Watershed Modeling Breakout

Presenter:

Bob McKane

U.S. Environmental Protection Agency

Facilitators:

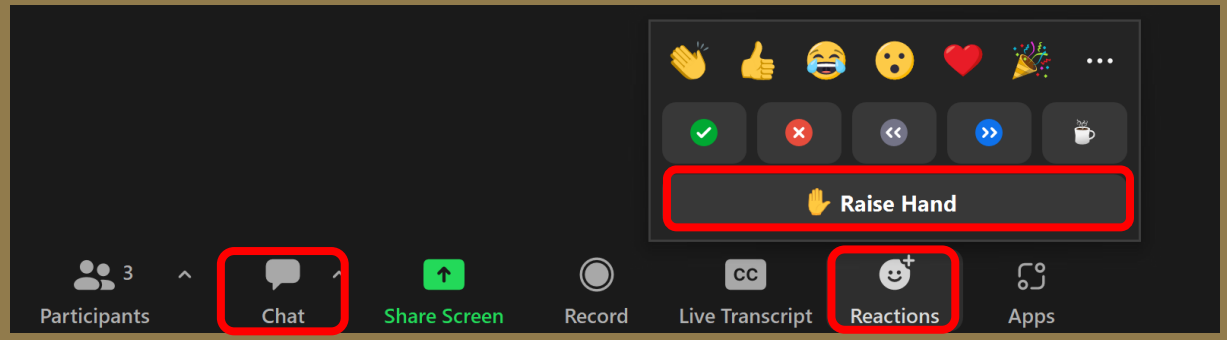
Caitlin Magel & Rachael Mueller

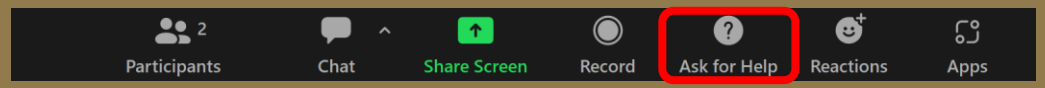
Puget Sound Institute, UW Tacoma

Welcome! Please feel free to use your video.

Questions or Comments?

- Type them in the Zoom Chat
- Raise your hand





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Breakout: Watershed Modeling

Targeted Technical Uncertainties:

- Advance beyond current watershed regression inputs to understand:
  - what is going on in the watershed (spatially),
  - what are the drivers of watershed loading (e.g., land-use and land cover),
  - and what is the effectiveness of proposed policy and program changes for receiving waters?
- Reduce uncertainties associated with watershed scenarios and level of confidence in model application

Proposed Research Actions:

Compare loading inputs and estimates from different model sources

Regression approach (2022 – 2024): Ecology/USGS update to SPARROW to include all Puget Sound watersheds and estimate seasonal nutrient loads. Coordinate with local implementation groups and local/state agencies to update datasets on water quality, land use, and implementation activity.

Lead: D. Bilhimer, WA Department of Ecology

Strategies for reducing uncertainties in modeled urban stormwater runoff and contaminant loads in Puget Sound nearshore streams

Bob McKane[1], Jonathan Halama[1], Brad Barnhart[1], Paul Pettus[1], Allen Brookes[1], Kevin Djang[2], Vivian Phan[1]
Ed Kolodziej[3], Kathy Peter[3], Zhenyu Tian[3,4], Stefano Mazilli[3], Marielle Larson[3], Tessa Francis[3]

[1]U.S. Environmental Protection Agency, Corvallis; [2]CSRA, Corvallis, OR
[3]University of Washington Tacoma, Puget Sound Institute; [4]Northeastern University, Boston, MA

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Disclaimer: The views expressed here are those of the author[s] and do not necessarily represent the views or policies of the U.S. EPA.

