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DEAR READER,

From a very young age, we are conditioned to view the Earth like a classroom globe: colored in stagnant hues of pinks, purples, oranges and yellows. This default geographical image, one of straight-lined political borders and bolded fonts implies an underlying theme of separation. But, as we often forget, the most pressing environmental problems cannot be separated. A mass of carbon dioxide is not confined to any political boundary. An oil spill need not apply for a passport when crossing an international border.

In 2009, the shared, unnamed body of water spanning from the bays of Washington state’s Puget Sound to the inlets of British Columbia, Canada was officially designated the Salish Sea — a name not bound to any side of the border, but to the Coast Salish people, a group of indigenous peoples who have lived in this region for centuries.

This newfound name reflected the realization that our environmental issues do not stop at an international border. They are interconnected. To solve these problems, the policies that address these issues must be interconnected as well.

In this issue of The Planet, we navigated the choppy, sometimes rogue, waters of the Salish Sea: international policy, people and environment.

We dove deep into the sea exploring a vibrant ecosystem increasingly threatened by oil spills, abandoned fishing nets and noise pollution. Soaring above the sea, we examined the spatial patterns of air pollution, noted the changing severity of wildfires and unearthed a tasty food rooted in the past.

We met people vowing to restore the seas ecosystem to historic levels and those trying to harness the carbon-free power of the tides.

The relationships of peoples divided by geopolitical borders but bound by a border-blind environment teeters on the edge of unsolvable complexity. But with the instruments of public policy, and the changing course towards environmental responsibility, waters that once appeared too rough to navigate are now being crossed. The ships of diplomacy have set sail.

Welcome aboard,

Christopher Zemp
Editor-in-Chief

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.

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FEATURES

02 DRAWING A NEW MAP
by Erik Swanson and Dylan Simpson
What is the Salish Sea, and how did it come to be?

14 BURDEN OF A BREATH
by Sam Carlos
Some Seattle neighborhoods have poorer air quality than others.

25 WAVES INTO WATTS
by Frederica Kolwey
Tidal energy is predictable and potentially plentiful. Why is it not being implemented?

07 GHOST GEAR
by Ryan Evans
Decades of lost fishing gear sit beneath the surface.

10 SIGNALED OUT
by Shannon Beach
Whale watching is fun for humans, but what about the whales?

12 INDIGENOUS STARCH
by Kyra Skaggs
A once-forgotten plant may be making a comeback.

18 AFTER THE SPILL
by Graeme Dyehouse
What happens if an oil spill crosses an international boundary?

21 BALANCING RISKS
by Jenna Rheuben
Washington's fish consumption rate is examined.

22 FIGHTING FIRE WITH FIRE
by James Shician
Should a fire always be suppressed?

RECOGNITION

In 2013, The Planet Magazine was one of three national finalists for Best Student Magazine in the Society of Professional Journalists Mark of Excellence Awards.

ON THE COVER

I have ventured all over the Northwest, but have only been on a plane twice. I knew this was my chance. Tearing through the evening sky in a four-seat prop plane was magical. When the pilot headed southwest, toward the southern tip of San Juan Island, I pointed my camera out the copilot’s window. As the bright orange stripe of the sunset started to fade over the San Juan Islands, Vancouver Island and the Strait of Georgia, I noticed the small town of Friday Harbor in the bottom of my viewfinder. Click.

- Kramer Janders
Until 2009, the northwestern body of water encompassing more than 16,800 square kilometers did not have a name. People have called the rich, evergreen-covered coastline their home for centuries but have identified it with different names. The Strait of Juan de Fuca, the Strait of Georgia and the Puget Sound are now part of one body of water: the Salish Sea.
THE NAMING OF THE SALISH SEA

After failing to gain support in the late 1980s, Bert Webber, professor emeritus of biology at Western Washington University, renewed his effort to name this shared sea in 2007. With Stefan Freelan, geographic information systems specialist at Western Washington University, Webber successfully catalyzed the official recognition of the Salish Sea in October 2009.

The reason behind the naming was to bring focus to the ecosystem that supports regional natural resource systems and acknowledge tribal nations that first settled in the Salish Sea, Webber said.

"I'm a biologist by trade and one of our favorite things to do is to name things. If you don't name something, it's hard to understand it," he said.

In 2008, natural resource management was more contentious than during Webber's initial effort. Regions without a name were difficult to manage, Webber said.

Webber knocked on the office door of his longtime friend, the son of a former Western Washington University colleague, Stefan Freelan, and asked him to make a map of the Salish Sea.

Years later, in his office, Freelan sat back in his chair with his hands folded behind his head. Assorted maps were pinned on the wall next to a bookcase with various publications, some containing his new map.

"He just wanted something that he could show and hold up to be able to talk about. So I said, well, let's make it beautiful," Freelan said.

Freelan's task was to construct a map without political borders or city names, representing the natural boundaries of the Salish Sea, Webber said.
Naming the geographic area had to pass through naming boards in Washington state and British Columbia, Freelan said. The boards inquire in local communities to test if a particular name is being used to determine its validity.

The name did not need a lot of publicity because from 1989 through 2008 it was being used informally in places such as natural resource management, Webber said.

Webber said it feels good to be connected with the Salish Sea — when he is associated with the name it is like an introduction and people give him a warm welcome.

"The name has caught on, it’s not going to go away," he said.

ECOSYSTEM DECAY

As of 2013, 119 species in the Salish Sea are endangered or at risk of becoming endangered, according to a report by the SeaDoc Society. This number has nearly doubled since 2002. If endangered species become locally extinct, biodiversity and its many functions will decrease, said John Rybczyk, an ecologist and professor at Western.

Each government manages threatened and endangered species with its own qualifiers and list, said Joe Gaydos, chief scientist at the SeaDoc Society. According to the report, Washington state lists 44 percent of the 119 species, the U.S. lists 22 percent, British Columbia lists 58 percent and Canada lists 61 percent.

Recognizing the Salish Sea’s economic contribution to the region is essential to effectively manage its resources, Gaydos said.

"It’s not just about loving it, it’s about actually having innate value," he said.


Ecosystems also offer non-marketable services, Rybczyk said. Wetlands filter pollutants from water and remove carbon from the atmosphere.

Diversity is important because organisms primarily provide these services, and a diverse system is more able to adapt and rebound from disturbances.

Less diverse systems remove fewer pollutants and support fewer fisheries, according to a 2006 Science article.

Chemical and noise pollution and overfishing plague the Salish Sea, Gaydos said. Population declines are not caused by any one variable, but rather a cumulative effect.

Population declines in the Salish Sea are indicative of ecosystem decay, according to the SeaDoc report. Ecosystem decay is a term coined by conservation biologist Tom Lovejoy to describe the effects of habitat fragmentation.

A habitat reduced in size cannot support the same number of species, Lovejoy said. In turn, the ecosystem will shed species and transition to a simpler state.

Historically, ocean conservation policy has focused on individual species, said Gary Davis, a marine biologist. But an integrated approach focusing on the whole ecosystem would best protect a system like the Salish Sea.

Davis suggests mimicking Australia’s Great Barrier Reef Marine Park, in which some areas are protected and some zoned for commercial or recreational use.

Zoning would be challenging because the Salish Sea crosses an international boundary and involves many native tribes and First Nations,
Davis said. Any regulation is met with competing social and economic interests of many separate sovereign entities, each with their own perspectives of conservation, he said.

Doug Tolchin, president of River Oak Properties, has applied the Salish Sea name to garner support for the proposed Salish Sea Marine Sanctuary, he said. The goal is to not only protect, but restore the wildlife population to 50 percent of its historical level.

Fracking, neonicotinoids — a type of insecticides — and GMOs would be banned, Tolchin said. Potential sanctuary regulations would cap fossil fuel tanker traffic at 2012 levels and launch restoration in tributaries, rivers, creeks and aquifers.

Marine sanctuaries maintain both the habitat and ecological services of natural living resources, like a national park of the sea, as described in the National Marine Sanctuaries Act.

