Toxic stormwater threats to Puget Sound at the watershed and landscape scales:

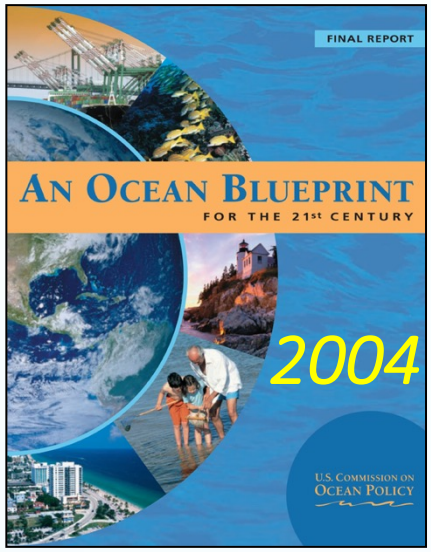
priority information gaps for the recovery of ESA-listed species

Nat Scholz, Julann Spromberg, and Blake Feist
NOAA Fisheries, Northwest Fisheries Science Center

Photo credit: Ken King, USFWS

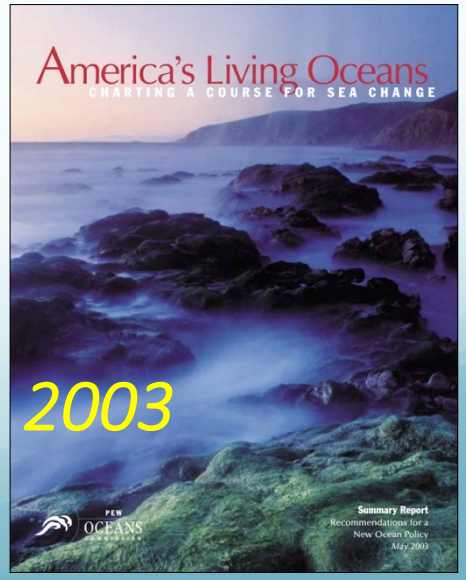
WA Ecology, 6PPD-q Proviso Update,
May 18th, 2022

Non-point source pollution



"Non-point source pollution occurs when rainfall and snowmelt wash pollutants… into our rivers and coastal waters… Our failure to manage the human activities that affect the nation's oceans is compromising their ecological integrity, diminishing our ability to fully realize their potential, costing us jobs and revenue, threatening human health, and putting our future at risk" - U.S. Commission on Ocean Policy

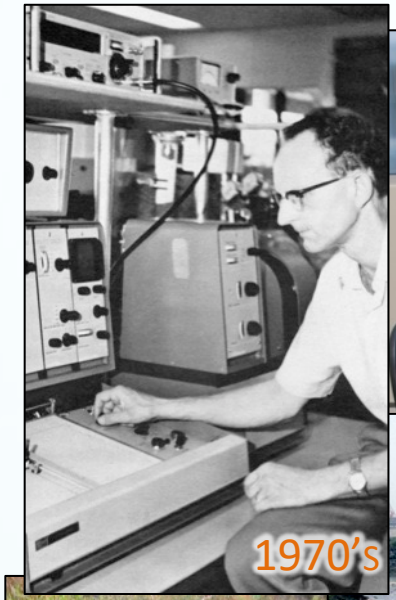
"Today, non-point sources represent the greatest pollution threat to our oceans and coasts… the situation requires that we apply new thinking about the connection between the land and the sea, and the role watersheds play in providing habitat and reducing pollution" - Pew Oceans Commission



These problem/vision statements have guided the past two decades of NOAA stormwater science in the Salish Sea

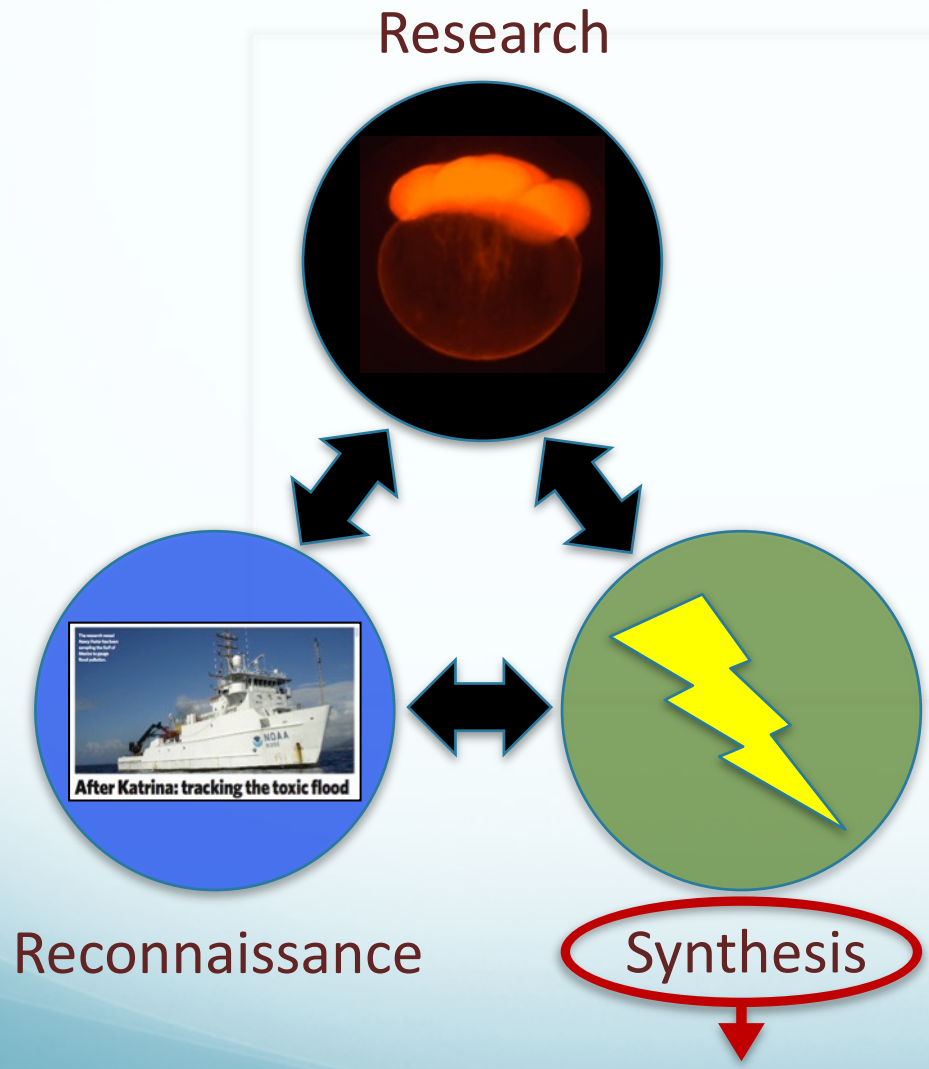
Celebrating 50 years of NWFSC toxics science

"Ecotoxicology" focus launched circa 1972, following the Shi Shi Beach oil spill on the outer Washington Coast



NOAA FISHERIES

The Ecotoxicology Program in a Nutshell



Healthy Habitats
- Water quality threats
- Mitigation effectiveness

Protected Resources
- ESA consultation support
- Risk and vulnerability analysis

Sustainable Fisheries
- Fisheries loss assessment
- Seafood safety

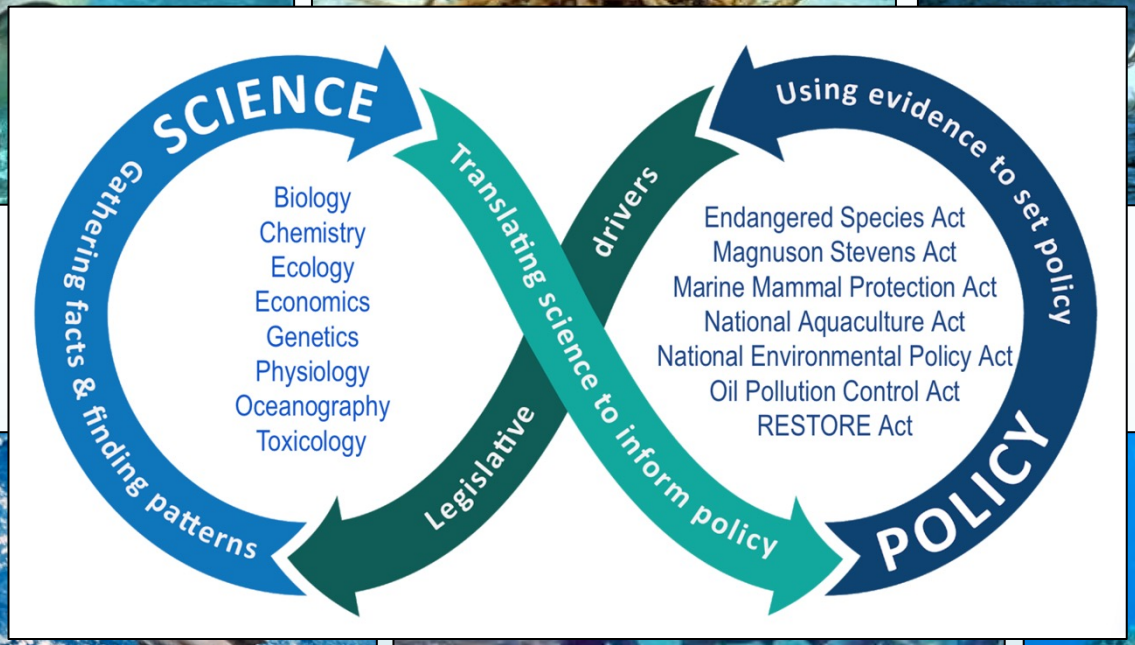
Science Quality and Impact
- Advanced technologies
- Exceptional scientific rigor

CORE OBJECTIVE: identify and minimize coastal and ocean pollution threats to the NMFS stewardship mission – past, present, and future

Policy-science feedback loop for NOAA-F

Habitats and endangered species are major drivers for Ecotox







Relative focus areas for federal agencies

The traditional divide (although lines overlap) is between environmental sources of toxics and impacts on natural resources

SOURCES

- *Track the release of toxic chemicals into the environment, and subsequent fate*
- *Develop high-throughput screens for emerging contaminants*
- *Monitor water quality, develop analytical methods*
- *Characterize emerging toxics via pollution source tracking*
- *Conduct toxicity bioassays on model organisms (e.g., rainbow trout, fathead minnows)*