Office of Research and Development
Center for Public Health and Environmental Assessment - Pacific Ecological Systems Division, Corvallis, OR

Longfellow Creek watershed, West Seattle, WA

The Seattle Times

Stormwater pollution in Puget Sound streams killing coho before they can spawn

October 18, 2017

1 of 2 | *Coho salmon, including females full of eggs, are dying before they can spawn in Puget Sound streams polluted with stormwater runoff. (NOAA Fisheries)*

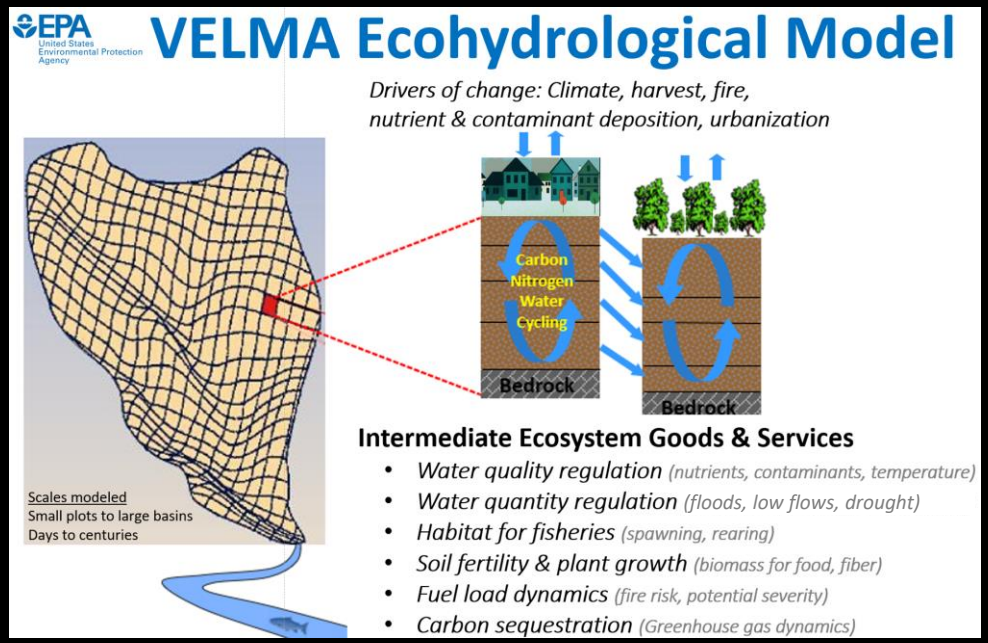
Science Tian et al. 2021 REPORTS

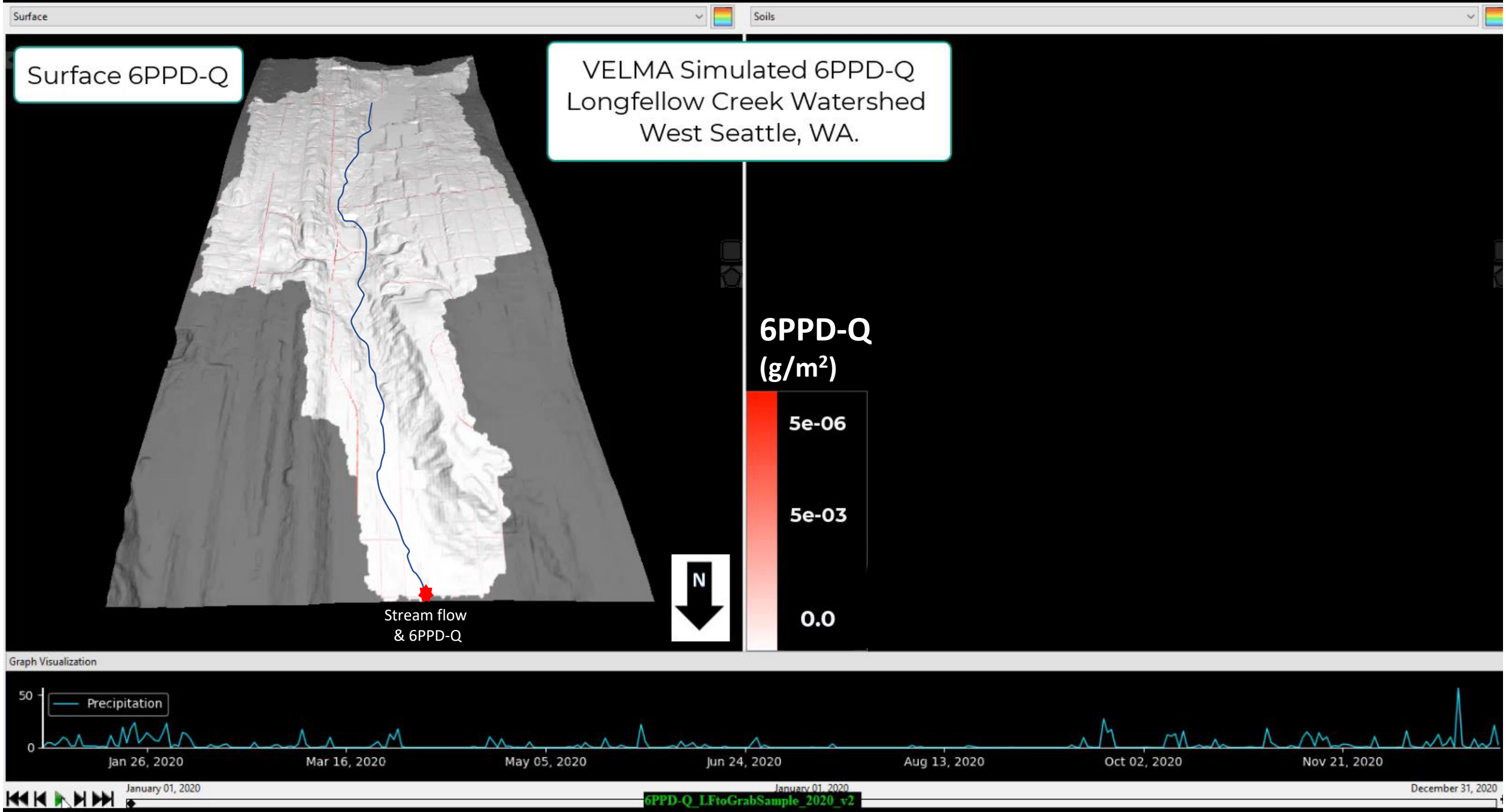
6PPD-quinone

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

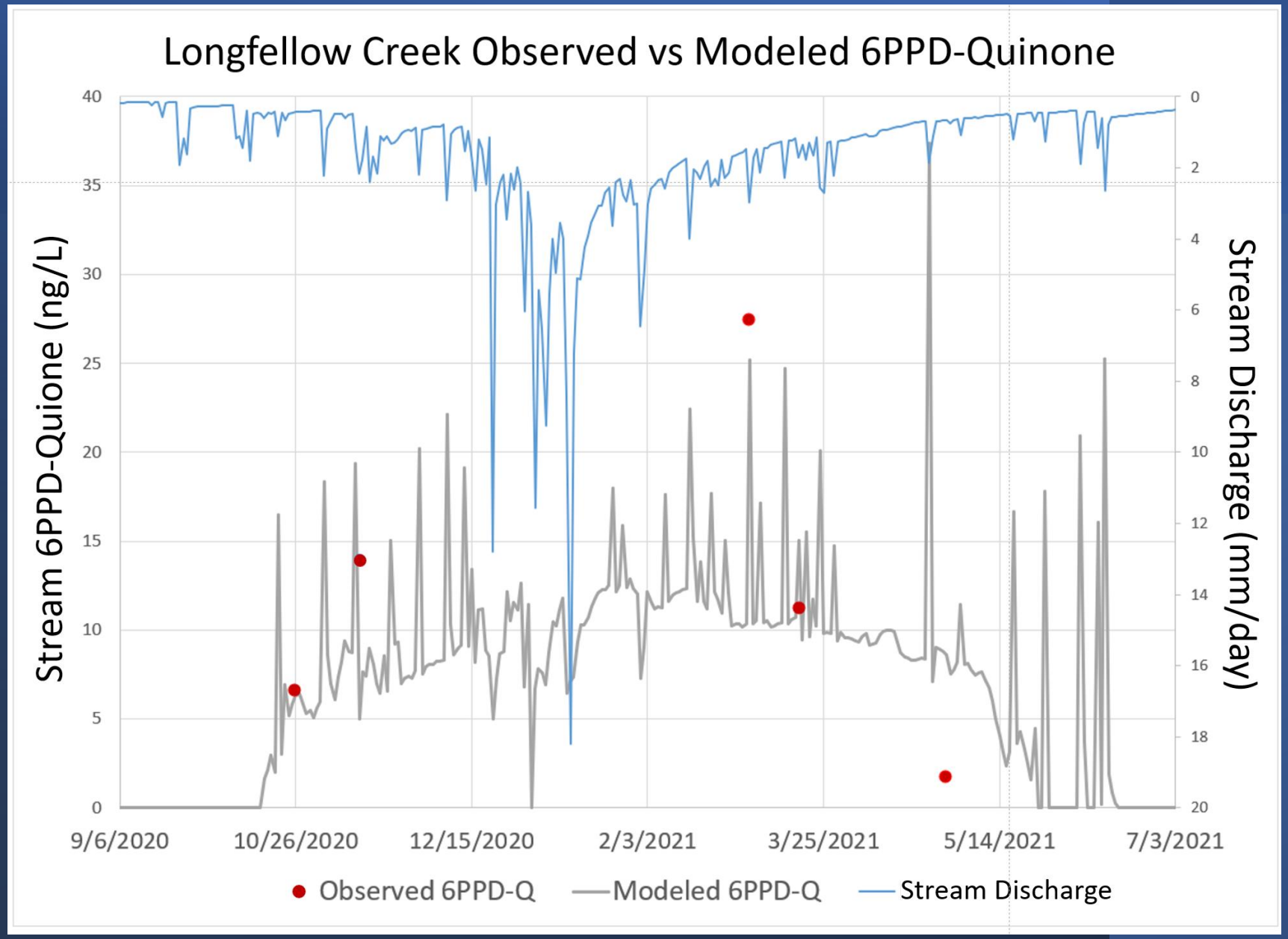
