."

Water chemistry returned to pre-accident conditions quickly after releasing all of the gasoline, but the creek could still use improvements, Fogelsong said.

"We put a lot of time and energy into it but there is always room for improvement in urban streams," Folgelsong said.

Abendhoff said the Olympic Pipeline is now operating extremely well.

"Based on what our annual maintenance plans are and what we do on an annual basis to keep it in good operating conditions," Abendhoff said, "I believe it is one of the safest, if not the safest, pipeline in the country."

Frank King, father of Wade, said he does not feel pipelines are safe enough today and has done substantial work trying to raise awareness about pipeline safety.

But trying to make changes with pipeline safety laws is difficult because oil companies are a powerful lobby, Frank King said.

When they testified before congress, there were four or five people testifying for Bellingham, but the representative's oil lobby filled the room.

Three years after the accident, Frank Hopf, one of the pipeline workers responsible for the accident, visited the King's home. For a long time, the Kings wanted him to go to prison, Frank King said.

"We did the meanest thing we thought we could do and brought him up to Wade's room, which had not changed since the day of the accident," Frank King said.

The Kings have since forgiven the pipeline workers whose actions led to the death of their son, but they still are not forgiving the pipeline company.

"We realized it was not the people running these pipelines, it was the culture that came along with these people and was passed on from generation to generation," Frank King said.

The Pipeline Safety Program in Washington has expanded since the accident; previously, there were four pipeline inspectors — now there are seven and more will be hired soon, Subsits said.

Federal agents inspected pipelines prior to the accident, but in the years following, the state also inspected pipelines locally, Subsits said.

State inspectors have become more familiar with Washington pipeline systems, including the history, risks associated with them and the people who work there, resulting in more efficient inspections, Subsits said.

"Federal agents inspected pipelines prior to the accident, but in the years following, the state also inspected pipelines locally."

"Look at the news, we are still having pipeline accidents," Subsits said. "Are there going to be accidents in the future? Well, I think safely we would say yeah, there will be."

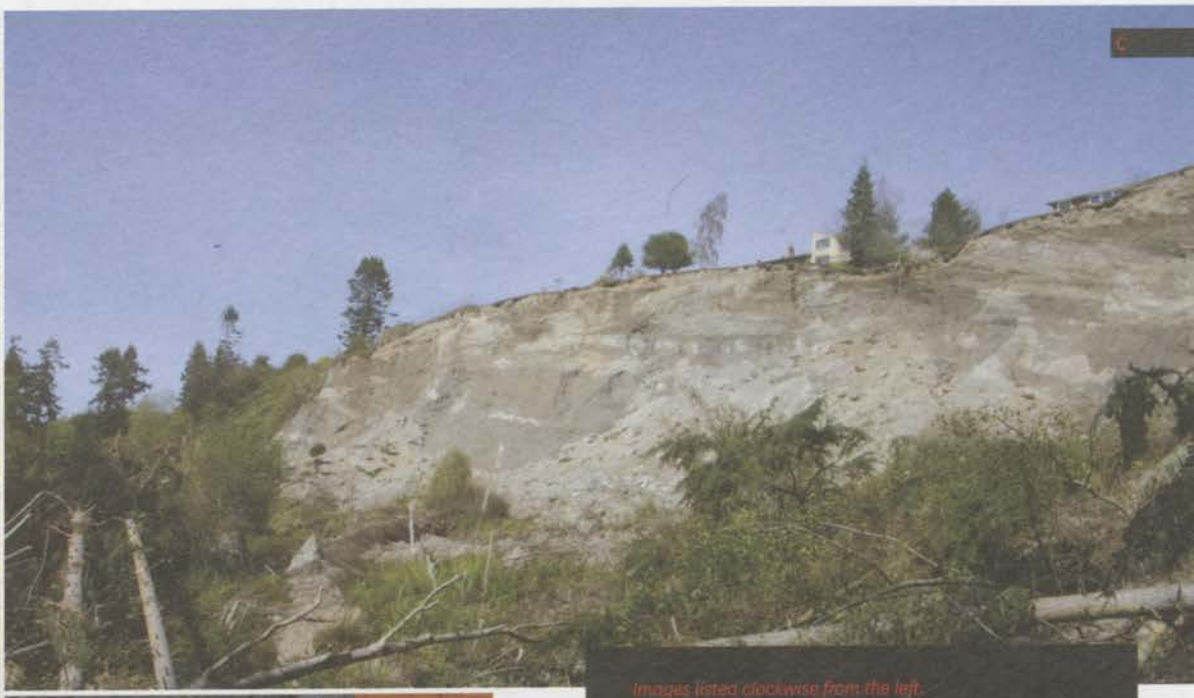
LINDSEY OOSTERHOF is a junior majoring in public relations at Western Washington University. When not studying, she enjoys reading novels with a good cup of coffee in hand.

JASPER GIBSON, a sophomore at Western Washington University's Fairhaven College, is an avid outdoor adventure photographer from Sandpoint, Idaho. He studies human connections with nature through visual journalism.

LIVING ON THE EDGE

STORY KAMRY MCRAE
PHOTOS KATY BENTZ

Seventy feet of land plummeted 200 feet down the side of Whidbey Island in Coupeville, Wash. at 3:45 a.m. on March 27 this year. In 2010, the county sent researchers out to evaluate the danger. They saw large cracks on the streets and lots of leaning alder trees indicating ground movement, said Stephen Slaughter, hazards geologist for The Department of Natural Resources.



Images listed clockwise from the left.

A Landslides occur frequently around the island, which can result in homeowners losing their property. In 2006, officials went door-to-door warning community members of the risk for potential landslides.

B One home was dislodged in the landslide.

C The top of the hill is made of cement-like glacial till. Under the till is sand that water can flow through easily and the bottom layer is thick clay. Waves eroded the clay and sand, leaving the top unstable and causing the landslide.

D Because of the landslide, four homes were red-tagged, meaning residents are not allowed to enter because of the risk. Additionally, six homes were yellow-tagged, meaning residents can enter the premises, but are not advised to stay long because of the potential of another landslide.

E Ralph Young looks up at what is left of his backyard and other residents' properties. "When your house does not slide away by that close of a margin, you feel blessed," he says. "You thank your lucky stars, put your head down and just try to help others."

F Trees lean outward after moving 200 feet in the landslide.

KAMRY MCRAE is a junior studying communication and journalism at Western Washington University. Her dream is to become a sports broadcaster for the Pittsburgh Steelers.

KATY BENTZ is a junior studying theater with an acting concentration at Western Washington University. Driven by creativity, she enjoys theater, photography, music and keeping herself busy.

A car passes a deer carcass on the side of the highway.

ANIMAL INTERSTATE

STORY SAMANTHA KLINGMAN | **PHOTOS** GREG CROOKS

Driving down a quiet four-lane highway outside Coeur d'Alene, Idaho, Western Washington University junior Isaac Martin saw an elk out of the corner of his eye. In a split second, the 800-pound elk stepped in front of his Dodge Caravan going 70 mph. The collision totaled Martin's van and the elk died on the scene.

RIGHT: *Without barriers preventing wildlife from entering the highway or a safe passage around roads, animal-vehicle collisions are more likely.*

BELOW: *Isaac Martin collided with an elk, killing the animal and totaling his vehicle.*

THE INTERSTATE 90 SNOQUALMIE PASS East Project is designed to improve a 15-mile stretch of highway between the towns of Hyak and Easton, Wash. Part of the project plans to reduce wildlife-vehicle collision. Construction began in 2009 and may help reconnect genetically-isolated animal populations divided by the I-90 corridor.

According to the Washington State Department of Transportation's website on wildlife collisions, more than 1,100 wildlife-vehicle collisions are reported to Washington State Patrol annually, but not all collisions are reported. The department removes nearly 3,500 deer and elk carcasses from highways every year.

According to the department's website, wildlife-vehicle collisions cause about 1,190 human injuries and two fatalities every year in Washington.

Jason Smith, Washington State Department of Transportation's environmental manager, oversees environmental design, maintenance and roadway construction within an 11-county region, including the I-90 Snoqualmie Pass East Project.

As part of the project, the department plans to upgrade the highway to six lanes, address sharp curves and install wildlife bridges and underpasses along the corridor, Smith said.

Jen Watkins, conservation associate at Conservation Northwest and outreach director for I-90 Wildlife Bridges Coalition, staffs the group working on the project.

Two vegetated wildlife bridges and 12 vegetated underpasses will be constructed within the 15-mile corridor, allowing animals to safely cross the highway, Watkins said.

Deer, elk, wolverines, salamanders, black bears, cougars, otters and more species live within this protected land and need to be able to move north and south, Watkins said.

The wildlife bridges will be 150 feet wide and placed 10 miles apart. The 12 wildlife underpasses will be about one mile apart, Watkins said. Unlike typical paved underpasses and overpasses, these crossings will have plants and trees to resemble the animal's natural habitat. This will provide wildlife with a continuous habitat beneath and over the highway.

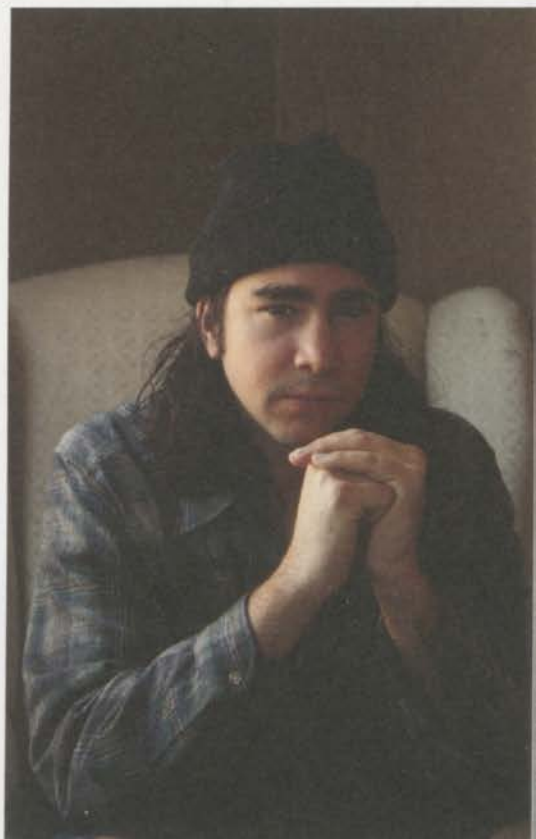
Continuous habitat may reduce inbreeding among isolated populations, Watkins said.