RESOURCES

- *Identify toxic threats to protected resources, essential fish habitats, and managed fisheries*
- *Assess species-specific risks based on life history and habitat use*
- *Provide "eyes on the ground" surveillance of species and habitats*
- *Incorporate species-specific parallel stressors (e.g., climate change) into study designs*
- *Evaluate pollution impacts across biological scales, from individuals to populations and ecosystems*

The Services contribute much of the "eco" in ecotoxicology

Puget Sound Federal Task Force

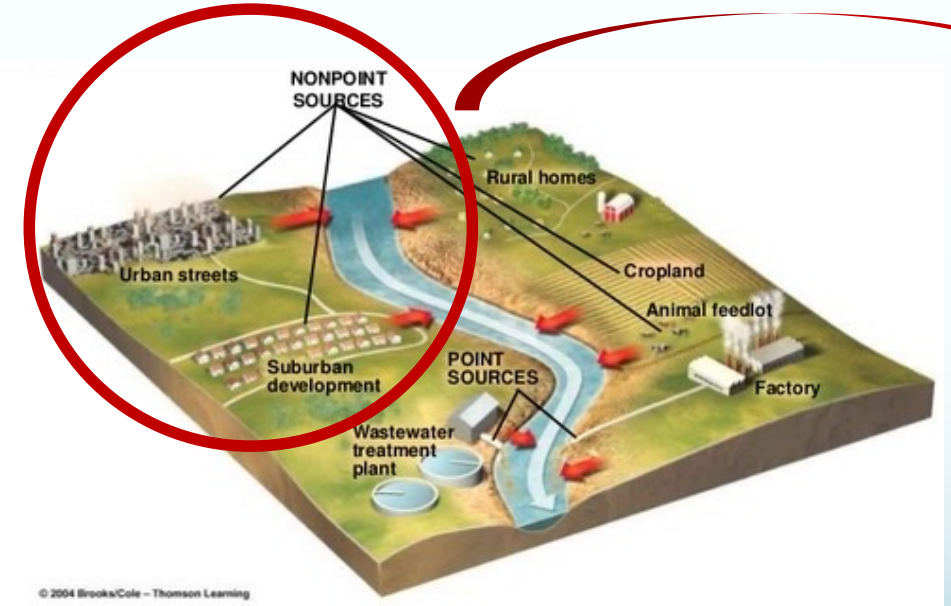
Topics

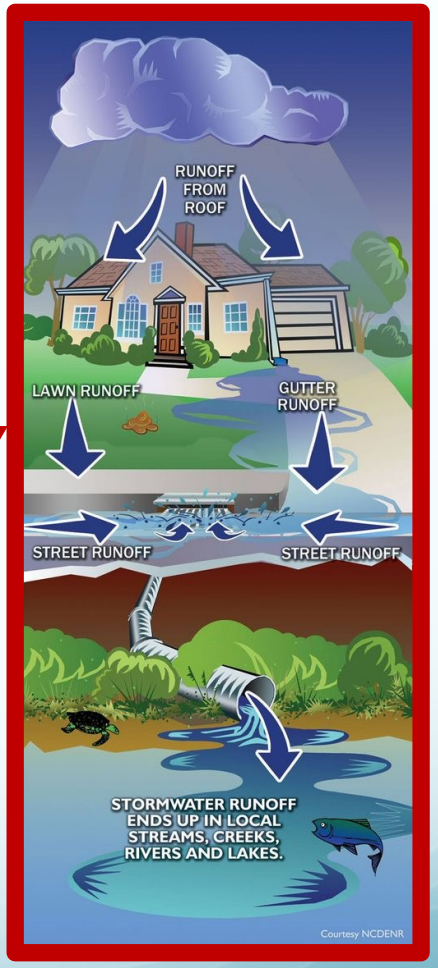
1. PSFTF Co-chairs Overview and Relationship to Treaty Rights
2. Cross-cutting Actions
3. Cross-cutting Habitat Actions
4. Nearshore and Shoreline
5. Floodplains, Riparian and Estuaries
6. Fish Passage
7. Stormwater
8. Shellfish
9. Science and Monitoring
10. Coordination

Crosscutting focus areas for the Puget Sound Federal Action Plan

2017-2021 Federal Action Plan - Stormwater

Stormwater is a major driver of non-point source pollution from forested, agricultural, urban, and suburban land uses. Ongoing Puget Sound federal actions are particularly focused on ***urban runoff***





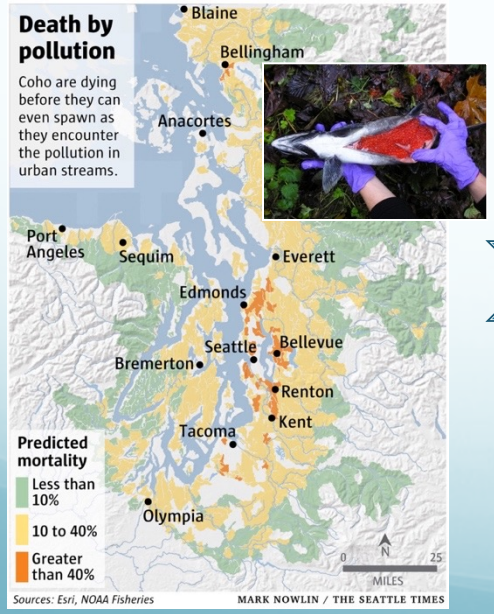
2017-2021 Federal Action Plan - Stormwater

Overarching and shared goals across federal natural resource agencies

1. Define the nature and extent of stormwater threats to Puget Sound

2. Identify affordable and effective clean water mitigation strategies

3. Promote the building of green cities and communities



2017-2021 Federal Action Plan - Stormwater

Accomplishments – spotlight on the coho urban mortality syndrome

1

Define the nature and extent of stormwater threats to Puget Sound

Environmental Science & Technology

Article

Cite This: *Environ. Sci. Technol.* 2018, 52, 10317−10327

pubs.acs.org/est

Using High-Resolution Mass Spectrometry to Identify Organic Contaminants Linked to Urban Stormwater Mortality Syndrome in Coho Salmon

Katherine T. Peter,*[†,‡] Zhenyu Tian,[†,‡] Christopher Wu,[‡] Peter Lin,[‡] Sarah White,[‡] Bowen Du,[∥] Jenifer K. McIntyre,[⊥] Nathaniel L. Scholz,[#] and Edward P. Kolodziej*[†,‡,§]

pubs.acs.org/est

Article

Treading Water: Tire Wear Particle Leachate Recreates an Urban Runoff Mortality Syndrome in Coho but Not Chum Salmon

Jenifer K. McIntyre,* Jasmine Prat, James Cameron, Jillian Wetzel, Emma Mudrock, Katherine T. Peter, Zhenyu Tian, Cailin Mackenzie, Jessica Lundin, John D. Stark, Kennith King, Jay W. Davis, Edward P. Kolodziej, and Nathaniel L. Scholz

Science

EMBARGOED UNTIL 2:00PM US ET, THURSDAY 3 DECEMBER 2020

REPORTS

6PPD/6PPD-quinone

Cite as: Z. Tian *et al.*, *Science* 10.1126/science.abd6951 (2020).

A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon

Zhenyu Tian[1,2], Haoqi Zhao[3], Katherine T. Peter[1,2], Melissa Gonzalez[1,2], Jill Wetzel[4], Christopher Wu[1,2], Ximin Hu[3], Jasmine Prat[4], Emma Mudrock[4], Rachel Hettinger[1,5], Allan E. Cortina[1,2], Rajshree Ghosh Biswas[5], Flávio Vinicius Crizóstomo Kock[5], Ronald Soong[6], Amy Jenne[6], Bowen Du[6], Fan Hou[3], Huan He[3], Rachel Lundeen[1,2], Alicia Gilbreath[7], Rebecca Sutton[7], Nathaniel L. Scholz[4], Jay W. Davis[5], Michael C. Dodd[6], Andre Simpson[3], Jenifer K. McIntyre[4], Edward P. Kolodziej[1,2,3]*

[1]Center for Urban Waters, Tacoma, WA 98421, USA. [2]Interdisciplinary Arts and Sciences, University of Washington Tacoma, Tacoma, WA 98421, USA. [3]Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98195, USA. [4]School of the Environment, Washington State University, Puyallup, WA 98371, USA. [5]Department of Chemistry, University of Toronto, Scarborough Campus, 1265 Military Trail, Toronto, ON M1C1A4, Canada. [6]Southern California Coastal Water Research Project, Costa Mesa, CA 92626, USA. [7]San Francisco Estuary Institute, 4911 Central Avenue, Richmond, CA 94804, USA. [8]Environmental and Fisheries Sciences Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, WA 98112, USA. [9]United States Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, WA 98503, USA.

2

Identify affordable and effective clean water mitigation strategies

Journal of Applied Ecology

Journal of Applied Ecology 2016, **53**, 398–407

doi: 10.1111/1365-2664.12534

Coho salmon spawner mortality in western US urban watersheds: bioinfiltration prevents lethal storm water impacts

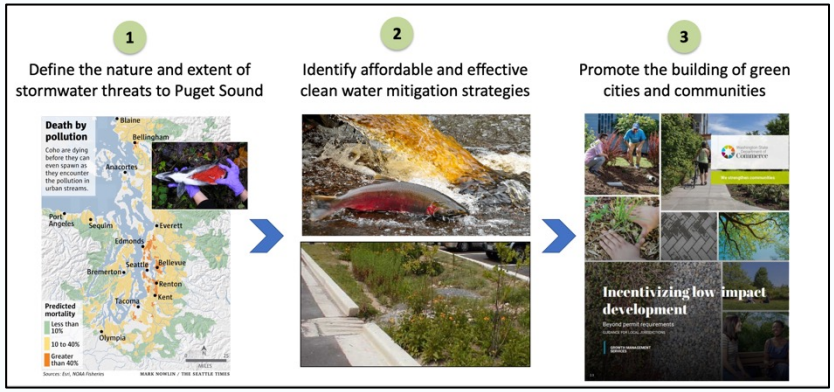
Julann A. Spromberg[1], David H. Baldwin[2], Steven E. Damm[3], Jenifer K. McIntyre[4], Michael Huff[5], Catherine A. Sloan[2], Bernadita F. Anulacion[2], Jay W. Davis[3] and Nathaniel L. Scholz[2]*