Tolchin said he hopes Washington state will have the opportunity to vote on this park of the sea in November 2016. Roughly 8 percent of voters must first sign a petition to create a citizen initiative that adopts the proposed sanctuary. May 2017 is the next citizen-initiated vote in B.C.

"The power is with the people, but they have to unify and agree around whatever it is that they want to express their power toward," Tolchin said.

COAST SALISH RIGHTS AND CULTURE

Several years before the official naming of the Salish Sea, local tribes gathered in Tulalip, Washington to sign a treaty. The signatures, signed on a deer hide, showed that though they

CHEMICAL AND NOISE POLLUTION AND OVERFISHING PLAGUE THE SALISH SEA, GAYDOS SAID. POPULATION DECLINES ARE NOT CAUSED BY ANY ONE VARIABLE, BUT RATHER A CUMULATIVE EFFECT.
have been separated by tribal affiliation they are all Coast Salish people, said Randy Kinley, harvest policy representative at Lummi Natural Resources (LNR).

Kinley said Tolchin’s proposed sanctuary could put them in a bad position by impeding their treaty rights and requiring them to enforce new laws within their reservation that go against cultural tradition.

Matthew Sparke, director of Integrated Social Sciences at University of Washington, said one of the more problematic aspects of the name Salish Sea was it referenced native people directly but may not extend beyond acknowledgement.

“You might think that it’s a reference of respect for first people’s indigenous sovereignty at some level, but it seems to me that it doesn’t go that deep,” Sparke said.

Native communities are frustrated that indigenous imagery and names are often used as examples of aboriginal Cascadia without being invited to make any sort of decisions, Sparke said.

The issue needs to go beyond the cultural relationship of the name and involve native leadership, he said.

Kinley said the tribes put a lot of effort toward conservation and management objectives, but the burden of habitat conservation should fall to those outside the tribal members.

“The end result is that it’s going to be a complex issue. The tribes are going to get behind when you start calling it a sanctuary, then you’re going to get some resistance. It would be more on us than anybody,” Kinley said.

Frank Lawrence, water resources planner and future department director of LNR, said some people choose to ignore the native perspective.

“Everything that we fight for and everything we talk about, we talk from our spiritual point of view. We do this because it’s us,” Lawrence said. “Most of the world doesn’t seem to want to listen or care about who we are, how we are and where we’ve come from.”

Sparke said finding agreement between all parties can have its challenges but it can work.

Different issues on each side of the border make establishing something like an international marine sanctuary difficult. While U.S. Navy sonar blast drills kill sea mammals, Victoria is pouring sewage into the water, Sparke said.

“I think it’s worth struggling for,” Sparke said. “Personally, I think it’s an obvious thing around which local people on both sides of the international boundary ought to be able to come to agreement on.”

ERIK SWANSON is a journalism student who hopes to make an impact through writing. He is always planning his next adventure and has yet to find anywhere that beats the Pacific Northwest.

DYLAN SIMPSON is a native of the Pacific Northwest pursuing a degree in environmental science. He enjoys hiking, biking, climbing and sleeping outside. Also, books.

CHRISTOPHER YOUNG is a senior pursuing a major in environmental science. During the summer, he enjoys campfires and crabbing on the Salish Sea.

SARAH HEIDRICH is an aspiring veterinarian and a senior biology major at Western Washington University. She works at a doggie daycare and is an advocate for the environment and animal rights.

LEFT: The great blue heron, native to the Pacific Northwest, is on the British Columbia Ministry of Environment blue list as a species sensitive to human activities. It is not endangered.
A diver looks through the dark water down the length of a net that stretches out of sight. Dungeness crabs struggle, legs entwined in the fibers. A juvenile seal is trapped, becoming more frantic every minute.

OVER DECADES of fishing, tens of thousands of nets and crab pots have been lost in the Salish Sea. The gear traps animals and disrupts the ocean floor ecosystem. Every year, these lost pots cost the crab fishing industry between $451,000 and $744,000 in lost revenue, according to the Northwest Straits Initiative, a marine conservation organization that helps remove abandoned fishing gear.

Northwest Straits estimates in less than half a year a single net killed 1,800 birds, 450 salmon, 1,300 spiny dogfish, 16,900 crabs and 11 harbor seals, including estimates of animals that decomposed.

According to a report by Kirsten Gilardi of the SeaDoc Society, seals die in lost nets because their movements are restricted, which wounds them and prevents them from foraging for food.

Tom Good, research biologist at the Northwest Fisheries Science Center, analyzes data on animals caught in ghost nets.

"It's very easy to understand," Good said. "Nets kill things. Take the nets out, those things don't die."

The nets are introduced into the ecosystem in a variety of ways, said Kyle Antonelis, a partner at Natural Resources Consultants (NRC), a company that recovers derelict nets.

"Let's say a net is fishing 100 feet deep and it accidentally drifts over a pinnacle that's sticking up 60 feet off the sea floor," Antonelis said. "It's going to get snagged up on there."

Crab pots are most commonly lost when the rope attaching the pot to a buoy sinks, leaving nothing to grab from a boat, said Brett Mattson, a commercial crab fisher.

"The crab pot is all but unobtainable, but I have known some fisherman to use grappling hooks to chain and drag along the bottom where they think their crab pot is," Mattson said.

The impact from abandoned gear is not only ecological, said Joe Gaydos, chief scientist
at the SeaDoc Society. SeaDoc researchers used Northwest Straits data to determine the economic impact of Dungeness crabs caught in gillnets.

"It maybe costs about $1,300 and some change to get a net out on average," Gaydos said. "But each net is killing about $1,900 worth of crab a year."

For every one dollar spent on recovering fishing nets, $14 are saved, according to Gilardi’s report.

"Even if you hated the ocean and you just loved money, that is a good investment," Gaydos said.

The nets can be as large as 550 meters long and 30 meters wide, about the size of three football fields, Antonelis said. These nets can be expensive.

"Nobody wants to lose their gear," Antonelis said. "If somebody lost their entire net that would probably be the last time they fished in that fishery just because of that cost."

When ghost nets are left in the fisheries, whatever they catch is wasted.

"If nothing else, you can appeal to people’s commercial sense. Anything that gets caught by a ghost net doesn’t get caught by a human," Good said.

Joan Drinkwin, program director at the Northwest Straits, leads the charge in the recovery of abandoned nets. She acknowledges that there are a lot of competing ecological pressures in the Salish Sea, but the Northwest Straits decided to tackle the specific problem of derelict fishing gear.

In 2012, Northwest Straits initiated a lost-net reporting system. Under state law, commercial fishers in Washington must report lost nets within 24 hours.

Northwest Straits sends the report to NRC, which contacts the fisher within an hour, Drinkwin said.
“IT MAYBE COSTS ABOUT $1,300 AND SOME CHANGE TO GET A NET OUT ON AVERAGE, BUT EACH NET IS KILLING ABOUT $1,900 WORTH OF CRAB A YEAR.”

JOE GAYDOS

NRC puts the GPS coordinates of the lost net into a database. A removal team is then mobilized to those coordinates.

Out on the water, the team anchors above the gear and a diver enters the water. They report what they see: the animals trapped and the habitat the net covers.

The divers bundle up as much of the net as they can. They connect it to a recovery line and detach it from the seafloor before the net is hoisted toward the surface.

On the boat, the net is examined to determine the size, type and age of the gear, Antonelis said.

The live animals are freed from the net. The field biologist on the boat then documents all of the animals entangled in the net and inputs the information into a database, Drinkwin said.

The problem of abandoned fishing gear is not unique to the Salish Sea. More than half a million metric tons of fishing gear are lost or abandoned in the world’s oceans every year, Good said.

However, in the Salish Sea the majority of nets found are ‘legacy nets’ that were lost in the ’70s, Antonelis said.

“When [the legacy gear] is removed, what’s left is maintenance,” Antonelis said. “Maybe every year there are 10 to 30 nets lost in a new season. If those are reported then we have means of getting them.”