"It is similar to if we took a human family and said just you and your aunt and uncle will be isolated from all of humanity," Watkins said. "Slowly, inbreeding will make you less healthy than if we are able to have exchange with a wider population of individuals."

David Wallin, Huxley College of the Environment professor, has been conducting research on mountain goat populations in the Cascades for about 10 years.

The crossings will let wildlife move across the corridor safely, which could allow for

"The crossings will let wildlife move across the corridor safely, which could allow for healthier, larger and genetically-diverse populations."



"It is difficult to tell how successfully these bridges and underpasses will reconnect animals across I-90."

ABOVE: *Around 3,500 deer and elk carcasses are taken off Washington state highways each year.*

healthier, larger and genetically diverse populations, Wallin said.

"The biggest factor [affecting] mountain goat populations in the Cascades is the I-90 corridor," Wallin said. "Genetically, the animals south of I-90 are very different than the animals north of I-90."

Forty to 50 years ago, there were about 10,000 mountain goats in the Cascades. Today, there are close to 3,000, Wallin said.

The initial reduction was mainly due to hunting, but in the last 20 years, hunting has decreased in the area. The population in the Cascades has not recovered over the past decade, which is likely due to inbreeding, Wallin said.

Historically, the Cascades were home to one large, genetically diverse population unimpeded by man-made barriers. Today, there are at least two or more isolated sub-populations, Wallin said.

"By building those wildlife crossing structures on I-90, there is going to be more potential for those animals to move around, less inbreeding and higher genetic diversity," Wallin said. "It is going to be beneficial not just for goats, but a wide variety of other wildlife species."

It is difficult to tell how successfully these bridges and underpasses will reconnect animals across I-90, Wallin said.

"The construction of those crossings structures in many ways is a test," Wallin said. "It might make things worse."

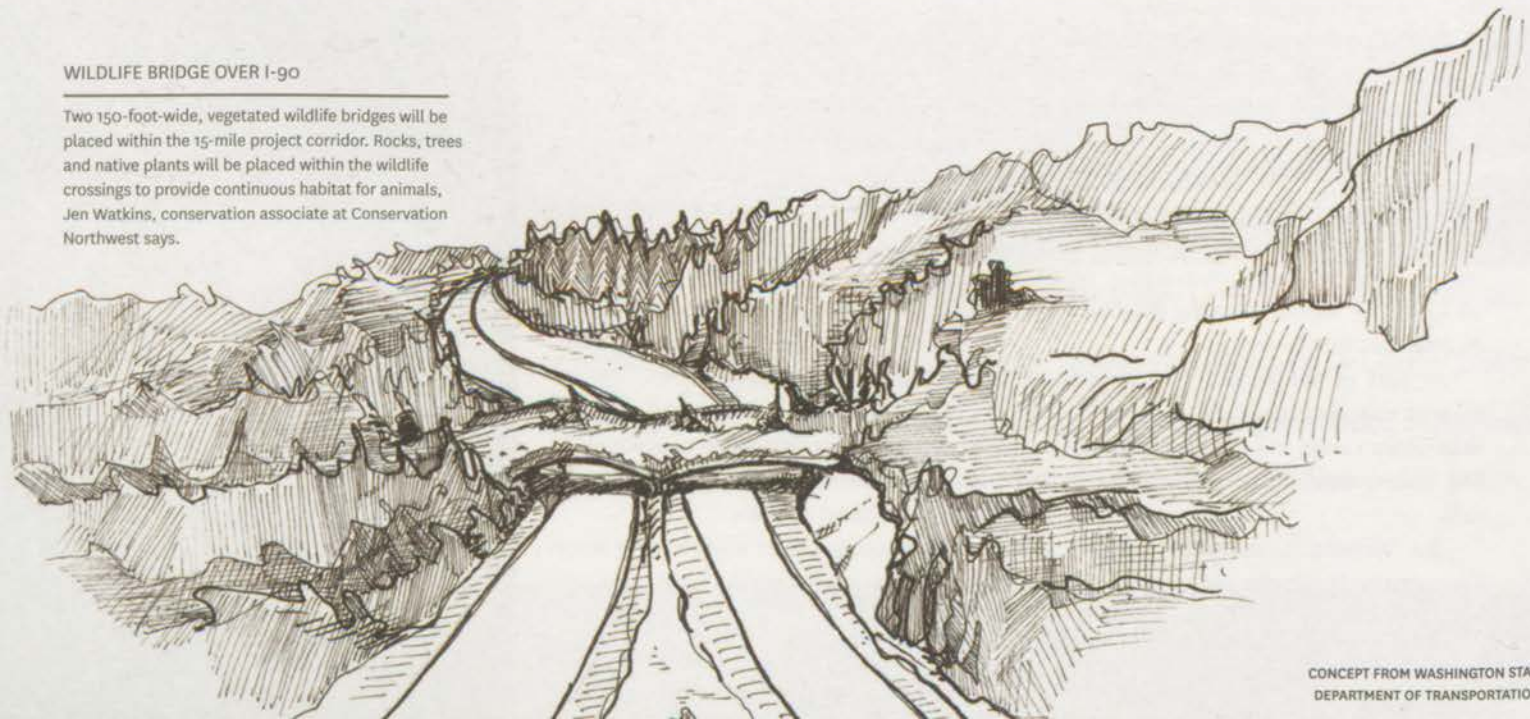
Massive fences along the highway will direct large animals like deer, elk, mountain goats and cougars to the crossings and keep them from entering the highway and endangering the public, Wallin said.

According to a 2010 study conducted on wildlife crossings in North Carolina published in the Journal of Wildlife Management, the further distance animals were from the wildlife underpass, the more likely the animals were to follow fencing away from the underpass to where the fence ends. Animals like deer, opossums and raccoons would then get hit crossing the highway where fencing ends.

"I think there is always an issue with fencing, since the fence has to end somewhere," Watkins of Conservation Northwest said. "What we have going for us on I-90 is topography where fencing naturally can end in some places, like large lakes."

WILDLIFE BRIDGE OVER I-90

Two 150-foot-wide, vegetated wildlife bridges will be placed within the 15-mile project corridor. Rocks, trees and native plants will be placed within the wildlife crossings to provide continuous habitat for animals, Jen Watkins, conservation associate at Conservation Northwest says.



CONCEPT FROM WASHINGTON STATE DEPARTMENT OF TRANSPORTATION.

A state treasury account funds the project through a gas tax that was implemented over four years. The first five miles of the project was estimated to cost $588 million, but after running under budget, the department was able to complete the first seven miles with the tax fund. Currently, the last eight miles of the project is unfunded.

Located close to the town of Hyak, the first two wildlife underpasses, known as Gold Creek and Rocky Run, will be completed in summer 2013, and the rest will be completed by 2019, Smith said.

"What is really interesting when you look at I-90 is it is a project building on decades of conservation work and restoration, so it does not stand in isolation," Watkins said. "It is a really exciting story that has been unfolding for years, and now we are getting to see some of the fruits of that labor on the highway."

Martin was in shock after hitting the large elk and stood on the side of the highway as a truck driver who stopped to help moved the elk carcass out of the roadway. A police officer believed the elk may have been pregnant, based on her large stomach.

"When we hit the elk, the windshield exploded at us," Martin said. "There was hair, blood and somehow elk guts got inside of the van."

Martin said he hopes these crossings will prevent potentially fatal accidents like his in the future.