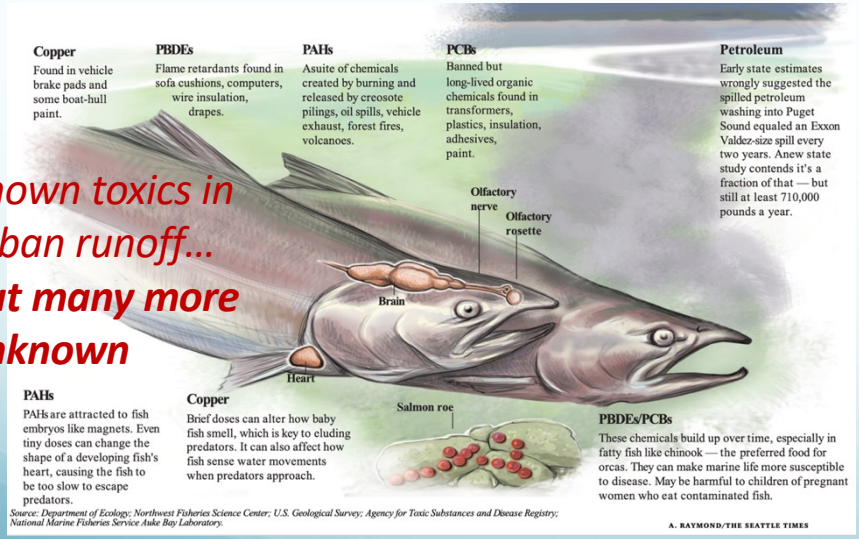
[1]Ocean Associates, Under Contract to Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112, USA; [2]Environmental and Fisheries Science Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112, USA; [3]U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, 510 Desmond Dr. S.E., Lacey, WA 98503, USA; [4]Puyallup Research and Extension Center, Washington State University, 2606 W. Pioneer Ave., Puyallup, WA 98371, USA; and [5]Suquamish Tribe, PO Box 498, 18490, Suquamish Way, Suquamish, WA 98392, USA

3

Promote the building of green cities and communities

2022-2025 Federal Action Plan - Stormwater





Known toxics in urban runoff…
but many more unknown

- Continue research on the large list of unidentified chemicals in urban runoff
- Develop consistent monitoring methods for priority emerging threats (e.g., 6PPD-q)
- Incorporate other major habitat co-stressors (e.g., climate) into salmon vulnerability forecasts

RESEARCH

MANAGEMENT

- Develop and implement effective clean water strategies (watershed and decadal scales)
- Streamline federal interagency consultations under the ESA (e.g., transportation sector)
- Continue close coordination with Tribal comanagers and non-federal stakeholders

Evolving conservation policy and science

Rough timeline	Framing of conservation	Key ideas	Science underpinning
1960–1970	 Nature for itself	Species Wilderness Protected areas	Species, habitats and wildlife ecology
1980–1990	 Nature despite people	Extinction, threats and threatened species Habitat loss Pollution Overexploitation	Population biology, natural resource management
2000–2005	 Nature for people	Ecosystems Ecosystem approach Ecosystem services Economic values	Ecosystem functions, environmental economics
2010	 People and nature	Environmental change Resilience Adaptability Socioecological systems	Interdisciplinary, social and ecological sciences

Mace et al., 2014, Science 345:1558

Foundational U.S. natural resource management laws (CWA, ESA, etc.) passed or amended

Current paradigm

Increasing coordination with tribal partners

Billy Frank Jr., "Being Frank" (2012)

Home | Member Tribes » | About Us » | Publications » | Employment | Contact | Sections »

Stop the slow down to save Puget Sound

Apr 2nd, 2012 • Category: Being Frank

Polluted stormwater runoff is one of the biggest obstacles to salmon recovery and the cleanup of Puget Sound.

Scientists have seen adult coho salmon dying within 24 hours of returning to some polluted urban streams in western Washington. In some cases, 60 to 90 percent of the coho are dying before they can spawn.

What's killing the fish? It's a poison soup of brake pad dust, oil, gasoline and other pollutants that are washed by rain or melting snow from yards, sidewalks, parking lots and roads, right into our streams and Puget Sound.

We need to stop the pollution from getting into our waters in the first place. Prevention is a lot cheaper and more effective in the long run than trying to clean up waters once they are polluted.

Development has changed the way rainwater runs off here in western Washington. Our watersheds were once like giant sponges, absorbing rain in the fall and winter, releasing it slow and steady in the spring and summer. As our watersheds are paved over, rainfall has nowhere to go except downhill. Fast. Winter floods are becoming more intense, causing increased damage to property and salmon habitat, while summer stream flows are becoming too low for salmon returning to spawn.

We know there are ways to grow other than those that hurt salmon. The Nisqually Tribe, for example, is working closely with the Eatonville community to reverse its stormwater impacts on two important salmon tributaries. The aim of the joint project is to completely disconnect the city's stormwater system from the two rivers.

The Tulalip Tribes recently retrofitted a school's stormwater drains on their reservation with low impact design technology. Engineered wetlands help absorb stormwater runoff from the school, while vegetation helps filter pollutants before they can reach Tulalip Bay.

Low impact development reduces impacts to salmon and our environment, and in most cases, it actually costs developers less to do the right thing.

The state Department of Ecology is working toward a stormwater permitting process to help cities and developers stop polluted runoff from getting into our waters. One way is by requiring low impact development practices that help preserve the natural conditions that we still have left in our watersheds.

These stormwater permits have already been delayed by the political process. They need to move forward, and soon. Puget Sound chinook have been on the Endangered Species Act list for more than a decade, yet there have been no substantial improvements to the environmental laws that got us into the problem to begin with. That needs to change, and the stormwater permitting process is a step in the right direction.

Billy Frank Jr. is the chairman of the Northwest Indian Fisheries Commission.

RELATED STORIES

- Grovers Creek coho used for testing pre-spawning mortality causes
- Tulalip Tribes to build wetland as stormwater filter
- Tulalip Tribes engineer wetlands to treat stormwater
- Piling on Puget Sound (Part 3): Comments against cumulative impacts
- Squaxin Island Tribe Further Testing Mushrooms as Water Quality Solution

MORE FROM BEING FRANK

- Stop the slow down to save Puget Sound
- Traditional foods are treaty foods
- We need to win the battle for salmon recovery
- Salmon are for everyone
- It's time to stand up for clean seafood

BROWSE BY SECTION

- Being Frank
- News
- NWIFC Blog
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- Employment
- Annual Report
- Muckleshoot Tribe
- Nisqually Indian Tribe
- Nooksack Tribe

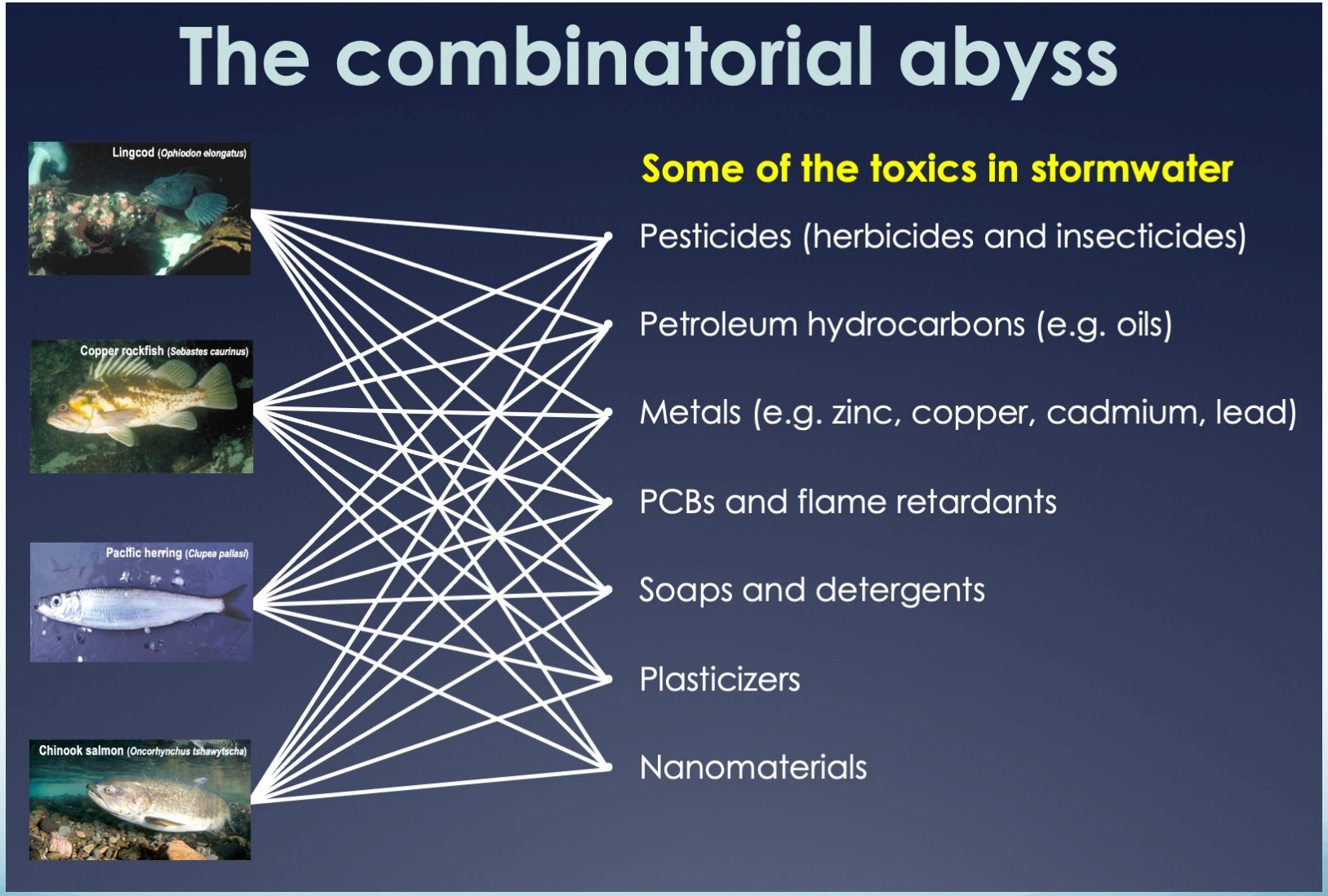
LINKS

"Polluted stormwater runoff is one of the biggest obstacles to salmon recovery…"

"Low impact development reduces impacts to salmon and our environment…"

"Vanishing Salmon" by Susan Point (1998)

Chemical complexity of stormwater science



★ Historical perspective – 2010 ★

★ Historical perspective – 2010 ★

The impacts of toxic runoff…

What are they?
How can they be minimized?
How do we make good decisions going forward?

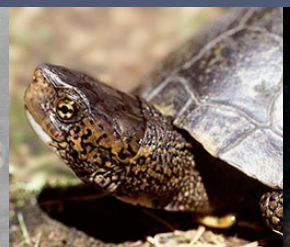
We need appropriate indicators and, specifically, *sentinel species*…

What makes a good stormwater sentinel?