Deep-water nets and an estimated 12,000 crab pots lost every year are still concerns. However, the problem of abandoned fishing nets has a rare trait: a solution.

“It’s one of the pervasive problems in Puget Sound that we know how to solve,” Drinkwin said.

Raised awareness of the issue, collaboration with the fishing industry and legislation requiring people to report lost nets help to stop more nets from being abandoned.

It has a potential endpoint that most studies do not have, Good said. A lot of studies end with, “and then we will know more about this problem,” he said. This ends with, “and then there will be no more nets in Puget Sound.”

RYAN EVANS is a senior at Western Washington University pursuing a creative writing major. He is interested in the new school of journalism, popularized by Tom Wolfe.

SARAH HEIDRICH is an aspiring veterinarian and a senior biology major at Western Washington University. She works at a doggie daycare and is an advocate for the environment and animal rights.

BELOW LEFT: Fishing nets are not the only form of derelict fishing gear; an estimated 12,000 crab pots are lost every year in the Salish Sea. Northwest Straits archives data on lost crab pots, but does not have the funding to recover them currently.

BELOW RIGHT: Fishing nets lost at sea continue fishing, trapping and eventually killing marine life, such as this juvenile harbor seal found near Sares Head, Washington, in October 2008. The Washington based Northwest Straits Foundation contracts many vessels, such as the Bet-Sea, to recover derelict fishing gear. (Photo courtesy of Northwest Straits Foundation)
The skeleton of a southern resident orca sits on display at the Whale Museum in Friday Harbor, Washington, collected from the remains of the 3-year-old orca Sooke who washed ashore in February 2012. The creature suffered from acute head trauma, an impairment ending her life.

ON AVERAGE 10 to 18 boats within 800 meters of an orca between 2007 and 2009, putting auditory stress on the declining population, according to data collected by the Whale Museum’s Soundwatch Education Program. The proportion of stress caused by noise can be difficult to determine because numerous stimuli impact orcas and their environment.

A 2011 federal regulation by the National Oceanic and Atmospheric Administration (NOAA) requires vessels to stay at least 180 meters away from traveling orcas and prohibits vessels from anchoring in their paths.

In some cases, up to 20 boats follow the same group of whales all day, said Jenny Atkinson, executive director of the Whale Museum.

Southern resident orcas process noises form vessels using echolocation, or the tracking of objects with sound waves, according to a 2007 study by Tim Hunt.

High volumes of sound emitted by a ship in a short amount of time can be deadly to nearby, said Lori Marino, executive director at the Kimmela Center for Animal Advocacy. Marino has studied cetaceans for 25 years.

"It is like being next to a bomb where the pressure just basically makes them bleed out. It’s like a concussion of sound and that’s what actually kills them," Marino said.

As of the 2014 migration season, 79 southern resident orcas inhabited the Salish Sea. This is the second lowest recorded population since the species was listed as endangered in 2005, Atkinson said.

"They hadn’t had a successful baby in over two years. We think that correlates to [humans] spending time on the west side," Atkinson said.

From May to September, southern resident orcas follow salmon runs through the Strait of Juan de Fuca. The three pods — J, K and L — congregate west of San Juan Island in what is called a "super-pod," where social mixing takes place, according to the NOAA species recovery plan.

The area west of San Juan Island acts as their living room and supports diversity through genetic mixing, Atkinson said.

Sam Wasser, director for the Center of Conservation of Biology at the University of Washington, contributed to a 2012 study of prey and vessel traffic. According to the study, large numbers of whale-watching boats following pods disturb orcas by complicating their ability to hunt and causing psychological stress.

"Currently I think [whale-watching expeditions] do more harm than good by far and that’s because of the scale," Wasser said.

Eight million people live in the Salish Sea region and over half a million people go on whale-watching expeditions in this region.
"IT IS LIKE BEING NEXT TO A BOMB WHERE THE PRESSURE JUST BASICALLY MAKES THEM BLEED OUT."

LORI MARINO

every year. Based on numbers alone, humans have a huge impact on orcas in the Salish Sea, Atkinson said.

"It's just like if you have a sibling that follows you all day long. At some point you get kind of tired of it and you want your own space," she said.

Accommodating large groups of people on sightseeing vessels can help whales by reducing the total number of boats on the water, Wasser said. However, whale-watching vessels still emit engine noise within range of migrating whales.

"People used to watch them from the shore, and one of the consequences of these big boats is they have really loud, large engines," Wasser said.

Wasser and a team of biologists collected fecal samples of Salish Sea orcas to identify stress hormones, similar to how pregnancy tests detect specific hormones in women, he said. The stress hormones found in orcas' feces correlate with hormone levels in their blood, which reflect environmental stresses experienced by the whales.

According to a 2002 acoustic impact study conducted by Christine Erbe, orcas were surrounded by boats for eight to 10 hours a day, seven days a week during peak whale-watching seasons. According to the study, a maximum of five boats should be permitted to follow a group of whales at a minimum distance of 400 meters to limit stressful disturbances.

"There are so many boats out there right now and many of them obey the laws only when someone's watching them, and the whales don't get a break," Wasser said.

Until recently, boat engines were not the only sources of noise pollution.

In the past, whales migrating in the Salish Sea avoided mechanisms called acoustic harassment devices (AHDs), which can deter whales from interfering with salmon stock by causing them physical pain, according to a 2001 study on the displacement of whales by high amplitude sound.

The Washington Department of Fish and Wildlife is determining the necessity of deterring orcas from swimming near oil spills by banging on pipes, said Howard Garrett, co-founder of the Orca Network.

Pods that originally migrated through the Broughton Archipelago where AHDs were present relocated to the Johnstone Strait where AHDs were not. According to the 2001 study, orca displacement was likely a direct result of AHDs among migration routes. Use of AHDs within the Salish Sea ceased in 1999.

Thomas White, an ethics expert at Loyola Marymount University, was a contributing author for the Declaration of Rights for Cetaceans, a document advocating for the recognition of cetaceans as persons. The document concludes that as individuals, whales have the right to basic human rights. It recognizes scientific research that has exposed the complexity of their minds and the strong role social interaction plays in their culture.

Whales in captivity are often given anti-stress medication, which shows they are capable of demonstrating signs of stress recognized by humans. Aggressive behavior exhibited by whales in captivity is not brought on by predator instincts, but rather mental instability from living in a stressful environment, White said.

"You can't have that sophisticated of a brain and nervous system and not be experiencing stress when things aren't exactly going your way in your environment," White said.

According to the declaration, the well-being of whales and humans are equally important. Each deserves the opportunity to thrive within their natural environment.

SHANNON BEACH is an environmental studies major at Western Washington University. Her heart belongs to the alpine meadows of the Pacific Northwest, but her passion lies with wildlife and habitat conservation everywhere.

BRIANNA STOUTENBURGH is pursuing a major in public relations. When she is not hitting the books, she can be found exploring the alpine of the Pacific Northwest.

OPPOSITE: A 2011 NOAA regulation requires vessels to stay at least 180 meters away from orcas and prohibits vessels from anchoring in their paths. Boats surround orcas for eight to 10 hours a day, seven days a week during peak whale-watching seasons. According to a 2002 study, a maximum of five boats should be permitted to follow a group of whales at a minimum distance of 400 meters to limit disturbances.

LEFT: Jenny Atkinson is the executive director of the Whale Museum in Friday Harbor, Washington. The museum opened in 1979 to educate the public and research orcas and the Salish Sea ecosystem.
Two hundred twenty years ago, many Pacific Northwest Native Americans harvested tubers beneath large, arrowhead-shaped leaves protruding from calm water along the banks of the lower Columbia River. Hidden beneath mud, no bigger than a person’s palm, those starchy tubers were a staple of their diets for thousands of years. This plant is called wapato.

WAPATO POPULATIONS declined with the introduction of the potato and more intensive land use since the late 18th century. This shifted indigenous diets and damaged cultural traditions. Pacific Northwest tribes are beginning to restore native wapato habitat in an effort to reconnect with this important food source.