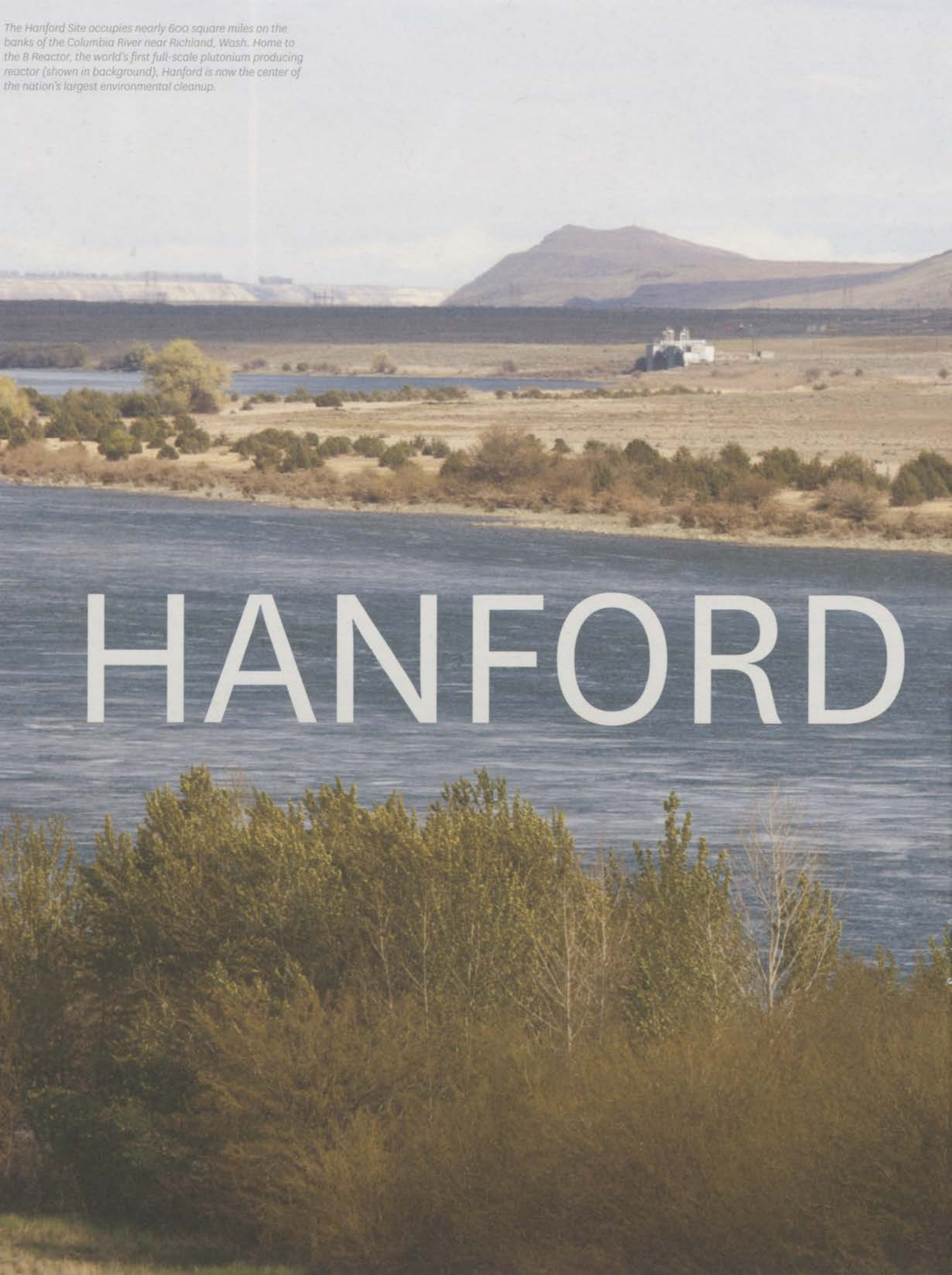
ABOVE LEFT: *The Gold Creek underpass allows wildlife a safer means of crossing I-90.*

ABOVE RIGHT: *Fragmentation is when a span of habitat is broken up into smaller sections, interrupting animal movement.*

BELOW: *Fences line highways to prevent wildlife from crossing. Some animals follow the fence until it ends, causing an area where animals gather and collisions occur more frequently.*

SAMANTHA KLINGMAN is a junior studying journalism and anthropology at Western Washington University. She enjoys traveling to new places, creative writing and trying different foods.

GREG CROOKS is a senior pursuing a photography concentration in Western Washington University's art department. When he is not in the art department, he is hiking northwest trails, camping or playing Ultimate.



The Hanford Site occupies nearly 600 square miles on the banks of the Columbia River near Richland, Wash. Home to the B Reactor, the world's first full-scale plutonium producing reactor (shown in background), Hanford is now the center of the nation's largest environmental cleanup.

HANFORD

A PROBLEM FROM THE PAST

In 1943, Hanford, a nuclear production complex in Eastern Washington, began producing plutonium for the atomic bomb dropped on Nagasaki, Japan. After World War II, nine nuclear reactors continued production through the Cold War until 1987. Today, the Hanford site is the largest environmental cleanup project in the nation. The discovery of highly radioactive tank leaks has sparked fears that Hanford is polluting the nearby Columbia River. But the situation at Hanford is not as bad as it seems.

STORY MEG DUKE | **PHOTOS** TIM SEGUIN

"Hanford's 177 underground tanks hold approximately 55 million gallons of toxic waste, including waste from old nuclear fuel."

LOCATED JUST NORTH OF THE TRI-CIties, Hanford has 177 underground tanks, six of which are leaking hazardous radioactive chemical waste. While these leaks are long-term waste management dilemmas, they are not an immediate threat to the Columbia River.

Since 1989, the Department of Energy (DOE) has handled the cleanup of Hanford and made considerable strides to mitigate the threat of the nuclear waste. Today, the river is considered safe and is used for swimming, boating, fishing and drinking. However, cuts to Hanford's multi-billion dollar annual budget in March 2013 delayed cleanup, which is already expected to continue through 2050.

LEAKING TANKS

In February 2013, new leaks were discovered in six of Hanford's underground tanks. According to the DOE's Hanford Site Cleanup Completion Framework published in January 2013, Hanford's 177 underground tanks hold approximately 55 million gallons of toxic waste, including waste from old nuclear fuel.

Altogether, the six tanks are estimated to be leaking around 3 gallons of waste per day, said Dieter Bohrmann, communications manager for Washington State Department of Ecology's Nuclear Waste Program, in an email.

The Department of Ecology, along with the Environmental Protection Agency, regulates the DOE's cleanup of Hanford.

Located in the central plateau, the underground tanks are 5 to 8 miles from the Columbia. Even groundwater, which is subsurface water, is 200 to 300 feet below the tanks. At its current rate, the waste would take decades to reach groundwater, and there are no immediate health risks from the leaks, Bohrmann said in an email.

Built between 1943 and the mid-1960s, many of these tanks are decades past their 20-year lifespan. According to the Cleanup Completion Framework, 67 tanks are suspected to have collectively leaked around 1 million gallons of waste. Old leaks have reached groundwater, and pump-and-treat systems in the central plateau are working to prevent the spread of contamination.

"The age of the tanks is a concern. The longer the waste stays in the tanks, the more likely they are to fail," Bohrmann said in an email. "The discovery of leaking tanks underscores the importance of retrieving and treating this tank waste as quickly as possible to mitigate the chances for further releases to the environment."

According to the Cleanup Completion Framework, tank waste remains one of the greatest challenges for Hanford cleanup.

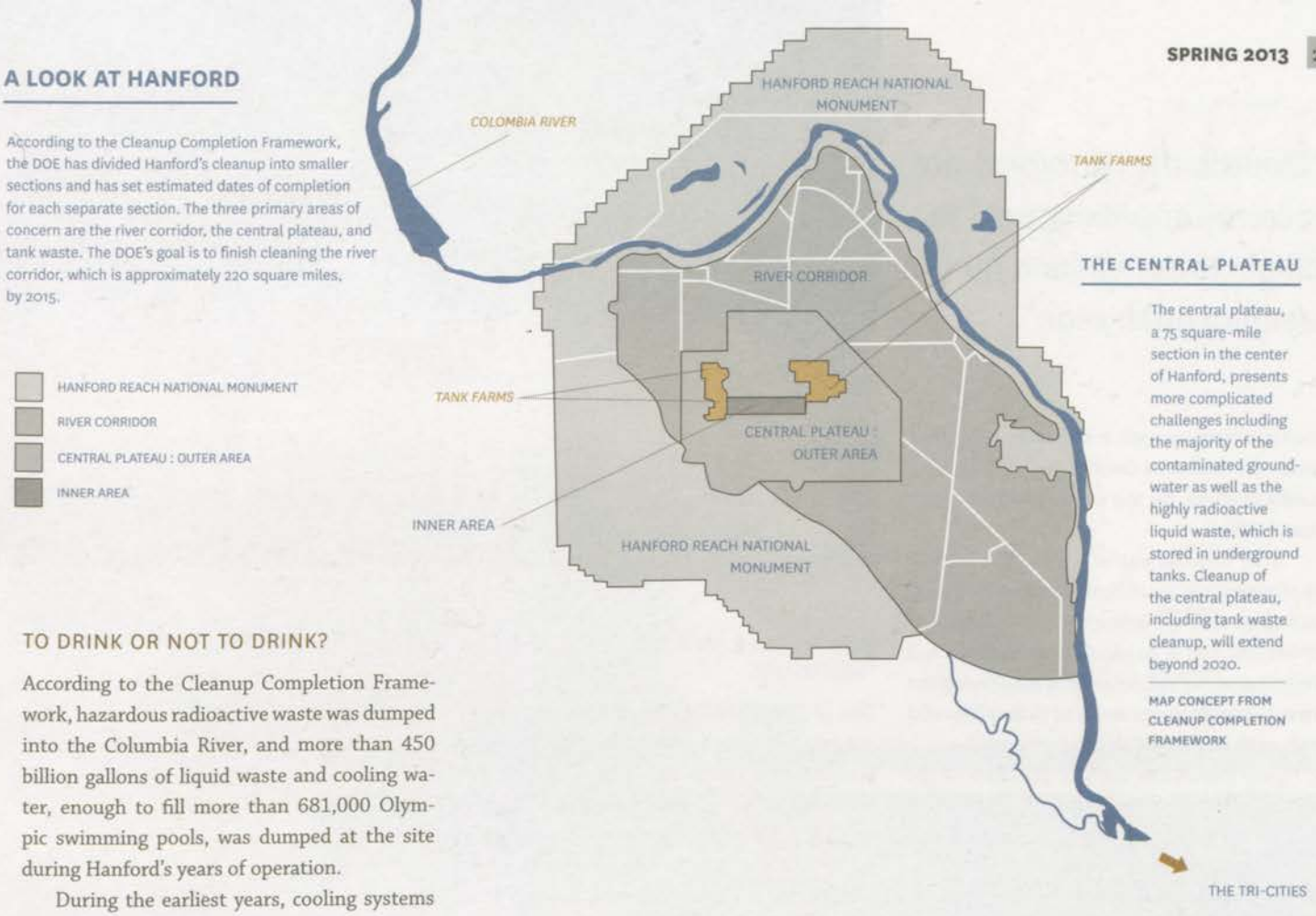
According to the DOE's Hanford website, the department is building a waste treatment plant, also known as the vitrification plant, which is designed to eliminate liquid tank waste by combining it with glass-forming particles and firing the mixture at extremely high temperatures, turning the liquid into glass. Vitrification makes disposal of high-level radioactive waste simpler than dealing with hazardous liquids. The plant is more than 63 percent complete and is required to begin operation by 2019.