- **Wide distribution** ★ Historical perspective – 2010 ★
- **Lives in habitats impacted by stormwater**
- **Sensitive to toxic runoff**
- **A good ambassador for biological communities**
- **Practical for monitoring and research**
- **A warning system for human health**
- **A species the public cares about**

? ? ? ? ? ?





Introducing… coho salmon

★ Historical perspective – 2010 ★

- Widely distributed
- Lowland streams
- > 1 yr in freshwater
- Supported by a diverse food web
- Sensitive to water quality & quantity
- Species of Concern

If we protect coho, we'll (likely) protect the health of estaurine habitats

- Coho freshwater habitats are conduits for non-point source pollution
- Major toxics loadings reductions may be necessary to ensure sustainable coho populations
- This would reduce the need to evaluate the impacts of stormwater on estuarine/marine species

★ Historical perspective – 2010 ★

As a sentinel species, coho…

- Simplify the narrative – what needs to be done to reduce toxic runoff to the extent coho viability is ensured?

- Focus limited scientific resources on key information gaps – what do we still need to know?

- Provide biological context for evaluating the effectiveness of pollution control measures – do they work?

- Exemplify an ecosystem-based approach to stormwater management

- Serve as a familiar icon to stimulate public awareness and engagement

★ Historical perspective – 2010 ★

Watershed Teacher Training Program

★ Historical perspective – 2012 ★



- NOAA Bay-Watershed Education and Training funding
- Translating research to education and service-learning

A Partnership Between
Service, Education, and Adventure (SEA)
and
Edmonds Community College Learn and Serve
Environmental Anthropology Field (LEAF) School

S·E·A
SERVICE • EDUCATION • ADVENTURE

Environmental Anthropology Field-School
Edmonds Community College

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Salmon-Safe Certification

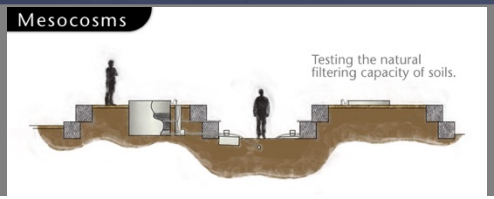
★ Historical perspective – 2012 ★

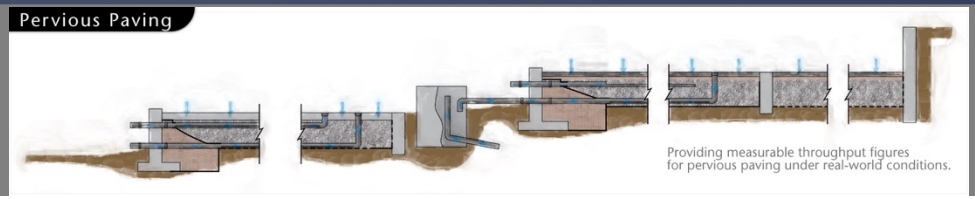
- Applying NOAA research findings on stormwater impacts
- Developing local incentives for pollution reduction
- Promoting public outreach and education

Evaluating the Effectiveness of Low Impact Development

- New research facility under construction
- Integrate stormwater engineering, landscape architecture, soil chemistry, botany, toxicology, etc.
- Identify cost-effective solutions that work
- Scale these to local communities throughout Puget Sound

★ Historical perspective – 2012 ★





Puyallup Research and Extension Center

LID/Stormwater Management Project

In partnership with the City of Puyallup and the Washington Department of Ecology

WASHINGTON STATE UNIVERSITY

Urban redevelopment and pollution source control

RESTORE OUR WATERS

High Point Revitalization

- Novel technologies for use in the built environment
- Urban watersheds are revealing the challenges ahead

★ Historical perspective – 2012 ★

Seattle Public Utilities

SEA Street: 98% retention

Coho as sentinels for toxic runoff

Fall 2000

Katherine Lynch, Seattle Public Utilities

Fall 2014

Puget Soundkeeper Alliance

Pre-spawn mortality in adult female coho – nearly 100% egg retention in carcasses (unspawned).

The coho urban runoff mortality syndrome: initial findings

1

OPEN ACCESS Freely available online

PLoS one

Recurrent Die-Offs of Adult Coho Salmon Returning to Spawn in Puget Sound Lowland Urban Streams

Nathaniel L. Scholz[1]*, Mark S. Myers[1], Sarah G. McCarthy[2], Jana S. Labenia[1], Jenifer K. McIntyre[1], Gina M. Ylitalo[1], Linda D. Rhodes[1], Cathy A. Laetz[1], Carla M. Stehr[1], Barbara L. French[1], Bill McMillan[3], Dean Wilson[2], Laura Reed[4], Katherine D. Lynch[4], Steve Damm[5], Jay W. Davis[5], Tracy K. Collier[1]

1 Northwest Fisheries Science Center, NOAA Fisheries, Seattle, Washington, United States of America, **2** Department of Natural Resources and Parks, King County, Seattle, Washington, United States of America, **3** Wild Fish Conservancy, Duvall, Washington, United States of America, **4** Seattle Public Utilities, City of Seattle, Seattle, Washington, United States of America, **5** Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service, Lacey, Washington, United States of America

2

OPEN ACCESS Freely available online

PLoS one

Landscape Ecotoxicology of Coho Salmon Spawner Mortality in Urban Streams

Blake E. Feist[1]*, Eric R. Buhle[1], Paul Arnold[2], Jay W. Davis[2], Nathaniel L. Scholz[1]

1 Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Washington, United States of America, **2** Washington Fish and Wildlife Office, United States Fish and Wildlife Service, Lacey, Washington, United States of America

3

Integrated Environmental Assessment and Management — Volume 7, Number 4—pp. 648–656

Estimating the Future Decline of Wild Coho Salmon Populations Resulting from Early Spawner Die-Offs in Urbanizing Watersheds of the Pacific Northwest, USA

Julann A Spromberg† and Nathaniel L Scholz†*

†National Oceanic and Atmospheric Administration (NOAA) Fisheries, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington 98112, USA

As-yet unidentified toxics in stormwater are likely killing coho salmon. Yearly mortality rates are often high – i.e. > 70% of a total run.

Mortality is closely associated with land cover (urbanization). Many Puget Sound watersheds are currently at risk.

Wild coho salmon cannot withstand the high rates of annual spawner die-offs observed in urban/urbanizing watersheds since 2000.

Near-term research priorities (NOAA)

Determine relative risks to other west coast salmonids – particularly steelhead and Chinook

coho

chum

Untreated urban runoff AND tire leachate is acutely lethal to adult coho <u>but not chum</u>

Environmental Pollution 238 (2018) 196–203

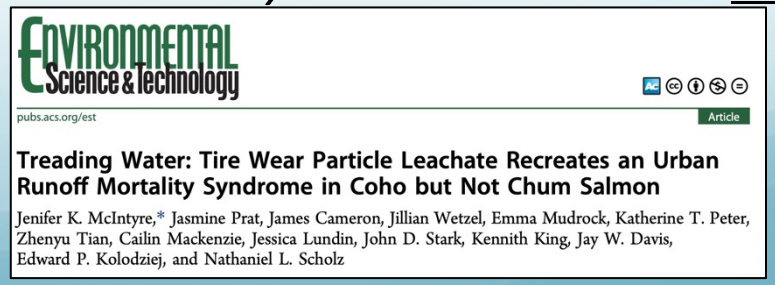
Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Interspecies variation in the susceptibility of adult Pacific salmon to toxic urban stormwater runoff*

Jenifer K. McIntyre [a, *], Jessica I. Lundin [b], James R. Cameron [c], Michelle I. Chow [d], Jay W. Davis [e], John P. Incardona [f], Nathaniel L. Scholz [f]



Environmental Science & Technology

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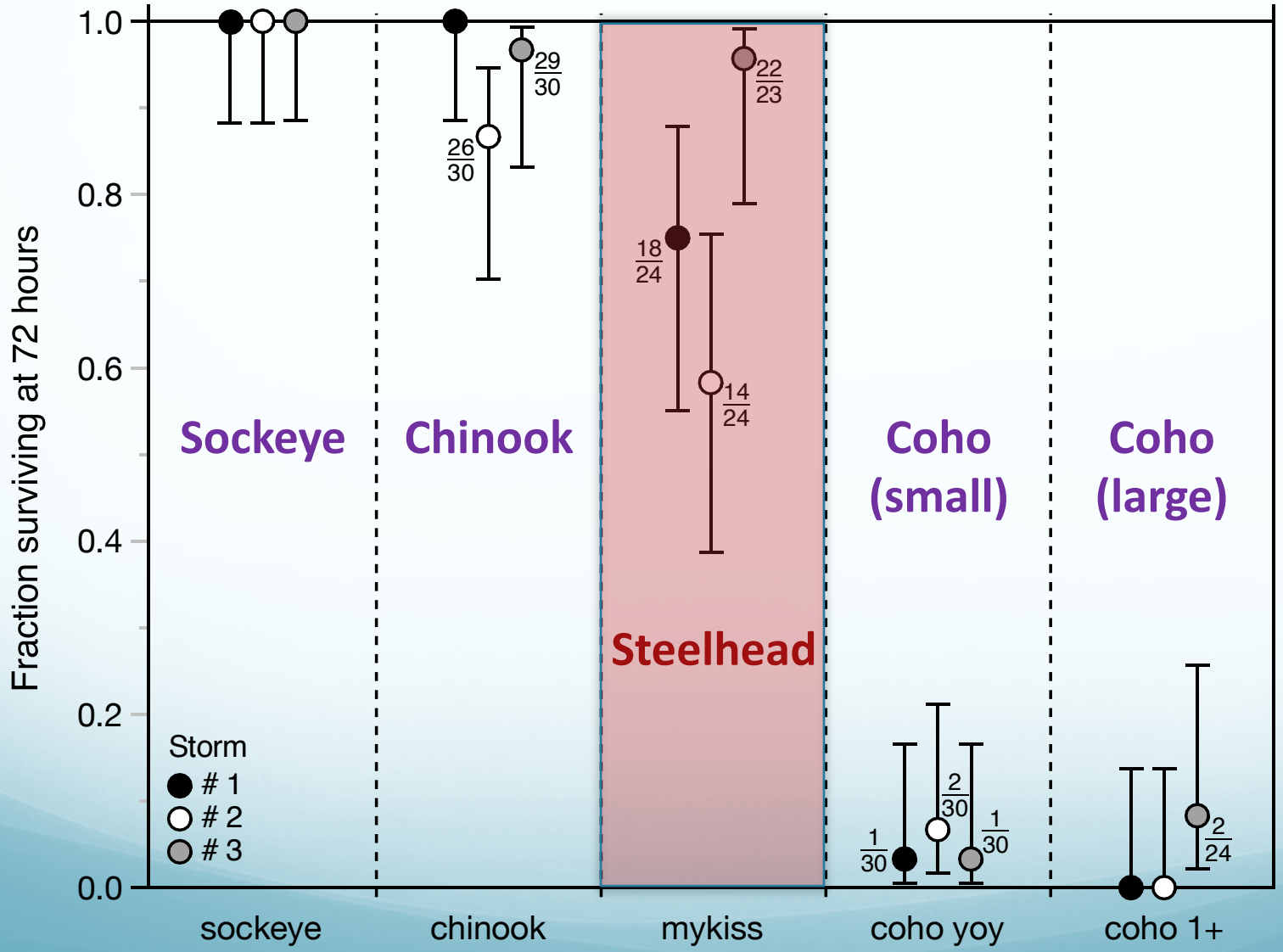
Article