Native Americans of the lower Columbia River and Fraser River valleys relied on wapato as a major source of starch in their diets, said Valerie Segrest, a member of the Muckleshoot Tribe and expert on native wild foods.

Wapato, *Sagittaria latifolia*, is a perennial plant that reproduces both by seeds and by rhizomes — underground stems that spread like roots, said Abe Lloyd, who runs Salal, the Cascadian Food Institute. At the end of the growing season, each plant sends down a rhizome, which thickens on the end to produce a tuber. Tubers store carbohydrates to survive the winter and sprout new plants the following spring.

The tubers’ thick blue and white speckled skin must be peeled before cooking, Lloyd said. They can be boiled, roasted or baked and taste like potatoes but slightly sweeter and drier.

Wapato tubers are higher in protein than potatoes and take longer to digest, which means they have less of an effect on blood sugar, Segrest said.

Lloyd said he enjoys the taste of wapato so much he is growing it in a homemade pond. Wapato grow best in 30 to 100 centimeters of water that fluctuates slightly, such as wetlands and sloughs. Lloyd turned a piece of drain culvert on end, sunk it into the ground and kept it filled with water throughout the growing season.

Wapato was once abundant on the shores of lowland lakes and rivers, Lloyd said. Tribes such as the Katzie First Nation and the Klickitat people built villages near large wapato patches.

They cultivated patches by removing other wetland plant species and dead organic material, and preventing predation, wrote Melissa Darby in a chapter of the book “Keeping it Living.”

Spanish explorers introduced potatoes to the Northwest Coast in the 1790s, Lloyd said. Native Americans began growing potatoes and stopped tending wapato patches, which are smaller and more difficult to harvest. In turn, native wapato suffered.

Logging that began in the 1850s hurt wapato in a different way, Lloyd said. Harvested logs were stored in rivers and sloughs where wapato grow best.

Diking was probably the most significant factor affecting wapato populations, Lloyd said. In the 1870s, pioneers began farming salt marshes — flat areas regularly flooded by saltwater — and diking rivers and sloughs to protect their crops from floods. Diking eliminates areas of shallow water along banks where wapato commonly grew.

Wild populations of other native food plants have declined as well, said Nancy Turner, ethnobotanist and professor at the University of Victoria.

“IN OUR ORAL TEACHING, WHEN OUR FOODS CEASE TO EXIST, SO DO WE.”

VALERIE SEGREST

IN OUR ORAL TEACHING, WHEN OUR FOODS CEASE TO EXIST, SO DO WE.

OPPOSITE: From top to bottom: red potato, wapato and yellow potato. Even though both tubers have similar names, potatoes grow in relatively dry areas while wapato grow in water-saturated soils.

BELOW: Abe Lloyd grows his own patch of wapato along with many other Northwest indigenous foods. Lloyd runs Salal, the Cascadian Food Institute and believes indigenous food systems can provide sustenance instead of large farms.
Wapato is an indigenous North American plant found in shallow water environments such as lakes, ponds or on the edge of streams and rivers. Salish and other tribes relied on wapato as a major source of starch in their diets and were able to cultivate areas of wapato to feed their communities.

The flavor of wapato is slightly sweeter than a potato, with a crisper texture. It can be boiled, roasted or baked the same way a potato would be — just with the skin peeled off before cooking.

Though the distribution of wapato is inconsistent in the Northwest, the plant’s resilience allows it to grow naturally when presented with the right conditions. This patch of Wapato is in a trail-side culvert near Western’s campus.

According to the USDA, wapato contains five times more iron, four times more calories and three times more protein than Yukon gold potatoes per 100 grams.

The decline of wapato has impacted more than the diets of indigenous people, Lloyd said. Wapato is a significant food source for other animals as well.

“We don’t even know what we missed,” Darby said. “These beautiful, luxurious patches of wapato provided so much food for ducks, geese, swans, muskrats, beaver and people, and they were ubiquitous.”

Wild foods are regaining popularity in many places due to recent local food movements, Lloyd said. The opportunity exists for wapato to re-enter modern diets as a native alternative to the potato.

Nurseries are starting to grow and sell wapato and tribes are reconnecting with their traditional reliance on wild foods. The Klickitat tribe recently flooded an old farm field to restore a former wetland and wapato came back on its own. Wapato is a resilient species. If the right habitat exists, it will thrive, Darby said.

“The most important thing for people coming from outside of tribal communities to remember is that there is a food system here that’s existed for thousands of years and it’s fed people very well and it’s kept people very healthy for a very long time,” Segrest said.

The best way for people to reconnect with wild foods is to pick one food and become its advocate, Segrest said. Understanding and advocacy can help bring wild foods back into modern diets.

KYRA SKAGGS is a senior double majoring in environmental education and dance. She loves backpacking in the mountains, creating art inspired by nature and talking about native plants.

LENA DONOVAN is a life enthusiast who enjoys homemade food, nature romps and fun experiences. Photography allows her to capture it all.
The air in the Duwamish Valley rests in a geographical sink, an atmospheric blend of highway and industrial plume. Though air quality monitors in the region are measuring safe concentrations of air pollutants, the health of South Seattle locals tells a different story.

Resident of South Seattle are experiencing asthma hospitalization rates twice as high as the rest of King County. Levels of toxic air pollution in the area threaten human health, and socially vulnerable communities are bearing the load. Air quality research and regulation in the Salish region are beginning to uncover these disparities.

Huxley professor Troy Abel's 2011 study shows a strong correlation: the city's highest air pollution zones follow the lowest income populations. Though Seattle industrial toxic air pollution has decreased by 99 percent from 1990 to 2007, those at risk for exposure to remaining pollution are consistently of lower socioeconomic status, according to the study.

"Whatever industrial toxics are left are now totally concentrated in South Seattle," Abel said. This pattern is a result of certain regions becoming more gentrified following Seattle's de-industrialization period between 1990 and 2000, Abel said. According to Abel's study, a simulation showed a 96 percent decrease in risk of exposure to toxic industrial air pollution. "Because the [Seattle] central district is not industrial, it's a very attractive place for gentrifiers," Abel said.

Gentrification is a socio-economic shift that causes a neighborhood's housing values to increase. In Seattle, lower income and non-white residents were displaced by raised rents as cleaner areas of the city became more attractive to wealthier, usually white, renters. Neighborhoods with relatively cheaper housing were the same neighborhoods that continued to emit high levels of pollutants.

"It's a kind of environmental injustice, or even more extreme, it's environmental racism. We're putting our pollution near the poor and minority communities," Abel said.

Particulate matter from highway emissions, diesel engines, wood smoke and industrial sources pose threats to human health in Puget Sound's surrounding regions, according to a 2005 report by the Puget Sound Clean Air Agency.

The Georgetown, Beacon Hill, South Park and Duwamish neighborhoods have the greatest exposure to these pollutants, according to Abel's
Asthma hospitalization rates in these communities were twice as high as the rest of the county, according to a 2013 health impact assessment by the University of Washington.

Increasing exposure to these pollutants heightens a community’s risk for heart attack and stroke, said Eric Saganic, air resources manager at Puget Sound Clean Air Agency.

Neighborhoods with higher rates of respiratory disease and hospitalization are linked to higher air pollution levels, Abel said.

Abel is currently working on an environmental justice project, a collaboration with the Duwamish River Cleanup Coalition/Technical Advisory Group (DRCC/TAG), funded by the Environmental Protection Agency. This project encourages community members to participate in their local government’s decision-making process.

Environmental justice is the fair treatment and meaningful involvement of all people in environmental issues, Abel said.

This collaborative agreement will create air pollution maps that can be easily accessed by the public and facilitate discussions between the community and policy makers over air quality issues.

This way, Abel said, community members can better understand the disproportionate health risks that exist in their area and become more involved in addressing the need for solutions.

Puget Sound Clean Air Agency, a regulatory body that covers King, Skagit, Pierce and Snohomish counties in Washington, includes environmental justice in their discussion of air policy.