OPPOSITE RIGHT: *Plants that grow on the Hanford site may uptake radioactive strontium-90 and other hazardous chemicals through their roots. Small amounts of these contaminants become mobile when the plants die and enter the Columbia River as tumbleweeds.*

LEFT: *A fence displays signs from demolished Hanford facilities. Washington's Department of Energy is responsible for the cleanup of the Hanford Site, which will cost billions of dollars, and is expected to extend beyond 2020.*

A LOOK AT HANFORD

According to the Cleanup Completion Framework, the DOE has divided Hanford's cleanup into smaller sections and has set estimated dates of completion for each separate section. The three primary areas of concern are the river corridor, the central plateau, and tank waste. The DOE's goal is to finish cleaning the river corridor, which is approximately 220 square miles, by 2015.



THE CENTRAL PLATEAU

The central plateau, a 75 square-mile section in the center of Hanford, presents more complicated challenges including the majority of the contaminated groundwater as well as the highly radioactive liquid waste, which is stored in underground tanks. Cleanup of the central plateau, including tank waste cleanup, will extend beyond 2020.

MAP CONCEPT FROM CLEANUP COMPLETION FRAMEWORK

TO DRINK OR NOT TO DRINK?

According to the Cleanup Completion Framework, hazardous radioactive waste was dumped into the Columbia River, and more than 450 billion gallons of liquid waste and cooling water, enough to fill more than 681,000 Olympic swimming pools, was dumped at the site during Hanford's years of operation.

During the earliest years, cooling systems pumped river water through the nuclear reactor's core, then dumped the water straight back into the Columbia, said Bruce Napier, environmental health physicist for the Pacific Northwest National Laboratory.

Radiation affects people in two general ways, Napier said.

"The first is external radiation – radiation from a source outside of the human body. That is simply when you are standing there, it is irradiating you, and when you walk away it is done," he said. "The other kind I will call internal radiation, and that is where you get radioactive materials in your body by breathing or eating it."

According to the Cleanup Completion Framework, cleanup of the river corridor has been one of the DOE's main goals in its effort to protect the Columbia since the early 1990s. In this area, contaminated groundwater poses one of the biggest threats to the Columbia and remains a high priority for cleanup.

According to the Department of Ecology's online Hanford cleanup page, contaminated groundwater covers about 72 square miles.

The DOE implemented many strategies to keep contaminated groundwater from reaching the Columbia including pump-and-treat systems and permeable reactive barriers. These barriers are 50-foot-deep holes drilled along the river's shore about 10 feet apart and filled with a substance that reacts chemically with the toxicants, making them less harmful, Napier said.

"Our most immediate attention is on groundwater protection," said Dennis Faulk, program manager in the EPA's Hanford Project Office. "We have two really large pump-and-treats along the river that are removing chromium from the groundwater, and then a very large system up in the central part of Hanford."

The Cleanup Completion Framework details two of the most prominent toxicants present in river corridor groundwater: hexavalent chromium and strontium-90. Hexavalent chromium is a byproduct of the chemical used to keep the reactors from corroding during cooling, and could negatively impact the health of aquatic life and animals that live along the river's shores. Currently, the chromium in Hanford's groundwater is more than 10 times greater than drinking water standards.

The radioactive pollutant strontium-90 is another major concern because if ingested, the human body stores it in bones in the same way calcium is stored. This causes internal radiation, where strontium-90 would radioactively decay inside the body, Napier said.

However, river contamination is so low,

"The DOE implemented many strategies to keep contaminated groundwater from reaching the Columbia including pump-and-treat systems and permeable reactive barriers."

"Overall, the [Hanford] site receives approximately $2 billion to $2.2 billion for cleanup each year."

contaminants are not measurable after they enter the river, said Geoff Tyree, who handles media relations for the DOE's Richland Operations Office.

"[The Department of] Ecology considers the Columbia River at Hanford safe for all uses, including fishing, swimming and drinking," Bohrmann said in an email. "Both the state and federal government are actively monitoring the river to ensure we are aware of all possible risks to human health and the environment."

Gary Petersen is the vice president of the economic development group Tridec, the Tri-Cities Development Council. He deals with Hanford issues, including funding, community support and risk factors as seen from the Tri-Cities' economic view. Petersen has lived in Richland since 1965 and raised two daughters there. Hanford's presence does not affect him, he said.

"I drink the water out of the Columbia River. The city of Richland gets its drinking water from the Columbia," Petersen said. "And while my home is not the closest to the Hanford site, it is probably one of the hundred homes that are closest."

BELOW: *Cleanup workers move a drum containing hazardous waste from the U Plant, one of Hanford's plutonium processing plants. Photo courtesy of Cameron Hardy.*

ABOVE: *Richland High School principal Tim Praino poses with a bomber mural, painted on the school's gym in 1993. As a student, Praino and his classmates at Richland High voted to keep the bomber mascot and mushroom cloud insignia in 1988.*

BUDGET CUTS AND LOOKING TOWARD THE FUTURE

One of Hanford's current concerns is sequestration, which reduces its cleanup budget. Sequestration limits the federal budget and puts a cap on government spending across the board. Because Congress was not able to agree on and enact a reduced budget before March 1, 2013, budget cuts took effect.

"Overall, the [Hanford] site receives approximately $2 billion to $2.2 billion for cleanup each year," said Tyree. "That is for both the Office of River Protection and its contractors, and the Richland Office and our contractors."

In recent years, about $1 billion of the budget was allotted to the Richland Office and the other $1 billion to $1.2 billion was given to the Office of River Protection, Tyree said.

However, if the DOE plans on meeting its 2015 vision of a nearly completed cleanup of the river corridor, both offices need more funding than their average allotment. Faulk said he estimates the DOE needs about $3 billion to meet their goals for 2015.

With sequestration, Hanford's cleanup budget was reduced by about 7.5 percent, Petersen said. This means about $165 million is being cut from Hanford's budget, which already falls short of the DOE's funding requirements to fulfill its 2015 vision.

"Originally, everybody thought cleanup was going to be easy," Petersen said. "As a matter of fact, they had a nickname for it called 'suck, muck and truck.' They just thought you could send workers out there to suck up all the radioactive material, truck it someplace, bury it and everything would be fine."

While Hanford's leaking tanks are problematic, they are not currently threatening the Columbia. Rather, they emphasize the importance of timely cleanup for Hanford. The DOE is making significant strides on groundwater remediation and hopes to approach its goal of river corridor cleanup by 2015. However, the budget cuts will delay cleanup, which will already take decades and billions of dollars to complete. Because the DOE has mitigated the immediate threats to the Columbia, now Hanford's cleanup needs funding and time.

MEG DUKE, a Western Washington University creative writing major, loves worshipping Chelsea FC, playing pickup soccer, drinking tea and reading good books when she is not drowning in work.

TIM SEGUIN is a senior pursuing a degree in environmental photography through Huxley College and Western Washington University's art department. When he is not in the darkroom, he enjoys snowboarding and birding.

According to the Washington Department of Fish and Wildlife's information on gray wolves, wolves were no longer a breeding species in Washington state in the 1930s due to trapping, poisoning and hunting. They are now returning to the state, bringing with them political controversy.

WOLVES ON THE FENCE

STORY KENNETH CLARKSON AND THE EDITORIAL STAFF **PHOTOS** KATY BENTZ

EDITOR'S NOTE: Repeated attempts were made to contact the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife. Neither replied for comment. As well, the information about the proposed rule from the Department of the Interior and the U.S. Fish and Wildlife Service is breaking news obtained by the Associated Press. Any factual inaccuracies as a result of this are not the intention of the writer or the editorial staff.

The gray wolf is locked in a struggle to hold on to whatever territory it has left. Amidst rancher conflicts, trophy hunting and poaching, the wolves must now face an even bigger opponent.

IN 2011, THE U.S. FISH AND WILDLIFE Service removed gray wolves living in the Northern-Rockies and Great-Lakes regions from the 1973 Federal Endangered Species Act. When wolves are no longer considered an endangered species federally, all management is turned over to the state governments and their fish and wildlife services, said Josh Laughlin, campaign director at Cascadia Wildlands.

On April 25, 2013, information obtained by the Associated Press stated a proposed rule written by the U.S. Fish and Wildlife Service, under the Department of the Interior, could remove federal protections for gray wolves throughout the rest of the country. The only exception would be the Mexican gray wolf in Arizona and New Mexico, said Timothy Preso, managing attorney at the Montana environmental law firm Earthjustice.

After delisting, state governments showed

hostility toward wolf populations and conservation plans. They limited the wolves' range in Montana, Idaho and Wyoming. Wolves' opportunity to breed is now minimal and limited, Preso said.

"It begs the question," Laughlin said. "Are we going to drive the Rockies' population back down to the bare minimum where they may have to get relisted at some point?"

The Northern-Rockies region consists of Wyoming, Idaho, Montana and the eastern quarters of Oregon and Washington. Wolf-kills in these areas have steadily increased since the 2011 delisting, Preso said.

"It has become a killing zone," Preso said.

Before federal protection in the 1900s, wolves were hunted to near extinction levels, Preso said.

According to a 1994 report on wolves by the U.S. Fish and Wildlife Service, to boost dwindling populations, the service introduced gray wolves from Alberta, Canada into the Northern-Rockies region in the 1990s.

Over time, the wolves dispersed from the Rockies region throughout the western part of the country. In 2011, a lone wolf named "Journey," became the first wolf to step foot in Northern California in years and Laughlin said he hopes Journey will establish a pack in the area.

According to the U.S. Fish and Wildlife Service's proposed rule, with about 5,000 gray wolves in the Northern Rockies and Great Lakes regions, extinction is unlikely.