Treading Water: Tire Wear Particle Leachate Recreates an Urban Runoff Mortality Syndrome in Coho but Not Chum Salmon

Jenifer K. McIntyre,* Jasmine Prat, James Cameron, Jillian Wetzel, Emma Mudrock, Katherine T. Peter, Zhenyu Tian, Cailin Mackenzie, Jessica Lundin, John D. Stark, Kennith King, Jay W. Davis, Edward P. Kolodziej, and Nathaniel L. Scholz

Lethality in steelhead and Chinook

Juvenile salmonids exposed to runoff from three separate storms



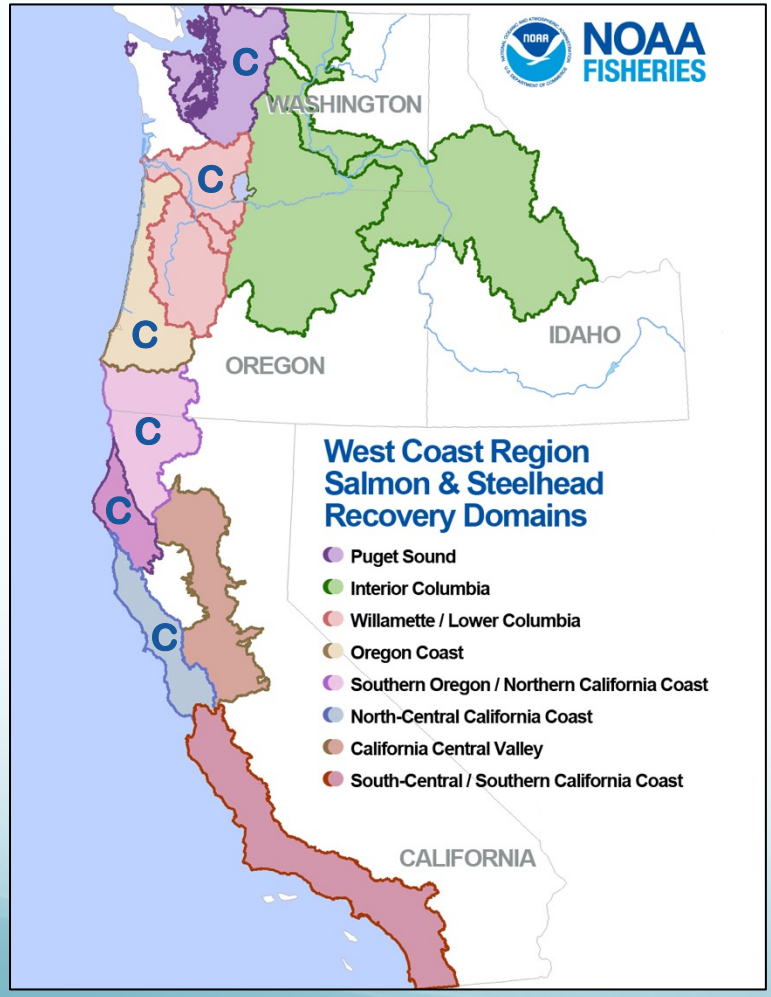
100% survival

100% mortality

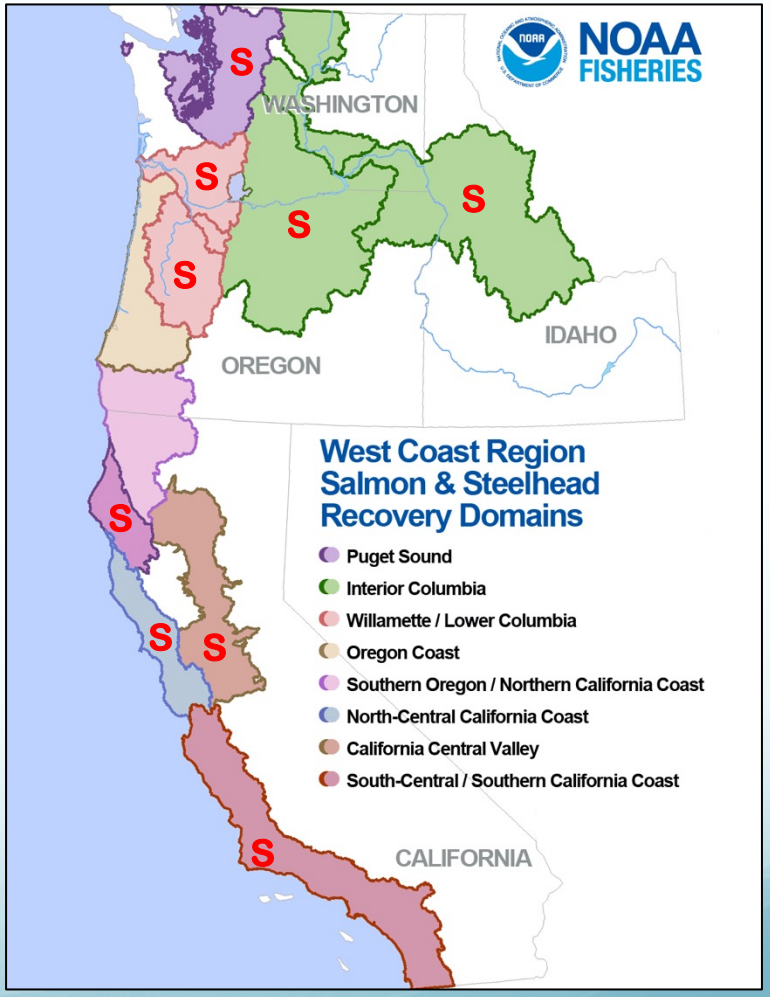
French et al.., manuscript in NWFSC internal review

Recovery domains for coho and steelhead

Between the two species, nearly all of the U.S. West Coast domains



COHO

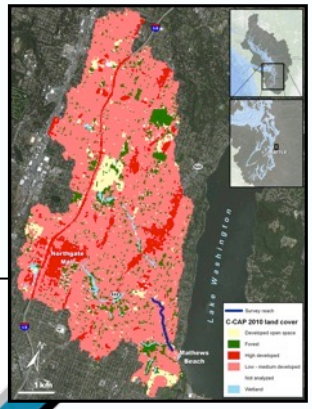


STEELHEAD

Basin-wide vulnerability forecasting

Field survey data (coho spawner mortality)