A ubiquitous tire rubber-derived chemical induces acute mortality in coho salmon

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[2], 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]*




Surface
Soils
Surface 6PPD-Q
VELMA Simulated 6PPD-Q
Longfellow Creek Watershed
West Seattle, WA.
6PPD-Q
(g/m²)
5e-06
5e-03
0.0
N
Stream flow
& 6PPD-Q
Graph Visualization
50
0
Precipitation
Jan 26, 2020
Mar 16, 2020
May 05, 2020
Jun 24, 2020
Aug 13, 2020
Oct 02, 2020
Nov 21, 2020
January 01, 2020
January 01, 2020
December 31, 2020
6PPD-Q_LFtoGrabSample_2020_v2

Halama et al. in review



Sources of uncertainty in modeled stormwater runoff and contaminant loads

Sources of Uncertainty	Key Questions
1) Model equations and parameters	Does the model adequately represent the processes controlling the outputs of interest? *For example, runoff via natural (soil matrix) and engineered (stormwater infrastructure) flow paths.*
2) Data for model implementation	Do the data accurately represent the system at the scales required to model the outputs of interest?
3) Calibration methods	Has the problem of equifinality been minimized? *Can we systematically disqualify solutions for which calibrated parameters provide the right answers for the wrong reasons?*
4) Propagation of uncertainty among submodels	Has model calibration reduced model uncertainty and its propagation among submodel components? *What model performance tests can help address these questions?*