"We’re relatively early on in our exploration and understanding of the work around equity and environmental justice, which we are at the same time trying to build into our strategic plan," said Tania Park, environmental justice coordinator at Puget Sound Clean Air.

This strategic plan sets goals for the agency’s operations over the next seven years, Park said.

Puget Sound Clean Air operates with other agencies, including the EPA and Environment Canada. One of its collaborative efforts to reduce air pollution is the Northwest Ports Clean Air strategy, which creates a set of primary objectives.

"IT’S A KIND OF ENVIRONMENTAL INJUSTICE, OR EVEN MORE EXTREME, IT’S ENVIRONMENTAL RACISM."

TROY ABEL

ABOVE: Refineries represent an example of a stationary point source of air pollution, according to a 1997 report by the Natural Resource Defense Council. Despite attempts to contain pollution, refineries, power plants, factories and high-tech industries continue to contribute to decreased air quality.
between environmental agencies in both the U.S. and Canada on diesel and greenhouse gas emissions, according to the 2007 official strategy document.

The U.S. and Canada's air quality partnership sets frameworks for reducing air pollution on both sides of the border. According to a strategy update in 2013, environmental agencies intend to meet air quality targets by Dec. 31, 2014.

The 2005 Georgia Basin-Puget Sound International Airshed Strategy, a collaborative effort between environmental agencies including Puget Sound Clean Air, establishes international initiatives for reducing air pollution and improving scientific and legislative coordination.

"An airshed is basically a box of air that we share collectively," Saganic said.

The box of air surrounding the Georgia Basin-Puget Sound region — the Salish Sea — is blind to the international border, he said.

"WE CAN WORK COOPERATIVELY TO REDUCE THE OVERALL EMISSIONS FOR EVERYBODY."

DON ALPER

AIR MONITORING STATIONS

The Duwamish River Valley has a disproportionately higher concentration of air pollutants compared to other neighborhoods in King County. Fine particulate matter, one class of air pollutants, is shown in the graph below. Though air pollutant concentrations are not distributed uniformly they are still within EPA standards.

**AIR MONITORING STATIONS**

The Duwamish River Valley has a disproportionately higher concentration of air pollutants compared to other neighborhoods in King County. Fine particulate matter, one class of air pollutants, is shown in the graph below. Though air pollutant concentrations are not distributed uniformly they are still within EPA standards.

**ABOVE MAP:** Sources: City of Seattle, Puget Sound Clean Air.
ArcMap 10.1 Adobe Illustrator CS6
By Makie Matsumato-Hervol

**RIGHT:** The Duwamish Waterway passes through Seattle's Industrial District and between communities of concentrated poverty and disproportionate exposure to air pollution.
Diesel emissions and agricultural burning in the Pacific Northwest emit particulate matter, which is small enough to enter the lungs and can cause intensified asthma, chronic bronchitis and decreased lung function, according to a 2007 EPA study. The largest of these particles are 10 micrometers, or one-fourth the thickness of a human hair.

**POLYCYCLIC AEROMATIC HYDROCARBONS**
- benzo[a]pyrene
  - Carcinogenic
  - Decreased birth weight
  - Respiratory problems

**CARBON MONOXIDE**
- Colorless, odorless
- Inhibits blood's ability to carry oxygen
- Respiratory problems

**QUINONES**
- 1,4-napthoquinone
  - Eye and skin irritation
  - Not classified as a carcinogen

**CLIMATE CHANGE AND AEROSOLS**
With the exception of black carbon, most aerosols in the atmosphere actually contribute to global cooling by reflecting light from the sun.

This international effort includes diverse ideas to reduce air pollution impacts within the Salish airshed. The strategy works to support environmental justice in its regions, according to the 2005 strategy document.

Creating international agreements involves the alignment of different laws and values, said Don Alper, director of the Border Policy Research Institute at Western Washington University.

"That's why it's important to have these international agreements," Alper said. "We can work cooperatively to reduce the overall emissions for everybody."

Part of an approach to supporting environmental justice, according to Abel, is transparency between residents and policy makers. The DRCC/TAG map-making work is particularly important in representing concerns of community members living within the airshed.

"Mapmakers had a great deal of power in world history," Abel said. "This is kind of devolving that power back to community members and communities where environmental injustice is a concern."

**EDITORS NOTE:** Christopher Zemp, editor-in-chief of The Planet, served as an intern on the Duwamish River Valley mapping project from June to September 2014. He was not involved in the reporting of the story.

**SAM CARLOS** is a Chemistry major at Western Washington University. He is fascinated by astronomy and interpersonal neurobiology.

**MALLORIE ESTENSON** is a photographer and storyteller forever chasing her next outdoor adventure. When she's not out climbing rocks, she's reading and writing about rock climbing for her blog.
As global energy demand and the price of oil change, industry expansion in the Salish Sea could be profitable. Yet potential impacts loom over marine ecosystems.

**INCREASING DILUTED** Bitumen exports will lead to more tanker traffic in the Salish Sea. Three major tankers leave the Westridge Marine Terminal through the Strait of Juan de Fuca every month, according to Trans Mountain project overview.

The project, proposed by Kinder Morgan Energy Partners, would expand the diameter of the existing pipeline running from the Alberta tar sands to the Westridge Marine Terminal in Vancouver, British Columbia. If the proposed project is completed, 34 tankers will ship monthly.

Tar sands oil, or bitumen, is a molasses-like fossil fuel found in Alberta, which must be diluted with lighter petroleum products so it is less viscous and can travel through pipelines, according to the Canadian Energy Pipeline Association.

Much of the increased export would be heavy tar sands oil. A new bulk carrier terminal is proposed for Cherry Point, Washington, and a terminal expansion is planned for Delta Port, British Columbia, according to the Vessel Traffic Risk Assessment.

Both the U.S. and Canada have emergency response plans if an oil spill occurs. However, transborder policy gaps may stall international cleanup efforts.

According to the assessment, if maritime terminal developments are approved, major oil spills frequency may increase by 18 percent throughout the Salish Sea. A major oil spill is considered to be 38,000 liters or more — less than one-fourth of a semi-truck.

If approved, the expansion would be operational by 2017.

The Canadian government’s lack of research into oil spill cleanup is not reassuring, said Sheila Malcolmson, chair of the Island Trust Council in Canada, raised concerns about Canada’s contingency plan regarding tar sands oil spills. In a simulation, only 15 percent of oil was recovered.
According to a letter sent to the Canadian Tanker Safety Panel from the council, the regulated three-day response time for spills of 10 million liters of oil or more is insufficient. Delaying cleanup could result in oil coating the shores.

Oil spills in Canadian waters carried by fast currents into the Puget Sound and San Juan Islands are a transboundary risk, Malcolmson said.

According to a 2011 report by the British Columbia Oil Response Task Force, by Canadian law private Washington responders are not an approved response organization and are therefore not afforded legal immunity, which U.S. law gives to Canadian spill responders.

Without responder immunity, private responders in nearby states — like Alaska and Washington — would have to pay their own cleanup costs rather than billing the responsible party, said David Byers, response manager for Washington State Department of Ecology. Therefore, Washington responders are liable for the cost of cleaning up the spill, according to a newsletter from the Spill Control Association of America.

The last time the Canadian Shipping Act was updated, a clause was left out of legislation that allowed for responder immunity, said Graham Knox, director of the Environmental Emergency Program. Knox's program is part of the British Columbia Ministry of the Environment.

The Marine Spill Response Corporation will not cross international borders to aid in a spill taking place in Canadian waters without responder immunity, Byers said.

On average worldwide, about 15 percent of oil is recovered after an oil spill. Washington recovers a much higher average of 40 percent, he said.

"We're doing fairly good, thanks to support from the legislature that gives us strong authorities and regulations," Byers said.

The oil industry recognizes that prevention and effective cleanup procedures, which protect fragile ecosystems, are good for business, said David Nelson, professor of economics at Western Washington University.

"An ounce of prevention is worth a pound of cure," Nelson said.