However, immediately after delisting in some of the states, trapping and hunting

ABOVE: *The U.S. Fish and Wildlife Service is considering a reclassification of Pacific gray wolves in the lower 48 states. Wolves attacking livestock have created controversy between ranchers and wildlife conservation organizations.*

LEFT: *A map indicating where gray and red wolves originally lived. Currently, wolves inhabit the Northern-Rockies and Great-Lakes regions.*

BELOW: *Fladry is an electric flag-fencing placed around livestock. It is a non-lethal way to prevent wolves from attacking farm animals. (Photo Illustration)*

"A lot of people place intrinsic value on having native wildlife restored."

ABOVE LEFT: *Wolves have already been delisted federally in the Northern Rockies region. Sanctuaries such as Grouse Mountain Refuge for Endangered Wildlife in Vancouver, B.C. and Wolf Haven International in Tenino, Wash. create a safe place for wolves to live.*

ABOVE RIGHT: *Wendy Danielson, a volunteer at Wolf Haven International, gives tours to educate the public about wolves.*

wolves became legal, Preso said.

"We have seen more than a thousand gray wolves shot or trapped in [the Northern-Rockies region] since they were delisted federally," Laughlin said.

Currently in Oregon and Washington, wolves are protected from hunting by state laws even though they have lost their federal protection in the eastern quarter. However, wolves can be shot if they endanger livestock, Laughlin said.

According to a statement released in September 2012 by the Washington Department of Fish and Wildlife, an authorized state marksman eliminated the Wedge Pack by helicopter because they injured and killed 15 cattle in the area. The Wedge Pack was one of ten confirmed gray wolf packs in Washington.

The Washington Department of Fish and Wildlife's Conservation and Management Plan went into effect in 2011 after gray wolves were federally delisted in the state. The goal is to ensure a self-sustaining population of wolves can inhabit Washington again.

"One of the main things we have done is try to prevent delisting the wolves until there was an adequate state-law safety net to prevent this wholesale killing spree that we have seen since delisting occurred," Preso said.

The plan stresses non-lethal wolf-control measures for ranchers and provides compensation for loss of cattle due to wolf attacks.

Examples of these measures include the use of fladry, an electrified flag-fencing put around the perimeter of an area near livestock pens. The flags spook wolves, preventing them from attacking. Ranchers can also use protective dogs or hire ranch-hands to watch over herds. Having this sort of territorial presence works to keep wolves away from livestock, Laughlin said.

With the reintroduction of the wolf population, fewer elk would graze by streams increasing plant growth, Laughlin said.

According to a 2011 study by Robert Beschta and William Ripple in the Biological Conservation Journal, plant growth increases when wolves are reintroduced into degraded-streamside ecosystems. The study has shown an increase of cottonwood, willow and aspen trees in areas of Yellowstone National Park.

"Keystone predators like gray wolves are an ecosystem force that drive relationships and balance on the landscape," Laughlin said.

The reintroduction of wolves into the ecosystem not only supports active recovery to streamside areas, but also shows an increase in songbird, beaver and rodent populations, he said.

"A lot of people place intrinsic value on having native wildlife restored," Preso said. "Even apart from their ecological effects, a lot of people like wolves as a symbol of wildness and wilderness."

Currently, the U.S. Department of Interior and the U.S. Fish and Wildlife Service has released no new information. So, wolves and humans alike will have to wait for the final decision.

"It is all about time and tolerance at this point," Laughlin said.

KENNETH CLARKSON is studying journalism and environmental science at Western Washington University. Three things he enjoys other than writing are the Baltimore Orioles, making music and adventuring in the outdoors.

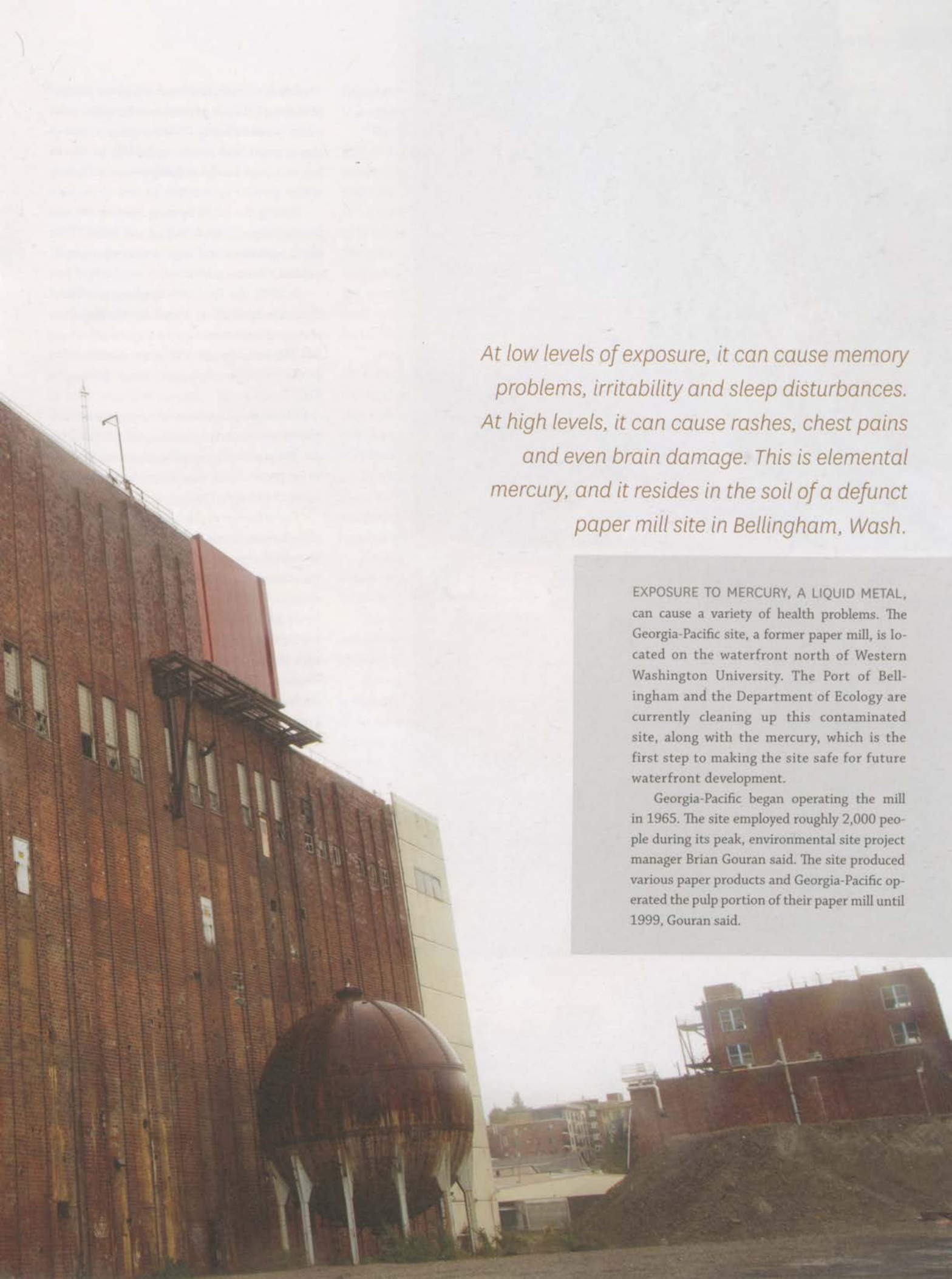
KATY BENTZ is a junior studying theater with an acting concentration at Western Washington University. Driven by creativity, she enjoys theater, photography, music and keeping herself busy.

The abandoned digester building, the tallest building on the site, is located in the Georgia-Pacific West area.

HEAVY METAL

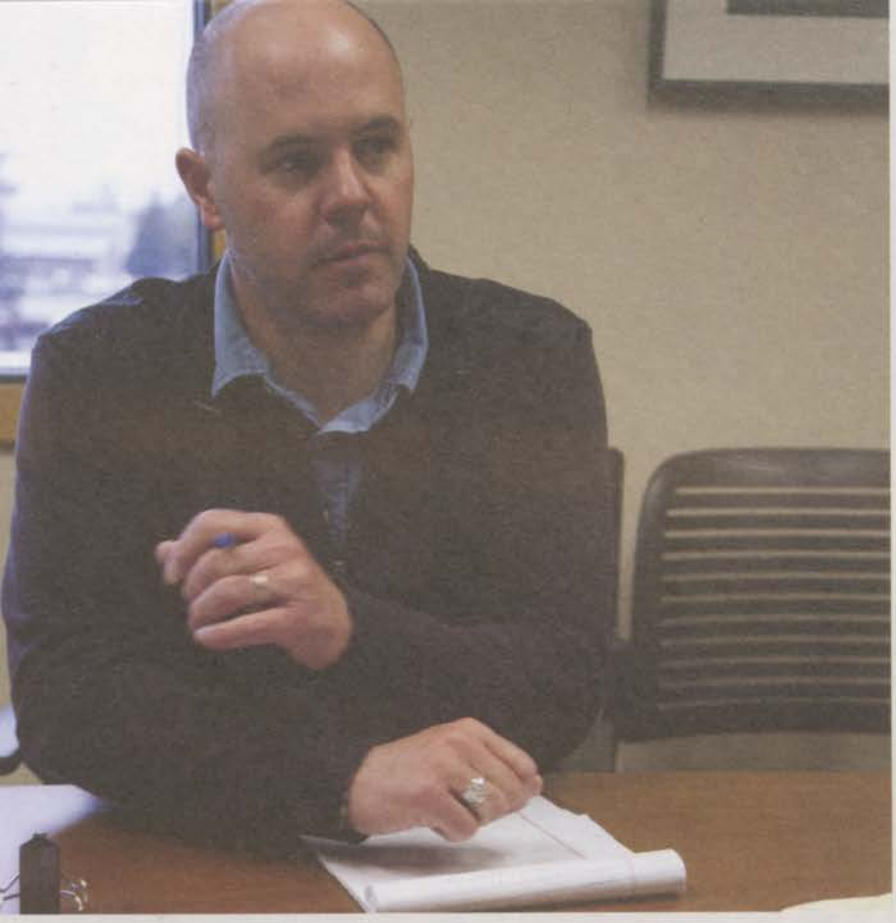
STORY COLE FINCHEN | **PHOTOS** GREG CROOKS

At low levels of exposure, it can cause memory problems, irritability and sleep disturbances. At high levels, it can cause rashes, chest pains and even brain damage. This is elemental mercury, and it resides in the soil of a defunct paper mill site in Bellingham, Wash.