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Roadway daily additions of 6PPD-Q (g m^{-2} d^{-1})

Parameters used to calculate roadway tire wear particle (TWP) deposition and 6PPD-Q daily loads	Low Range	High Range	Longfellow watershed value	References
TWP mg/km per vehicle counted	100 (cars)	600 (trucks)	Function of car/truck traffic count data	• TWP deposition per Kole et al. 2017 • Traffic count data per City of Seattle & WSDOT
6PPD g / tire rubber g	0.004	0.02	0.02	Tian et al., 2021
6PPD-Q yield g / 6PPD g	0.01	0.75	0.38	Tian et al., 2021

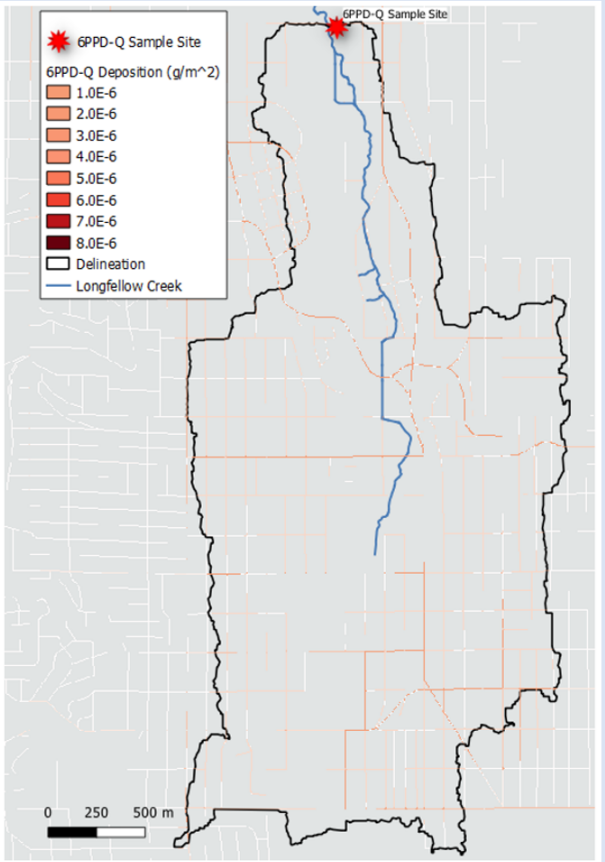
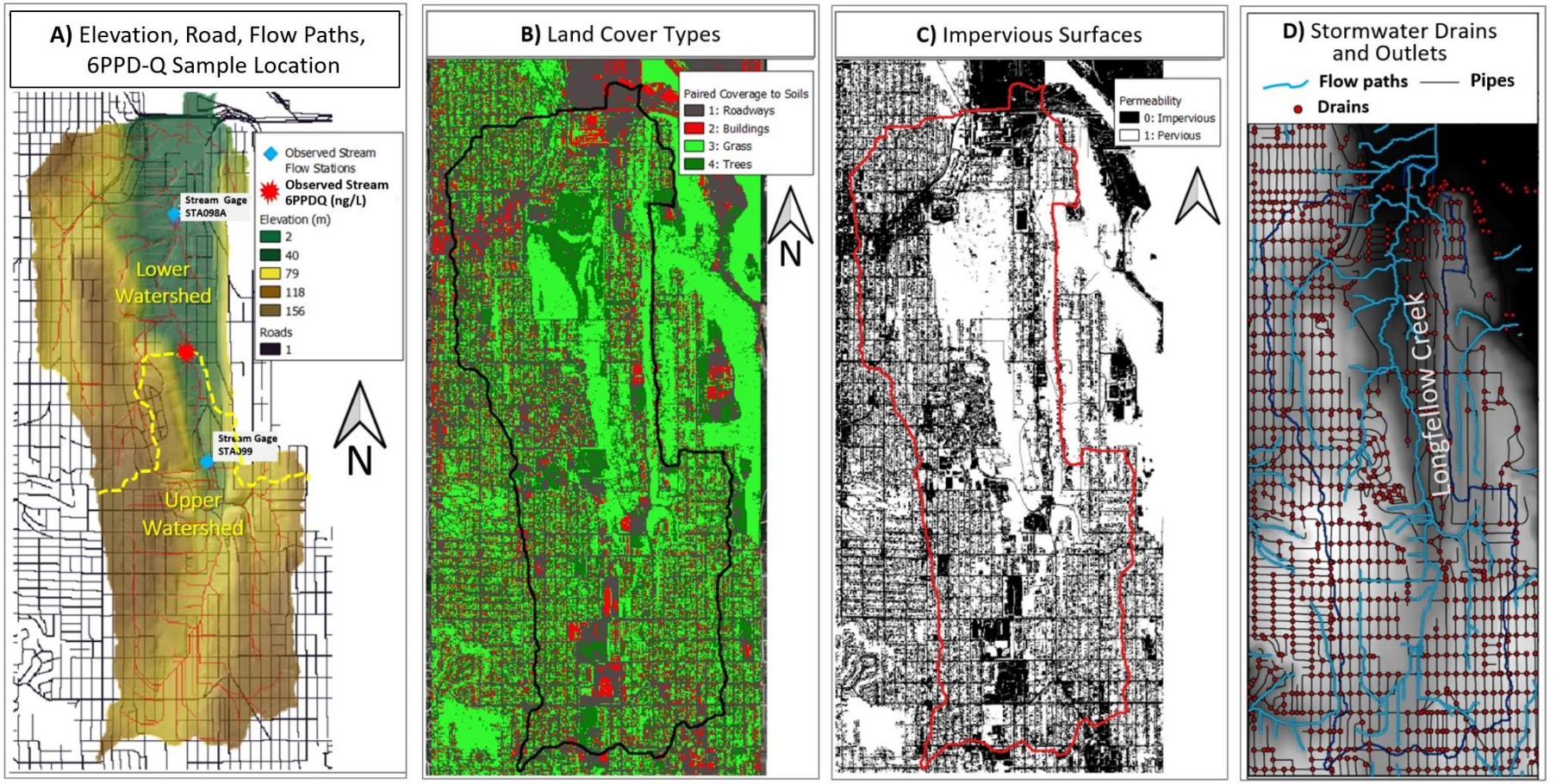