"We're doing fairly good, thanks to support from the legislature that gives us strong authorities and regulations," Byers said.

The oil industry recognizes that prevention and effective cleanup procedures, which protect fragile ecosystems, are good for business, said David Nelson, professor of economics at Western Washington University.

"An ounce of prevention is worth a pound of cure," Nelson said.

The recent developments and expansion plans could mean significant economic gains in the future, said Hart Hodges, director of the College for Business and Economics Research at Western Washington University.

As long as the oil industry maintains a profit in the current market, it will continue to develop and sell its products, Hodges said.

Demand for oil and energy costs in the U.S. is low right now. As a result, profits and stocks fall in line with falling oil prices, Hodges said. As of now, the oil industry is not yielding large profits.

Even though demand is currently low, oil companies operating in the Alberta fields are investing $5.4 billion, according to the Trans Mountain website project overview.

In the past, other firms have made investments in renewables and these investments have failed, Hodges said. Oil companies consistently make profit.

The plans to expand oil transportation in the Salish Sea are part of an investment the companies are making. They are hoping for an increased oil demand in the next several years.

If demand goes up, the price per barrel will go up and oil companies will get returns on their investments, he said.

The issue is complicated and does not rest solely with the oil producer. The consumer, who may want tanker traffic to stop, will still consume oil products, Hodges said.

Demanding oil traffic is stopped is not as important as decreasing everyday fossil fuel use.

"We do way too much to make ourselves feel good, and not nearly enough to change the energy economy," Hodges said.

In the case of diluted bitumen, a portion of the substance sinks when it interacts with sediments in the water. One of the difficult parts of cleaning up tar sands oil is detecting the substance once it sinks, Byers said.

Tar sands oil sinks because it consists of long hydrocarbon chains. Even with sonar and divers armed with underwater vacuums, removing the oil is difficult, Byers said.

Washington's current contingency plan for spills relies on skimmers and booms to physically remove and contain spilled oil, Byers said.

Booms are more effective at cleaning lighter oil than tar sands oil, according to the Environmental Protection Agency.

Oil that is persistent stays in the water column and may enter the food chain, potentially...
MAJOR AND MINOR OIL SPILLS IN THE PUGET SOUND

The Puget Sound has experienced a total of 18 oil spills between 1988 and 2014, caused predominately by vessel collisions, container leaks and oil transfer processes. Additional proposals to build new and expand existing oil facilities as well as shipping terminals that serve as warehouses for oil cargo and docking stations to transfer oil have followed the pipeline proposal.

creating long-term issues, said Dave Keeney, who formerly worked with spill prevention at the Department of Ecology.

Dredging the water with nets can help remove some oil from the water column, Byers said.

While these methods have been mandated, they have not been extensively tested and their effectiveness is unknown, he said.

"That's a challenge we don't have a 100 percent solution for," Byers said.

Canada has been exporting tar sands oil through the Salish Sea since the 1980s, Knox said. To deal with diluted bitumen spills, Canadian response task forces are asking companies to provide cleanup plans and shipping methods. Many techniques can be used to clean up spilled tar sands oil, and the province is researching the most effective procedure to clean up sunken diluted bitumen, Knox said.

"It's really not a matter of if there is going to be an accident as much as when," Hodges said.

"That's the nature of risk."

GRAEME DYEHOUSE is a senior pursuing a degree in public relations and communications at Western Washington University. He has previously been a reporter on The Western Front.

LENA DONOVAN is a life enthusiast who enjoys homemade food, nature romps and fun experiences. Photography allows her to capture it all.
Years of attempting to redefine two small numbers have brought Washington state to the height of controversy. Wedged among the needs of environmental and social justice advocates, tribal entities, industry leaders and municipalities, policy makers are conflicted over how stringent state water quality standards should be.

IN JULY 2014, Governor Jay Inslee formally directed the Washington Department of Ecology to increase state water quality standards. Municipalities raised concerns over the technical feasibility of implementing expensive treatment technologies to meet stringent standards. Meanwhile, tribal entities and social justice advocates are pushing for standards that would protect Washingtonians who consume greater amounts of fish.

At the heart of these revisions lie two controversial elements: the daily fish-consumption rate and the excess cancer risk rate. The fish-consumption rate is an estimated average daily amount of fish consumed per person. The excess cancer risk rate describes the probability an individual will develop cancer due to carcinogen exposure over a lifetime. These variables are part of a complex equation that determines how policy makers regulate discharges by industry and municipalities into Washington waterways and will determine how clean the state's waters should be for years to come.

On Sept. 30, 2014, Ecology released the Preliminary Draft Rule outlining Washington's new water quality standards. The draft raised the acceptable excess cancer risk from 1-in-1 million to 1-in-100,000 and raised the fish-consumption rate from 6.5 grams to 175 grams per day. This new fish-consumption rate is not only Inslee's directive but also Oregon's rate, the most stringent fish-consumption rate in the country.

These policies involve many groups with diverse interests — this is not the whole story. Please visit www.theplanetmagazine.net for in-depth coverage.

JENNA RHEUBEN is a senior studying environmental science at Huxley College of the Environment. Her hobbies include goat herding, fly fishing and drinking excessive amounts of earl grey tea.

MALLORIE ESTENSON is a photographer and storyteller forever chasing her next outdoor adventure. When she is not out climbing rocks, she is reading and writing about rock climbing for her blog.

### CHANGING WATER QUALITY STANDARDS

<table>
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<tr>
<th>CURRENT STANDARD</th>
<th>VS</th>
<th>PROPOSED STANDARD</th>
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<tr>
<td>RL</td>
<td>1/1,000,000</td>
<td>1/100,000</td>
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<tr>
<td>FCR</td>
<td>6.5 g/day</td>
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Three of the five variables in the marine water quality standard equation are planned to stay the same. A decreased risk level (RL) lowers water quality standards, while an increased fish-consumption rate (FCR) raises water quality standards. Proposed changes are specifically for human-based water quality standards for carcinogens. To the right, the proposed fish-consumption rate change is illustrated using Dungeness crab.
Seventy years ago, a bear cub with burned paws was rescued by the U.S. Forest Service and became the iconic Smokey the Bear. Smokey's famous proclamation, “only you can prevent wildfires,” instilled the belief that wildfires are inherently bad. This belief has altered fire cycles and is largely responsible for intense wildfires occurring today.
HUMAN-DRIVEN fire suppression over the past century has altered unchanged fire regimes throughout Washington and much of the western United States. This policy, in an effort to protect development, has decreased the total area burned but increased the severity and intensity of wildfires.

To make the current fire regimes more manageable, new strategies of fire management are currently being explored and implemented. A fire regime is the frequency, intensity and size of wildfires in a certain area.

According to the Climate Impacts Group (CIG), a University of Washington research group studying the impacts of climate change, the trend of increasing fire severity will continue as temperatures rise and summers become drier. The total area burned within the Columbia River Basin will also increase two to threefold by 2080.

“We started suppressing fires, and all of a sudden we started having catastrophic fires because the underbrush grew up to be a devastating fire load,” said Peter Dybing, a chief officer on a federal fire team.

Wildfire is cyclical, and burning is a part of a forest’s life cycle. In an unchanged fire cycle, dead organic matter on the forest floor works as fuel and burns periodically. The low-level fires that result do not kill many trees and allow new growth to occur.

Homes and other structures in forested areas lead humans to suppress fires, Dybing said.

When forests do not burn, the fuel accumulates increasing the potential for a fire to become so hot that wind spreads it across the tree canopy, and the fire decimates all plant matter. This event, known as a crown fire, could soon occur on a large scale in western Washington, Dybing said.

“We know that this year fires were already starting to pop up in western Washington just before the heavy rains came,” Dybing said about the summer of 2014. “Had it been another week or two of drying, we would have had catastrophic fires in western Washington.”

According to a government project called Monitoring Trends in Burn Severity, roughly 60,000 hectares burned in the state of Washington in 2013.

