PUGET SOUND INSTITUTE

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Salish Sea Currents

timely, local stories about ecosystem recovery

2017-18

Special Report
for
PUGET SOUND POLICYMAKERS

implementation strategies

Chinook salmon
toxics in fish
floodplains
estuaries
shellfish beds
eelgrass
shoreline armoring
land development and cover

ABOUT THE PUGET SOUND INSTITUTE

The Puget Sound Institute (PSI) was established at the University of Washington to identify and catalyze the science driving Puget Sound and Salish Sea ecosystem recovery. Since its founding in 2010, PSI has advanced our understanding of the region through synthesis, original research and communication in support of state and federal agencies, tribes and many other organizations. PSI receives major funding from the Environmental Protection Agency.

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Cover:

Heartbeat line overlays Seattle Skyline from Alki Beach. Graphic: Puget Sound Institute w/ iStockPhoto images

Map of the Salish Sea & Surrounding Basin. Stefan Freelan, WWU, 2009

Dear Salish Sea colleagues,

Welcome to our third annual collection of stories from our online magazine *Salish Sea Currents*.

This publication comes during a critical time for Salish Sea ecosystem recovery. In many ways, scientists and policymakers have reached a turning point.

The changes began decades ago with pioneering researchers who identified some of the early pressure points on Puget Sound. When scientists began finding evidence of toxic contaminants like PCBs in fish, many local residents were surprised to find that Puget Sound's postcard-ready scenery hid an undeniable truth — the ecosystem was in trouble.

Headlines read "Don't Eat the Fish" and alarmed policymakers eventually established the Puget Sound Water Quality Authority which set in motion a process that continues to this day. By 2007 with the creation of the Puget Sound Partnership, state and federal agencies began the hard work of establishing indicators of ecosystem health and recovery targets to measure success. Those steps now inform a detailed blueprint for action, but we still face a difficult journey forward.

This year's collection of articles focuses on that journey. It includes 11 stories behind a new initiative launched by the U.S. Environmental Protection Agency. The agency is now putting into motion a series of aggressive but pragmatic "implementation strategies" to focus and speed up Salish Sea recovery. The State of Washington, tribes, academic organizations and NGOs are all pulling together to inform and develop these strategies which range from plans for improving water quality to removal of shoreline armoring and eelgrass recovery.

We begin with an overview of this process. Veteran journalist Christopher Dunagan traces the origin of the implementation strategies and looks at how they are constructed. We then follow some of the key science informing their development.

Some of the stories in these pages are already grabbing widespread attention. Our coverage of predation of Chinook salmon by harbor seals (read Derrick Nunnally's article on page 12) grapples with a long taboo subject: Could officials seek to revise the Marine Mammal Protection Act — or even conduct lethal or non-lethal removal of Chinook-eating seals and sea lions in some cases? Other stories look at cutting edge research to identify chemicals in stormwater, as well as good news about the steady decline in toxic flame retardants in the Salish Sea. Overshadowing everything is the region's exploding population. An estimated 1.5 million more residents are expected to move to the Puget Sound region within the next 20 years, prompting a race to protect undeveloped lands and to restore critical habitat like floodplains and estuaries.

One of our jobs at the Puget Sound Institute is to assess the science behind these recovery efforts and to support solutions from an ecosystem perspective. We believe that the ultimate debate on the issues should be about the solutions, not the science. That starts with good access to the best information, and we hope that the articles here are a continued step in that direction.

Dr. Joel Baker

Director, Puget Sound Institute

Salish Sea Currents

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INTRODUCTION

When a scientist wades into an eelgrass bed or measures the weight of a Chinook salmon, their connection to the environment is clear. Much of what we know as the 'scientific process' takes place on the ground at a local scale. Measurements and observations are made and extrapolated. Scientists get their feet wet.

But what do you do when you are studying an entire ecosystem? In the case of Puget Sound, you can't wade — or even see — the whole thing. To some degree, such a large system is an abstraction. It is infinitely complex and unknowable, with thousands of species and countless other variables.

Here at the Puget Sound Institute, our scientists conduct plenty of on-the-ground research, but we also look at the big picture. In the fall of 2016 our team began working closely with other scientists funded by the EPA to establish what are known as Implementation Strategies. These strategies will identify and apply solutions to improve Puget Sound's overall Vital Signs, a series of indicators established by the Puget Sound Partnership to measure the region's health.

It is part of a "learn and adjust" approach known as adaptive management. Adaptive management is gaining traction for ecosystem conservation worldwide and has played a central role in state and federal Puget Sound cleanup efforts since 2007.

PSI is helping to synthesize and analyze the state of the science for many of the Vital Sign indicators and will provide recommendations for science-based solutions aimed at improving them. We are also telling the stories behind these solutions.

This booklet begins by describing what the Implementation Strategies are and where they are going. Our lead article is a must-read for anyone who wants to understand how Puget Sound policy is organized and how state and federal resources will be martialed in the future. It outlines what some are calling a blueprint for ecosystem recovery — an approach that connects scientific findings across a range of pressure points on the ecosystem. We then report on some of the most critical of these findings, including the latest papers on salmon, toxics in fish and many other key issues.

In that sense, we see this booklet as more than just a collection of interesting stories about Puget Sound and the Salish Sea. It's also a practical guide for understanding the issues that drive (or in some cases will drive) many of the key decisions affecting our region and the places we call home.

New EPA-funded Implementation Strategies are designed to target Puget Sound recovery in the most direct and coordinated way ever conducted by state and federal agencies. We report on how these strategies will affect Puget Sound's Vital Signs for years to come, and why you should care (a lot).

KEY TAKEAWAYS

- *Implementation Strategies are designed to target and improve the Puget Sound 'Vital Signs,' a carefully selected set of indicators of ecosystem health and human well-being.*
- *They prioritize and focus Puget Sound recovery actions, while adjusting for new and emerging science.*
- *There are nine Implementation Strategies in development and more yet to be launched.*
- *As they are completed they will provide essential content for the Puget Sound Action Agenda and will guide recovery efforts for years.*
- *The development of Implementation Strategies is funded by EPA, and led by several state agencies with cooperation from a multitude of partners.*

Implementation Strategies will target Puget Sound 'Vital Signs'

date: 12/7/2016 author: CHRISTOPHER DUNAGAN
web: eopugetsound.org/magazine/is/implementation-strategies

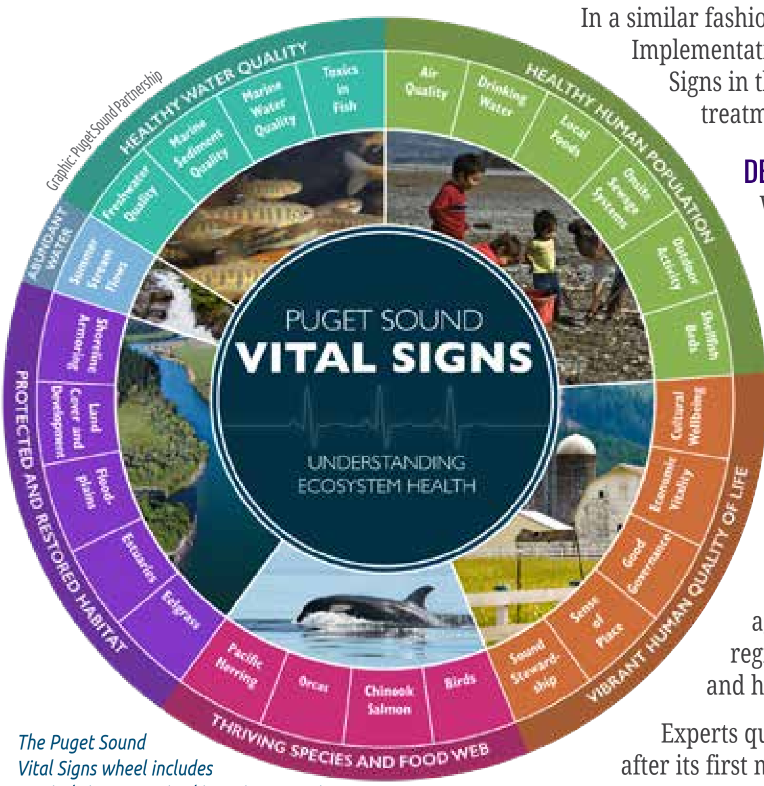
On the surface, Puget Sound seems like the picture of health. Its gorgeous blue waters and abundant wildlife draw tourists from around the world. And while the region's natural beauty is undeniable, it hides a disturbing truth. If Puget Sound were a patient, it would be pretty sick.

That's the general opinion of scientists and researchers who have been monitoring Puget Sound's so-called Vital Signs — 25 indicators of ecosystem health ranging from water quality and shellfish harvests to Chinook salmon runs and human wellbeing.

Creating these Vital Signs became an important step in Puget Sound recovery several years ago when they were established by the state as a way to gauge improvements or declines in the ecosystem. Scientists, like doctors, need some way to measure the health of the patient.

But knowing how sick the patient is doesn't necessarily solve the problem. You actually have to prescribe the correct treatment for a specific ailment and observe carefully to see if it is working or causing side effects. You adjust the treatment as needed.

In a similar fashion, Puget Sound's recovery docs are zeroing in on their patient's problems. Implementation Strategies, a culmination of this process, are designed to target the Vital Signs in the most direct and coordinated way ever conducted for Puget Sound. If the treatment works, Puget Sound's condition will improve.



The Puget Sound Vital Signs wheel includes 25 vital signs organized into six categories.

DEVELOPING MEASURES OF ECOSYSTEM HEALTH

When the Puget Sound Partnership's Leadership Council met for the first time in June of 2007, members believed that their mission would be difficult but not impossible.

The Washington State Legislature had just passed a law creating the Puget Sound Partnership, a new agency charged with coordinating efforts to restore Puget Sound to a healthy condition. The agency would consider the entire watershed, from "snow caps to white caps," and it would be part of one of the most ambitious cleanup efforts in the country, with a goal of significant change by 2020.

The seven-member Leadership Council was placed in charge of the massive endeavor but was given no regulatory authority. Instead, the effort would rely on volunteer cooperation from local, state and federal agencies, tribes and — in the broadest sense — residents of the entire region. Plans would address habitat and species, water quality and quantity, and human health and well-being, as mandated by the Legislature.

Experts quickly pointed out plenty of things that needed fixing. Just over a year after its first meeting, the Leadership Council adopted the first Action Agenda, a comprehensive conservation plan for Puget Sound — its roadmap to recovery. [CONTINUED NEXT PAGE]

IMPLEMENTATION STRATEGIES WILL TARGET PUGET SOUND 'VITAL SIGNS' [CONTINUED]

The Action Agenda outlined hundreds of projects to protect and restore the ecosystem, but it still needed a way to track progress. Identifying indicators of ecosystem health, known as "Vital Signs," could give managers a sense of whether their actions were helping. The Leadership Council's first chairman, Bill Ruckelshaus, recalls the difficulty of taking this next important step, as scientists involved in the selection process struggled to narrow down hundreds of possible indicators.

"Once we had the overall plan," Ruckelshaus said, "we needed the indicators to say how we were going to make progress." It was obvious, he said, that they would need a proper indicator to restore salmon, but "what we found was that it was harder than we thought to get those [other] indicators down."

The agency was dealing with an area twice the size of Connecticut with thousands of different species, more than 10,000 streams and a multitude of opinions about where to focus recovery efforts.

With the help of scientists from around the region, the Leadership Council narrowed the Vital Signs to 25 key indicators of ecosystem health, from orcas and Chinook salmon to clean water and protected forestland.

While they didn't satisfy everyone, "I think the indicators we ended up with are pretty good," Ruckelshaus said recently while considering the overall progress. "If we could get them in a good condition, then Puget Sound would be pretty healthy."

Adaptive management cycle. Diagram: Conservation Measures Partnership

LEARN AND ADAPT

The implementation Strategies are part of an overall "adaptive" approach to management for Puget Sound — the idea that successful efforts should be recognized and propagated elsewhere, while less effective actions should be revised or eliminated. Interdisciplinary teams of scientists and other experts are combining their forces to account for new and emerging issues, as well as the practical considerations that come with moving from planning to implementation.

REINVIGORATING THE ACTION AGENDA

No one doubts that past restoration projects have improved scattered habitats throughout the region, and protecting special places remains a key part of the endeavor. But getting Puget Sound on a clear road to health has proven difficult, and experts agree that more focused efforts are needed.

The Puget Sound ecosystem is "super complex," and the restoration effort involves a multitude of government entities and nongovernment partners, said Kari Stiles, adaptive systems manager for the Partnership. With many of the Vital Signs showing no improvement, the Implementation Strategies could help reveal effective pathways to success.

"We are not starting from a blank slate," Stiles said, "but the Implementation Strategies are intended to define the roadmap of how we get from here to there for each of the Vital Signs."

So far, nine Implementation Strategies are under development, with more yet to be launched. As completed, these will provide essential content for the Puget Sound Action Agenda and will guide recovery efforts for years.

Such decisions are especially important in a time of scarce resources, officials say. A 2015 report by the Puget Sound Partnership describes a shortfall of more than $800 million dollars for what it called "Near Term Actions" during the years 2014–2015. With an average of about $30 million federal dollars per year dedicated to these actions, experts view prioritization as critical. But figuring out where efforts will do the most good is no easy task.

"As more of these issues are expressed as chains of cause and effect, it becomes clear that we must address root causes to get traction," says Nick Georgiadis, a research scientist with the University of Washington Puget Sound Institute, who has been focusing on the details of the Implementation Strategies. "Most of them require social and behavioral changes for any of this to pan out."

It is not just a recovery effort, he added. "It is about learning to live sustainably in a modern society."

> *"It is not just a recovery effort. It is about learning to live sustainably in a modern society."*

HOW IT WORKS

Each Implementation Strategy addresses a problem — such as the loss of shellfish beds or toxic chemicals in fish — by first identifying the various "pressures" that created the problem. Actions that might help reduce the pressures and solve the problem are considered and prioritized, informed by the latest scientific findings and understanding.

In the case of shellfish beds, the goal is to allow for the safe harvesting of shellfish, an economic and cultural tradition going back to the mid-1800s. Washington leads every other state in commercial shellfish production, and each year Puget Sound growers sell more than 16 million pounds of clams, oysters and mussels worth more than $72 million. That production is still significant, despite the closure of thousands of acres of shellfish beds because of pollution.

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IMPLEMENTATION STRATEGIES WILL TARGET PUGET SOUND 'VITAL SIGNS' [CONTINUED]

Cleaning up just a portion of that pollution could result in hundreds of new jobs in the shellfish industry, as well as expanded recreational opportunities on public and private beaches. Ready access to shellfish remains important for many people — including Native Americans, who eat a lot of fish and shellfish and place these traditional foods at the center of their cultural gatherings.

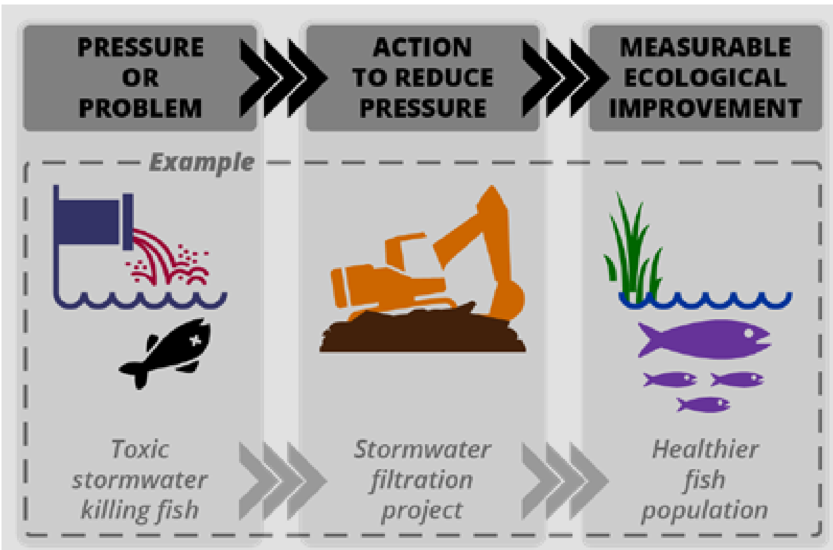


Diagram: Puget Sound Institute

Implementation Strategy process: Pressure –> Action –> Improvement.

The approved indicator for healthy beaches calls for a net increase in shellfish beds open to commercial and recreational harvest. The Implementation Strategy describes a series of high priority "approaches" for reducing pollution, such as that from failing septic systems. Ideas include programs to increase awareness among homeowners while providing funding for needed upgrades. Much of that work is underway.

The shellfish Implementation Strategy also has revealed that more work is needed in areas where shellfish beds are affected by agricultural runoff. One priority approach includes increased support for farmers who raise livestock to improve waste-management systems.

While the shellfish strategy involves cleaning up pollution, it also recognizes that currently open shellfish-growing areas must remain open. Otherwise, reaching the target of a net increase of 10,800 acres of harvestable shellfish beds becomes even more difficult. Careful monitoring and rapid response to increasing pollution are considered essential.

ORGANIZING THE REGIONAL EFFORTS

The new Implementation Strategies are organized under the three existing strategic areas of emphasis, or Strategic Initiatives, in the Action Agenda. Labeled Stormwater, Shellfish and Habitat, each initiative is led by one or more agencies.

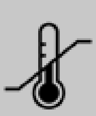
"Until now, we have asked people to submit their ideas for funding to advance one of the three Strategic Initiatives," said Angela Adams, EPA's team leader for Puget Sound. "But when you do that, you are not necessarily matching priorities with actions."

The EPA is a major source of funding for development of the Implementation Strategies, with funds flowing through the congressionally authorized National Estuary Program.

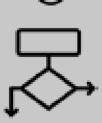
[CONTINUED NEXT PAGE]

WHAT IS CONTAINED IN AN IMPLEMENTATION STRATEGY?

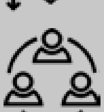
Implementation strategies are typically designed to advance a single Vital Signs indicator, a measure of ecological health or human well-being. A complete strategy should include the following elements:



A DESCRIPTION OF CURRENT CONDITIONS:
What is the status of the Vital Signs indicator, and how much work is left to be done before the target is reached?

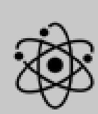


LOGIC MODELS:
What are the problems to be overcome, and what sequence of actions will most likely lead to the desired improvement?

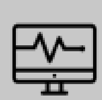


ONGOING PROGRAMS:
What efforts are already established to improve the conditions, and how effective are those programs?

NEW IDEAS:
How will changes in policies, actions and approaches best achieve the goal?



SCIENCE AND RESEARCH:
Is the natural system understood well enough to predict the consequences of human intervention? If not, what further studies are needed?



MONITORING:
Are the ongoing ecosystem changes adequately measured? What will it take to understand the outcome of various actions?

ADAPTIVE MANAGEMENT:
How could prescribed actions be changed in response to what is learned along the way?

COSTS:
Once a strategy is outlined, what kind of financial support is needed for each of the proposed actions needed to achieve the recovery target?