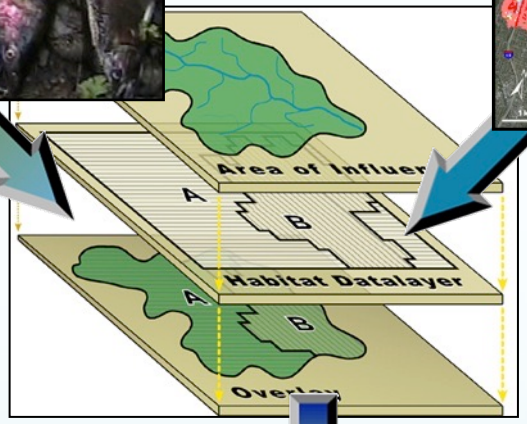
Land cover data



MODEL OVERVIEW

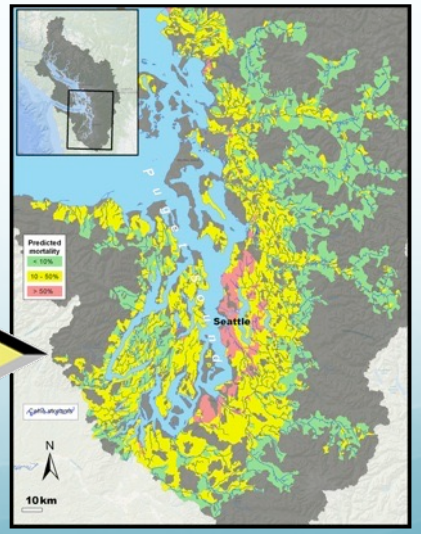
Geospatial analyses

Blake Feist



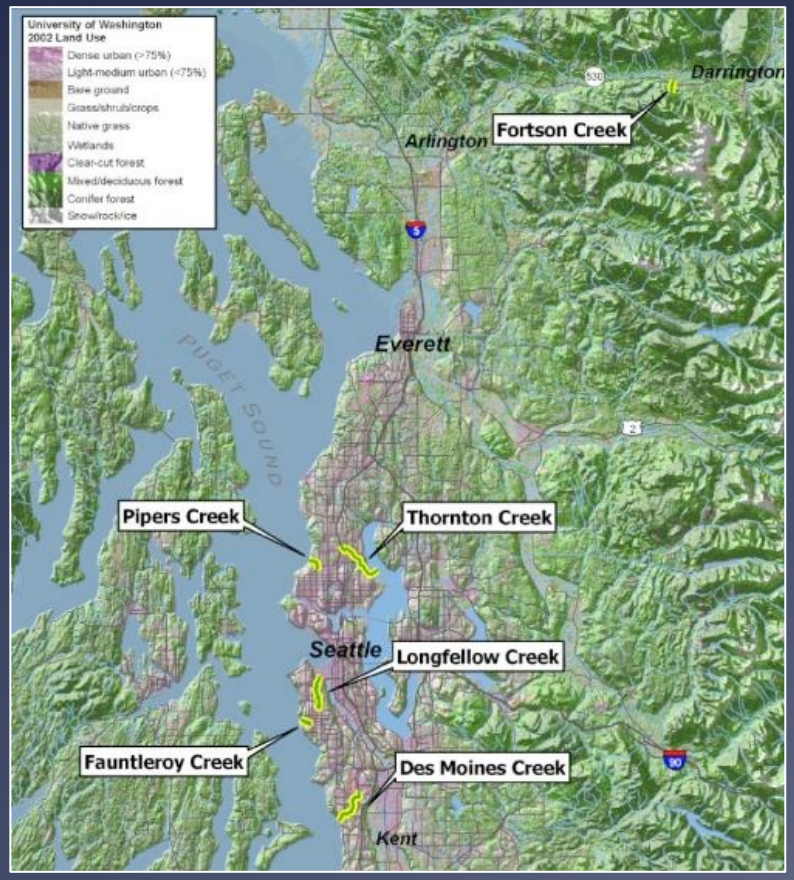
Statistical analyses and modeling

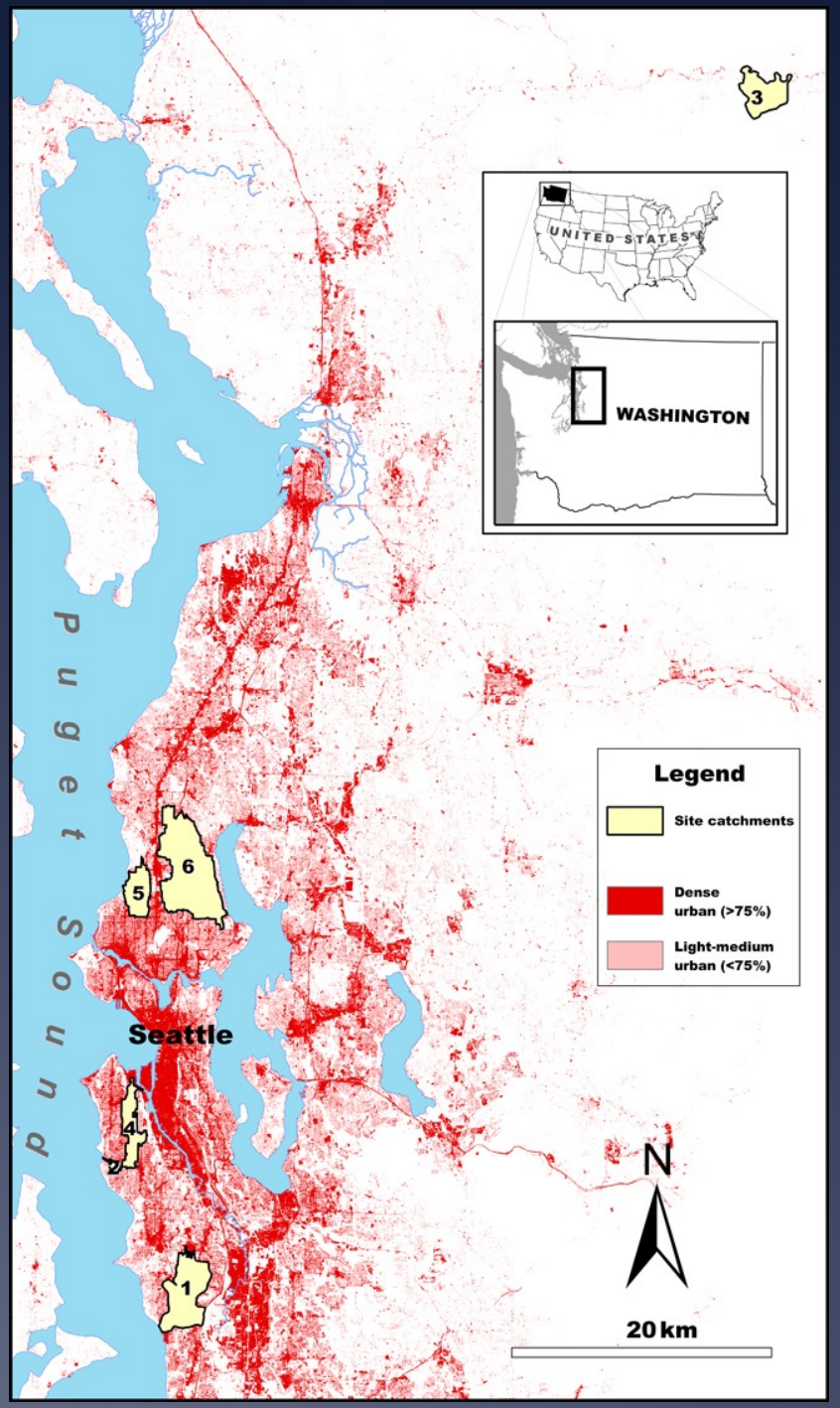
Eric Buhle

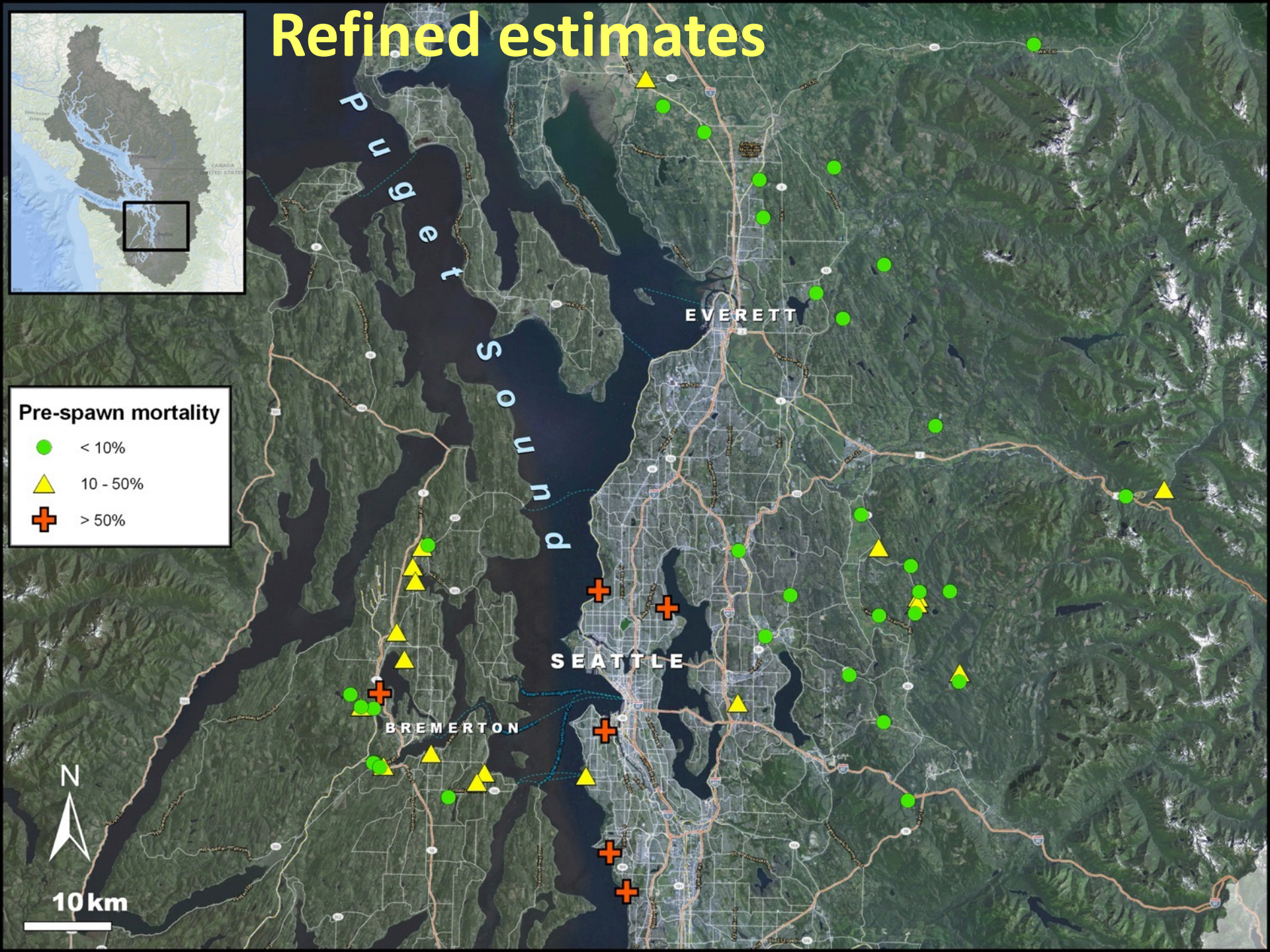


Predictive model for coho die-offs in Puget Sound watersheds

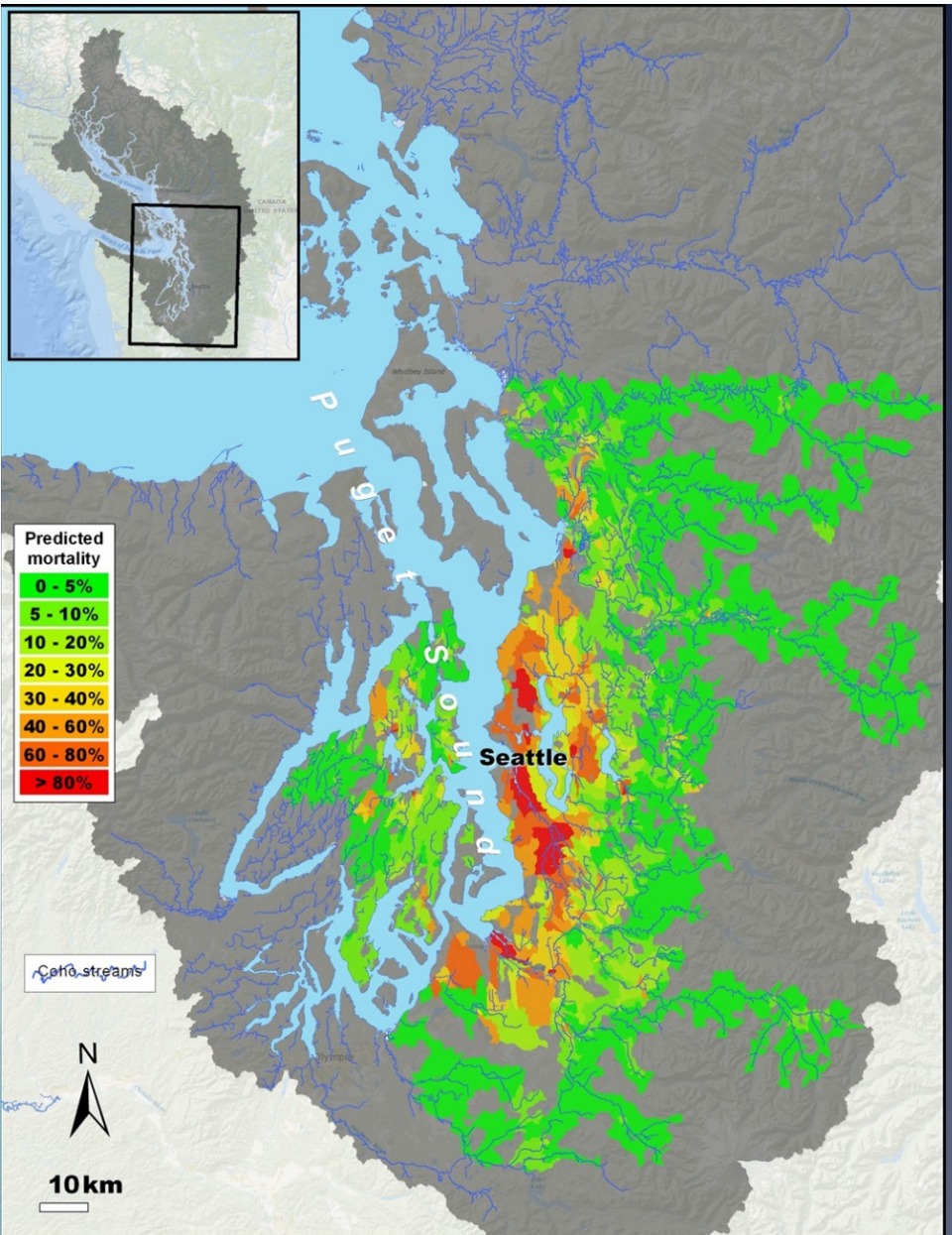
Study sites


University of Washington
2002 Land Use
Dense urban (>75%)
Light-medium urban (<75%)
Bare ground
Grass/shrub/crops
Native grass
Wetlands
Clear-cut forest
Mixed/deciduous forest
Conifer forest
Snow/rock/ice
Darrington
Arlington
Fortson Creek
Everett
PUGET SOUND
Pipers Creek
Thornton Creek
Seattle
Longfellow Creek
Fauntleroy Creek
Des Moines Creek
Kent

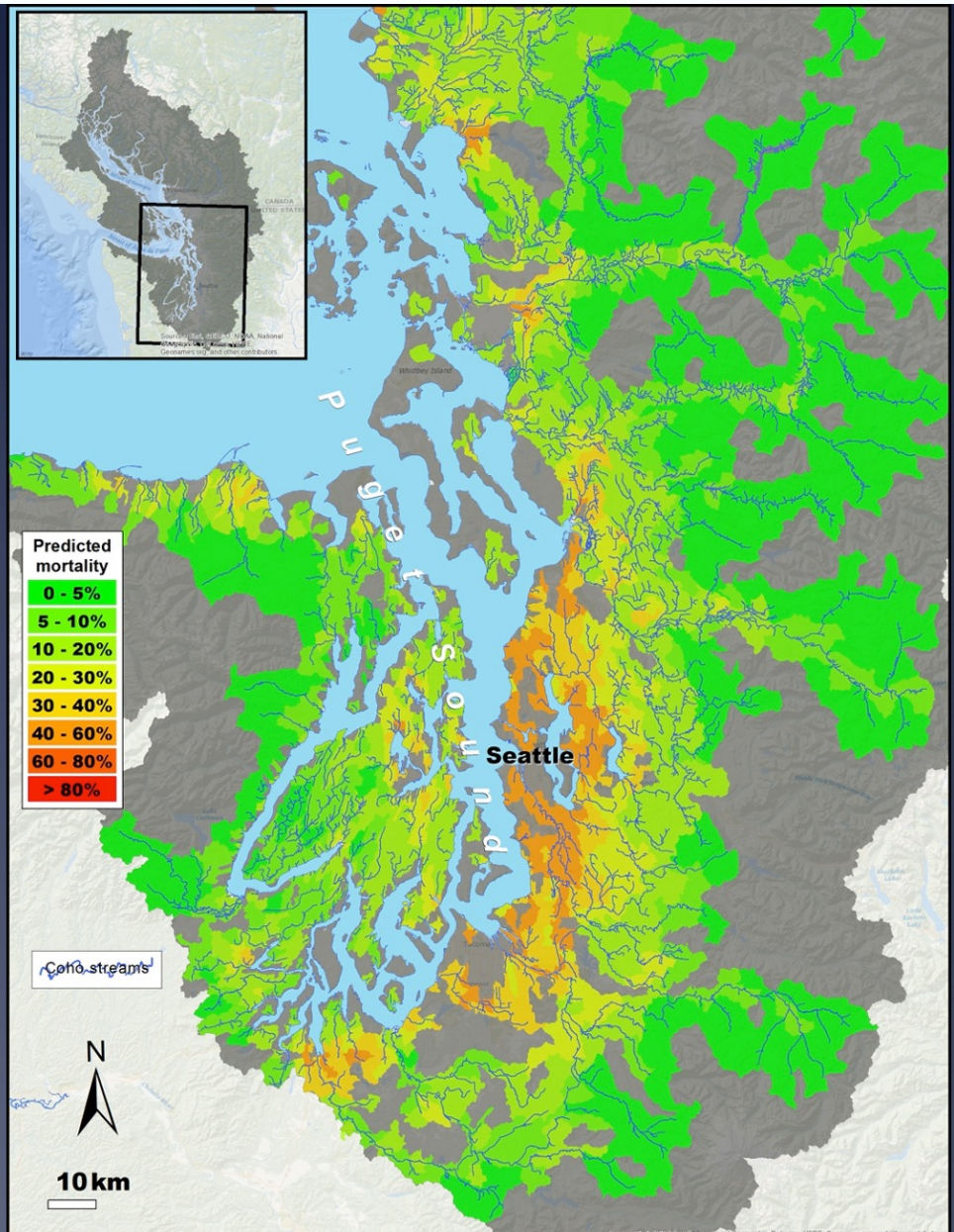

3
UNITED STATES
WASHINGTON
Legend
Site catchments
Dense urban (>75%)
Light-medium urban (<75%)