Driven by a changing climate, the fire regime of Washington state may soon start resembling that of Northern California 30 years ago when 1.6 million hectares of forest burned in one year alone, said Michael Medler, associate professor of physical geography at Western Washington University.

A changing climate may impact fire regimes through less direct means.

In the region between the Cascade Range and Rocky Mountains, insects such as bark beetles feed on the inner bark of pine and fir trees, cutting off water flow within the tree. Without water, trees become dry fuel for fire. Currently, insect kill does not affect western Washington, but that could change along with the climate, Dybing said.

Cold winters kill insects, keeping them from killing trees. Without cold winters, insect kill becomes rampant, said Jacob Lesser, a graduate student working with Medler.

According to a 2014 report by the CIG, most watersheds in Washington will be rain dominated by the end of the 21st century, resulting in decreased snowpack and less seasonal snowmelt. With less available water, risk of crown fires will increase.

The number of fires in the western U.S. has more or less remained constant in recent years, though suppression along with warming and drying causes many more wildfires to become crown fires, Lesser said.

Crown fires lead to widespread erosion, said Lee Benda, a geologist with the Earth Systems Institute, a non-profit focused on mapping the relationship between landscapes and rivers.

According to the Washington Department of Natural Resources, 15 catastrophic landslides have occurred in recorded history in Washington. Combining loose soil with western Washington’s high tendency for days of rain, erosion and...
THE PLANET

FIRE SUPPRESSION EFFECTS ON FOREST

1. UNCHANGED CYCLE

Dead organic matter, referred to as a duff layer or leaf litter, accumulates on the forest floor. Lightning or occasional spontaneous dry leaf combustion sparks the organic matter into flame, burning some vegetation but leaving most trees unharmed. The trees are left standing after the fire, but the organic matter is consumed by the flame.

2. ACTIVE FIRE MANAGEMENT

Historically the fire cycle has been suppressed by the US Forest Service and other organizations. Without periodic burning, organic matter on the forest floor accumulates so high that when the fire burns, it is much more intense. Flames travel to the canopy and destroy the forest.

“IF DONE APPROPRIATELY, PREScribed FIRE IS AN IMPORTANT TOOL IN THE TOOLBOX FOR MANAGERS.”

REBECCA FLITCROFT

Landslides may increase. Annual precipitation in Bellingham is about 90 cm and nationally ranks in the top 12 percent for number of rainy days, according to data from NOAA.

If a crown fire were to occur, organic matter would be burned away, greatly reducing soil stability, Medler said. Massive amounts of eroded soil introduced to watersheds impacts productivity of fish and other aquatic life.

“You get big fires that are not part of the natural regime and you’re going to end up with big soil pulses in the salmon spawning grounds,” Medler said. A soil pulse occurs when precipitation falls onto the organic-depleted, unstable soil, causing the soil to enter a waterway.

Soil pulses and erosion primarily damage vulnerable salmon eggs, but can also kill adult salmon, said Rebecca Flitcroft, a fish biologist with the Forest Service.

Decisions on whether a fire should be left to burn or suppressed are made on a case-by-case basis. For example, if a fire is threatening a wildlife refuge that is host to an endangered species, a fire manager may move to suppress the fire. However, the best decision is not always clear. In some cases, a fire may be beneficial to a certain species in an ecosystem, Dybing said.

Allowing forests to burn uncontrolled could be dangerous, but there are other options. “If done appropriately, prescribed fire is an important tool in the toolbox for managers. Along with that, moving away from only doing clearcuts and expanding things like thinning and partial cuts may be another useful piece,” Flitcroft said.

The more options provided to fire managers, the better the outcome, she said.

The Forest Service commonly implements prescribed burns, carefully contained wildfires ignited by humans, in an attempt to mimic an unchanged fire cycle.

“The only way that we are going to get back to a pre-suppression fire regime is by fire,” Medler said.

A tree canopy shades underbrush on the forest floor, causing a decrease in potential fuel. For many years after a clearcut, new growth does not have time to establish a canopy. Without a tree canopy, underbrush on the forest floor experiences abnormal amounts of sunlight, leading to overgrowth. The potential for a severe fire is then greatly increased, Dybing said.

More than 15 years ago, the Forest Service ceased to focus on harvesting resources and instead focused on scientific research. Since then the Forest Service developed a firefighting philosophy centered on protecting salmon spawning habitat, urban infrastructure, regrowth of forests and endangered species, Dybing said.

“The Forest Service is doing a much better job at actually catching these fires early and making good, sound, science-based decisions about it, which is refreshing,” Dybing said. “Many times we’re managing fires from multiple objectives now, not just putting the fire out.”

Though wildfire will indefinitely need management, Smokey’s message may soon change. This wildfire icon may instead advocate for reduced emissions instead of changes in ecological processes.

JAMES SHAHAN is a sophomore at Fairhaven College. James is a skier, mountain biker, dog sled guide and river guide.

LENA DONOVAN is a life enthusiast who enjoys homemade food, nature romps and fun experiences. Photography allows her to capture it all.
As the moon orbits around the earth, oceans are pulled along with it. Most people see tides, but the scientists see an opportunity to make electricity. Harnessing tidal energy is feasible, but funding for research and construction is hard to secure.
THE ELECTRICITY GRID

1. FOSSIL FUEL PRODUCTION

Much of the electricity production in the United States is generated with fossil fuels, considered baseload power sources because they are cost-effective and can produce the exact amount of electricity demanded. Nuclear, geothermal, and large-scale hydroelectric dams are also baseload power sources but are not as widely used.

2. INTERMITTENT PRODUCTION

It is difficult to predict how much electricity will be generated from intermittent sources at any given time. Utilities using intermittent sources can be forced to quickly add a fossil fuel source to the power system. Rapid addition of fossil fuel sources wastes energy and strains the grid.

3. TRANSMISSION

Electricity is transmitted to customers through a network of roughly 257,000 kilometers of power lines that cross the United States, according to the Energy Information Administration. That is enough power lines to cross the length of the United States about 50 times. About 6 percent of the energy is lost traveling through transmission lines.

4. DISTRIBUTION

Electric utilities must balance their output with customer demand instantaneously. Daily and seasonal demand follows relatively predictable cycles where small imbalances can produce brownouts and larger imbalances can lead to blackouts. Intermittent electricity technology only has the capacity to produce as much as the sun is shining, the wind is blowing or the tide is flowing.

WHEN COST estimates almost doubled, the first tidal project in the Salish Sea was stalled in September 2014 after approximately eight years of research. While tidal energy has been installed in the Kvichak River in Alaska and Pentland Firth, Scotland, the proposal for the Salish Sea lacked support for even a pilot research survey. The initial cost projection of the project was $20 million, and the United States Department of Energy (DOE) and the Snohomish County Public Utility District (SnoPUD) were prepared to contribute $10 million each, said Neil Neroutsos, public relations liaison for SnoPUD.

The initial estimate grew to $37 million. Without increased DOE support, SnoPUD could not afford the new budget, Neroutsos said. Cost projections grew mainly because proposed environmental monitoring, equipment and construction costs increased. Data from the project would have helped scientists understand possibilities of tidal technology.

This project would have been the first commercial-scale, grid-connected tidal energy plant in the western United States, according to a SnoPUD press release from March 2014.

Washington state policy requires 15 percent of its energy production be comprised of renewable resources excluding hydroelectric by 2020, according to the Database of State Incentives for Renewables and Efficiency.

According to the press release, two 6-meter-wide turbines built by the Ireland-based company OpenHydro would have been placed off the southwest coast of Whidbey Island in Admiralty Bay. One cable from each turbine would have run along the seafloor and connect to the power grid near the ferry terminal on Whidbey Island.

As a pilot project, the turbines would have been monitored for three to five years to test their environmental impact and determine if tidal energy was viable for SnoPUD, according to the press release.

Right now, it is too expensive for companies to make money from tidal energy and it may be for a long time, said Jim Thomson, a member of the University of Washington research team on the Admiralty Bay project.