Icons: Noun Project

STATUS OF IMPLEMENTATION STRATEGIES

The following nine Implementation Strategies are under development with others yet to be launched. These strategies are designed to improve specific measures, called indicators, which track the 25 Vital Signs used to measure ecological health. Many of the Vital Signs (the headings below) have multiple indicators, but Implementation Strategies have not yet been proposed for all indicators.* Ultimately, the strategies are designed to advance the major Puget Sound recovery goals of improving water quality, water quantity, habitat, the food web, human health and human quality of life. (Status information provided by the Puget Sound Partnership.) ■

TOPIC	GOAL	INDICATOR	TARGET	PROGRESS	HIGH-LEVEL STRATEGIES	STATUS OF IS
 Chinook salmon	Improve species and food web	Salmon population	Stop the overall decline and increase two to four populations in each region of Puget Sound.	None. Nearly all populations are declining or show no trend.	Under review.	In progress, completion mid-2017.
 Eelgrass	Protect and restore habitat	Area of eelgrass beds	Increase the area of eelgrass beds by 20 percent over a 2000–2008-baseline measurement.	None. The amount of eelgrass has grown to about 8 percent above the baseline, but experts declared the trend "not changing" because of uncertainties in the estimates.	Protect eelgrass through regulations and state leasing policies; retrofit docks to allow light to pass through; locate mooring buoys away from eelgrass beds; expand no-anchor zones in eelgrass areas; and reduce pollution that can increase water turbidity.	Early prototype, not complete.
 Estuaries	Protect and restore habitat	Area of estuarine wetlands restored to tidal flooding	7,380 acres restored to functioning conditions	2,791 acres have been restored as a result of 28 restoration projects.	Incomplete, but ideas include working with the agricultural community to restore unusable farmland; improving nearby drainage for agriculture; and rezoning or purchasing upland areas to allow farmers to relocate from lands affected by rising tides.	Overall strategy and narrative complete. Still to be developed are specific actions, changes in programs and policies, needs for research and monitoring, and cost estimates.
 Floodplains	Protect and restore habitat	Area of floodplains restored to proper function	Restore or have projects underway to restore 15 percent of degraded floodplains, which amounts to 43,557 acres	About 3,851 acres of floodplains have been improved with 56 projects through 2015.	Discourage development and redevelopment in sensitive floodplains; restore floodplains, including levee removal or setback; and involve communities in land-use planning.	Overall strategy and narrative complete. Still to be developed are specific actions, changes in programs and policies, needs for research and monitoring, and cost estimates.
 Freshwater quality	Water quality	Benthic Index of Biotic Integrity, a measure of stream invertebrates	"Excellent" scores retained for all lowland streams, with improvements from "fair" to "good" for 30 streams	Mixed. Only 76 percent of "excellent" streams maintained that ranking, but more streams listed as "fair" improved than declined.	To be developed.	Planning underway, completion late 2017.
 Land development and cover	Protect and restore habitat	Acreage of ecologically important lands converted to development and other uses	Loss of vegetated area on ecologically important lands not to exceed 0.15 percent over any five-year period	None. Losses may be occurring at an increasing rate.	Improve implementation of growth-management regulations to protect sensitive lands; increase acquisition of important habitats; provide incentives for protection by private landowners; and encourage compact growth.	Overall strategy and narrative complete. Still to be developed are specific actions, changes in programs and policies, needs for research and monitoring, and cost estimates.
 Shellfish beds	Healthy human population	Harvestable acreage of shellfish growing areas	Net increase of 10,800 acres by 2020, including 7,000 acres where harvest was prohibited.	New openings of 9,254 acres and closures of 5,559 acres result in a net increase of 3,695 acres by September 2016.	Identify and repair failing septic systems; work with farmers to improve manure management systems where; and protect upgraded areas from further pollution.	Overall strategy and narrative complete. Still to be developed are specific actions, changes in programs and policies, needs for research and monitoring, and cost estimates.
 Shoreline armoring	Protect and restore habitat	Length of man-made bulkheads and seawalls	The total amount of armoring removed should exceed the total amount added from 2011 to 2020	The total amount permitted armoring removals in two years — 2014 and 2015 — exceeded the amount of permitted new construction, but total permitted construction since 2011 still exceeds removal.	To be developed.	Planning underway, completion late 2017.
 Toxics in fish	Water quality	Toxic chemical levels in fish tissue.	Toxic levels should fall below multiple health-effects thresholds and screening levels.	Mixed. For example, levels of polychlorinated biphenyls (PCBs) have not declined in Pacific herring, but levels of polybrominated diphenyl ethers (PBDEs) have met the target except for a few samples in South Puget Sound.	To be developed for one or more indicators.	Planning underway, completion late 2017.

Table image credits: NOAA, NOAA, USFWS, NWIFC, King County, King County, NOAA, NOAA, WDFW

* Although it is unlikely that an independent Implementation Strategy will be developed for every Vital Sign, all Vital Signs will be addressed by at least one Implementation Strategy. In cases where key pressures, recovery approaches, barriers or opportunities are common across multiple Vital Signs, an Implementation Strategy could address more than one Vital Sign. Source: Puget Sound Partnership

Fir Island Farms habitat restoration monitoring. Photo copyright: Bob Friel

As threatened Chinook populations in Puget Sound continue to lose ground, the state is looking to new strategies to reverse the trend. In the Skagit watershed, the scientists — and the fish — are among those leading the way.

KEY TAKEAWAYS

- *Wild Chinook stocks in Puget Sound are not consistently meeting population goals and most of them continue to lose ground.*
- *The Skagit watershed is considered to have the healthiest and most intact salmon habitat in Puget Sound, boasting runs of all five salmon species plus steelhead and coastal cutthroats, and producing more than half of the Sound's wild Chinook.*
- *However, some 98% of the freshwater wetlands and floodplain forest between Skagit Bay and the foothills of the Cascades have been lost to logging, agriculture and development.*
- *Scientists are working to protect existing habitat and restore some previously developed lands in the Skagit delta.*
- *The new EPA-funded Chinook Implementation Strategy is an ambitious plan to coordinate regional Chinook recovery across state and federal agencies, tribes and NGO's.*

Finding a strategy to accelerate Chinook recovery

date: 3/30/2017 author: BOB FRIEL
web: eopugetsound.org/magazine/is/chinook-strategy

Muck boots and waders sinking deep into freshly deposited silt, the scientists and natural resource technicians of the Skagit River System Cooperative (SRSC) slog across what was, for the last 100-plus years, farmland.

Water slowly crests the small channels that snake through the site and begins to seep across fields that still bear faint scars from disc plows. But it's not fresh water released to irrigate barley or seed crops. The shimmer atop these Fir Island Farm fields this mid-February morning is a briny blend of groundwater and the Skagit Bay seawater that's flooding in with the rising tide. The brackish water would be poisonous to crops, but it's ideal for young Chinook salmon.

"Salinity 4.2, temp 4.6, depth 1.5 meters," calls out tech Jason Boome from a small metal boat floating in the middle of No Name Slough.

Rich Henderson, SRCS's Senior Field Operations Manager, checks his GPS and marks the spot for the first sampling trawl. He hands the end of a beach seine with miniscule mesh to Jade Luckhurst, who climbs into the boat as Jason reverses the outboard. They pull the 80-foot-long net out into the channel in a smooth arc and then return it to the muddy shoreline where Rich and tech Ric Haase immediately begin retrieving it.

As the seine closes and sweeps towards shore, everyone crowds around and stares into the brown water. Finally, the mesh surfaces.

"Hmm," says Eric Beamer, SRSC's Research Director. "No fish."

Luckhurst plucks a small, translucent critter out of the net. "Mysid," he says, before dropping it and a few others back into the channel. Shrimp don't live in potato patches, so that's a good sign. But it's not what the monitoring team is looking for.

Henderson starts counting off paces to the next sampling spot while everyone else helps pile the net back into its plastic bin then picks up the rest of the gear and follows him.

In typically mercurial February fashion, the early morning frost covering Skagit's farmlands had shrugged off a thick blanket of fog that spread over the valley and then suddenly vaporized in a blast of brilliant sunshine.

"Longjohns and suntan lotion," laughs Beamer, who'd started the day back in SRSC's fisheries offices in LaConner, discussing the new EPA-funded Chinook

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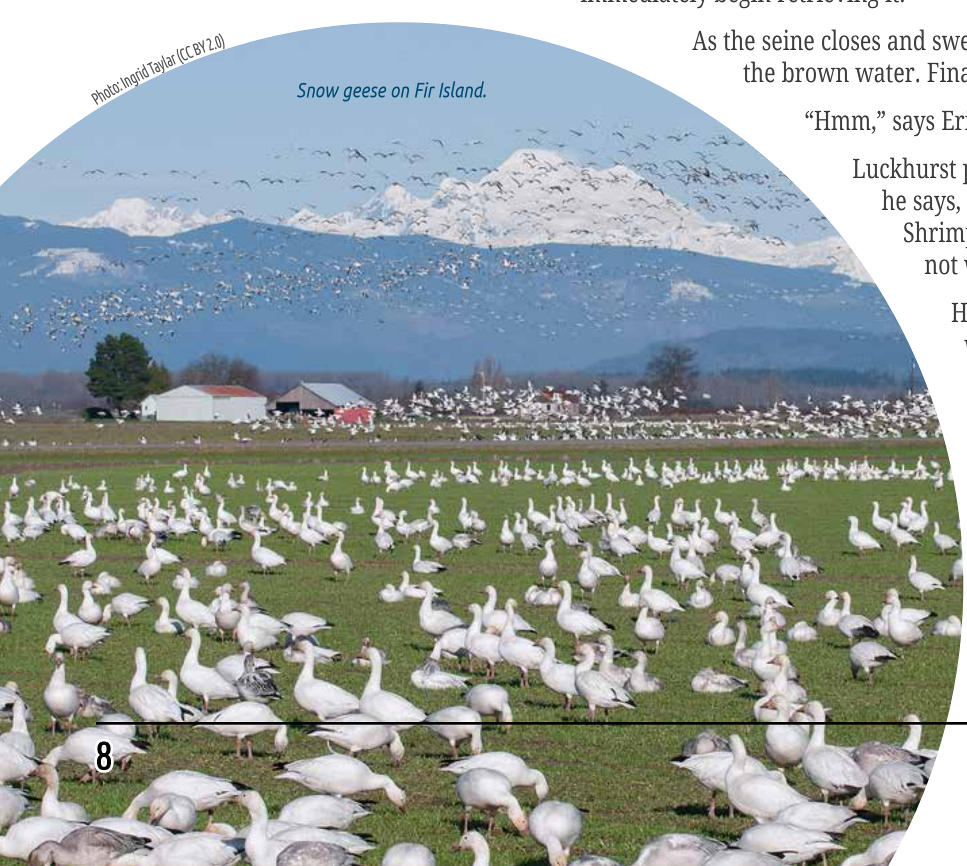
Photo: Ingrid Taylar (CC BY 2.0)

Snow geese on Fir Island.



Implementation Strategy (IS), an ambitious plan to coordinate regional Chinook recovery across state and federal agencies, tribes and NGO's.

"Here in the Skagit watershed," he said, "our local Chinook recovery plan is solid in the science — we know what needs to be done and why. But like all the local plans throughout Puget Sound, it has weaknesses in exactly how you execute the plan. That's where we're hoping the new Implementation Strategy comes into play."

> *"This is history being made."*
>
> *Rich Henderson,*
> *Senior Field Operations Manager*
> *Skagit River System Cooperative*

NEW STRATEGIES

The Chinook IS is also, in part, an SOS.

Call them an "indicator," "keystone" or "umbrella," no other species is as important to the overall recovery of Puget Sound as the Chinook salmon, which connects to veritably every other aspect of the health and happiness of the Sound's ecosystem and its residents. From killer whales to cultural practices, water quality to recreational fishing: as go the Chinook, so goes Puget Sound. And the news on Chinook is not good.

That's the message from the state's 2015 State of the Sound report, a biennial reckoning of ecosystem health produced by the Puget Sound Partnership. That agency's report "showed that despite tremendous efforts by local watershed groups, tribes and partners across Puget Sound, we're not making progress towards our 2020 recovery target for Chinook salmon," says the Partnership's Stacy Vynne, who serves as project manager for the Chinook Implementation Strategy. That target calls for a stop in "the overall decline" of the region's Chinook, and "improvements in wild Chinook abundance in two to four populations in each biogeographic region."

With the Chinook Vital Sign heading in the wrong direction — none of the wild Chinook stocks are consistently meeting population goals and most of them continue to lose ground — the state reached out to local partners in order to find out what could be done at the regional level to help accelerate Chinook recovery.

According to Vynne, that new strategy charts hundreds of steps needed to move recovery forward, along with their estimated impact, feasibility and certainty of success. Its framers hope it provides a launching point for a regional workplan to advance salmon recovery.

Such a workplan would be broad, ranging from habitat restoration to education and outreach, better funding for local partners, streamlining of permits and prioritization of research.

This sounds promising to Eric Beamer who, during his three decades working to recover Skagit River salmon, has run headlong into all these issues.

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Graphic: Puget Sound Institute from Google Maps

Fir Island Farms project area in the Skagit River valley.

"We foresaw the ESA listing of wild Chinook back in 1994 — five years before they were listed — and thought 'Let's get ahead of the curve and do some research.'" Their science informed a set of goals for the Skagit watershed expressed in solid figures such as the number of additional Chinook smolts that need to make it out of the river, and the acres of habitat they need to either protect or restore.

There are no wild Chinook without healthy habitat, and Beamer's no-brainer illustration for the Skagit shows that they can reach 61% of their recovery goal simply by protecting the natural habitat that already exists — which is also the cheapest and easiest conservation method. The next priority is habitat restoration, which is neither cheap nor easy.

HISTORIC FARMLAND

The drive out to the Fir Island Farm Estuary Restoration Project clearly lays out the challenges for the Skagit. Although this watershed is considered the healthiest and most intact in Puget Sound (boasting runs of all five salmon species plus steelhead and coastal cutthroats, and producing more than half of the Sound's wild Chinook) some 98% of the freshwater wetlands and floodplain forest between Skagit Bay and the foothills of the Cascades have been lost to logging, agriculture and development.

The view from the top of the bridge crossing the North Fork of the Skagit where the river historically spread out into its tidal delta is now farms as far as you can see. The vibrant agricultural community here has been working this rich land for more than 100 years and they produce a remarkable bounty of seed crops, cattle feed, berries, dairy cattle and, of course, Skagit's famous flowers, with some 20 million bulbs and 75 million cut flowers harvested in the county each year.

However, Skagit's 65,000 acres of delta farmland is below the high tide mark, and to make it usable takes 147 miles of levees and dikes that constrict the river and hold back the bay. The dikes also prevent salmon from utilizing what was, since the last ice age, much of their most critical rearing habitat, the shallow, protected areas with a tidal mixing of fresh and salt water where they can spend time growing, gaining strength, and transforming from freshwater fry to estuarine smolts that can then migrate out to sea.

The greatest challenge in the Skagit watershed may be restoring salmon habitat without destroying the farmers' way of life. "It comes down to a land-use issue," says Beamer. "And that's too big, too complex, and too expensive for the watershed to deal with. It's where we need regional help."

Despite some impressive habitat gains achieved since 2004 through dike breaches and setbacks, fill removal and other estuarine projects, Beamer estimates that at the current rate of restoration it will take at least another 60 years to reach their goals for the Skagit delta.

Taking that long to reach recovery targets seems, to Beamer, "like an expensive societal failure." He's hopeful, though, that the new IS will offer some bold ideas to expedite the pace of restoration. "That's where an effective Chinook Implementation Strategy could really help change the future."

WILL THEY SHOW UP?

Down at the Fir Island restoration site, the SRSC monitoring team is still hoping to find signs that this site is becoming a functioning ecosystem after the old dike was breached in August 2016. This spring is the first chance Chinook fry would have to find their way here.

The second and third pulls also come up empty except for more mysid shrimp. "A lot of the Chinook fry haven't even emerged yet," says Beamer, looking down at the fish-free net. "Peak abundance is usually April."

Rich Henderson nods as he walks toward the next sampling spot, "Yeah, it depends on river flows and temperature."

Luckhurst jokes that maybe the crew should have brought a barbecue to cook all the shrimp they're catching.

Fir Island is a good example of the difficulty facing those working for Puget Sound salmon recovery. Even though the project took place on state land, it still took years to get moving. Another nearby project on the Skagit took six years to complete even though it was on private land purchased specifically for fish habitat restoration.

Fir Island was a complex, difficult and expensive undertaking that entailed the construction of 5,800 feet of new diking, a large flood-control reservoir, pumping station, tidegates and pilot channels before the old dike could finally be breached and tidal flow restored to 131 acres of estuary habitat.

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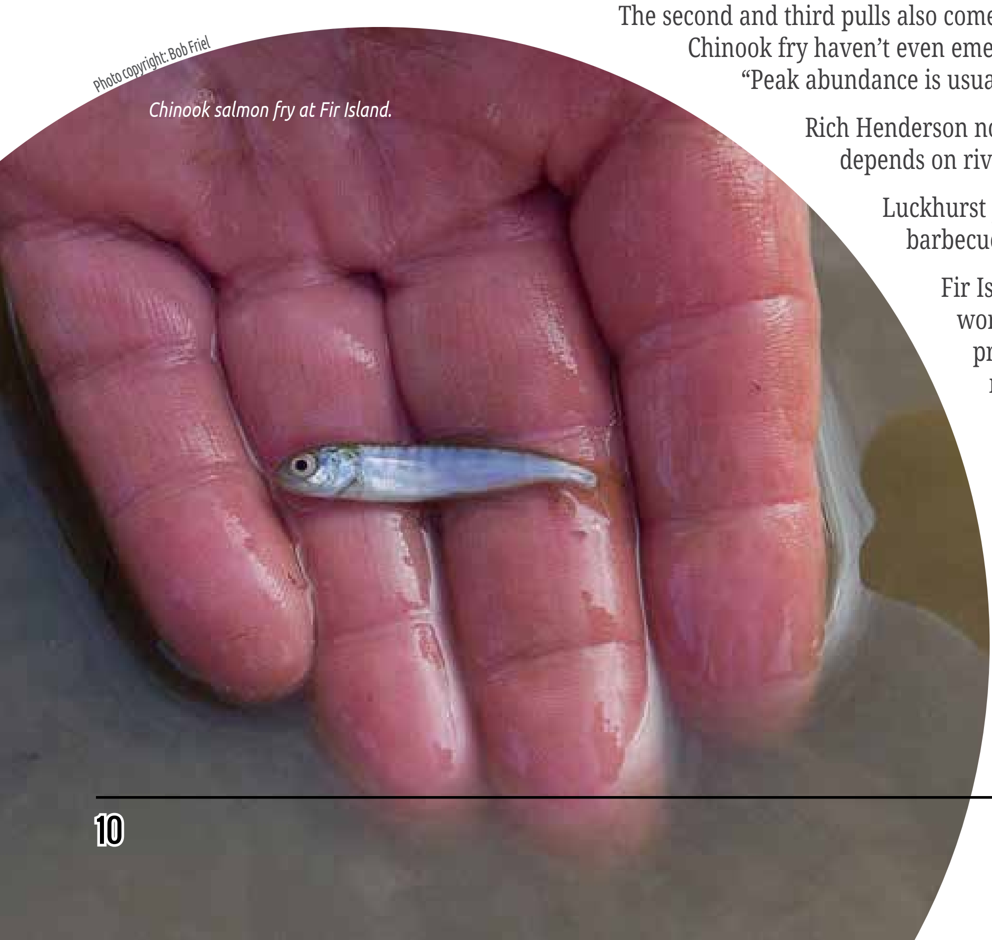

Chinook salmon fry at Fir Island.

For now at least, Fir Island is also a less than ideal restoration since the new habitat is not directly connected to the river. Any fish that noses into No Name Slough or Fir Island's other channels will first have had to brave a section of Skagit Bay's nearshore environment.

There's unspoken pressure on the team to get some results out of these cool, russet waters, and when the fourth pull comes up nothing but net, Henderson puts a fine science spin on it. "Hey, it's good to start very early in the season and catch zero," he says. "Zero is a result, that's valid data, and this way we can find out when they first show up."