EXPOSURE TO MERCURY, A LIQUID METAL, can cause a variety of health problems. The Georgia-Pacific site, a former paper mill, is located on the waterfront north of Western Washington University. The Port of Bellingham and the Department of Ecology are currently cleaning up this contaminated site, along with the mercury, which is the first step to making the site safe for future waterfront development.

Georgia-Pacific began operating the mill in 1965. The site employed roughly 2,000 people during its peak, environmental site project manager Brian Gouran said. The site produced various paper products and Georgia-Pacific operated the pulp portion of their paper mill until 1999, Gouran said.



TOP: *Brian Gouran, Port of Bellingham's environmental site project manager, explains the mercury cleanup process as one part of a larger effort.*

ABOVE: *The Port of Bellingham purchased the site from Georgia-Pacific for $10. Currently, they are cleaning up contaminants such as mercury.*

Georgia-Pacific used mercury in the process of making chlorine gas and caustic soda in the mercury cell building. Chlorine gas was used to bleach paper, and caustic soda, also known as lye, was used in the pulping process, Gouran said.

During the site's infancy, wastewater was pumped directly into the bay, until the 1970s when environmental regulations were implemented, Gouran said.

In 2005, the Port of Bellingham purchased the property at a low price with the intention of decontamination.

"We basically got 137 acres of waterfront property, albeit contaminated property, for $10," Gouran said.

Although some form of mercury contamination was expected around the cell building, the discovery of elemental mercury, or mercury in its purest form, was surprising in part because of its rarity, Gouran said.

Department of Ecology project manager and environmental engineer Brian Sato said elemental mercury is volatile, meaning it can transition to a vapor state at certain temperatures and can then be inhaled.

Huxley College of the Environment associate professor Ruth Sofield said mercury damages the liver, kidneys and nervous system. However, inhaling vaporous mercury can also damage the lungs, meaning the vapor state produces unique problems. Mercury can also be absorbed through the skin, adding to the danger of soil contamination, Gouran said.

Once in the body, mercury has a neurological effect resulting in headaches, twitches and brain damage with prolonged exposure. It is especially toxic to pregnant women and fetuses, Gouran said.

A developing fetus can be exposed to mercury through the placenta, Sofield said.

Because it is a controlled, outdoor site, concerns about exposure are low. The big concern is the future development of the waterfront, because gases could build up in a closed space like a basement, Sofield said.

Georgia-Pacific sold the property for such a low price because of cleanup expenses. Under the Model Toxics Control Act, the Port of Bell-

"The petroleum dig we did last year was $50 or $60 per ton [of removed soil]. [For the mercury cleanup] we are at anywhere between $200 and $400 per ton."

ingham is eligible for cleanup grants that a private company would not be eligible for, making decontamination much cheaper, Gouran said.

Although Georgia-Pacific sold the property to the Port of Bellingham years ago, it is not completely free of obligations relating to the lengthy cleanup, Gouran said.

"When we acquired the property from [Georgia-Pacific] we said 'if the costs go above and beyond our expectations, you are coming back,'" Gouran said.

In a deal with the Port of Bellingham, Georgia-Pacific bought an environmental insurance policy to help cover cleanup costs, but it is still responsible for unexpected costs not covered by insurance, Gouran said.

For mercury-contaminated soil to be considered safe for humans, there must be less than 24 parts per million of the contaminant, Gouran said.

This is like pouring 1 teaspoon of ink into a 55-gallon barrel of water.

While other areas on the Georgia-Pacific site exceed this standard, pure elemental mercury is the biggest concern. Even at levels of up to hundreds or thousands of parts per million, the metal would still be unseen with the naked eye. However, levels are so high at this site, beads of elemental mercury can clearly be seen in the soil, Gouran said.

The site is still undergoing the remedial investigation and feasibility study, which determines what must be done to clean up the entire site. Cleanup of the whole site is on hold while this investigation is completed, but interim actions can be taken in cases where contamination is especially concerning. Last year, the Port dealt with the issue of petroleum-contaminated soil, which was much less strenuous and less expensive, Gouran said.

"The petroleum dig we did last year was $50 or $60 per ton [of removed soil]. [For the mercury cleanup] we are at anywhere between $200 and $400 per ton," Gouran said.

Increased costs reflect the greater difficulty in removing such a dangerous contaminant. The soil cannot simply be excavated. Since mercury is a liquid heavy metal, it can roll back into the excavation hole, so a powerful vacuum is used because the suction prevents the heavy metal from escaping, Gouran said.

Trying to collect mercury without the vacuum is like trying to collect only the broth from a bowl of chicken noodle soup with your hands. This task would be much easier with a straw, just like how the vacuum helps to remove mercury from contaminated soil.

Workers for the Strider Construction Company, which was chosen to perform the cleanup, must wear respirators and hazardous materials suits.

Air samples must be taken regularly in order to ensure mercury vapor is not escaping from the ground, Sato said.

This ensures the mercury is not volatilizing and releasing toxic metal gas into the air, Gouran said.

Once contaminated soil is removed, it is mixed with sulfur, which bonds with the metal to create mercury sulfide. This stabilizes the mercury and makes it ready to mix with cement, which is done to lock in the contaminant. While typical concrete is 5 to 10 percent cement, the concrete used to efficiently trap the mercury sulfide is 45 percent cement, Gouran said.

This mixing process happens in the mercury cell building, which will be demolished upon completion of this cleanup and examined as well, Sato said.

The concrete is poured into thick bags and taken to a toxic waste facility. Although the concrete blocks are safe and can be stored outside, they must still be transported like toxic waste, Gouran said.

While soil is the primary issue, other debris is being removed due to contamination concerns.

"We are pulling out concrete, foundations, footings, timber piles, debris – and that [sic] material we cannot mix with the sulfur or mix it with cement," Sato said. "Most of it is soil, but everything we pull out of the ground we have to manage."

The eventual sale of the decontaminated property will help cover expenses from the cleanup efforts, Gouran said.

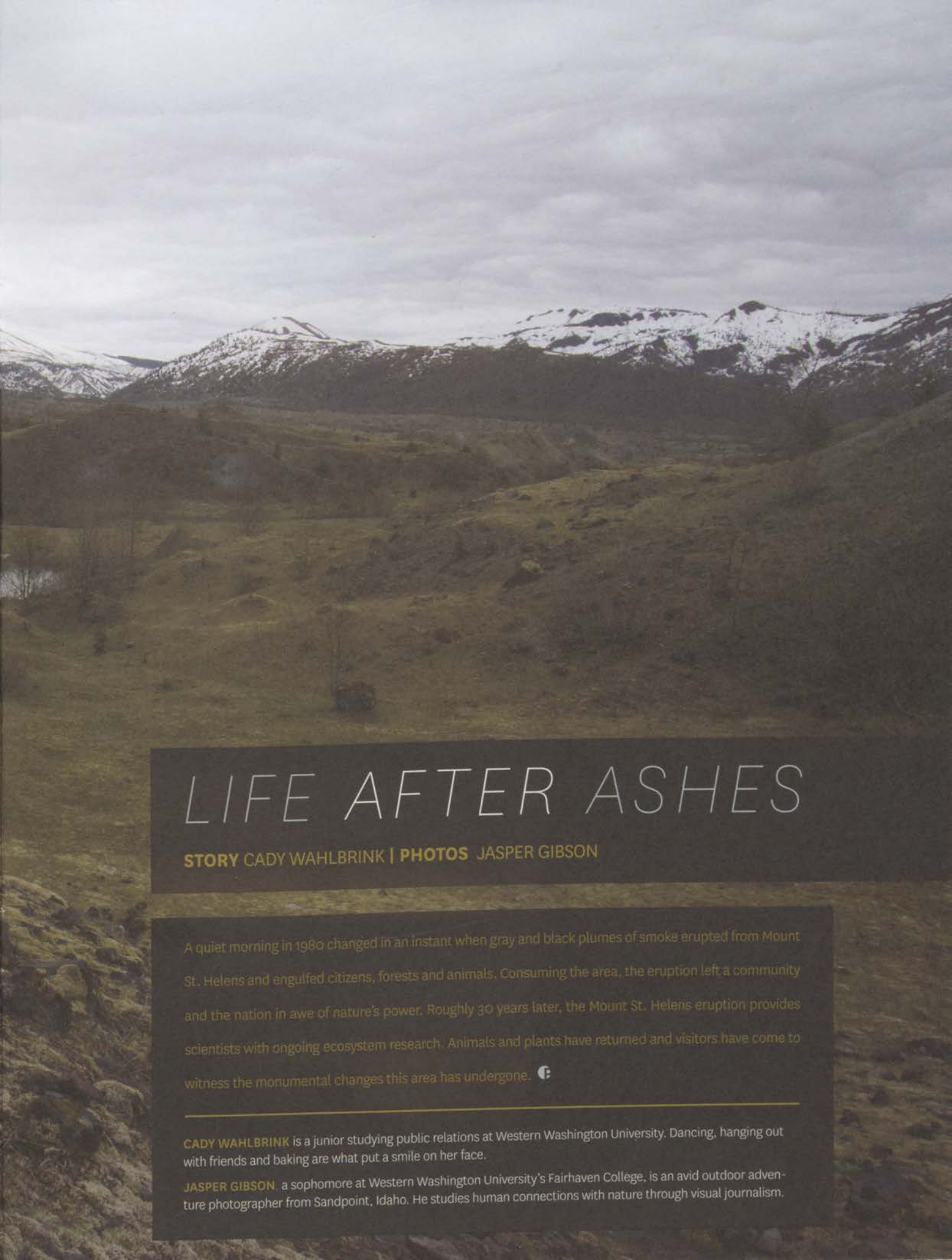
"We want to transition this [land] to a different type of use and have it safe for everybody. Not just workers, not just fishermen, not just people who eat fish – we want this general cleanup to be acceptable for everyone."