Since use of tidal power is expected to increase, the cost of tidal energy is expected to decline by about 40 percent by 2030 as companies

"IT'S PURELY AN ECONOMICS THING. FROM A TECHNICAL AND ENVIRONMENTAL PERSPECTIVE, WE'RE READY."

JIM THOMSON
learn ways to reduce costs, according to a technology brief written in 2010 by the International Energy Agency (IEA).

"It's purely an economics thing. From a technical and environmental perspective, we're ready," Thomson said.

The project was intended to demonstrate the viability of tidal turbines in Admiralty Inlet without technological failures or adverse impacts to the environment or society, said Brian Polagye, the co-director of the Northwest National Marine Renewable Energy Center at the University of Washington.

"A demonstration of boredom would be the best thing that can come out of a project like this," Polagye said.

The goal of new renewable technology is for it to quietly work in the background, Polagye said.

Tides, which ebb and flood with the periodic gravitational pull of the moon, generate the most predictable electricity of current renewable technology, according to the IEA.

Energy supply from coal or natural gas plants can be regulated with the turn of a dial, but utilities have less control over how much energy is produced from tidal turbines.

Tidal energy is only produced as tides flow in and out, but the transition happens slowly so tidal energy is predicted to combine with non-renewable sources more easily than other renewable sources, according to Levi Kilcher of the National Renewable Energy Laboratory (NREL).

Renewable resources in general are unpredictable. The unpredictability of a resource is called its intermittency. Energy output must be balanced with energy demand, otherwise blackouts and brownouts can occur, according to the IEA.

"The intermittency of energy generated from tides is a problem the industry can overcome, in part by using techniques pioneered by the wind and solar industries," said Michael Lawson of NREL.

Fish and marine mammals avoided the turbines during OpenHydro's testing, according to a March 2014 press release from SnoPUD. The DOE predicts tidal turbines may be the least environmentally damaging of other tidal technologies because they do not disrupt fish and other marine animals' migratory patterns.

Funding for a commercial-scale tidal energy project was secured in Pentland Firth, Scotland on September 18, 2014, according to MeyGen Limited, the owner of the project. Funding amounts to about $81 million, including support from the U.K. Department of Energy and Climate Change.

Once completed, the project will include up to 269 installed turbines, according to an August 2014 MeyGen press release.

No tidal energy plants of this scale currently exist in the United States. Government support is needed in order for ocean energy technologies to enter the market, according to the IEA.

Tidal energy is currently being explored by the Ocean Renewable Power Company (ORPC) in two small coastal communities in Alaska, one in Nikiski and one on the west side of Fire Island about three kilometers from Anchorage. The price of energy tends to be high in these remote communities, Kilcher said.

Part of the exploration of the project in Nikiski, Alaska was a demonstration of ORPC's turbine system in the Kvichak River in Igiugig, Alaska. ORPC announced the success of the project on Sept. 24, 2014 according to an article from Alaska Business Monthly.

COST EFFECTIVENESS

The Levelized Cost of Energy (LCOE) is a cost summary of fuel, capital, operations and maintenance, policy incentives and more. With so many factors it is hard for economists to agree on the LCOE of establish technologies; new technology like tidal is even more uncertain. Tidal energy is reported below as an average of current estimates.

ABOVE: Part of the University of Washington tidal energy research team in February of 2010 comprised of engineers and applied physicists. Pictured left to right, is Jeff Epler, Brian Polagye, Joe Tolbert, Jim Thomson, Andy Rosy-Ellers and Chris Bassett. Thomson and the crew of researchers worked on a ship and used instruments such as a Sea Spider tripod (pictured in the front) to measure the speed of the current, ambient noise and water quality. (Photo courtesy of Jim Thomson, applied physics laboratory of University of Washington.)
The success verifies the potential to use alternative energy resources, such as tidal, to decrease cost and environmental impact of energy acquisition in rural communities like Igiugig.

Kilcher grew up in Homer, Alaska, a town west of Nikiski along the Cook Inlet, which has the second highest tidal range in North America, according to ORPC.

"Even though I grew up surrounded by large tides, I didn’t plan to become a tidal energy researcher, but as I’ve gotten to where I am it’s rewarding to work on a technology that might one day provide energy to the community I grew up in," Kilcher said.

Large-scale integration of renewables is feasible and necessary in order to meet goals that limit the amount of CO2 in the atmosphere. The intermittency of renewables will need to be coupled with a variety of non-intermittent energy sources in power systems, according to the IEA.

Even though the SnoPUD project was stalled indefinitely, many aspects of the project were successful, Thomson said. The information collected on the SnoPUD project will be useful for understanding the local waters in the Salish Sea area and for understanding other potential tidal energy sites around the world.

"Here’s a resource that is more intense than the most superb wind site but also completely predictable," Polagye said. "That’s pretty great, right? Why wouldn’t you want to try to harness that?"

FREDDERICA KOLWEY is a sophomore at Western Washington University. She enjoys traveling, going on backpacking trips and trying new foods, especially anything with avocado.

CHRISTOPHER YOUNG is a senior pursuing a major in environmental science. During the summer, he enjoys campfires and crabbing on the Salish Sea.

ABOVE RIGHT: A model of the turbine proposed by Snohomish County Public Utility District (SnoPUD).

RIGHT: Proposed Admiralty Bay tidal energy site looking west towards Whidbey Island from Fort Casey. Two 6-meter-wide turbines built by the Ireland-based company OpenHydro would have been placed off the southwest coast of Whidbey Island. One cable from each turbine would have run along the seafloor and connect to the power grid near the ferry terminal on Whidbey Island.
Salmon are a keystone species in the Salish Sea, providing food for both humans and top predators. While salmon used to be an abundant source of high quality protein in the Pacific Northwest, it is not a common part of most people's diets today. With awareness of the threats to salmon coupled with growing restoration efforts, salmon are making a comeback, and could eventually become an important source of protein for people once again.

Kinder Morgan proposed an expansion project to the Trans Mountain Pipeline that runs directly through Burnaby, British Columbia. The pipeline expansion would increase flow from the tar sands in Alberta to the Westridge Marine Terminal in Burnaby. Burnaby community members are protesting the threat this project poses to the city and the Salish Sea. With the support of the mayor, Burnaby has begun active opposition against Kinder Morgan's expansion project.

Visit the Planet Website at www.theplanetmagazine.net for exclusive online stories, additional photographs and other content.

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### THE METRIC SYSTEM

The Planet has switched from the imperial system to the metric system, which is used by most countries. Only Liberia, Myanmar and the United States still widely use the imperial system. Instead of complicated conversions, metric math only consists of multiples of ten, with each multiple corresponding to a prefix. Constantly converting from imperial is difficult, so look below for some common references.

**LENGTH**
- Seattle to Bellingham: 145 km
- Height of Mt. Baker: 3.3 km
- Football field: 90 m
- Car length: 5 m
- Average human height: 1.7 m
- Pencil: 10 cm

**TEMPERATURE**
- Boiling water: 100 °C
- Human body: 37 °C
- T-shirt weather: 15 °C
- Long sleeve weather: 10 °C
- Wearing a coat: 5 °C
- Water freezes: 0 °C
- Siberian winter: -40 °C

**SPEED**
- Walking: 5 kph
- Usain Bolt's world record: 44 kph
- Driving on the highway: 120 kph

**MASS**
- Honda Accord: 1.5 tonnes
- Unabridged dictionary: 1 kg
- Paperclip: 1 g

**VOLUME**
- Olympic pool: 2.5 million L
- Average fridge: 150 L
- Bottle of wine: 750 mL
- Shot glass: 44 mL

**AREA**
- Washington state: 185,000 km²
- 0.5 hectares
- American football field: 1.7 m²

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The Planet, an independent publication rooted in the language of science, has decided to break the norms of Associated Press style, the common format for journalistic writing. We have italicized species names and peer-reviewed academic journals, as this is the widely used format in well-respected scientific literature.
"A new consciousness is developing, which sees the earth as a single organism and recognizes that an organism at war with itself is doomed.

We are one planet."

CARL SAGAN