Left unspoken is "If they show up." But that doubt would go against everything they've learned here on the Skagit. Beamer's research has shown that there are more than enough Chinook fry for the habitat currently available to the fish.

"We know that these fish are density dependent in their early life stages," he says. "If the existing habitat already has its maximum amount of fish, the excess fry are forced to move on to the next stage before they're ready and maybe at the wrong time for natural events like prey abundance and water flow, all which means there's a much greater chance they won't survive."

By this reasoning, increasing the number of Chinook fry that make it into the nearshore waters (and then out to the ocean and ultimately back to the river to spawn) is a "simple" matter of increasing the quality and quantity of their rearing habitat. The Fir Island project alone is projected to enable at least an additional 65,000 fry to survive, a nice chunk of the total Skagit watershed goal of 1.35 million more wild Chinook fry through habitat restoration.

If the theory is correct, it means there are already many thousands of tiny "excess" fry pouring out of the Skagit River and desperately trying to find suitable estuarine habitat to use as refuge where they can feed and grow and go through their physiological changes. If it's correct. The only way to tell is by monitoring.

"Hey!" shouts Rich Henderson as the net is pulled in for the fifth time. There's a little glimmer visible inside the seine's soft folds as it surfaces from the coffee-colored water. "You just caught an endangered species!"

The SRSC crew does this almost every day, hauling nets to sample sites on the river, along the shore and out in the deep waters of the Salish Sea. But it's clear that this is something special.

"Sweet!" says Luckhurst as he gently removes the little fish and slides it onto a measuring device. "Pretty good-sized Chinook, actually. Forty-six millimeters."

"This is history being made," says Henderson. "This is the first time that this channel has been connected to the rest of the world, and here we find fish already using it. That is really cool." ■

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On August, 1, 2016, crews used large excavators to remove a 3,110 foot long marine dike. For the first time in 100 years, ocean water began to flow across 131 acres at Fir Island Farms estuary.

Photo: WDFW

As wildlife managers work to recover Puget Sound's diminished Chinook population, a proposed white paper is expected to review the impacts of some of the salmon's chief predators. The study would include a section on potential management of seals and sea lions, prompting open discussion of a long taboo subject: Could officials seek to revise the Marine Mammal Protection Act — or even conduct lethal or non-lethal removal of seals and sea lions in some cases? Such actions are hypothetical, but we look at some of the ongoing discussions around the issue as prompted by a new resolution from the Puget Sound Leadership Council.

Study would explore changes to protections for seals and sea lions

date: 1/17/2018 author: DERRICK NUNNALLY topic editor: JOE GAYDOS
web: eopugetsound.org/magazine/is/managing-seals

KEY TAKEAWAYS

- *Puget Sound's population of seals and sea lions has increased greatly since the establishment of the Marine Mammal Protection Act in 1972.*
- *Harbor seals are the most abundant pinniped in the region and are eating large amounts of juvenile Chinook salmon, diminishing the amount of food available to the region's endangered orcas.*
- *State officials at the urging of local tribes are proposing a study of potential management actions to protect Chinook salmon from increased predation by seals and sea lions.*
- *Despite the large amounts of Chinook being consumed by pinnipeds, however, scientists say there are still many questions about the specific impacts.*
- *Changes in management of seals and sea lions must also take into consideration the Marine Mammal Protection Act which forbids actions such as population control or relocation in most cases.*

Tribal leaders as well as the Puget Sound Leadership Council, the governing body of the state's Puget Sound Partnership, are calling for a study of "targeted management" of seals and sea lions that would include a look at potential revisions to the Marine Mammal Protection Act (MMPA). The resolution is spurred by recent scientific findings that say harbor seals are flourishing to the point that they and, to a lesser extent, sea lions may be harming the size of populations of young Chinook in Puget Sound.

Predation of West Coast Chinook has risen six-fold since 1975, according to a recent paper in the journal Scientific Reports. That could be undercutting salmon recovery efforts, the paper said, also harming endangered southern resident orcas that rely almost exclusively on Chinook for food.

Some see it as a classic food web trade-off pitting predator against predator, something that is increasingly urgent as the local orca population declines to 76 animals, its lowest level in three decades.

Much of the discussion centers around the growth in Puget Sound's harbor seal population. Once hunted for bounties and sport, their numbers have greatly increased since the establishment of the MMPA in 1972. There are now more than 50,000 harbor seals living in the Salish Sea, making this among the most densely populated areas for the pinnipeds in the world. Harbor seals far outnumber the region's sea lions and eat the most salmon of the two groups.

> **"Our Chinook populations continue to decline... So there is an urgency."**
>
> *David Herrera*
> *Puget Sound Salmon Recovery Council*

The Puget Sound Partnership's Leadership Council has pledged to take a hard look at the subject. In a Nov. 1, 2017 meeting, the Leadership Council approved a formal resolution to boost Chinook recovery work and a list of regional priorities approved by tribal officials and the Salmon Recovery Council.

The list includes a wide variety of recommended "bold actions" — from protection of salmon habitat to improvements to water quality. It also takes on the issue of predation, calling for a white paper analyzing the impacts of pinnipeds and looking at potential law changes "to allow targeted management of pinnipeds on salmon" according to a document approved last September (PDF).

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What "targeted management" means has yet to be defined, but some say it could include a wide variety of options — among them lethal and non-lethal removal of seals and sea lions in certain cases. Such options are currently not allowed under the MMPA and would require congressional action to become legal.

"I imagine it could include lethal removal," said David Herrera, chair of the tribal management conference and a member of the Puget Sound Salmon Recovery Council. "But maybe there's other actions we can take with it where you don't have to go there." Non-lethal options might be numerous, he speculated, such as providing alternate food resources or making vulnerable Chinook areas uncomfortable for predators.


Photo: Judd Hall (CC BY-NC-ND 2.0)

Sea lions take over a float along the Columbia River in Astoria, OR.

A FRAUGHT SUBJECT

In theory, such actions would help revive the Chinook population, providing more food for endangered southern resident orcas, while not harming the viability of the populations of harbor seals and sea lions that have rebounded under the MMPA. But the idea of lethal government measures against any marine mammals remains a fraught subject.

"We're not necessarily coming out here and saying we need to start getting rid of pinnipeds," Herrera said. "What we're saying is that we think it's an issue."

State wildlife officials say they are aware of the studies showing the potential impacts of pinnipeds on salmon, but are quick to point out that they don't know what form of predator management might be implemented, if any.

"We're still in the exploration stage. We're not ready for management action is my sense at the moment," said Scott Pearson, a research scientist with the Washington Department of Fish and Wildlife.

That wait and see approach was echoed by U.S. Rep. Derek Kilmer, co-founder of the Puget Sound Recovery Caucus. "While it's clear more needs to be done to ensure more wild salmon can make it home to spawn every year, I don't think our community has reached consensus on the best pathway forward," Kilmer wrote in a statement to Salish Sea Currents. "It's important to me that we find a solution that is based on the best-available science and that adequately protects the wildlife that is so important to our region's economy and identity."

Puget Sound Partnership Executive Director Sheida Sahandy also said it was too early to make any judgments. "It is not yet clear what actions would be most effective and appropriate to reduce predation on threatened and endangered species like Chinook salmon," she said. "We are gathering additional scientific information on the problem and possible solutions and will work with our partners to decide which options to pursue, based on scientific, economic and social considerations."

Despite the large amounts of Chinook being consumed by seals, scientists say there are still many questions about the specific impacts. Pearson said studies have not concluded definitively that predation is the kind of dominant factor in the survival rates of young Chinook to justify population controls. He uses steelhead as an example. Those populations have shown some problems with parasites and genetic issues that could be influencing the amount that get consumed by marine mammals.

"If you have a predation issue, is it a result of the fact that the fish are not in good shape and therefore are easy to catch?" he said. "Or is it just the fact that there are too many predators out there?"

The question is further complicated by the fact that there are just as many if not more pinniped predators in Alaska where the salmon populations are more robust and scientists say pinniped predation is not an issue.

Harbor seals also eat upwards of 60 species of fish, not just salmon. Would changes in harbor seal populations impact other aspects of regional biodiversity?

A CALL FOR MORE STUDIES

If targeted management did occur, the scope of potential ways wildlife managers might try to cut down predation rates could be broad, officials said. Hypothetically, problem predators could be given alternate food resources. The way salmon are released from hatcheries could be changed. Or if there's a way to make a vulnerable Chinook area uncomfortable for mammals without simply shifting the predation to a different spot, that too might happen. Understanding "the potential management options" would be explored in the proposed study called for by the Leadership Council in its November resolution.

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While revision of the MMPA may only be speculation at this point in Puget Sound, it's been done elsewhere. Sea lions on the Columbia River can be trapped and euthanized by state officials because of the high predation rates there. However, the Sound is a different ecosystem to manage than a river where all the fish have to pass through a single fish ladder.

"In Puget Sound, you have many different rivers coming onto that system, and all of those rivers have different ecosystem effects," Pearson said.

POLITICAL DEVELOPMENTS

While discussion in Puget Sound has been evolving, a simultaneous political development has been gaining momentum elsewhere.

A bill in Congress, filed by U.S. Rep. Jaime Herrera Beutler last July, would expand removal of California sea lions to give tribes the ability to take the animals on more of the Columbia and its tributaries. The bill cites findings that up to 3,000 California sea lions have been foraging along the lower 145 miles of the Columbia, and taking at least 20 percent of the spring Chinook run.

If passed as written, the legislation would enable the killing of up to 100 sea lions there.

David Herrera said he and other tribal officials learned of the Columbia River sea lion bill while they were assessing how predation factored into the priorities for salmon restoration. He said it offered some precedent for building a case for population management in the Sound as well.

"We looked at that and said, if we need to, somebody's taken the lead on that," Herrera said.

But Puget Sound presents a different quandary than targeting specific predator sea lions across 145 miles of river.

Eric Ward, an ecologist with NOAA's Northwest Fisheries Science Center, said the complexities of trying to weigh pinniped protection against the needs of Chinook salmon — and the humans and orcas that harvest them — are magnified by the expanse of the Sound.

"You don't have a pinch point where you can remove some pinnipeds and have an impact on the predation issue," Ward said.

POTENTIAL CONTROVERSY

The idea of killing animals of one species to promote the viability of others has also provoked controversy. The Humane Society has attempted to use lawsuits to block efforts to cull the predatory sea lion population on the Columbia River, saying that natural predator-prey behavior is being blamed for human-caused salmon mortality.

Sherrie Duncan, a Tacoma marine biologist, said the idea of removing some of the Puget Sound's flourishing population of harbor seals could have unintended consequences for the rest of the ecosystem, and compared the situation to the removal and reintroduction of wolves in Yellowstone National Park.

"The top predators are part of a functioning ecosystem," Duncan said. She noted that transient orcas have returned to South Sound waters more frequently in recent years, as the seal population has grown.

"It seems to me it (lethal pinniped population management) would further imbalance the ecosystem, because it's just another Band-Aid fix," Duncan said.

State officials said there is no set timetable for when or if a policy change might be formally contemplated. The process is complex; scientific studies are required before a law change is drafted to allow population-control efforts in theory. Government work to decide how to take action would only follow that.

Tribal representatives say "This list of actions we put together, we feel like there's an urgency to all of these," said Herrera, chair of the tribal management conference. "Our Chinook populations continue to decline. Despite our best efforts, they're not recovering. So there is an urgency." ■

Yellowstone wolves chasing a bull elk (2007).

Photo: Doug Smith (public domain)

Contaminated stormwater from SR-520 flows directly into Seattle waterways. Photo: Kathy Peter

Researchers are trying to determine which chemicals in stormwater are contributing to the deaths of large numbers of coho salmon in Puget Sound. It has prompted a larger question: What exactly is in stormwater anyway?

What is killing the coho?

date: 12/5/2017 author: ERIC WAGNER topic editor: JOEL BAKER
web: eopugetsound.org/magazine/is/stormwater-mystery

KEY TAKEAWAYS

- *Scientists are trying to understand which chemicals in stormwater are responsible for high amounts of prespawn mortality in the region's coho.*
- *There are potentially thousands of toxic chemicals in stormwater, but scientists are starting to focus on chemicals from automobiles, such as compounds found in car tires.*
- *Researchers at the Washington Stormwater Center at Washington State University are studying the impacts of chemicals from automobiles on coho and other salmon species.*
- *Other researchers at the University of Washington Center for Urban Waters are identifying the chemicals themselves.*
- *New analysis using sensitive instruments can identify the presence of chemical compounds to a degree of accuracy not previously possible.*

Jenifer McIntyre holds out a large Ziploc bag full of a mysterious black substance. "What do you think is inside?" she asks.

I take the bag and heft it, squeeze it. The material is fine and feels dry, lightweight, oddly synthetic. I hazard a guess. "Is it some kind of dust or dirt or something?"

McIntyre shakes her head. "Nope!"

I squeeze the bag again. "I don't know, compost? Coffee grounds, maybe?"

"Nope." McIntyre grins. "It's ground-up car tires." She takes the bag back and gives it an affectionate pat. "I've been waiting awhile to get this, so it's a good day."

McIntyre, an aquatic ecotoxicologist with Washington State University (WSU), is part of a broad coalition of scientists at groups including WSU, NOAA Fisheries, the U.S. Fish and Wildlife Service and the University of Washington working together to solve a longstanding mystery. The ground-up tires are for use in an upcoming study to see what chemicals might leach out of them during a rainstorm, as rain turns into urban stormwater. The results might help clarify what is killing large numbers of coho salmon in the waters of Puget Sound, a condition known as "pre-spawn mortality."

Stormwater may be Puget Sound's most well-known pollutant, and at the same time its least known. While the state has called stormwater Puget Sound's largest source of toxic contaminants, scientists are still having a tough time answering two basic questions about it: What is stormwater, exactly, and what does it do?

LET IT RAIN

Every year, the Puget Sound region receives up to forty inches of precipitation, most of it as rain. In the past, which is to say before the I-5 corridor became the bustling urban matrix it is today, much of that rain seeped into the soil or collected on leaves and grass and then evaporated back into the atmosphere; less than one percent was thereafter left to trickle into the Sound as surface runoff. But as humans altered the drainage basin of Puget Sound, so, too, did we alter the fate of the rains. Now, with more than 350,000 acres of impervious surfaces—streets, roads, highways, parking lots, building roofs, and so on—between twenty and thirty percent of precipitation turns into surface runoff. This translates into more than 370 billion gallons of stormwater per year pouring into Puget Sound.

Photo courtesy: Washington State University

Dr. Jenifer McIntyre, an Aquatic Ecotoxicologist, uncovers stormwater impacts in streams.

As modern stormwater sluices downhill, it gathers whatever is in its path. By the time it becomes soundwater, it is a formidable toxic stew. According to a 2015 report from the Washington Department of Ecology, at least 33 pollutants have a 50% or greater detection frequency in stormwater, meaning that they are found in at least half of samples. The list includes almost

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Stormwater picks up contaminants from vehicles.

Photo: Daniel Parks (CC BY-NC 2.0)

WHAT IS KILLING THE COHO? [CONTINUED]

everything from fecal coliform to polycyclic aromatic hydrocarbons, or PAHs, which are known carcinogens. On top of those pollutants, 16 others are found in at least 20% of samples, and hundreds of other chemicals also are present.

All of these pollutants and toxins can have profoundly negative effects on Puget Sound's biota, such as aquatic insects and, especially, salmon runs, several of which are federally listed as threatened. Nathaniel Scholz, a biologist with NOAA, and colleagues from several government agencies showed in 2011 that between 60 to 100 percent of coho salmon returning to some lowland urban streams in Puget Sound die before spawning. More recent work found that juvenile and adult coho salmon die within hours of exposure to untreated runoff from the 520 bridge between Seattle and the eastside of Lake Washington. And in a new paper in Ecological Applications, biologists from NOAA and the Washington Department of Fish and Wildlife found that across 40 percent of coho's Puget Sound range, returning spawners are being especially hard-hit in urban areas, primarily due to stormwater.

A COMPLEX MIXTURE

So which of the potentially thousands of chemical compounds found in stormwater might be killing the coho? That question is behind McIntyre's research today at the Washington Stormwater Center in Puyallup, and it is why she has waited so eagerly for the bag of tire shavings.

Among the biggest suspects, not surprisingly, are the millions of cars that pass nearby, shedding potentially toxic substances such as synthetic rubber from tires, motor oil, windshield washer fluid, transmission fluid, brake dust and automobile exhaust. Those and other substances are being tested at the lab.

If in fact the problem is cars, McIntyre wonders: "Could we find a vehicle pollutant source that is responsible for most of the toxicity?" And if so, could that help regulators deal with the issue?

For the study of the ground up tires, McIntyre will run water through the grounds — a process not unlike making a cup of coffee — and see whether the contaminants that leach out match the toxicity of urban stormwater runoff. Early results have been intriguing. Coho salmon have died when exposed to the leached chemicals, but other chemicals may have similar results and it's too early to say what role automobile tires might have in pre-spawn mortality of coho in the wild.

"Stormwater is a complex mixture," McIntyre says. It can vary by location (urban, rural), habitat type (forest, farmland), and season (winter, summer). As to its exact chemical makeup, she demurs. "That's probably a better question for someone like Ed Kolodziej," she says.

NEW ANALYSIS

While McIntyre is doing the biology — by researching how salmon react to certain chemicals — Ed Kolodziej is looking deep into the chemistry of stormwater. When I find Kolodziej, he is at work in a backroom in the Department of Civil and Environmental Engineering, which serves as his makeshift office on the UW Seattle campus. He is just here for the day; he spends most of his time at the UW Tacoma Center for Urban Waters where he works with a series of specialized instruments that can measure the presence of molecules in a water sample in the parts per billion [Editor's note: The Center for Urban Waters is the parent group of the Puget Sound Institute, which publishes Salish Sea Currents].

Kolodziej is using a process known as high resolution mass spectrometry to understand stormwater's convoluted chemical makeup. If a particular chemical is in the water, the instruments at the lab are likely to find it. The proverbial needle in a haystack? No problem. But what if you don't know exactly what you are looking for? That's more difficult, and it's where Kolodziej's work may differ from that of other researchers.

Conventional diagnostic methods are best at finding known chemicals. Typically, when facing a sample, a researcher will come up with a list of toxicants they think they're likely to find, called targets, and then test for those substances.

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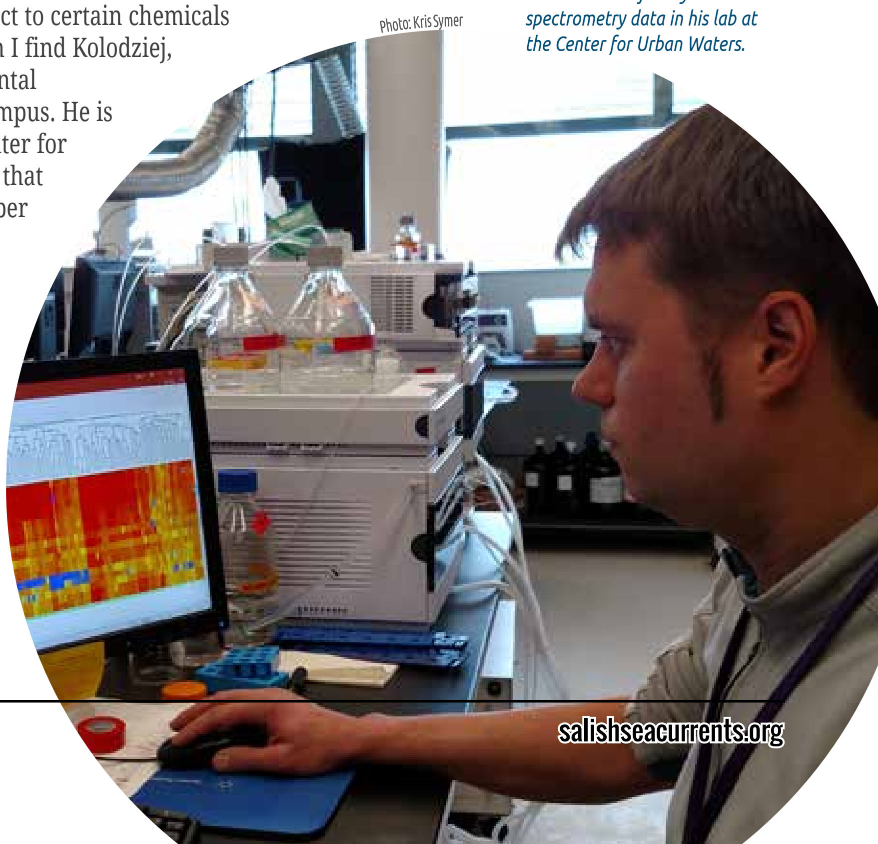
Photo: Kris Symer



Dr. Ed Kolodziej analyzes mass spectrometry data in his lab at the Center for Urban Waters.