Figure 4. Spatial pattern of 6PPDQ deposition (g m^{-2} d^{-1}) on roads within the Longfellow Creek upper watershed, based on methods described in section 2.3.2.

Sources of Uncertainty	Key Questions
2) Data for model implementation	Do the data accurately represent the system at the scales required to model the outputs of interest?

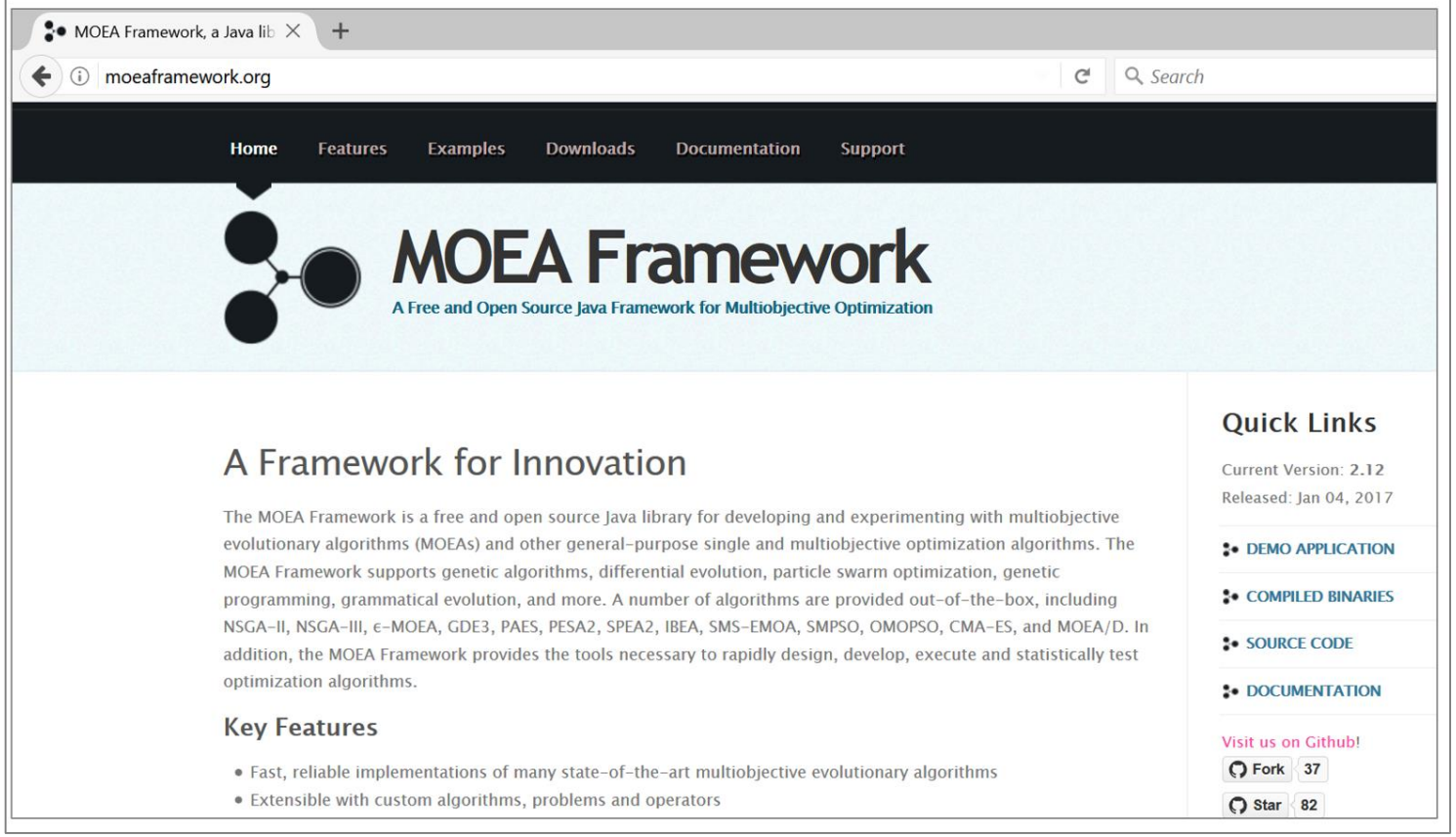
VELMA Urban Spatial Data Layers (5-meter Grid)



Halama et al., In review. Improved urban runoff prediction using high-resolution land-use, imperviousness, and stormwater infrastructure data applied to a process-based ecohydrological model.

Sources of Uncertainty	Key Questions
3) Calibration methods	Has the problem of equifinality been minimized? *Systematically disqualify solutions for which calibrated parameters provide the right answers for the wrong reasons.*