COLE FINCHEN is a senior at Western Washington University studying creative writing and journalism. When not studying, he can be found performing stand-up comedy around campus.

GREG CROOKS is a senior pursuing a photography concentration in Western Washington University's art department. When he is not in the art department, he is hiking northwest trails, camping or playing Ultimate.

RIGHT: *Mercury at the Georgia-Pacific site is in its elemental form. This kind of mercury, also known as quicksilver, can more readily volatilize into a toxic metal gas. (Photo Illustration)*

Mount St. Helens looms in the background. After the 1980 eruption, the surrounding ecosystem changed drastically.



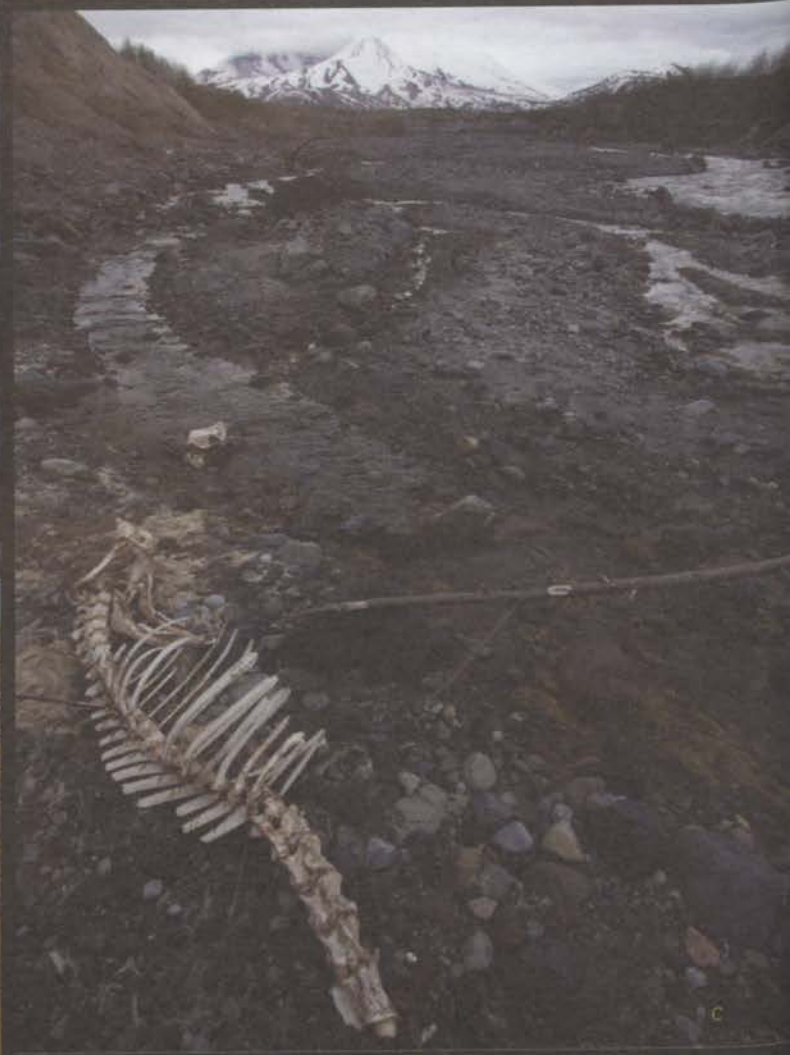
LIFE AFTER ASHES

STORY CADY WAHLBRINK | **PHOTOS** JASPER GIBSON

A quiet morning in 1980 changed in an instant when gray and black plumes of smoke erupted from Mount St. Helens and engulfed citizens, forests and animals. Consuming the area, the eruption left a community and the nation in awe of nature's power. Roughly 30 years later, the Mount St. Helens eruption provides scientists with ongoing ecosystem research. Animals and plants have returned and visitors have come to witness the monumental changes this area has undergone.

CADY WAHLBRINK is a junior studying public relations at Western Washington University. Dancing, hanging out with friends and baking are what put a smile on her face.

JASPER GIBSON a sophomore at Western Washington University's Fairhaven College, is an avid outdoor adventure photographer from Sandpoint, Idaho. He studies human connections with nature through visual journalism.



Images listed clockwise from left

A *A variety of tree species have become established after the eruption. These trees have benefitted from the nutrient-rich ash deposited.*

B *Eric Parker treks to the summit at 8,365 feet. After Mount St. Helens erupted, few tourists came to see the area. Years later, visitors began returning to the mountain.*

C *An elk skeleton lies in the Toutle River Valley in the destruction path. Elk populations in the area have since grown. They make up one of the 10 identified herds in Washington.*

D *The blast from the eruption flattened trees up to 10 miles away from the crater, leaving scattered woody debris in its path.*

E *The eruption sent an ash cloud 80,000 feet into the air and ash rained down on 22,000 square miles. The ash is nutrient rich, which helped the ecological recovery of the area.*

F *Large chucks of ice catapulted by the eruption formed pits among the piles of rocky debris, which filled with rain and groundwater forming ponds. Scientists watched as amphibians and birds recolonized these newly formed habitats.*

FUNGAL REMEDY

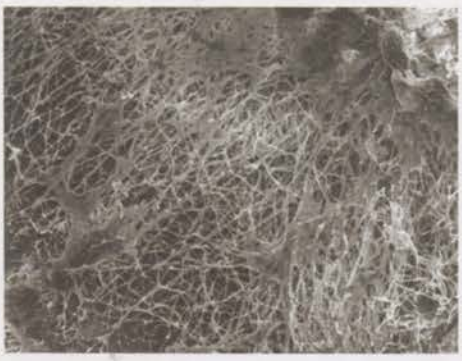
The air is warm, moist and saturated with thousands of mushroom spores. Stacked like a dank library of fungi, rows of shiitake, lion's mane and oyster mushrooms fill the room. They quietly consume bricks of sawdust, flourishing off of the woody nutrients.

STORY CAROLYN BOWIE | **PHOTOS** KATY BENTZ

SURROUNDED BY THESE LIVING SHELVES STANDS ALEX WINSTEAD, FOUNDER and owner of Cascadia Mushrooms in Bellingham, Wash. This warehouse, known as the fruiting room, is where thousands of mushrooms are cultivated year-round. Operating one of Washington's mushroom farms includes supplying mushrooms to the Community Food Cooperative, local restaurants and the Bellingham Farmer's Market. In spring 2012, Winstead began experimenting with a new method of cultivation: using fungi to clean up contaminants.

Fungi's natural ability to decompose matter has inspired a new method of harnessing this power to break down contaminants in soil. This process, called mycoremediation, is a quickly developing cleanup technology being applied to pollution in

"The fungi kingdom is home to some of the most powerful decomposers on the planet, breaking down some of the toughest materials in nature."



ABOVE: *A scanning electron microscope, magnified to one-fifth of a millimeter, shows the dense network of oyster mushroom mycelium.*

the Pacific Northwest and around the world.

"Our target was fecal coliform contamination in surface water," Winstead said.

Fecal coliform is a group of bacteria, commonly found in livestock feces, indicating possible sewage contamination in water run-off from farms. According to the Environmental Protection Agency's Water Monitoring and Assessment Fecal Bacteria page, the bacteria caused by fecal contamination can pose a serious risk to water quality downstream and to those consuming shellfish.

According to a study by Batelle Marine Science Laboratories in 2004, using fungi to help break down and filter contaminants in soil has been demonstrated to reduce fecal coliform concentrations by 97 percent.

In an attempt to reproduce similar cleanup success, Winstead established oyster mushrooms (*Pleurotus ostreatus*) along a drainage basin in Burlington, Wash. to intercept waste runoff from cattle and old septic systems.