Photo: Ed Kolodziej

Dr. Kathy Peter loads samples into the mass spectrometry instrument at the Center for Urban Waters labs.

What Kolodziej is helping to develop is a method for testing urban stormwater that uses liquid chromatography coupled to high-resolution quadrupole time-of-flight mass spectrometry. (This goes by the equally formidable acronym LC-QTOF-MS.) He and his co-authors described the process last August in a paper in Environmental Sciences: Processes & Impacts. "Basically, I think of it as someone going fishing for a specific kind of fish, versus a trawler that pulls everything in and then sorts through the catch," says Kathy Peter, Kolodziej's postdoctoral scientist and one of the study's co-author. "When you run a stormwater sample, you might see 1,000 or 2,000 features, and each feature is a chemical. Some of them will be natural, but some will be synthetic compounds that you need to test."

This sort of non-target analysis is good at uncovering what Kolodziej calls the unknown-unknowns of stormwater. "What are the emerging contaminants?" he says. "We're good at building analytical methods for things we know about, but there's tons of stuff we don't know about." To help assemble a wide array of urban runoff samples, he has enlisted citizen scientists. If someone sees a salmon die in a stream, they can take water and tissue samples. Kolodziej can then analyze the water that salmon was swimming in, and try to figure out what killed it.

Even as Kolodziej and his colleagues have identified possible toxins, their precise origin remains as murky as the stormwater itself, at least in the published literature. "But," he says, "cars and trucks seem to be the biggest culprits." Motor vehicles are always shedding little bits of themselves as they whiz down roads and highways: flakes of brake, tire dust, droplets of motor oil, antifreeze and gasoline. All of it adds up. The question is how might these different substances interact with one another. Can they become greater than the sum of their parts?

POSSIBLE SOLUTIONS

As for what to do about stormwater, McIntyre and her colleagues at the Washington Stormwater Center are testing a variety of possible solutions. With coho and the lethal stormwater cocktail streaming off the 520 bridge, McIntyre was able to reduce the runoff's toxicity simply by running it through a vertical soil treatment column: essentially, a barrel full of sand, shredded bark, and compost. After that, the coho were basically fine. (An interesting quirk is that chum salmon—or, as McIntyre calls them, "zombie fish" — were essentially untroubled by what killed the coho. "They just swam right through it like nothing," she says.) And in a greenhouse down the road, Ben Leonard, one of her graduate students, is testing different lengths of swale for the extra removal of metals, running gallons of stormwater over a mix of Dutch clover and red fescue. His goal is to learn what a minimum effective length of swale might be, so Washington Department of Transportation engineers know how much to plant next to roads.

"It's an issue of horizontal versus vertical, and how long stormwater stays in contact with the media," Leonard says. "Horizontal is better for roadways, but vertical is good for, say, a road next to a steel refinery next to a river where salmon spawn."

All of these fixes may one day solve what at present seems like an intractable problem. Once everyone has a better idea of the contaminants in stormwater, people can start to recommend changes in a policy sphere. Source control is always better than treatment after the fact, as Kathy Peter points out. "You don't want to be managing a problem like this in perpetuity," she says. ■

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Photo: Kathy Peter

A dying female coho salmon in the Lower Duwamish spotted by Puget Soundkeeper volunteers in October 2017.

English Sole (Parophrys vetulus) in Puget Sound. Photo: biodiversityguy

A new study shows a surprising decline in some toxic chemicals in Puget Sound fish, while levels of PCBs increased in some cases. Scientists say the study shows that banning toxic chemicals can work, but old contaminants remain a challenge as they continue to wash into Puget Sound.

KEY TAKEAWAYS

- *Polychlorinated biphenyls (PCBs), a class of oily chemicals once used in a wide variety of applications, stubbornly persist in fish tissues 38 years after their use was widely banned in the United States.*
- *Other chemicals, however, including toxic flame retardants, seem to be disappearing from Puget Sound fish at a rate that has surprised even researchers.*
- *PCBs may still be flowing into Puget Sound through sources such as stormwater or may come from dredging of existing contaminants in the sediment.*
- *Researchers are encouraged by the decline in flame retardants, saying that it shows that source control of chemicals can work.*
- *Some of the most dramatic flame retardant declines were found in Pacific herring, with annual declines of up to 8 percent.*

PCBs in fish remain steady while other toxics decline

date: 8/25/2017 author: CHRISTOPHER DUNAGAN topic editor: JOEL BAKER
web: eopugetsound.org/magazine/is/fish-toxics

For 28 years, a team of researchers has been casting nets into Puget Sound to find out what the fish can tell them about toxic pollution in both urban bays and remote inlets.

Now, following extensive analysis, these researchers have released some surprising results — with discouraging findings for one group of pollutants and hopeful signs for others.

Polychlorinated biphenyls (PCBs), a class of oily chemicals once used in a wide variety of applications, stubbornly persist in fish tissues 38 years after their use was widely banned in the United States. Concerns remain high for the health of people who eat fish laden with PCBs, and experts warn that the entire Puget Sound food web remains at risk.

Other chemicals, however, including toxic flame retardants, seem to be disappearing from Puget Sound fish at a rate that has surprised even the researchers. The dramatic decline in flame retardants containing polybrominated diphenyl ethers, or PBDEs, is raising the hope that these chemicals will no longer be a concern in the not-too-distant future.

PCBs and PBDEs are both large groups of compounds, and some chemicals in the two groups are known to be more toxic than others. Based on animal studies, even low levels of these compounds may cause cancer; trigger reproductive problems; reduce the body's immune response to disease; and impair kidney, nerve and metabolic function.

In Puget Sound, and throughout the world, levels of PCBs declined rapidly after they were banned in the 1970s. The hope, of course, was that PCBs would eventually fade out of existence. But that has not happened.

"Across the board, we've seen either no decline or even increases in our English sole, which is really kind of shocking considering all the remediation that has been going on," said Jim West, a toxicologist with the Washington Department of Fish and Wildlife.

English sole are flatfish that live on the bottom of Puget Sound and pick up contaminants from sediments through the food they eat. The new study reports that PCB levels in these fish have not declined in any location sampled in Puget Sound over an 18-year period. In fact, levels appear to be increasing in the urban bays of Seattle and Tacoma, as well as moderately developed areas near Everett and in Bainbridge Island's Eagle Harbor, according to the new report by West and co-authors Sandie O'Neill of WDFW and Gina Ylitalo of NOAA's Northwest Fisheries Science Center.

STORMWATER AND DREDGING

The failure of PCBs to decline in bottom fish is not simple to explain, West said. One factor is that these chemicals were so widely used in electrical

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Photo: Sparky (CC BY-NC 2.0)

Rain on freeway surfaces washes automotive contaminants into stormwater, which often flows untreated into Puget Sound.

Lower Duwamish Waterway dredging on superfund site.

Photo: Gary Dean Austin (CC BY-SA 2.0)

equipment, building materials and even automobiles that they are still getting into stormwater and eventually making their way into Puget Sound.

"Even though the production and use of PCBs has been banned, I would say there are still sources (of PCBs) coming into Puget Sound," West said.

Another factor that could expose bottom fish to PCBs is the dredging of contaminated sediments, either to improve navigation conditions or to clean up the sediments themselves. During a cleanup operation in Seattle's Duwamish Waterway in 2006, a contractor accidentally allowed a plume of pollution to disperse. The following year, higher levels of PCBs were measured in bottom fish.

"We saw a spike (in PCB levels) in '07," West said, "and our conclusion then was that the fish had picked it up from that event. But the levels have not gone down since then."

PCBS IN HERRING

West and his colleagues tell a somewhat similar story regarding PCBs in Pacific herring. These are small fish considered central to the Puget Sound food web. Herring pick up PCBs by eating plankton and then pass on the toxic compounds to a variety of fish, including salmon, as well as birds and marine mammals.

Similarly, top predators such as killer whales accumulate PCBs at the highest levels of all. Killer whale experts have expressed concerns about how these toxic compounds may be impairing the reproduction and immunity of the Southern Resident orcas that frequent Puget Sound.

PCBs in herring were sampled in four locations in Puget Sound. Levels declined in the relatively undeveloped areas near Semiahmoo and Cherry Point in northern Puget Sound, but they were relatively unchanged in a Squaxin Island stock that swims around South Puget Sound and a Port Orchard stock associated with Central Puget Sound.

DECLINE IN FLAME RETARDANTS

Not all of the news was bad. While concerns about PCBs remain unabated in the latest findings, toxic flame retardants appear to be on the decline for Pacific herring in most places around Puget Sound. West said the researchers went through an extensive analysis to make sure that the decline was not related to other factors — such as size, since herring are getting smaller over time.

"I now feel like this is a solid trend, and that's really exciting," West said. "I believe it is related to our efforts in source control."

Health concerns over flame retardants were running high throughout the U.S. in 2007, when Washington state banned the most toxic forms of PBDEs. Such flame retardants had been widely used to reduce the risk of fire in furniture, automobiles and computers.

After the ban, concentrations in herring began to decline, yet the chemicals continued to accumulate in other animals, including marine mammals, until recently.

Public domain photo

Electrical and electronic components made from plastics. Most polymers are flammable and contain flame retardant additives.

"The PBDE decline was way more dramatic for herring," West said. "The herring are actually surprising us."

In every location sampled, herring have shown less and less flame retardants over time, with annual declines up to 8 percent.

Why are toxic flame retardants disappearing from the environment while PCBs stubbornly remain in circulation? The answer is not clear, but it may come down to the way people used the chemicals, West said.

Toxic flame retardants were generally used in indoor products, such as in furniture cushions and electronic components. It is believed that the chemicals get into the air and attach to clothing and fabrics that go through the wash. A portion of the chemicals pass through sewage-treatment plants and into Puget

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Sound. Many of the products containing flame retardants eventually end up in landfills, where the risk of exposure is low.

PCBs, on the other hand, were widely used in outdoor electrical components, such as transformers, and in building materials. In some communities recycled PCB oil was even sprayed on roads to reduce dust. Because of widespread outdoor contamination, PCBs are likely to continue working their way into Puget Sound well into the future.

Some people are still being exposed directly to flame retardant chemicals through old furniture and electronics still in their homes, said Holly Davies, toxics policy coordinator for the Washington Department of Ecology [Since this interview, Ms. Davies has taken a new position at the Washington State Departmet of Health]. Health effects, especially for children, may continue to be a concern until the old materials are replaced.

Unfortunately, she said, some of the newer flame retardants have proven to be no better than the ones that were banned. In fact, the Washington Legislature last year banned five additional flame retardants used as replacements. Some of these chemicals have begun showing up in fish tissue at low levels.

“We are trying to figure out which alternatives are safer,” Davies said.

Because both PCBs and PBDEs accumulate in fat tissue, older animals tend to accumulate more chemicals, West said. His study focused on herring that were typically 3 years old, but the English sole could be up to 20 years. That could help explain some of the differences in tissue levels between herring and sole.

As with the herring, some of the English sole showed significant declines in flame retardants over time. Specifically, sole caught near both Seattle and Bremerton — two highly developed areas. — showed notable declines, along with fish caught near remote Vendovi Island in northern Puget Sound. But for six other locations around the Sound, concentrations in the sole did not decline much, if at all.

While the levels of flame retardants in herring are on the decline, the levels are still high enough to cause health problems, based on findings in other studies.

Another long-lasting pollutant, DDT, also was tested in the study and found to be of low risk to Pacific herring and English sole. The one exception was English sole taken from the Tacoma City Waterway, where the fish were showing an annual 5-percent increase in the concentration of DDT.

Sources for the DDT could include farmlands along the Puyallup River, which spills into the city waterway. Studies have shown that DDT in soil can continue to leach from agricultural lands after many years. The waterway also has been subject to dredging and other cleanup activities, which might have released DDT that was buried in the sediments.

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NEW HEALTH WARNINGS FOR HERRING?

The ongoing findings of high PCB levels in herring will probably trigger new health warnings from the Washington State Department of Health, according to Dave McBride, a toxicologist with the agency. Until recently, it was assumed that almost nobody eats herring, although longtime health warnings have been in effect for chinook salmon, which prey on the smaller fish.

New information from an advisory group addressing toxic chemicals in the Duwamish Waterway suggests that some people are eating herring from the Duwamish, despite warnings against eating any resident fish from the waterway. McBride said he plans to issue a new health advisory about the risks of eating herring from various locations in Puget Sound.

MORE AGGRESSIVE ACTIONS NEEDED?

Because PCBs are not disappearing on their own, the new study suggests that more aggressive actions may be needed to eliminate these oily compounds from the bottom of Puget Sound, even as efforts continue to disrupt their flow into the waterway.

The Department of Ecology developed a strategy, known as a chemical action plan, to reduce PCBs in the environment, but implementation has been slow because of limited funding, Davies said.

Meanwhile, a team of experts is just beginning to take a new look at the problem by developing an "Implementation Strategy for Toxics in Fish." The idea is to accelerate efforts to meet Vitals Signs targets adopted by the state's Puget Sound Partnership. Specifically, the goal includes reducing PCBs and toxic flame retardants to levels safe for herring and sole as well as humans who eat them.

As a result of more stringent water-quality standards, sewage-treatment plants may be required to upgrade their equipment to reduce PCBs in their effluent, Davies said.

The problem, she added, is that the ban on PCBs in the 1970s still allows for their use at levels up to 50 parts per million. That seemed like a very low level when the ban was imposed, she said, but it still allows for some PCBs to escape into the environment.

One low-level source of PCBs are the pigments and dyes used in printing and other applications. Through no fault of their own, newspaper-recycling operations as well as sewage-treatment plants may find their wastewater discharges in violation of new water-quality standards that placed PCB limits at 170 parts per quadrillion — or millions of times lower than the 50 ppm still allowed in the inks. These PCBs were not seen as a significant contributor to the fish studies, but remain on the radar of state regulators.

Because of the high cost of equipment to remove PCBs from wastewater, the Department of Ecology is pushing the federal government to further lower the legal limit for PCBs in various products on the market.

In another effort to limit the release of PCBs, the state of Washington is implementing new incentives in state purchasing contracts. Companies will be asked to use products containing the lowest levels of PCBs possible. One example is to practically eliminate PCBs from the yellow paint used to stripe roads throughout the state, Davies said. Yellow pigments contain some of the highest levels of PCBs still on the market.

Through the years, much has been learned about the hazards of PCBs and toxic flame retardants, Davies said. Still, cutting off the sources of these chemicals to make Puget Sound seafood safe to eat remains one of the great environmental challenges of our time. ■

Photo: National Geographic Creative / Alamy Stock Photo

Pacific herring (Clupea pallasii).

Salish Sea Currents

timely, local stories about ecosystem recovery

The Qwuloolt estuary hydrology restored by breaching a century old levee. WRP easement land in the foreground. Photo: USDA

KEY TAKEAWAYS

- *Estuaries — places where freshwater and saltwater mix — once covered tens of thousands of acres in the Puget Sound region. Much of that habitat has since been lost.*
- *Some rivers, like the heavily industrialized Duwamish and the Puyallup, have almost no intact estuary habitat left.*
- *A new EPA-funded effort to restore estuaries is being led by the Washington Department of Fish and Wildlife and the state's Department of Natural Resources. It focuses on the sixteen largest rivers that empty into Puget Sound.*
- *The state's goal is to have, by 2020, 7,380 acres of estuarine habitat restored basin-wide. This is about 20% of what biologists estimate to be the region's total need.*
- *As of 2015, there were ninety-nine estuary recovery projects on Puget Sound under the auspices of what the state and EPA are terming an "Implementation Strategy," an effort to help prioritize and accelerate the overall recovery efforts.*

"They're already seeing fish in the Qwuloolt."

Mike Rustay, habitat specialist
Snohomish County Surface Water Mgmt. Division

When rivers spill into Puget Sound, they provide some of the most productive habitat in the ecosystem. The ebb and flow of the tides creates a perfect mix of fresh and salt water critical for young salmon. But over the past 100 years, the region's tidal wetlands have declined by more than 75%. Now a coalition of state and federal agencies has a plan to bring them back.

Saving the last estuaries

date: 5/26/2017 author: ERIC WAGNER
full story on the web: eopugetsound.org/magazine/is/estuaries

When rivers spill into Puget Sound, they provide some of the most productive habitat in the ecosystem. The ebb and flow of the tides creates a perfect mix of fresh and salt water critical for young salmon. But over the past 100 years, the region's tidal wetlands have declined by more than 75%. Now a coalition of state and federal agencies has a plan to bring them back.

Mike Rustay pulls off the road a few miles outside of Everett, jounces down a ramp to a gravel lot, and parks his pickup next to a mobile office trailer. A couple of other pickups are here, along with a golf cart, but there isn't much of the hustle and bustle one would expect from an active construction site. "It's quiet because the project's in the winter break," Rustay says. "Everyone'll be up and running again soon, when the weather clears up." He hands me an orange safety vest nonetheless.

We are at Smith Island, a patch of land in the Snohomish River delta close to where it meets Puget Sound. Rustay is a habitat specialist with the Snohomish County Surface Water Management Division. "It's not much to look at right now," he says of Smith Island, "but it will be." And when it is, the site will add a little more land to the growing amount of restored estuary habitat in Washington.

Estuaries once covered tens of thousands of acres in the Puget Sound region. Much of that area has since been lost, whether drained or filled for urban development, or cut off from their rivers with dikes and tidegates and converted to farmland. Some rivers, like the heavily industrialized Duwamish and the Puyallup, have almost no intact estuary habitat left. Others, such as the Skagit and the Snohomish, have a bit more to work with, even if their acreage has been substantially reduced.

That estuaries provide a vast array of ecosystem services — especially for Puget Sound's beleaguered salmon runs — is well known, and it is the scarcity of intact tidal estuary that several local, state, tribal, and federal agencies are now trying to remedy. A new EPA-funded effort is being led by the Washington Department of Fish and Wildlife (WDFW) and the state's Department of Natural Resources. It focuses on the sixteen largest rivers that empty into Puget Sound: nine from the Cascades, and seven from the Olympics. The strategy is aspirational more than item-by-item. "It's a regional framework to hang local priorities on," says Jennifer Griffiths, an environmental planner with the agency. "It points to long-term recovery pathways, and projects will ideally have multi-benefit linkages and outcomes." The state's goal is to have, by 2020, 7,380 acres of estuarine habitat restored basin-wide. This is about 20% of what biologists estimate to be the region's total need.

Photo courtesy: Kalvin Valdillez, Tulalip News

Ebey Waterfront trail opens along Qwuloolt Estuary.