Puget Sound
6
5
Seattle
4
2
1
N
20 km


Refined estimates
Puget Sound
EVERETT
SEATTLE
BREMERTON
Pre-spawn mortality
< 10%
10 - 50%
> 50%
N
10 km

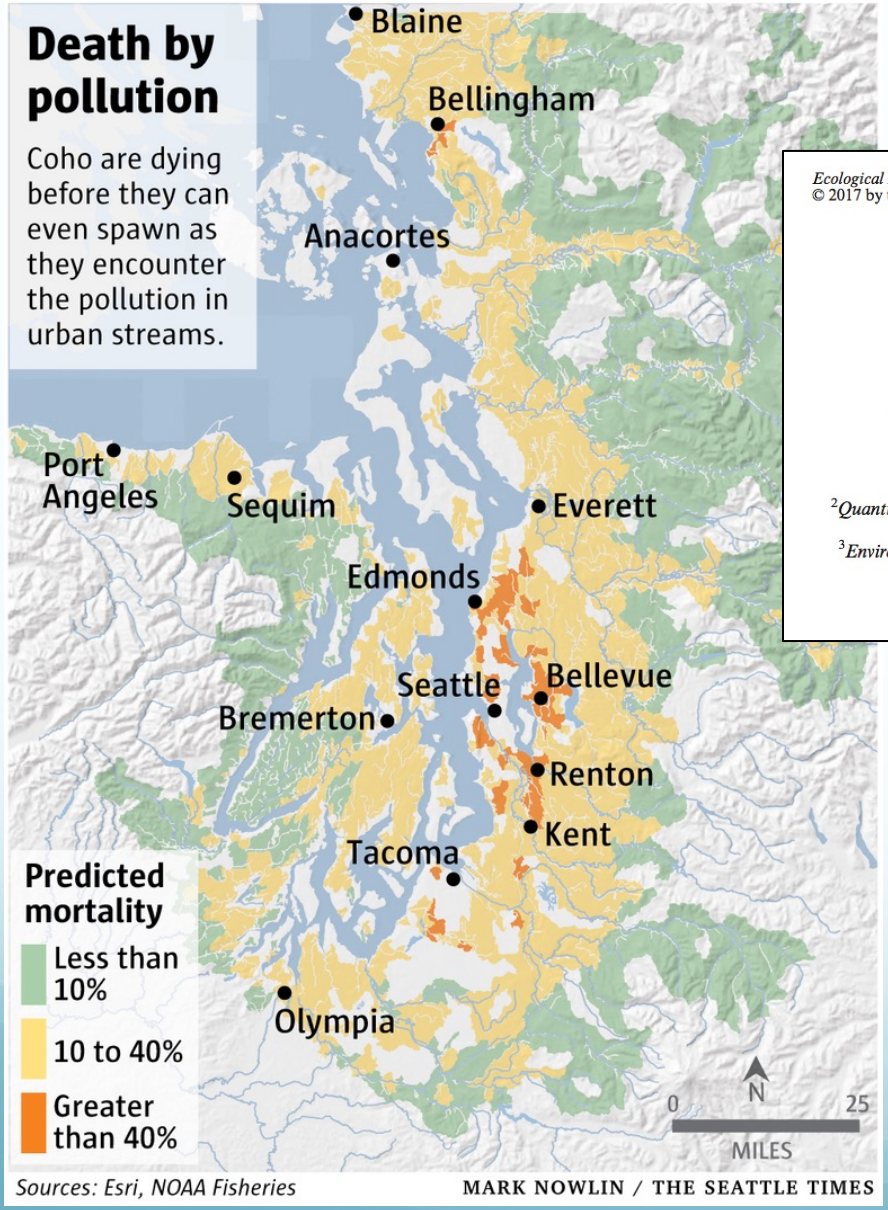
Version 1



Version 2



Mortality hotspot mapping for coho



Ecological Applications, 27(8), 2017, pp. 2382–2396

Roads to ruin: conservation threats to a sentinel species across an urban gradient

BLAKE E. FEIST,[1,5] ERIC R. BUHLE,[2] DAVID H. BALDWIN,[3] JULANN A. SPROMBERG,[3] STEVEN E. DAMM,[4] JAY W. DAVIS,[4] AND NATHANIEL L. SCHOLZ[3]

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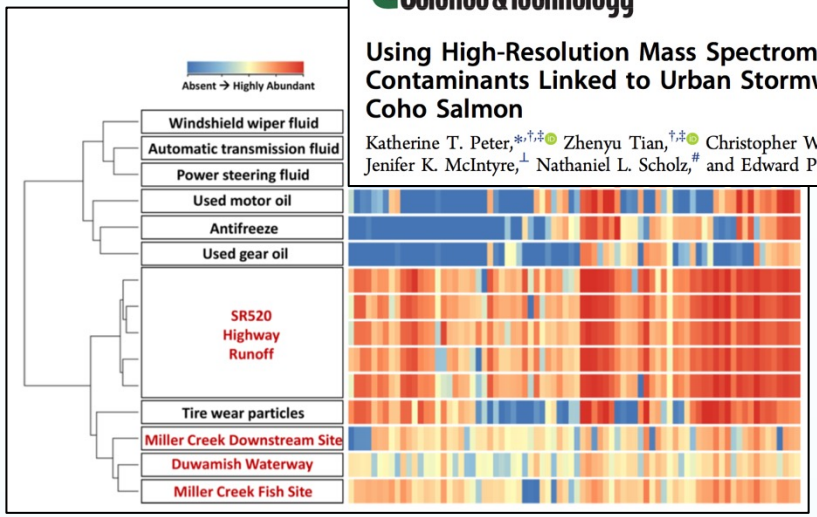
[3]*Environmental and Fisheries Sciences Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, Washington 98112 USA*
[4]*Washington Fish and Wildlife Office, United States Fish and Wildlife Service, 510 Desmond Drive SE, Lacey, Washington 98392 USA*

So… what's killing the coho?