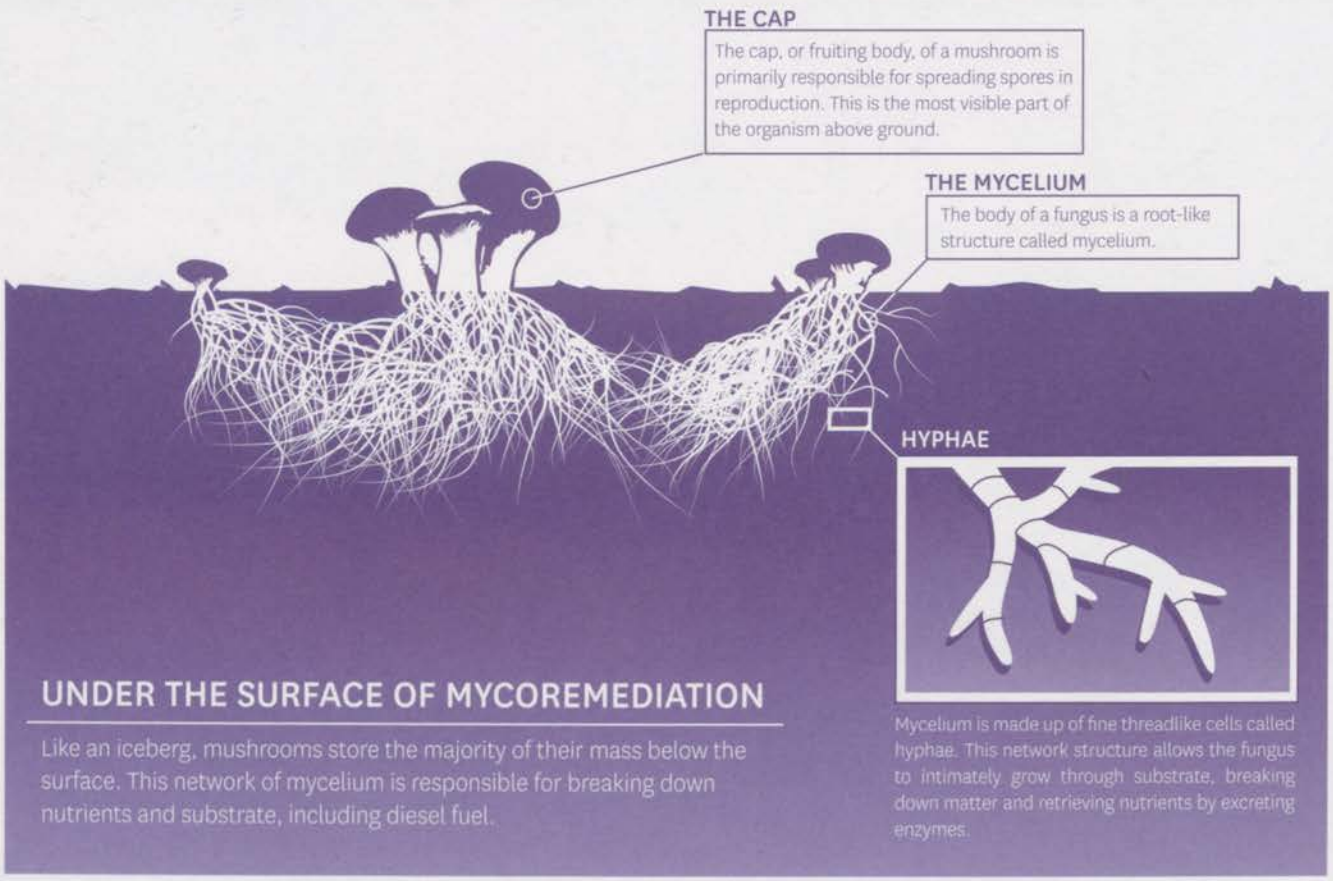
Mushrooms are like icebergs; only the surface is visible while the majority of the organism is hidden below ground. Underneath the cap of every mushroom is a constantly active network of mycelium resembling an intricate web of plant roots. Thousands of these delicate mycelia together are responsible for accessing nutrients and excreting enzymes which break down soil and plant matter, said Rebecca Bunn, assistant professor at Huxley College of the Environment.

According to Paul Stamets's book Mycelium Running, the largest organism in the world is a mass of mycelium spanning more than 2,400 acres in eastern Oregon. Living almost entirely underground, this fungus has worked to break down and cycle nutrients for roughly 2,200 years. The fungi kingdom is home to some of the most powerful decomposers on the planet, breaking down some of the toughest materials in nature.

Treating bacterial waste from cattle and old septic tanks is one of the applications of mycoremediation today.

"If you have contaminated water, you can pass [it] through a filter of mycelium, the mycelium will scavenge for nutrients and things it can decompose, and in turn, clean up the water," Winstead said.

For more than a decade, Howard Sprouse,



ABOVE: *Oyster mushrooms are used to clean up contaminated sites through mycoremediation. The mushrooms clean up polluted soil by breaking down contaminants such as oil or filtering fecal matter in water.*

ABOVE RIGHT: *Founded in 2005, The Remediators Inc. is an environmental service company that cleans up contaminants in soil. CEO Howard Sprouse researches applications of mycoremediation.*

RIGHT: *Underneath the visible mushroom, a network of microscopic branches called mycelium spread through the soil. Mycelium absorbs nutrients by breaking down organic matter.*

CEO of The Remediators Inc., has been researching and applying fungi to remediate soils contaminated with diesel fuel. The Remediators Inc., an environmental service company based in Port Angeles, Wash., restores contaminated soil using fungi.

"Diesel is pretty easy for fungi to completely break down," Sprouse said. "I have been able to go onto sites, put a fungal treatment in the ground and get the concentration from several thousand parts per million down to non-detectable in a few months."

Fungi can decompose as much as 97 percent of diesel-contaminated soil in eight weeks, according to the study, Mycoremediation of Aged Petroleum Hydrocarbon Contaminants in Soil, by S. Thomas of Battelle Laboratory.

The Cloud Forest Institute is applying this method to soils in the Ecuadorian Amazon region as part of the Amazon Mycorenewal Project, where more than 18.5 billion gallons of petroleum waste caused by oil companies contaminate soil and water. According to the project's website, this project allows scientists and humanitarians to work with indigenous cultures in creating methods to clean up the petroleum.

HURDLES OF EMERGING CLEANUP TECHNOLOGIES

Despite initial success using mycoremediation to restore contaminated sites, large government agencies like the EPA and the Washington State Department of Ecology have yet to use it.

Using fungi to clean up toxicants is limited because it is not a proven technology, said Norm Peck, an Environmental Specialist for the Department of Ecology's Toxics Cleanup Program.

Cleanup methods used on a site must achieve a minimum standard, Peck said. According to the Model Toxics Control Act, this standard is about 2,000 parts per million of diesel fuel in the soil.

"We would catch significant flack if we spent citizens' money on unproven cleanup methods," Peck said.

Researching and developing the use of fungi as a cleanup method is expensive. Sprouse finds new ways to continue funding research projects.

"We do not have the money it takes to navigate these extremely costly and complicated sets of hurdles put up by the governing organizations like the EPA and the Department of Ecology," Sprouse said. It takes more than proving the success of a product in a lab.

"In proving technologies, you need to be able to afford the expensive engineering, the legal aspects and get someone to believe in you enough to take that risk," he said.

For now, the primary application of mycoremediation is limited to small-scale projects funded by privately-owned companies like the Remediators and supported by research facilities like Padilla Bay National Estuarine Research Reserve, which has partnered with Cascadia Mushrooms.

Aside from the cost of research and development, another major limitation mycoremediation developers face is the sometimes-harsh climates. Winstead said he worries about his own experiment with oyster mushrooms. After one of the hottest summers on record in 2012, the Pacific Northwest experienced particularly heavy autumn rains.

"The next thing I knew after the summer drought, all the mushroom bags were underwater. Mushrooms do not survive underwater because they need oxygen," Winstead said.

Like every other organism, there is a range of environmental conditions mushrooms cannot tolerate. This creates both a challenge to people attempting to use fungi and a distinct disadvantage in comparison with other clean-up technologies.

In his research, Sprouse exposes mushroom strains to different types of toxicants and conditions to determine which strains are most resilient.

He has thoroughly tested a couple hundred strains of fungi to see which is the most effective decomposer, Sprouse said. Even the strongest strains are limited.

"It cannot do everything," Sprouse said. "The fact is in the real world, most polluted environments are very complex."

ADVANTAGES OF MYCOREMEDIATION

Despite the challenges of developing a new technology, mycoremediation has several advantages that inspire new research.

One of the more widely used methods to clean contaminated soil requires digging it up, hauling it away and then cleaning or dumping it. This requires considerable amounts of fossil fuels and space.

"Landfill capacity is simply a limited resource," Peck said.

Methods that significantly disturb contaminated soil also create a greater risk for toxicants to become airborne, Peck said.

"Almost anything you can [use to] treat contamination [on site] is going to be 'greener,'" Peck said.

Mycoremediation is also more affordable than other technologies. Using in-place methods is less expensive because you do not have to add the cost of handling the soil, Peck said. This prospect is especially important to small projects like the Amazon Mycorenewal Project and organizations like Cascadia Mushrooms.

ABOVE: *These petri dishes contain samples of native mushrooms that Sprouse is exposing to materials like wood and diesel fuel. He tests which species and conditions are most effective for breaking down contaminants in soil.*

BELOW: *Alex Winstead, founder of Cascadia Mushrooms in Bellingham, Wash., cultivates mushrooms sold at local stores, restaurants and the farmers' market. As of Spring 2012, he began exploring the use of oyster mushrooms to clean soils contaminated by fecal waste from agricultural runoff.*

MOVING FORWARD

As long as ambitious fungi cultivators exist, new uses of mushrooms will be put to the test. For thousands of years, fungi have been effective decomposers in the greater ecosystem. The applications of this organism are now in the hands of students, scientists, government officials and the general public seeking to improve soil health. Scientists must be dedicated to learning how mycoremediation works best and if it will ever be feasible on a large scale before it is successful.

As an entrepreneur in mushroom cultivation, Alex Winstead sees a lot of potential.

"We will be doing the testing this spring. We do not know if it is going to work yet, but that is the whole idea behind doing experiments," Winstead said.

CAROLYN BOWIE is pursuing a degree in environmental science with a minor in philosophy. Outside of her coursework, she enjoys exploring fermentation, dancing and challenging corporate privatization of water.

KATY BENTZ is a junior studying theater with an acting concentration at Western Washington University. Driven by creativity, she enjoys theater, photography, music and keeping herself busy.

MULTIMEDIA / ON THE WEB

FEATURED MULTIMEDIA STORY:

WASHED UP

Thanks to the efforts of volunteers, beach cleanup teams have worked to keep Pacific Northwest shorelines free of man-made debris. After the 2011 Japanese tsunami, scientists began to study the impacts and future implications of Japanese tsunami debris, yet two years later many questions still remain unanswered. Experts stress that the answer lies not just in tsunami-specific debris cleanup, but also in addressing the bigger issue of ocean contaminants on both domestic and international shores.

Story: Madeline Havenga
Photo/Video: Jennifer Hoang

ONLINE STORIES:

LEAD LAND
by Joshua Bennett

MEGATHRUST
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"The wounds we have
inflicted on the Earth
can be healed...
But if it is to be done,
it must be done now.
Otherwise, it may never
be done at all."
- Jonathon Porritt