SLOW AND STEADY

As of 2015, there were ninety-nine estuary recovery projects on Puget Sound under the auspices of what the state and EPA are terming an "Implementation Strategy," an effort to help prioritize and accelerate the overall recovery efforts. Of those, fifty-three

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Map courtesy: Tulalip Tribes

Map of Qwuloolt Restoration site and vicinity.

are done, thirteen, like Smith Island, are active, and the remaining thirty-one are prospective. It serves to highlight how estuary restoration tends to be a slow, steady process by nature. Individual projects might take years to be conceived, to get funded; and obtaining the relevant lands is no small thing. It took Snohomish County, for example, more than twenty years to secure all the land on the Smith Island site; and the project will cost more than $20 million, the funding cobbled together from a range of sources.

"All of our projects can't take twenty years to do," says Jay Kreinitz, the Estuary and Salmon Restoration Program Manager for WDFW. "But they do take time — you need to have community buy-in." This is especially true when land is being converted. "We have to show people who have come to value lands in particular ways how they will benefit from these new processes," Kreinitz says.

Like other projects, whether in the Snohomish or the Skagit or elsewhere, the Smith Island restoration hasn't been without its share of controversy. "Fish guys like me just want to say, Oh boy, fish habitat!" Rustay says. But behind the new dike sits $80 million worth of infrastructure: a marina next to the slough, a commercial nursery, what appears to be a small sheep farm, a timber mill, and, of course, the interstate. "All these folks were really interested in making sure we do this right," Rustay says.

While the going has been slow and steady, there has been progress nonetheless. "They're already seeing fish in the Qwuloolt," Rustay says on the drive back to Everett. The Qwuloolt estuary, site of its own project, is a mile or so to the north of Smith Island, on the other side of Steamboat Slough. He ticks off the fish already detected there: sculpin and starry flounder showed up almost immediately after the dike was breached, and now the Tulalip Tribes are seeing heavy use by juvenile salmon. "It's great to see how these projects end up functioning in the real world," he says. In fact, there's a ceremony of a sort for a new waterfront trail along the Qwuloolt and Ebey Slough. "It's opening this weekend," he says. "You should go check it out." So, I do.

NOT JUST FOR SALMON

It is a gray, blustery Saturday, and Marie Zackuse, the Chairwoman of the Tulalip Tribes, stands in front of a good-sized crowd in downtown Marysville. Behind her, four kayakers float in the Ebey Slough.

Zackuse gestures to the slough and its surrounding marshes. "Our people used these estuary lands for fishing, hunting and harvesting, especially duck hunting," she tells the assembled. "Our wild fish runs were healthy and productive until recent times, and with the Qwuloolt restoration, our salmon have been given the opportunity to survive." And it's true, or will hopefully be true before too long. The Qwuloolt project, which the Tulalip Tribes completed in 2015, reintroduced close to four hundred acres of former tidal marsh to the Snohomish River, about three miles from its outlet into Puget Sound. It is the second-largest such project completed in Washington to date, after the Nisqually river delta near Olympia.

But while the project's main goal was to make the delta more habitable for young salmon, that wasn't its only goal, and Zackuse hasn't come out to talk just about the salmon.

To her right, strands of green and blue ribbon are merrily strung across a newly paved 1.3-mile footpath that follows the slough's curves.

Zackuse speaks a little longer, and a couple of other dignitaries speak after her, and then she gathers behind the ribbon with Marysville Mayor Jon Nehring and Mike Deller from the Recreation and Conservation Funding Board. The three hold a comically oversized pair of scissors. With a hearty snip the ribbon falls, the Ebey Waterfront Trail officially opens, and the cheerful crowd streams onto the trail. But I think back to something Rustay told me as a kind of humorous aside: this official opening, while nice, is a bit superfluous. People have been using the trail for a while already, walking their dogs on it long before it was formally open to them. It is the same with the estuary they are now walking next to, and estuaries all around Puget Sound: always desired, always in use, one way or another. ■

Prime Drayton Harbor oyster. Photo courtesy: Steve Seymour

After a long struggle with pollution, Drayton Harbor has reopened to year-round commercial oyster harvesting for the first time in 22 years. Here's how the community cleaned up its act, potentially showing the way for shellfish recovery throughout Puget Sound.

Bringing the shellfish back:

How Drayton Harbor overcame a legacy of pollution

date: 3/7/2017 author: CHRISTOPHER DUNAGAN
web: eopugetsound.org/magazine/drayton-shellfish

KEY TAKEAWAYS

- *Several years ago, the state of Washington established a recovery target of 10,800 acres of renewed shellfish beds in Puget Sound by 2020.*
- *Drayton Harbor near Blaine, Washington is among the areas that officials hoped would be recovered. It had been celebrated for its oysters until shellfish harvesting was closed in 1999 due to pollution.*
- *In 2015 after long-term community and volunteer efforts to clean up pollution sources, shellfish operations opened again in the area.*
- *Success at Drayton Harbor relied extensively on volunteer efforts. As of 2010, volunteers had logged 38,000 hours of their time working on Drayton Harbor oyster recovery. That's equivalent to two people working full-time, 40 hours a week, for 9 years.*
- *The restoration effort resulted in 810 acres of newly approved shellfish beds for harvesting.*

In the narrow, brick-walled oyster bar near Drayton Harbor, a diverse group of people slurp oysters freshly harvested from a beach less than a mile away. They toast the community's success in restoring the year-round harvest of oysters on the beach near Blaine, just south of the Canadian border.

***The oyster beds on Jersey's coast
Have justly won a name
But we grow better flavored ones
Yes, sir, right here in Blaine.***

Blaine Journal Homeseeker's Edition, 1909.

"It's pretty crazy how people have rallied around having an oyster farm in their own backyard," says Steve Seymour, who, with his son Mark, owns the oyster bar and the restored oyster farm on Drayton Harbor.

Saving shellfish from pollution is often seen as a technical challenge of locating and fixing sources of bacterial contamination. But in places like Drayton Harbor, where intractable pollution once spewed freely, a spirit of community cooperation became the driving force to meet the challenge.

The story of Drayton Harbor's recovery is being played out on beaches throughout Puget Sound, as the region strives to restore more than 10,000 net acres of shellfish beds to year-round harvest — an accomplishment rarely seen anywhere in the world.

Several years ago, the state of Washington established a recovery target of 10,800 acres of renewed shellfish beds in Puget Sound by 2020. That formidable goal has resulted in a massive effort to clean up bacterial pollution, and Drayton Harbor is just one of the success stories. Now, more work is needed as the 2020 deadline nears.

Photo: Geoff Menzies

2005 seedcrew.

EARLY STRUGGLES

Large-scale shellfish bed closures in Drayton Harbor had been occurring due to pollution as early as 1988, but conditions were quickly worsening. By 1995, just three years after Steve Seymour formed Dayton Harbor Oyster Co. with his partner Geoff Menzies, the Washington State Department of Health declared most of the harbor "prohibited" from shellfish harvesting. That action effectively ended their fledgling oyster business, and the remainder of the harbor was shut down to all harvesting in 1999.

"I thought it was the end," Seymour said, "and I went on to other things."

The prospects for recovery were bleak. A 1998 pollution survey revealed a 21-percent failure rate among the septic systems near the shore. Breaks in aging sewer lines also were identified as a problem, as was the nearby marina where some boaters apparently were dumping human waste.

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Photo courtesy: Steve Seymour

Grandson Erik and son Mark, with Steve Seymour at the oyster bar.

Besides septic systems, sewer lines and boats near the harbor, pollution was coming in from Dakota and California creeks. These streams were contaminated from failing septic systems and poor livestock practices throughout the 36,000-acre watershed. As more and more sources of pollution were identified, a solution seemed almost out of reach.

COMMUNITY OYSTER FARM

Betsy Peabody, who founded Puget Sound Restoration Fund in 1997, said her group had been searching for projects. A meeting was set up with officials at Trillium Corporation, owners of the 200-room Semiahmoo Resort, which overlooks Drayton Harbor. Trillium's hope was to serve locally grown oysters in the resort's restaurant.

Although some people had doubts, Peabody teamed up with Menzies, who was disheartened at the prospect of losing Drayton Harbor's exceptional oysters. Their vision was to rally the community around clean water and what that can bring.

"In 2001, it wasn't clear that there was any one thing we could do to make a difference," Peabody said. "The way we approached it was to say there would be no finger-pointing. We would ask, 'What can each of us bring to the table to turn this around?'"

Although Peabody and Menzies had a positive outlook and were engaged in the labyrinthine effort to track down pollution sources, they soon learned that it was not enough. That's when Ken Hertz, a Trillium executive and former Bellingham mayor, spelled out the situation for them.

"When you want to make something happen, you have to invest in it," was Hertz' advice, Peabody recalled. "You don't talk about it or plan for things down the road. If you want oysters to be harvestable in Drayton Harbor, you'd better start growing oysters."

That optimistic vision was the impetus for the Drayton Harbor Community Oyster Farm, which started in 2001. With special permission from the state and help from volunteers, the nonprofit group planted baby oysters in an area where harvesting was prohibited.

"That started the clock ticking," Peabody said. "In three years, those oysters would be ready to harvest."

Led by Menzies, volunteers not only planted oysters but also tended to the growing area, collected water samples and helped spread the word. State and county agencies became partners in the effort while continuing to identify pollution sources.

TRACKING THE POLLUTION

The standard method of tracking pollution in Puget Sound has become known as Pollution Identification and Correction, or PIC. In theory, it involves locating "hot spots" where a stream, ditch or seep has a large concentration of fecal bacteria.

Investigators work their way upstream looking for potential sources, such as a failing septic system, cows in a stream, excessive manure on a field, or even an unusual collection of dog droppings. If a high level of bacteria is found on the downstream side of a suspected source and a low level is found on the upstream side, then the problem lies somewhere between.

"In Drayton Harbor, there was a whole suite of nonpoint sources," said Lawrence Sullivan of the state's Shellfish Program at the Washington State Department of Health. "They had agriculture, leaky sewer lines from the city of Blaine, stormwater, failing septic systems, marina problems, wildlife. You name it, they had it."

In most areas of Puget Sound with bacterial pollution, septic system failures are a big part of the problem, and they are not always easy to spot. When inspectors suspect a failing system, they can perform various tests, including the use of a fluorescent dye to help trace effluent from toilet to drainfield and beyond. State law requires all property owners to get their septic systems inspected — every three years for standard gravity systems and every year for other systems.

Out of nearly 400 septic systems tested in Drayton Harbor, 128 were found to be failing or were suspected of problems. Most systems were repaired, while some were hooked up to city sewers. Since then, nearly all 3,000 septic systems in the watershed have been inspected under the state's mandatory program.

Meanwhile, over the years, many other changes have been taking place to reduce human waste — from the replacement of sewer pipes to the relocation of boat pump-out facilities. Eventually a new advanced sewage-treatment plant was built to release only highly treated effluent into Drayton Harbor. And, to cover all bases, new pet-waste stations have been installed in parks and along public trails.

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Photo: Jack Kintner

Celebrating a community harvest at Drayton Harbor.

AGRICULTURAL ISSUES

Nearly half of all the land in the Drayton Harbor watershed is managed for farming. Seven dairies and dozens of other farms of all sizes are located upstream of the harbor. That's consistent with Whatcom County as a whole, which contains about a third of all the livestock in the Puget Sound region.

Tracking pollution from septic systems turned out to be far easier than figuring out how manure from nearby farms had gotten into the water.

"Septic systems don't move around," noted Andrea Hood, a state health inspector assigned to Whatcom's Clean Water Program. "It's somewhat black and white. They're either working or they're not."

Livestock, on the other hand, can be moved from place to place, she said. Manure may be applied to one field or another. It may be applied inconsistently or, inadvisably, just before a rainstorm.

One common obstacle is simply getting a landowner's permission to walk onto his farm in a search for pollution sources. "People have been farming this area for a long time," Hood said, "and some are wondering, 'Why should I change?'"

Whatcom Conservation District played a major role in helping farmers voluntarily improve their manure-handling practices.

Among the regulatory actions imposed through the years, the county outlawed the application of liquid manure on bare ground from September to March; the state implemented a dairy inspection program statewide; and the Environmental Protection Agency sent out warning notices to dairy farms with water-quality violations.

Despite some tension in the community, many of the resistant farmers were won over by the spirit of their neighbors, expressed in a series of town hall meetings. The discussion gradually became less about who was causing the greatest problems and more about how each person could help.

"As a general principle, we all want clean water for a variety of purposes," said George Boggs, executive director of Whatcom Conservation District. "Cattle need water to drink. People need water to play in. From that standpoint, farmers can understand that shellfish growers are farmers too."

COMMUNITY CONNECTIONS

Over the years, residents around Drayton Harbor continued to head down to the beach to tend to the oysters, although the shellfish could not be harvested. At the same time, efforts to stem the flow of pollution were beginning to pay off.

"A community effort brings an important dimension to a restoration project," said Peabody of Puget Sound Restoration Fund. "It gives people a chance to experience the place and the resource that you are trying to upgrade."

In June of 2004, state health officials reclassified 575 acres of shellfish beds from "prohibited" to "conditionally approved." It was the culmination of many years of hard work, and the reclassification allowed harvesting to resume — except for a waiting period after every heavy rainfall.

Photo: Julie Hirsch

Blaine 5th Graders on the Beauty with Geoff Menzies, manager of the Drayton Harbor Community Oyster Farm.

Menzies, who not only managed the community farm but also continued to work on pollution studies under a contract with Puget Sound Restoration Fund, recalled how the hard-working volunteers made a difference.

"Volunteers were picking oysters and loading them onto a barge, 40 pounds to a bushel," Menzies said. "We continued through 2008 and shipped 50 tons of oysters to China."

As of 2010, volunteers had logged 38,000 hours of their time working on Drayton Harbor oyster recovery. That's equivalent to two people working full-time, 40 hours a week, for 9 years.

As cleanup efforts continued in the watershed, the community oyster farm prepared to turn over the operation to a private business — a goal established at the beginning, Menzies said. In 2013, Steve Seymour, then retired, agreed to come back and assume the tidelands lease.

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LONG-AWAITED SUCCESS

Seymour started his new company with son Mark, restoring the name Drayton Harbor Oyster Co. In 2015, they opened the oyster bar in Blaine, offering fresh oysters directly from the harbor.

This past November, after 25 years of tracking down and cleaning up pollution, the long-awaited news finally came that 810 acres of shellfish beds had been reclassified as "approved." Much of Drayton Harbor could be considered recovered. Year-round harvests resumed for the first time in 22 years, and the community held a major celebration in December.

"People have been gathering food along these shorelines for thousands of years," Peabody said. "Gathering shellfish today helps us remember how important clean water is to our well-being."

In addition to state and local funding, Whatcom County has received about $1.3 million from the federal Environmental Protection Agency since 2012 for PIC programs throughout the county, including Drayton Harbor. Another $77,000 in EPA funding has gone to the county for monitoring, septic system maintenance and other projects.

"My biggest concern now," Seymour said, "is whether we can maintain the water quality in the bay. The goal has been reached; we've celebrated; now what?"

Drayton Harbor oysters have become part of the community conscience, Seymour said. People are making connections between their own actions, water quality and the finest oysters anywhere.

"I see dairy farmers and raspberry growers coming in here to slurp oysters," he said, adding that some of these folks were the ones who fought against making changes some years ago.

A clean Drayton Harbor is capable of producing up to $2 million in oysters each year on 100 acres of ground, said Menzies. But the real values are the social benefits of sharing locally grown oysters, the recreational opportunities from clean water, and the cultural traditions, both tribal and nontribal.

"Maybe I like a good battle, and that has kept me going all these years," Menzies said. "I don't want to lose this. If there are problems in the future, I think you will see people flooding the county council chambers in protest — and they are not going to be property-rights people; they are going to be oyster lovers." ■

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SHELLFISH BEDS IMPLEMENTATION STRATEGY

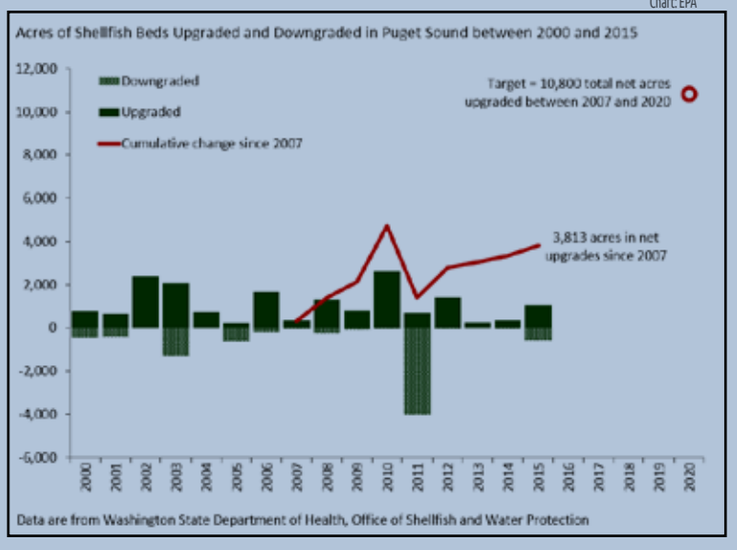
To push onward toward the 2020 goal, a team of experts led by the state Department of Health is developing a Shellfish Beds Implementation Strategy, described as a type of "road map" for meeting the defined target. The document spells out the various problems, including wastewater treatment plants, septic systems and livestock wastes.

In agricultural areas, the proposed strategy suggests addressing the complex issue of manure management. Ideas include:

- *Treating manure as a commodity with economic value to farmers,*
- *Providing real-time weather information about when to apply manure to fields,*
- *Developing a coordinated outreach program to small farms,*
- *Sharing information and building consensus around the best manure-management practices for avoiding water pollution.*

Key to the effort is ongoing funding from the Environmental Protection Agency, as well as state and local resources to support pollution identification and correction programs that track down sources of pollution, according to the strategy. Without diligence, problems have a way of returning.

Chart: EPA



To reduce pollution from septic systems, legislation may be needed to establish sustainable funding to help manage septic system inspections and provide low-interest loans for repairs, the report says.

For the long term, state agencies, in coordination with local tribes, should develop a plan to reduce pollution from sewage-treatment plants, which could shrink the shellfish-closure areas around sewer outfalls according to the document. Sewage effluent not only reduces commercial shellfish harvesting but it can damage other natural resources, such as aquatic vegetation, the report states.

Consistent with principles of adaptive management, Implementation Strategies are designed to be updated as new information becomes available. Concerns related to potential ecological damage from intensive shellfish cultivation were deferred to other Implementation Strategies focused on habitat protection and restoration.

One of the great lessons learned in developing the Implementation Strategy is that community perspectives and participation are essential to success, the report states. The strategy recommends outreach and "social marketing" to emphasize protection of public health; increased recreational opportunities, including shellfish harvesting; and economic benefits. ■

Scientists want to know why eelgrass is on the decline in some areas of Puget Sound and not others. The answer will affect future strategies for protecting one of the ecosystem's most critical saltwater plants.

KEY TAKEAWAYS

- *Overall, the eelgrass population in Puget Sound has remained stable for the past forty years, but scientists have seen some local declines.*
- *Variations in populations are not easy to explain and could relate to a number of different factors, ranging from increased nutrient pollution to disease and dredging, to shellfish aquaculture or other unknown sources.*
- *In Washington, eelgrass is highly variable and has poorly understood genetic diversity making it prohibitive for scientists to treat eelgrass the same in every location.*
- *Scientists across the Northwest are trying to figure out not only what affects eelgrass but also how well restoration projects and management practices work.*
- *Knowing where eelgrass is and how it is doing locally is at least a first step toward gauging the problem. Researchers at the Washington State Department of Natural Resources are conducting annual surveys during the eelgrass growing season.*

Eelgrass declines pose a mystery

date: 6/15/2017 author: RACHEL BERKOWITZ
web: eopugetsound.org/magazine/is/eelgrass

The Hood Canal, a narrow fjord extending from Puget Sound into the Olympic Peninsula, is home to salmon, crab, and a host of marine life. Walk along a tidal flat in the lower Hood Canal, and you may see a carpet of slick green shoots covering the shore. Until recently, eelgrass (Zostera marina) had been on the decline here, so its rebound is good news. But not all shoreline areas have the same good fortune — and scientists are struggling to explain why.