A decade ago, two major research obstacles

Analytical chemistry approaches to break complex stormwater mixtures into component chemical constituents

High throughput methods focused on juvenile salmonids



Environmental Science & Technology
Article
Cite This: Environ. Sci. Technol. 2018, 52, 10317−10327
pubs.acs.org/est

Using High-Resolution Mass Spectrometry to Identify Organic Contaminants Linked to Urban Stormwater Mortality Syndrome in Coho Salmon

Katherine T. Peter,*[,†,‡] Zhenyu Tian,[†,‡] Christopher Wu,[‡] Peter Lin,[‡] Sarah White,[‡] Bowen Du,[∥] Jenifer K. McIntyre,[⊥] Nathaniel L. Scholz,[#] and Edward P. Kolodziej[†,‡,§]

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journal homepage: www.elsevier.com/locate/aqtox

An urban stormwater runoff mortality syndrome in juvenile coho salmon

Michelle I. Chow[a], Jessica I. Lundin[b], Chelsea J. Mitchell[c], Jay W. Davis[d], Graham Young[a], Nathaniel L. Scholz[e], Jenifer K. McIntyre[c,*]

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[b] National Research Council Research Associateship Program, Under contract to Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112, USA
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[d] U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, 510 Desmond Dr. S.E., Lacey, WA 98503, USA
[e] Environmental and Fisheries Science Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 2725 Montlake Blvd. E., Seattle, WA 98112, USA

Motor vehicles: sources of thousands of distinct and potentially toxic chemicals

Oil, grease, exhaust, tires, etc.

A novel tire-derived chemical enters the salmon habitat picture

EMBARGOED UNTIL 2:00PM US ET, THURSDAY 3 DECEMBER 2020

Science

REPORTS

Cite as: Z. Tian *et al.*, *Science* 10.1126/science.abd6951 (2020).

6PPD-quinone

A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon

Zhenyu Tian[1,2], Haoqi Zhao[3], Katherine T. Peter[1,2], Melissa Gonzalez[1,2], Jill Wetzel[4], Christopher Wu[1,2], Ximin Hu[3], Jasmine Prat[4], Emma Mudrock[4], Rachel Hettinger[1,2], Allan E. Cortina[1,2], Rajshree Ghosh Biswas[5], Flávio Vinicius Crizóstomo Kock[5], Ronald Soong[5], Amy Jenne[5], Bowen Du[6], Fan Hou[3], Huan He[3], Rachel Lundeen[1,2], Alicia Gilbreath[7], Rebecca Sutton[7], Nathaniel L. Scholz[8], Jay W. Davis[9], Michael C. Dodd[3], Andre Simpson[5], Jenifer K. McIntyre[4], Edward P. Kolodziej[1,2,3]*

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***Corresponding author. Email: koloj@uw.edu**

In U.S. Pacific Northwest coho salmon (*Oncorhynchus kisutch*), stormwater exposure annua unexplained acute mortality when adult salmon migrate to urban creeks to reproduce. By i phenomenon, we identified a highly toxic quinone transformation product of N-(1,3-dimethy phenyl-p-phenylenediamine) (6PPD), a globally ubiquitous tire rubber antioxidant. Retrosp of representative roadway runoff and stormwater-impacted creeks of the U.S. West Coast i widespread occurrence of 6PPD-quinone (<0.3-19 μg/L) at toxic concentrations (LC_{50} of 0. These results reveal unanticipated risks of 6PPD antioxidants to an aquatic species and im relevance for dissipated tire rubber residues.

More people, development, traffic, and pollution are coming to coastal watersheds

Opinion

The Seattle Times

How the great outdoors, and great cities, can coexist in our Pacific Northwest

By Gene Duvernoy

July 26, 2019 at 12:54 pm | *Updated July 30, 2019 at 10:54 am*

Special to The Times

September 29th, 2019 | Lynda V. Mapes

In California, orcas and salmon have become so scarce people have forgotten what once was. Will the Northwest be next?

VIEW

In the final installment of our special report Hostile Waters, we travel south to California, where memories of what once was are fading, and to places closer to home, where orcas bursting through the water are still a sight to behold — but for how long?

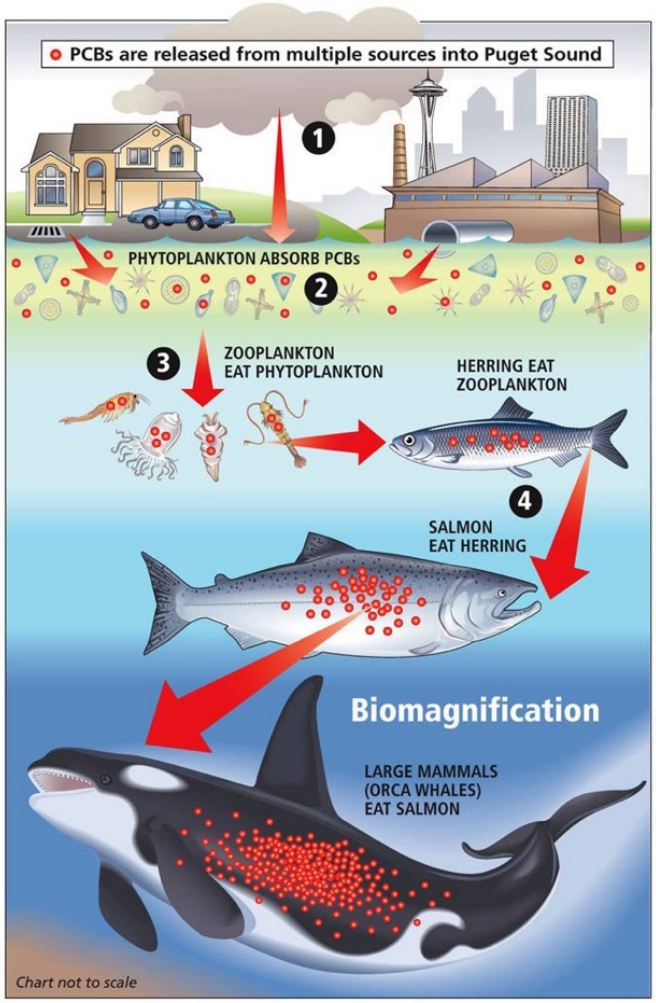
Climate change and stormwater intersect

- Water quantity – the 1960's adage "the solution to pollution is dilution" no longer applies (if it ever did)
- Changing weather – stormwater and other forms of non-point source pollution are driven by the timing and intensity of seasonal rainfall events
- Water temperatures – thermal stress and the influence of temperature on toxic uptake, metabolism, and synergism
- Other parallel stressors – e.g., ocean acidification

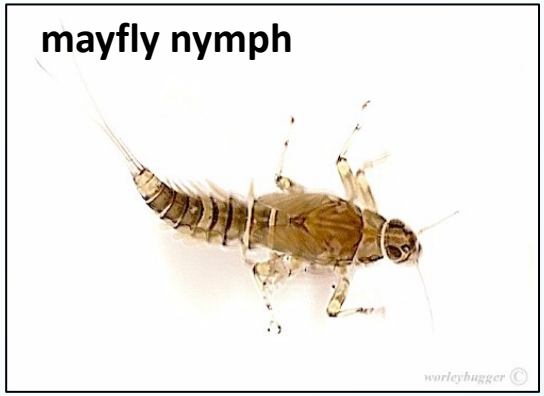
Also, emerging indirect forces that can be unpredictable, because they are driven by the behavior of humans (e.g., climate migration)

Near-term research priorities (NOAA-F)

Establish and validate new analytical methods for monitoring 6PPD-q and related chemicals in the the environment



WATERS I SEDIMENTS I TISSUES



Future landscape analyses – more than roads

Need to consider the landscape context in which a given road is located

- Varying transport pathways between roads and receiving surface waters (pipes vs. ditches, grey vs. green infrastructure)
- Influence of nearby wetlands and other natural buffers
- Local geomorphology and soil composition, as determinants of infiltration

Several of these factors may reduce the relative exposure risk for toxics in rural (vs. urban) areas

Near-term research priorities (NOAA)

Ensure poor upstream water quality doesn't undermine ongoing habitat restoration efforts (i.e., culvert removal)

Example of urban salmon habitat improvement efforts led by Seattle Public Utilities in the late 1990s (culvert replacement, Taylor Creek)

Pre-Restoration (1999)

Post-Restoration (2000)

Habitat-related efforts for salmon conservation should include careful review of site-specific physical, biological, and chemical threats to aquatic communities

Near-term research priorities (NOAA-F)

Future NOAA science will inform and support regional species recovery through two distinct but inter-related tracks:

1. Recovery planning at the scale of Evolutionary Significant Units, or Distinct Population Segments. Examples include biological scaling (genes to populations), relative risk analyses, habitat restoration effectiveness, ecological trap identification, interactions with climate and other large-scale forcing pressures, etc.

2. Scientific and technical support for site- and project-specific federal habitat actions related to interagency Section 7 consultations under the ESA. Much of this work will be specific to infrastructure projects and the expanding transportation grid.

Puget Sound Federal Task Force

Topics

1. PSFTF Co-chairs Overview and Relationship to Treaty Rights
2. Cross-cutting Actions
3. Cross-cutting Habitat Actions
4. Nearshore and Shoreline
5. Floodplains, Riparian and Estuaries
6. Fish Passage
7. Stormwater
8. Shellfish
9. Science and Monitoring
10. Coordination

Crosscutting focus areas for the Puget Sound Federal Action Plan