Eelgrass not only provides nursery habitat for fish and food for invertebrates; but also stabilizes sediment, absorbs carbon and nitrogen, and filters harmful bacteria. That's why the state designated it a vital sign of ecosystem health, with strategies for meeting 2020 targets of increasing eelgrass extent or acreage by 20%.

Earlier this year, scientists from the National Oceanic and Atmospheric Administration, the University of Washington, and the Washington Department of Fish and Wildlife reported that the eelgrass population in Puget Sound has remained stable for forty years. Local declines were noted but why some regions experienced these declines when other areas did not, or even grew in numbers, is a mystery. Scientists say that raises concerns about eelgrass health at the local scale.

> **"One advantage of talking about eelgrass response to aquaculture is that eelgrass stays put, unlike fish, and makes it easier to draw some conclusions."**
>
> *Jennifer Ruesink, zoologist*
> *University of Washington*

"One possible misinterpretation of that paper [would be to say] that we're fine if eelgrass is stable sound-wide. But that ignores locally significant declines," says Matt Goehring, Aquatic Policy Analyst for the Washington State Department of Natural Resources (DNR). "And we don't have conclusive evidence pointing toward which stressors are contributing to observed declines," or the relative magnitude of their impacts, he said.

Scientists across the Northwest are trying to figure out not only what affects eelgrass but also how well restoration projects and management practices work.

Bart Christiaen counting eelgrass shoot density at Dumas Bay.

SOMETHING IN THE WATER?

East coast estuaries conclusively point their finger at pollutants from agricultural activities, septic systems and wastewater that create turbid waters and shade out eelgrass. There, it's simple to show exactly what causes an eelgrass population to decline: when a pollutant source is removed, the eelgrass comes back.

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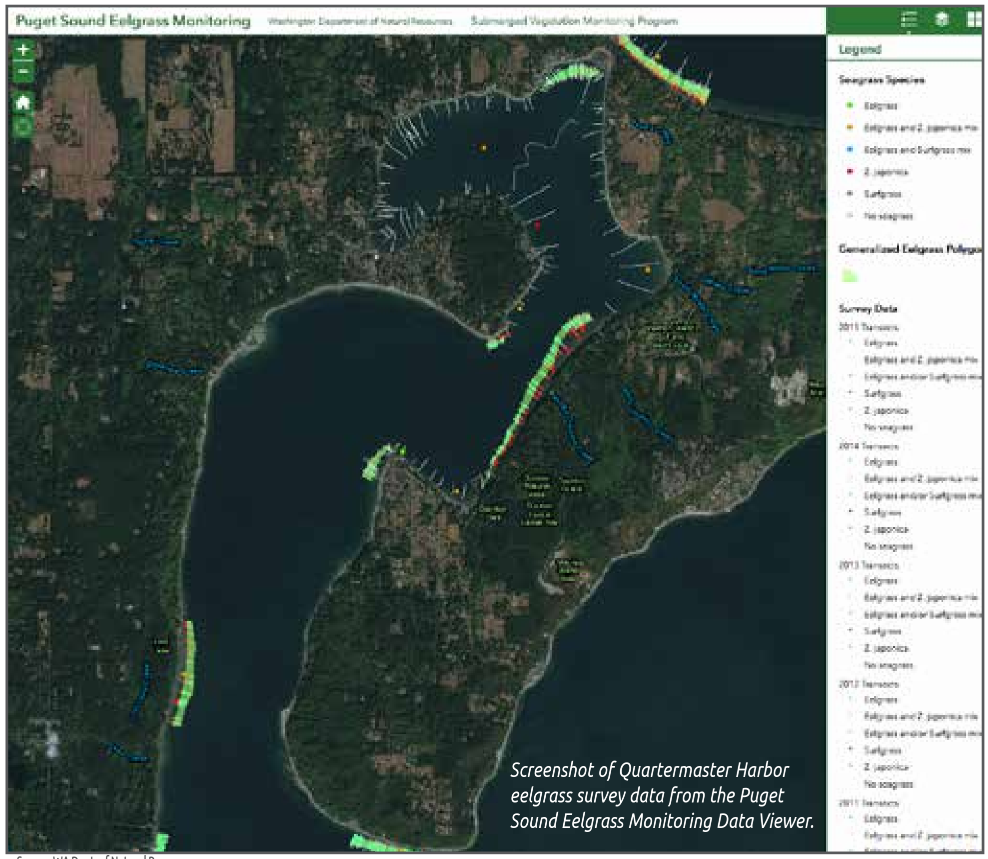
EELGRASS DECLINES POSE A MYSTERY [CONTINUED]

Puget Sound is experiencing an increase in pollution as more people move to the area. Septics and wastewater can lead to an increase in so-called 'nutrients' that spur harmful algae growth, but so far, it is not clear if this is changing local eelgrass populations. Puget Sound also receives marine-derived nutrients from cold upwelling in the Pacific Ocean, and big doses of land-based nutrients from our largest rivers. Currents within the Sound in turn create a complex environment that move nutrients and pollutants around the estuary.

"Research globally has demonstrated that seagrass can be impacted by excess nutrients. We do not have a good understanding of the effects of nutrient loading on eelgrass in Puget Sound," says Bart Christiaen, seagrass scientist at DNR.

Links between other possible threats and eelgrass declines are similarly ambiguous. Scientists are looking at a variety of potential impacts, from eelgrass wasting disease to shading from overwater structures to boat propellors and dredging. So far, no single factor stands out, and scientists say each eelgrass meadow or patch may be experiencing different impacts.



Screenshot of Quartermaster Harbor eelgrass survey data from the Puget Sound Eelgrass Monitoring Data Viewer.

Source: WA Dept. of Natural Resources

POPULATION SURVEYS

Knowing where eelgrass is and how it is doing locally is at least a first step toward gauging the problem. Since 2000, DNR's Aquatic Resources Division Nearshore Habitat Program has been watching eelgrass populations across Puget Sound. Annual surveys from May through September use underwater cameras to characterize the abundance and distribution of eelgrass throughout the Sound based on a random sample of sites.

The survey provides information by which to understand the complex variety of factors that affect the eelgrass population along with helping to identify which management strategies offer the best hope for success. A recent report on DNR's 2015 dataset, for example, suggests that eelgrass beds near heads of inlets and bays are particularly vulnerable. Unfortunately, still to be determined is what is behind their decline.

Part of this program's goal is to explore ways to restore areas observed to be undergoing an eelgrass decline. While eelgrass at Quartermaster Harbor in southern Puget Sound has been there historically, it's been absent from the inner harbor since 2012. But recent improvements in water quality count as a victory for state and federal agencies, and justify new restoration efforts. This summer, biologists will test transplanting eelgrass. If the transplants are successful, they'll carry out a larger scale project in the future.

Conserving and maintaining existing eelgrass populations is easier and better than replacing damaged plants. Ron Thom, Coastal Ecosystem Research Group Leader at The Department of Energy's Pacific Northwest National Laboratory, led a modelling effort based on historical data to identify sites where eelgrass restoration is most likely to be successful. They concluded that planting for mitigation is far less effective than protecting existing eelgrass and reducing stressors.

THE SHELLFISH FACTOR

Concerns over eelgrass declines have also shone the spotlight on shellfish aquaculture. The shellfish industry in Washington State includes areas suitable for native eelgrass among the private or leased tidelands used to grow their crops. This overlap sets up the possibility for shellfish aquaculture to act as a stressor for eelgrass, but also introduces opportunities for modified practices that reduce damage to eelgrass populations.

"One advantage of talking about eelgrass response to aquaculture is that eelgrass stays put, unlike fish, and makes it easier to draw some conclusions," said Jennifer Ruesink, zoologist at the University of Washington.

"One advantage of talking about eelgrass response to aquaculture is that eelgrass stays put, unlike fish, and makes it easier to draw some conclusions," said Jennifer Ruesink, zoologist at the University of Washington. Small-scale effects could come from different aspects of shellfish aquaculture, including space competition with shellfish, shading or sediment change from structures, or disturbance from harvest.

Shellfish also compete with eelgrass for space. And the reduction in light from shellfish bed structures is sometimes, but not always, associated with reduced eelgrass populations. Low-density structures in shellfish farms can increase water flow and therefore scour sediments. But high-

[CONTINUED NEXT PAGE]

density structures may increase sediment deposition, which reduces eelgrass growth. Digging and dredging activities for these farms immediately reduce eelgrass density. But then eelgrass can respond to the reduced density by enhancing its seed production or branching.

A management issue for Puget Sound is how to strike a balance between the different types of aquaculture and their impact on native habitat. An added complexity to this discussion is that in Washington, eelgrass is highly variable and has poorly understood genetic diversity so that it doesn't make sense to treat eelgrass the same in every location. "This begs the question of whether eelgrass traits may respond the same or different to coastal activities," says Ruesink.

Building on Ruesink's studies of local-scale effects, ecologist Brett Dumbauld at the USDA's Agricultural Research Service collaborates with the Pacific Shellfish Institute to investigate how oyster aquaculture affects eelgrass at the seascape scale. With aerial infrared photos and GIS data of Willapa Bay on Washington's Pacific Coast, his team is building a model to assess how seagrass will respond to proposed shellfish aquaculture activities.

Photo: Andrew Reding (CC BY-NC-ND 2.0)

Spotted sandpiper on eelgrass. Semiahmoo Spit, Blaine, WA.

With 8% of the bay's intertidal area devoted to oyster aquaculture and 35% of that covered in eelgrass, Dumbauld and Ruesink want to quantify the total impact of bivalve aquaculture on eelgrass. They suggest that oyster aquaculture reduces eelgrass presence at the landscape scale in Willapa Bay, but only by less than 1.5%. This largely neutral effect may occur because shellfish aquaculture stabilizes sediment on farms through removal of bioturbating shrimp, which can then be colonized by eelgrass, even while directly removing some eelgrass in other areas.

"Are the effects of aquaculture chronic or transitory from one year to the next?" asks Dumbauld. Studies show that most beds have the predicted amount of eelgrass present, with low variation between years. Shellfish harvesting method, whether mechanical or by hand, has been found to have the most impact, with mechanical harvesting associated with chronically low presence of eelgrass. Results of Ruesink and Dunbauld's work will help to inform the permitting process for construction in the Sound.

DREDGING FOR ANSWERS

Better monitoring and rigorous studies of individual stressors will gradually lead to a better understanding of Puget Sound eelgrass. But cause and effect still perplex scientists.

Despite the uncertainties, the best available science is getting better, and with it, hopefully better regulatory practices and mitigation efforts.

Laura Hoberecht, Aquaculture Coordinator at NOAA's Fisheries Service, pressed scientists to ask "How would you apply your shades of grey in a black and white [regulatory] world? And, regulators, how could you incorporate science into your management?"

The only certainty is that it's not going to be easy. Science, industry, and management alike need to work together to formulate the best possible evidence-based policy for conserving this vital plant. ■

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DNR's Nearshore Habitat Program colleagues Andrew Ryan, Kate Sherman, and Jessica Olmstead monitoring eelgrass at Dumas Bay.

Photo: Roger Tabor/USFWS (CC BY 2.0)

Climate change could cause sea levels to rise more than four feet in some parts of Puget Sound, leaving shoreline residents with some tough decisions. Experts say fighting the waves with conventional seawalls may not be the answer.

KEY TAKEAWAYS

- *In Seattle, the sea level has already risen about 9 inches since 1900 and is expected to rise as much as 56 inches (4.75 feet) in some places by 2100.*
- *As high tides grow more extreme, shoreline armoring — such as bulkheads and other seawalls — may not last as long as it has in the past or could be overcome by higher waters.*
- *Experts are advising against building more or higher bulkheads in many cases and are recommending alternatives such as soft shore protections.*
- *Hard armoring has been shown to be damaging to the environment and even ineffective in many cases.*
- *Local, state and federal governments are offering financial incentives to assist shoreline residents with alternative approaches to shoreline armoring.*

With sea-level rise, waterfront owners confront their options

date: 10/22/2017 author: CHRISTOPHER DUNAGAN
web: eopugetsound.org/magazine/is/slr

When John and Maia Vechey bought a waterfront house on Orcas Island six years ago, they immediately grappled with the idea of removing an old creosote bulkhead along the shore. The treated-wood structure was meant to protect the house from waves and erosion, but it was otherwise worthless.

The bulkhead produced a horrible, pungent odor in hot weather, Vechey said. It also blocked easy access to the beach, and it did nothing to benefit the fish and wildlife that used the nearshore habitat.

As the Vecheys pondered their options with the help of a landscape architect, concerns about sea-level rise came into play. Their final decision became fairly dramatic: Move the house back from the water, tear down the bulkhead, and restore the beach to a natural condition.

"We know there is going to be sea-level rise," Vechey explained. "Our intentions were always to do the right thing for the environment, the fish and the birds, as well as ourselves, so the decision became fairly easy."

> ***In Seattle, the sea level has already risen about 9 inches since 1900 and is expected to rise as much as 56 inches (4.75 feet) in some places by 2100.***
>
> *National Research Council*

The threat of sea level rise, caused by climate change, adds a new dimension to decisions being made by waterfront property owners throughout Puget Sound. As high tides grow more extreme, shoreline armoring — such as bulkheads and other seawalls — may not last as long as they have in the past. And if they do hold up, they may be over-topped during the extreme high tides of the future. Not everyone will go as far as to move their entire house, but shoreline residents are confronting a new reality. Old approaches to shoreline protection may no longer be effective.

> ***"The decision is more nuanced than we might assume."***
>
> *Ian Miller, coastal hazards specialist*
> *Washington Sea Grant*

BEYOND BULKHEADS

While some property owners may want to take a defensive posture by building their bulkheads higher and stronger, many experts are urging residents to look at other options.

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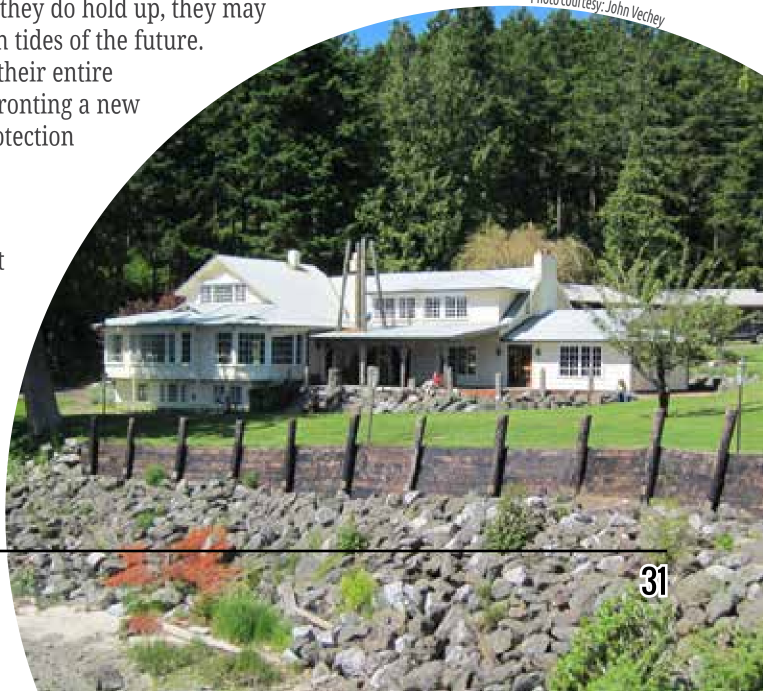
Photo courtesy: John Vechey

The Vechey residence and bulkead (circa 2013) before the restoration project.

WITH SEA-LEVEL RISE... [CONTINUED]

Rebuilding the slope after bulkead removal to allow for rising sea levels.

Photo courtesy: John Vechey

"The decision is more nuanced than we might assume," said Ian Miller, a coastal hazards specialist with Washington Sea Grant. "Building a bigger and better wall is an expensive decision, and the costs could quickly outweigh the benefits."

Bulkheads and seawalls must be maintained through the years, Miller said. Defending against erosion is an ongoing battle against tides, waves and storms. And sea-level rise brings a growing threat to hardened structures.

Hardened seawalls and bulkheads are also bad for the environment. Harm caused by shoreline armoring has been well documented. Extensive armoring can rob a beach of its natural sediment, leaving a coarse substrate unsuitable for forage fish, which require sand and small gravel for spawning. Clams may disappear as the sand and gravel is eliminated. Driftwood, which provides habitat for many small creatures, tends to drift on past properties with bulkheads. Dead kelp and seagrass, or "wrack," that supports invertebrates eaten by birds doesn't accumulate. Trees and shrubs that provide crucial shade to the beach disappear. The underwater habitat nearby is changed, too, and fish are less likely to be found near armored shorelines.

About 27 percent of Puget Sound's 2,500-mile shoreline has been altered with armoring, and about 60 percent of that armoring is located on residential waterfront property, making this is a top concern for planners and ecologists.

WEIGHING THE OPTIONS

Experts say every property has a unique set of conditions — from the rate of erosion and the makeup of the beach to human enjoyment and ecological values. Sometimes — as in urban areas where real-estate values are high — the most logical option may be to create an engineered seawall that can withstand the natural forces. In some cases, the size of a property can limit the practical options.

Moving a house may seem like a drastic step, Miller said. But recent case studies have shown that when all the costs and benefits are considered, relocating an existing structure to a safer location is not such a crazy idea. In other cases, an owner may already plan to tear down an old structure and build a new one, allowing a fresh look at where to place the home.

Property owners who live in flood-prone areas may qualify for federal funding to move their houses or raise their foundations. Maps of these areas have been developed by the Federal Emergency Management Agency to define zones where the risk of flooding is 1 percent for any given year (the so-called 100-year flood). To address sea-level rise without adding a bulkhead, some people have proposed similar financial assistance for coastal areas likely to be inundated by seawater at some future date.

The idea of removing solid walls along the shore or replacing them with so-called soft-shore protections has also gained momentum in recent years, as government funding comes through for shoreline restoration. In some locations, it turns out that old bulkheads were never needed, because the rate of erosion is very slow. In other locations, soft-shore protections — such as anchoring logs or rocks into a newly sloped beach — can be a practical alternative. The logs and rocks help absorb wave energy, with waves rolling up harmlessly on the sloping beach. Property owners often rave about the greater enjoyment they receive from a wider, sloping beach, which is also more environmentally friendly.

It is yet to be seen whether the threat of sea-level rise will cause more owners to reject bulkhead removal or wish to build new or taller bulkheads, state and local officials say. Despite higher tides expected in the future, removing old bulkheads can still have advantages for both property owners and the ecosystem — although experts say future sea levels should be factored in.

Photo courtesy: John Vechey

View after relocating the Vechey home and restoring the shoreline. A new dock surface allows sunlight through, enhancing the nearshore enviornment.

PLANNING FOR THE FUTURE

Because shoreline conditions vary from place to place in Puget Sound, some cities and counties have begun to incorporate knowledge of sea-level rise into their local plans — including shoreline master programs, comprehensive plans, zoning regulations and floodplain ordinances. Information is being coordinated through the Coastal Hazards Resilience Network, consisting of representatives from all levels of government along with businesses, environmental groups and academic researchers.

The rate of sea-level rise will increase in the future, but right now it is just something to keep in mind while planning for construction near the water, according to Miller and others. Protecting one's home against erosion today and sea-level rise tomorrow can involve many

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potential strategies, ranging from building a bulkhead to restoring a beach to just moving a house out of harm's way. Assessing the specific risk faced by each property is key to identifying what protection measures are necessary.

"We were fortunate that we could afford to move our house," said Vechey, whose decision to rip out the creosote bulkhead saved his Orcas Island beach. "We ended up with a lot more beach to enjoy, and now we go down there and have bonfires, and the kids can play along the beach."

If the bulkhead had been left alone or replaced with something more substantial, sea-level rise would eventually eliminate the beach, which had already been narrowed by shoreline armoring, Vechey said.

"You would eventually have tidelands and a creosote wall," he said. "You wouldn't have a beach."

The beach restoration, which included planting trees and shoreline vegetation, received state and federal funds totaling $91,000, or about 40 percent of the restoration cost. Friends of the San Juans sponsored the grants through the Salmon Recovery Funding Board and provided some consulting work.

Vechey said birds and wildlife already seem to be attracted to the improved shoreline. Boaters, some of whom have anchored nearby for 30 years, have told him that the beach looks a whole lot better.

Vechey said he believes that people who own waterfront property have a special responsibility to protect and restore habitat essential to sea life. Not all waterfront property owners will choose to move a house, he said, but everyone can learn about natural systems and do something to better accommodate nature.

"There are always things that people can do," he said. "If you don't want to treat the property right, then don't buy waterfront property." ■

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RELATED STORY

Shoreline armoring puts flood insurance at risk

date: 7/17/2017 author: JEFF RICE
web: http://bit.ly/shoreline-insurance

Communities across Puget Sound must consider salmon-safe alternatives to shoreline armoring or risk losing their flood insurance, according to requirements established by FEMA's National Flood Insurance Program.

The requirements stem from a Biological Opinion issued by NOAA in 2008 finding that shoreline armoring and other development in the floodplain (so-called "Special Flood Hazard Areas") can damage critical salmon habitat. The opinion protects threatened Chinook salmon, Hood Canal summer chum and endangered Southern Resident killer whales which rely on Chinook for much of their food. Newly-permitted shoreline structures are expected to demonstrate "no adverse effect" on species listed under the Endangered Species Act. Exceptions are allowed in some cases where property is at risk or additional permits are issued, according to NOAA.

Compliance with the FEMA requirement is voluntary, but without the endorsement of FEMA, flood insurance can be more expensive or difficult to obtain.

Shoreline armoring includes a variety of shoreline structures such as bulkheads and seawalls that are typically created to stave off beach erosion. New science shows that these structures interfere with natural processes critical to beach function and diminish food and habitat for a variety of fish species.

"If you're a fish, it's like living in a neighborhood where there is no grocery store," says Janet Curran, a biologist at NOAA Fisheries. [You can read more about shoreline armoring in our series "Rethinking shoreline armoring" in the Encyclopedia of Puget Sound.] "You could starve trying to find food."

Curran says that the Biological Opinion sets a higher standard for shoreline use and development by adding an additional layer of regulatory protection. "I would not say that it's going to stop all shoreline armoring," she said, "but it strengthens the toolkit for salmon protection." Currently, the Puget Sound region adds the equivalent of a mile of new armoring per year, although that number is offset by the removal of old armoring. About 25% of Puget Sound is classified by the state as armored.

According to FEMA, 122 Puget Sound municipalities such as counties, cities and tribal governments are potentially affected. FEMA doesn't enforce shoreline armoring regulations or permits, but asks local communities to certify that they are in compliance. A "community" in this case is defined by FEMA as any local government or collective responsible for issuing a permit.

FEMA says that all 122 such groups are currently in compliance with the National Flood Insurance Program, but that the agency is working closely with some groups that need special help meeting the "no adverse effect" requirement for shoreline structures. The FEMA standards are more stringent than "no net loss" requirements for state permits, which allow for some impacts as long as they are mitigated.

There are several options for meeting the FEMA standards. Known as "doors", these pathways include review of structures on a case by case basis, or satisfaction of a checklist of requirements that meet the equivalent of the Biological Opinion. If communities don't meet the requirements, they can be placed on probation, which includes an additional charge of $50 per year for insurance premiums and a year to satisfy the requirements. If a community is out of compliance for more than a year, it risks suspension, which means it would be ineligible to participate in the National Flood Insurance Program.

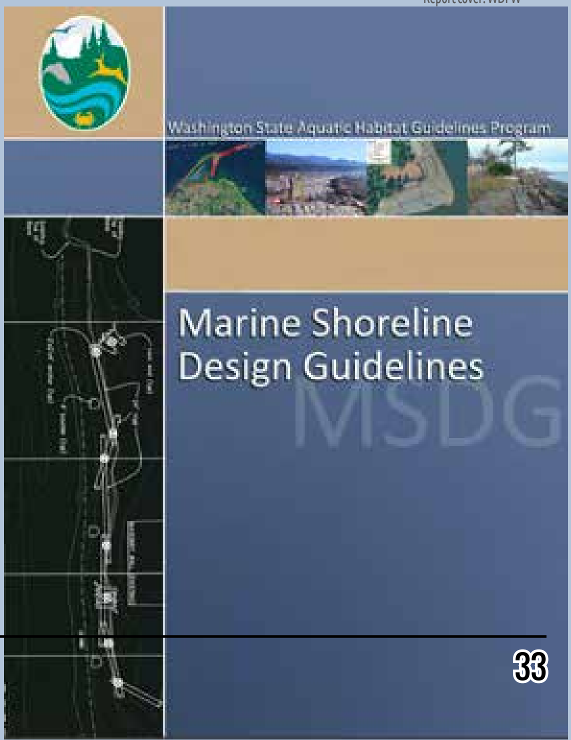
Although local governments are responsible for their own enforcement, FEMA works to correct minor violations through what it calls "community assistance visits," says John Graves, floodplains management and insurance branch chief at FEMA, Region 10. "It's like a tune-up on your car — preventative maintenance," Graves says.

The goal, Graves says, is to correct potential violations and satisfy the Biological Opinion, not to put people on probation or deny endorsement for flood insurance.

"We provide technical assistance," says Graves, "and teach that there are alternatives to hard armoring." Ultimately, he says, it's up to the local communities to decide how they want to respond. "You can't do it solely on the back of the FEMA Flood Insurance Program," he says. "We need to have people understand that hard armoring isn't always the solution."

FEMA and NOAA often refer communities and developers to the state's Marine Shoreline Design Guidelines for information about salmon-safe shoreline development. Removal of shoreline armoring is designated as a key "vital sign" of Puget Sound health by the state's Puget Sound Partnership. It is part of a new series of Implementation Strategies funded by the Environmental Protection Agency aimed at Puget Sound recovery. ■

Report cover: WDFW



Historic flooding on the Cedar River, King County, WA. Photo courtesy: Floodplains by Design

A new approach to flood control is taking hold across Puget Sound. Rivers, scientists say, can be contained by setting them free. Conservationists hope this is good news for salmon recovery.

Floodplain projects open doors to fewer floods and more salmon

date: 4/11/2017 author: CHRISTOPHER DUNAGAN
web: eopugetsound.org/magazine/biofilm

In 2006 and again in 2009, the Puyallup River spilled over its banks near the town of Orting in Pierce County, each time forcing thousands of residents to flee the muddy floodwaters that damaged many of their homes.

It was a pattern all too familiar across Puget Sound. Residents in flood-prone areas have historically risked millions of dollars in property damage, and in some cases even loss of life, from heavy rains and rising rivers.

Then, in 2014, the waters came to Orting again. They came with nearly the same volume, but this time the people remained secure in their homes. A new flood-control restoration project had allowed the flood surge to spread out in a new way, across a wider plain. The result, scientists say, has also been a more natural and salmon-friendly ecosystem.

FLOODPLAINS BY DESIGN

The Puyallup River is among 17 major river systems in the Puget Sound region where people are putting their heads together to reduce serious flooding problems, improve salmon habitat, support agriculture and often increase recreational opportunities — all at the same time.

Floodplains by Design, a program that encourages community members to work together, has attracted $80 million in state funding to work on 29 projects statewide over the past four years. Prevention of flood damages alone is expected to make up those costs over time, officials say, while the ecological benefits may be even greater.

In the effort to restore the entire Puget Sound ecosystem, the state established a target to restore 15 percent of the degraded floodplains by the year 2020. To that end, a team of experts funded by the Environmental Protection Agency is now working on a Floodplains “Implementation Strategy” to seek out ways to increase the likelihood of success.

HISTORY OF RIVER CONSTRICTION

Early farmers in the Puget Sound region often settled in floodplains along the major rivers, where rich soils had built up after centuries of river overflows during heavy rains. To protect their land from flooding during storms, farmers often built levees along the river.

“When you build a levee to confine one section of a river, it shunts the water downstream more quickly, raising the velocity and the height of the river,” said Bob Carey of The Nature Conservancy, which helped conceive the Floodplains by Design program.

Over time, more and more levees were built to control flooding on the major rivers. As more land was cleared upstream, runoff increased and water flows in the rivers became greater still, so the levees were built higher. The water became swifter. Erosion became more pronounced. Habitat for aquatic organisms, including salmon, began to unravel.

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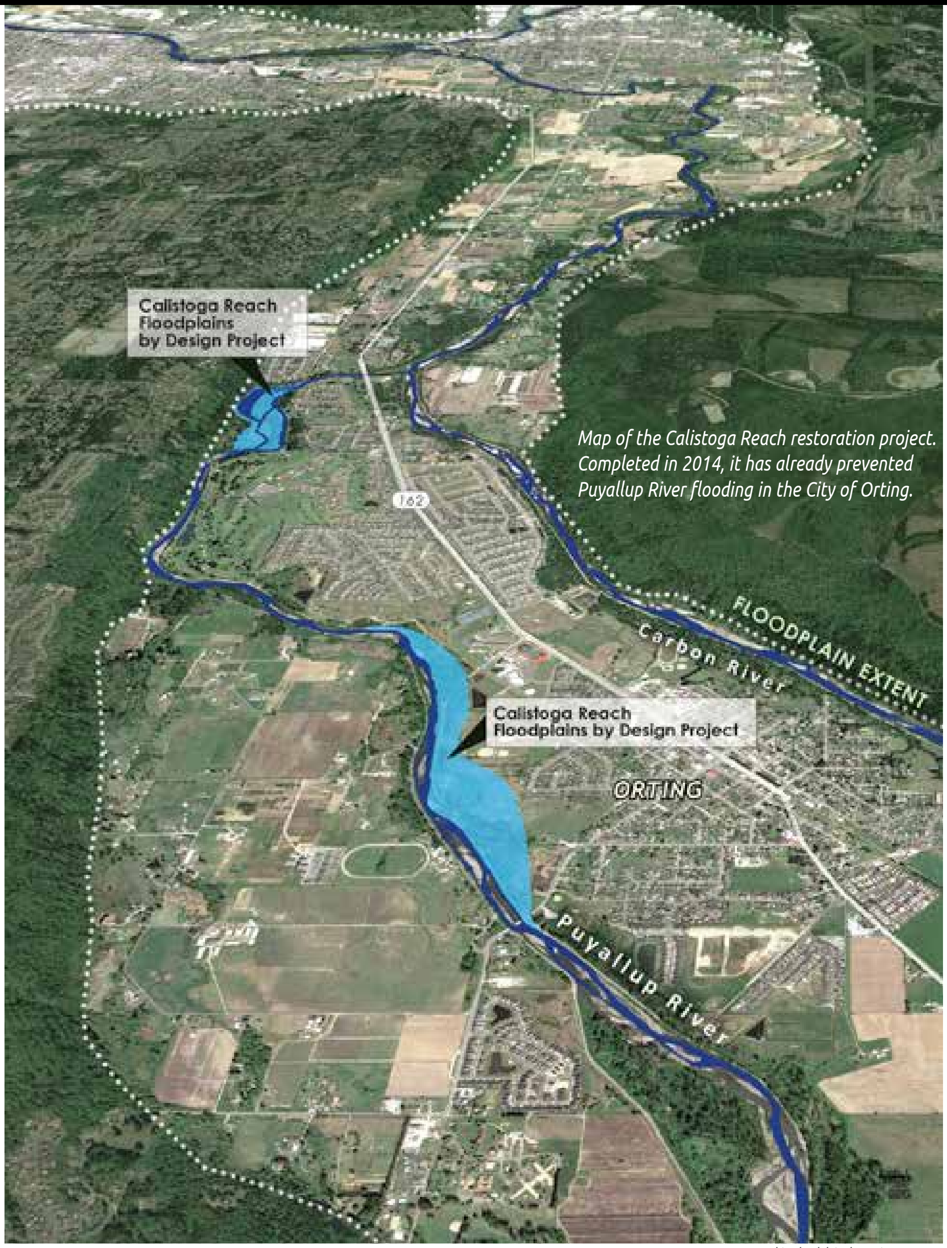
KEY TAKEAWAYS

- *Residents in flood-prone areas have historically risked millions of dollars in property damage, and in some cases even loss of life, from heavy rains and rising rivers.*
- *Traditional methods of flood control, such as diking and dredging have been hard on salmon populations and have not always been effective.*
- *Floodplains by Design is a program that restores floodplains and salmon habitat while offering new approaches to flood control.*
- *The state has established a target to restore 15 percent of the degraded floodplains in Puget Sound by the year 2020.*
- *To reach that goal, a team of experts funded by the Environmental Protection Agency is now working on a Floodplains “Implementation Strategy” to seek out ways to increase the likelihood of success.*

> ***“You have to figure out what the science says about the needs of the ecosystem.”***
> *Bob Carey, The Nature Conservancy*



Map of the Calistoga Reach restoration project. Completed in 2014, it has already prevented Puyallup River flooding in the City of Orting.

Data source: USGS; Graphic: Floodplains by Design

FLOODPLAIN PROJECTS OPEN DOORS [CONTINUED]

Until recently, efforts to restore the ecosystem often worked around the edges of the degraded river channel, a channel confined by levees and dredged to remove an accumulation of sediments that under natural conditions would have spread out across the floodplain.

As experts intensified their efforts to restore Puget Sound, they began to examine the larger functions of river systems, including wetlands and floodplains.

"There was a realization that a lot of great restoration work was going on," Carey said, "but there were a lot of other things happening that were not consistent with recovery goals."

People along the rivers — including farmers and valley residents — worried about flooding. Traditional methods of flood control, such as diking and dredging, remained the primary solution. Meanwhile, other folks were becoming dedicated to restoring salmon habitat. They wanted to restore the natural flow of the river.

State funding for flood mitigation was an entirely separate program from the increasing funding for salmon and habitat restoration, said Scott McKinney, floodplain management policy supervisor for the Washington Department of Ecology.

"The flood-hazard world and the restoration world were not coupled to each other," McKinney said, noting that things began to change when people stepped back and looked at the entire river system from top to bottom.

"When you look around, you begin to find opportunities on the landscape, places where you have a chance to relieve some of the flood hazard and also do salmon restoration," he said. "You can take a larger flood-management perspective and, to the degree you can, allow the river to do what it wants to do."

A NEW APPROACH

In developing Floodplains by Design, the three major partners — The Nature Conservancy and the state's Department of Ecology and Puget Sound Partnership — soon realized that community collaboration was the key to success in developing projects on a much larger scale than ever before.

"There is no standard approach to this," Carey said, noting that farms, housing developments, roads and topography are unique to each area, and the needs and desires of the community are paramount.

"You have to figure out what the science says about the needs of the ecosystem," he said, "but you need more than those who care just about salmon recovery. It is about bringing in other priorities, such as public safety, and putting them on an equal footing with environmental benefits. Only in that way can you get everyone working together at a meaningful scale."

Floodplains by Design is flexible enough to allow consideration of all things possible. Removing levees or moving them back from a river are options to reduce flooding and restore habitat. Changing farm practices, moving homes and realigning roads are other options. Restoring the river itself with side channels, wetlands and floodplains also can provide multiple benefits.

"It's a process," Carey said. "You start with a vision and from there try to get to more specific goals and develop a project that can achieve those goals."

The project on the Puyallup River, called the Calistoga Reach project, involved removal of about a mile of existing riverbank levee and construction of 1.5 miles of levee farther back from the river. Large logjams were added for habitat and to protect the new levee.

In addition, about 55 acres of restored habitat were connected to 44 acres of existing habitat. A new ¾-mile-long side channel to the Puyallup River increased floodplain forest habitat and reconnected 46 acres of backwater area, restoring a total of 101 acres of floodplain.

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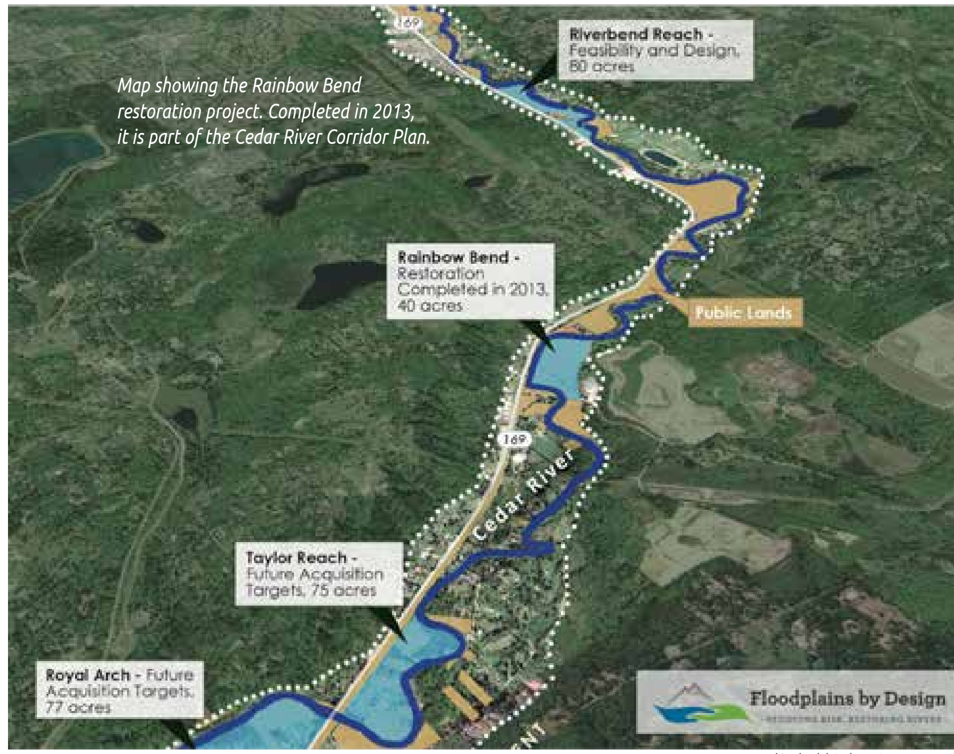
Besides the increased habitat, the $16-million project has proven itself with increased floodwater storage and conveyance, which has significantly reduced the flooding in the area for many years to come.

RAINBOW BEND

The Calistoga Reach Project is just one of many examples of floodplain restoration at work in Puget Sound. This year, seven new projects are underway across the region, each with its own challenges. A few dozen miles north of the Puyallup, in King County, people living along the Cedar River faced a familiar problem. A dogleg known as Rainbow Bend was notorious, sending savage floodwaters that also threatened Maple Valley Highway, a major corridor used by more than 50,000 vehicles a day. Also at risk was the Cedar River Trail, a regional hiking corridor.

Helped by county and state funding, the residents of Rainbow Bend were able to move out of harm's way by relocating elsewhere, and the river was allowed to reclaim a portion of its original floodplain. The highway, trail and other critical infrastructure are now protected from catastrophic failure.



Map showing the Rainbow Bend restoration project. Completed in 2013, it is part of the Cedar River Corridor Plan.

Data source: USGS; Graphic: Floodplains by Design

The $4.9-million Lower Cedar River project, an early pilot effort, removed nearly a quarter mile of levee near Rainbow Bend to allow floodwaters to flow across 40 acres of floodplain plus another 18 acres where a mobile home park was removed. Alterations to the flow substantially reduces the risk to the Maple Valley Highway and Cedar River Trail.

Most people in the Rainbow Bend area welcomed the opportunity to move, said Jon Miller, who had lived through two major floods that came into his house after a period of logging and development upstream. "Every time they forecast a pineapple express, the anxiety level rose," he noted.

IMPLEMENTATION STRATEGY

Still, despite some dramatic success stories, the established goal of restoring 15 percent of the degraded floodplains in the Puget Sound region "presents a challenge," states an early draft of the Floodplains Implementation Strategy. That could be an understatement, given that more than 43,000 acres of restoration are needed to meet the goal while 3,851 acres were listed as restored at the end of 2015.

> *"We tend to be overconfident in our engineering abilities..."*
>
> *Bob Carey, The Nature Conservancy*

Although the goal seems daunting, Floodplains by Design has accelerated the restoration effort while supporting other goals established by the state, such as improving salmon habitat, protecting sensitive lands from development and improving human health and well-being, according to the report.

One of the top recommendations of the Implementation Strategy is to increase discussions about the true risks of living in a floodplain and the costs of overcoming the natural tendencies of a river. In accommodating future population growth, planners should be acutely aware of the potential consequences before citing new construction within floodplains, the report says.

"We, as a society, generally have a poor understanding of the true risks," Carey said. "We tend to be overconfident in our engineering abilities to address that risk. If we did full cost accounting and really considered the environmental, social and economic costs and benefits, we would often come up with different solutions."

One of the historic patterns of development in the Puget Sound region is the conversion of farmland to residential development, a pattern that continues in floodplains despite growing efforts to conserve farmland. In addition to lost revenue, conversion of farmland in rural areas carries higher costs for infrastructure. That includes flood protection as well as roads and utilities.

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Image courtesy: CSI Drone Solutions and Washington Rock Quarries, Inc.

2016 aerial view of completed Calistoga Reach levee project in Orting, WA.

To discourage floodplain development, the report recommends identifying potential "cost subsidies." They include increased costs paid by society to maintain roads and utilities, provide emergency services and restore conditions after a major flood.

Understanding the risks and costs could lead to a shift in spending from unnecessary levee expansions to buying out homes in flood-prone areas, the report says. Additional spending could be targeted where ecological and social values could be enhanced.

"If these changes are made, in addition to new development paying for infrastructure and emergency services, land in floodplains would not be as desirable for residential and commercial development, existing residents would be encouraged to sell, and existing public infrastructure would not be redeveloped," the report says.

> **"You have to have stakeholder involvement; everybody gets that, from the legislators to the scientists."**
>
> *Scott McKinney, WA Dept of Ecology*

FUTURE CHALLENGES

Another risk often ignored in planning discussions is that of climate change, which is expected to bring more frequent and intense winter storms in the future, thus increasing the frequency of floods. Other factors wrought by climate change include increasing erosion and landslides, contributing to excessive sediment in the rivers.

"The continued development of floodplains within the context of climate change puts residents at further risk," the report states, adding that experts should study and quantify the economic, political, and social factors that result in floodplain losses.

The report also recommends regional planning at a scale that considers how multiple projects can protect a variety of land uses within a long stretch of a river.

"For agriculture, this may include land base needs, drainage and flood protection assurances, and an ongoing voice in floodplain planning processes," according to the report.

"For developed areas, strategic plans could include better flood protections for homes, businesses and critical infrastructure," the report continues.

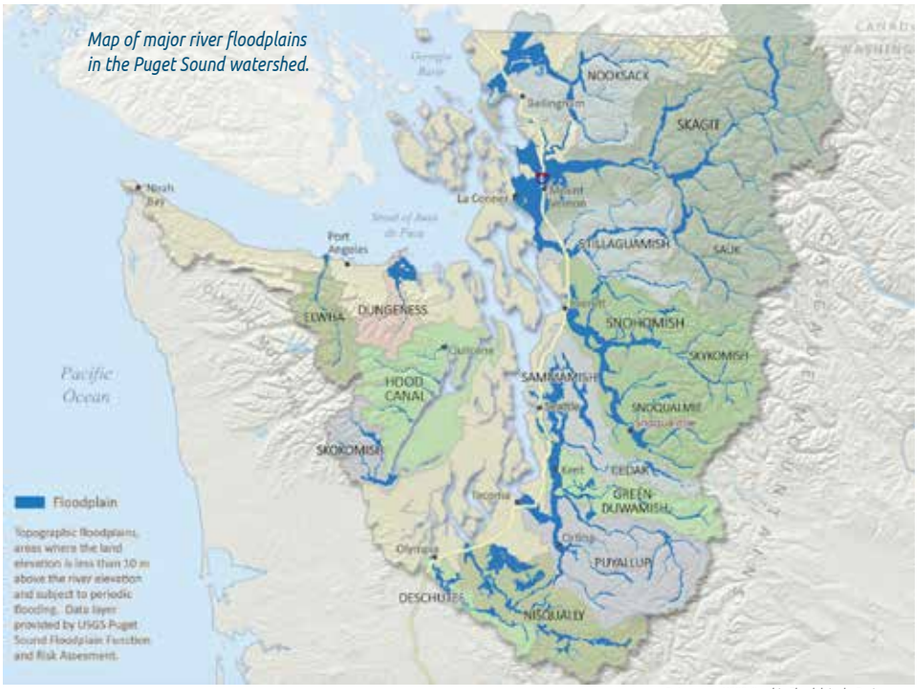
"Finally, the ecosystem recovery community will likely look to existing salmon recovery plans that identify the most critical areas to restore through levee setback and riparian zone planting for fish."

Because regional planning accounts for all viewpoints, projects proposed under Floodplains by Design have gained widespread support in the Legislature, Carey said. Addressing public safety and economic values are seen as strong points of the program.

Since the program officially started, state lawmakers have provided more than $80 million over the past two biennial budgets.

So far, state funding is limited to capital projects, including engineering and design, according to McKinney of Ecology. The early stages of planning, including organization and conceptual discussions, are not covered by state grants.

"You have to have stakeholder involvement; everybody gets that, from the legislators to the scientists," McKinney said. "Right now, we are not funding planning, so we rely on local governments to propose multi-year projects."



Map of major river floodplains in the Puget Sound watershed.

Data source: USGS; Graphic: Floodplains by Design

The Implementation Strategy recognizes the need for dollars to cover startup planning, as well as mediators or community facilitators able to help people work out their differences.

Phasing of projects is encouraged, McKinney said, but it is important to maintain large-scale thinking to avoid "a patchwork of activities or 'Frankenstein floodplain,' as we call it."

So far, a cost estimate has not been produced for meeting the Vital Signs target of restoring 15 percent of the degraded floodplains in Puget Sound.

But a 2014 study for implementing Floodplains by Design throughout Puget Sound came up with a rough estimate of $3 billion over the next 10 to 20 years. About $2.2 billion of that was associated with reducing flood risks, while $800 million would go for salmon recovery. ■

Students moving about at the growing University of Washington Tacoma campus. Photo copyright: UW Tacoma

The state of Washington estimates that the Puget Sound area will grow by more than 1.5 million residents within the next two decades. That is expected to have profound effects on the environment as more and more people move to undeveloped areas. The race is on to protect this critical rural habitat, but planners say what happens in the cities may be just as important.

Urban lifestyles help to protect the Puget Sound ecosystem

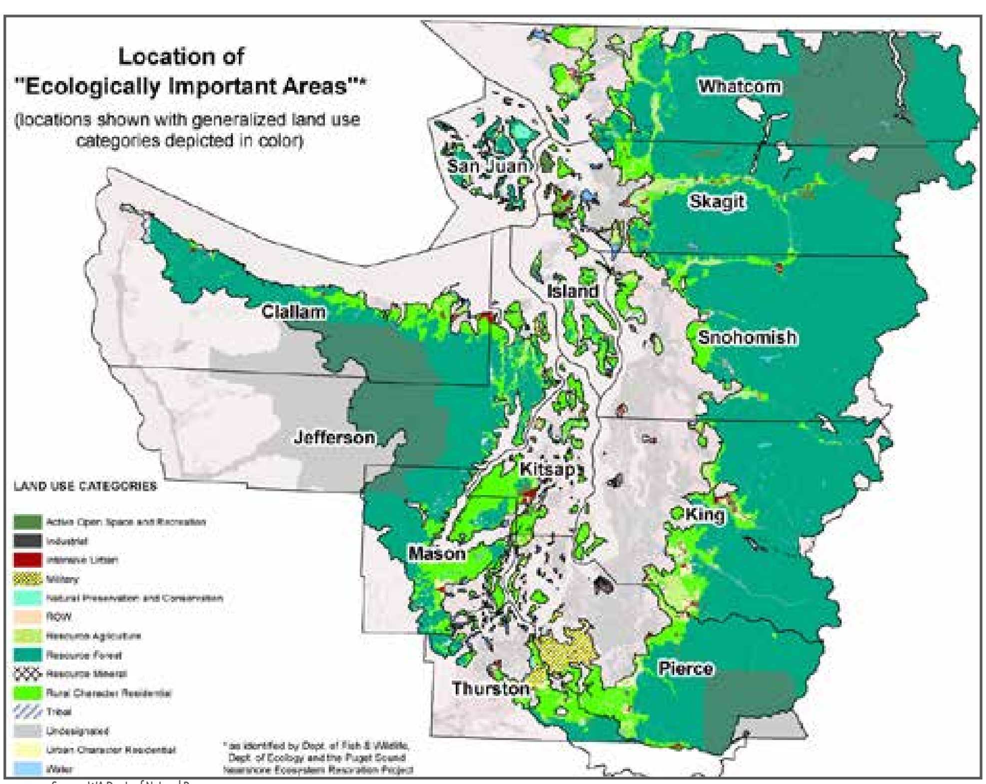
date: 5/2/2017 author: CHRISTOPHER DUNAGAN
full story on the web: eopugetsound.org/magazine/is/land-cover

> ***"It is not too late to make changes that could leave a positive effect on the ecosystem 100 years from now."***
>
> *Doug Peters, watershed planner*
> *WA Department of Commerce*

If you want to protect forests, maintain water quality and restore salmon runs, then you should focus on the cities and urban landscapes of Puget Sound, officials say.

This counterintuitive approach is a key element of a proposed state and federal plan to reduce the rate of new development taking over ecologically important areas. It is known as the "Land Development and Land Cover Implementation Strategy," and it addresses one of the central questions for Puget Sound recovery: Where do we put the millions of people who are now flocking to the region?

Over the past 150 years, Puget Sound has lost more than two-thirds of its old-growth forests, more than 90 percent of its native prairies and nearly 80 percent of its tidal marshes, according to figures from the state's Puget Sound Partnership. Each acre converted from natural landscape to housing and commercial development tends to degrade water quality, increase the risk of flooding and damage fish and wildlife habitats, despite modern land-use regulations designed to minimize damage.



Source: WA Dept. of Natural Resources

But protecting the remaining high-quality habitat is just half of the strategy, says Doug Peters, watershed planner with the Washington State Department of Commerce whose agency helped lead the early planning efforts.

The other half, he said, involves finding less sensitive places where people can live and work — places where people desire to move. That may be easier said than done.

"I think the central battle will be in the urban areas," Peters said, noting that higher-density residential development is needed to protect intact habitat elsewhere. Innovative developers working with state and local governments may be able to create unique urban settings where people would want to live.

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SETTING PRIORITIES

The new strategy is part of a larger effort funded by the Environmental Protection Agency to prioritize and measure Puget Sound recovery. One of its many goals is to slow the rate of development in areas where construction of new houses, roads and utilities is causing the greatest disruption of natural functions.

The strategy's first step was to identify areas that are both ecologically important and under high pressure for conversion to development. An interdisciplinary team of state and federal agencies, NGOs and tribes was brought together to assign ecological values using existing information about hydrology, habitat and biodiversity. Development pressure was scored using factors such as ownership, zoning and long-term legal constraints on the use of property.

After the analysis was completed, some 1.1 million acres, or 12 percent of the entire Puget Sound land area, was assigned the status of "ecologically important lands under high pressure for development." Such lands were judged to be the highest priority for reducing conversion from undeveloped to developed status.

In addition to protecting forests, the state promotes a policy of maintaining agricultural lands. These lands support the regional economy, produce locally grown food and can also protect natural habitat.

"The most achievable path forward is through public-private partnerships," Peters said. "It takes private-sector investment to build things that government can't build.

"I see our historical development patterns as causing most of our problems," he said, pointing out that the major cities were built on the region's most sensitive estuaries with railroad tracks altering the shoreline.

It is not too late to make changes that could leave a positive effect on the ecosystem 100 years from now, Peters said. The costs of protecting ecologically important lands are within reach. But the challenges will only increase as the population continues to grow and future "climate refugees" move into the region to escape harsher climate conditions elsewhere.

"If ever there was a time for concern," Peters said, "that time is now." ■

Railroad tracks run along the shore below Seattle's Carkeek Park.

Photo: Seattle Parks & Recreation (CC BY 2.0)

STRATEGIES FOR CHANGE

State and federal strategies in a nutshell:

- ***Reduce barriers to infill and redevelopment in urban areas:*** *Providing good schools, parks and recreational opportunities while reducing crime in urban areas could go a long way to making urban living more desirable. For developers, incentives could be provided to build compact urban communities. They might include zoning changes, priority permitting, tax incentives and government funding for infrastructure.*

- ***Preserve ecologically important lands:*** *Making sure people understand the higher costs of rural living could help shift market forces. To assist rural landowners and local governments, a big step would be to map ecologically important areas at a scale needed to make decisions about specific properties. Another idea is to require rural residents to pay a greater share of the costs to maintain roads and infrastructure to homes in outlying areas.*

- ***Build regional support to protect ecologically important lands:*** *A strategic plan to protect lands of ecological importance could work to reverse the economic forces that tend to drive development to rural areas. A regional plan would focus on ecological values irrespective of political boundaries. Ideas include purchasing development rights to protect high-value lands, including working farms and forests. Developers could also be allowed to transfer development rights to urban areas, thus protecting rural lands in exchange for higher urban density.*

- ***Develop studies to answer important questions:*** *What does the development community believe will make the greatest difference? Which cities and counties as well as specific land-use regulations are successful at protecting ecologically important lands? What growth patterns will emerge as ecologically important lands are better protected? Does protection of rural lands improve the human quality of life? How will climate change shift the ecological values across the Puget Sound landscape?*

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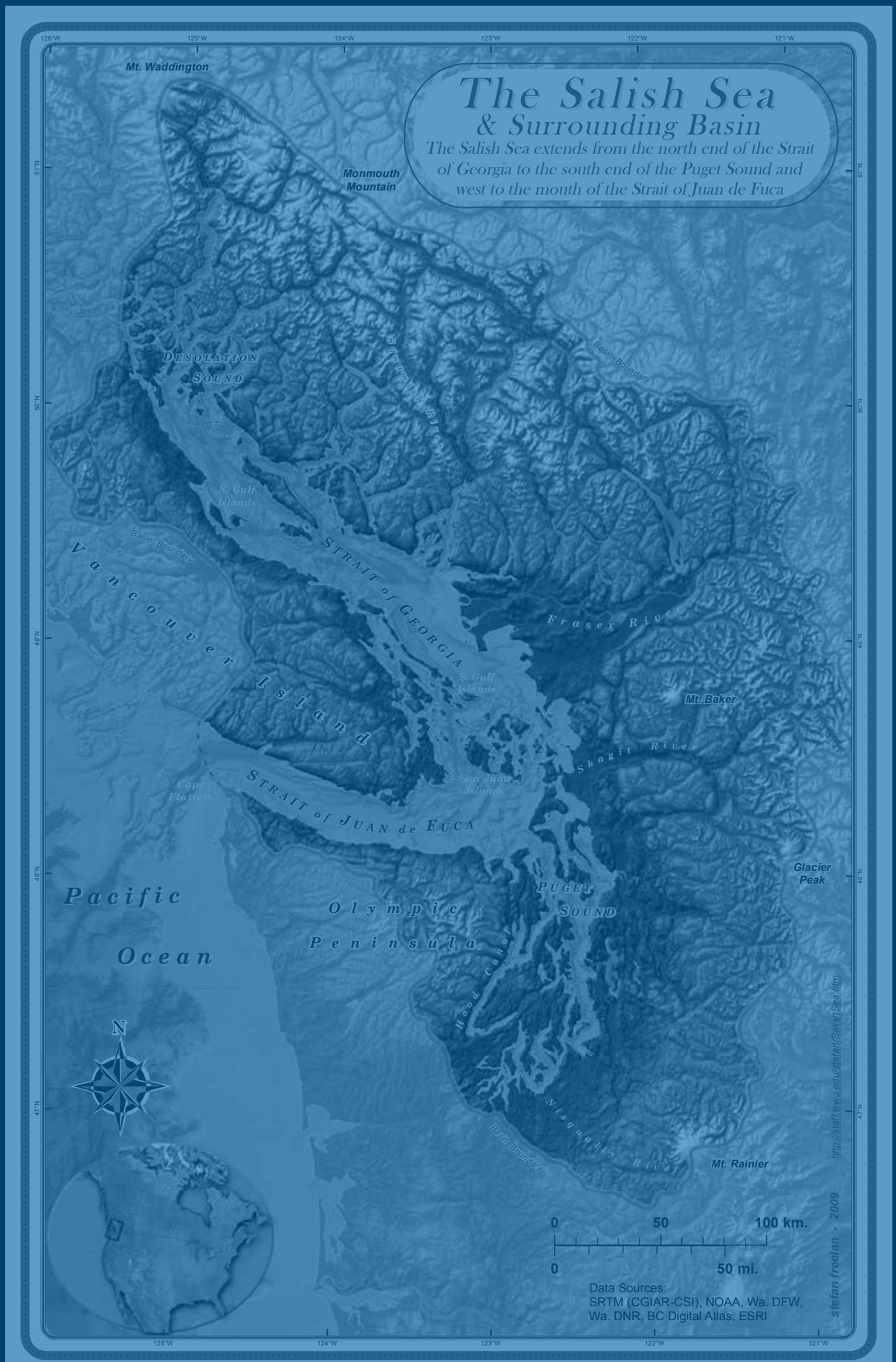
Right, back cover:

Map of the Salish Sea & Surrounding Basin, Stefan Freelan, WWU, 2009.


The Salish Sea
& Surrounding Basin
The Salish Sea extends from the north end of the Strait of Georgia to the south end of the Puget Sound and west to the mouth of the Strait of Juan de Fuca
Mt. Waddington
Monmouth Mountain
Desolation Sound
Basin Boundary
Squamish River
N. Gulf Islands
Basin Boundary
Strait of Georgia
Vancouver Island
Fraser River
S. Gulf Islands
Mt. Baker
Skagit River
San Juan Islands
Cape Flattery
Strait of Juan de Fuca
Glacier Peak
Pacific Ocean
Olympic Peninsula
Puget Sound
Hood Canal
Nisqually River
Basin Boundary
Mt. Rainier
N
0 50 100 km.
0 50 mi.
Data Sources:
SRTM (CGIAR-CSI), NOAA, Wa. DFW, Wa. DNR, BC Digital Atlas, ESRI
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http://staff.washington.edu/stefan/SalishSea.htm

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