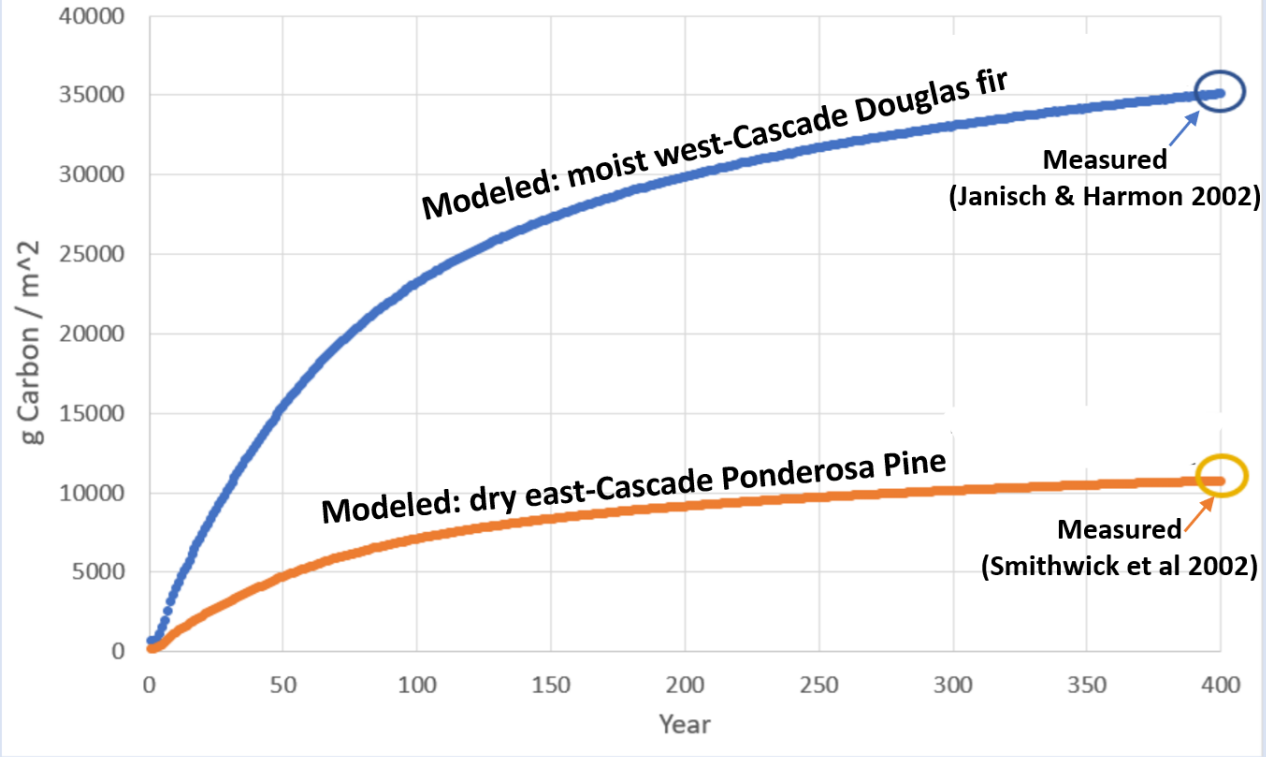
VELMA is calibrated using a Multi-Objective Evolutionary Algorithm (MOEA) that optimizes overall model performance for multiple outputs, e.g., runoff, soil moisture, decomposition, plant growth…..



Sources of Uncertainty	Key Questions
4) Propagation of uncertainty among submodels	Has model calibration reduced model uncertainty and its propagation among submodel components? *What model performance tests can help address these questions?*

Severe performance test: Are parameters calibrated for one location transferable to other locations?

- Modeled forest regrowth for moist (blue) & dry (orange) ecosystems in Oregon
  - Both were modeled using the same Douglas-fir VELMA parameter values



VELMA model parameters calibrated for a single forest calibration site (HJ Andrews ★) accurately predict, with minimal adjustment, forest ecohydrological processes at other sites (★) located across steep regional climate and soil nutrient gradients

***Possible exception, currently under study**

Reference: U.S. EPA. Comparative Assessment of the Impacts of Prescribed Fire Versus Wildfire (CAIF): A Case Study in the Western U.S. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-21/197, 2021.

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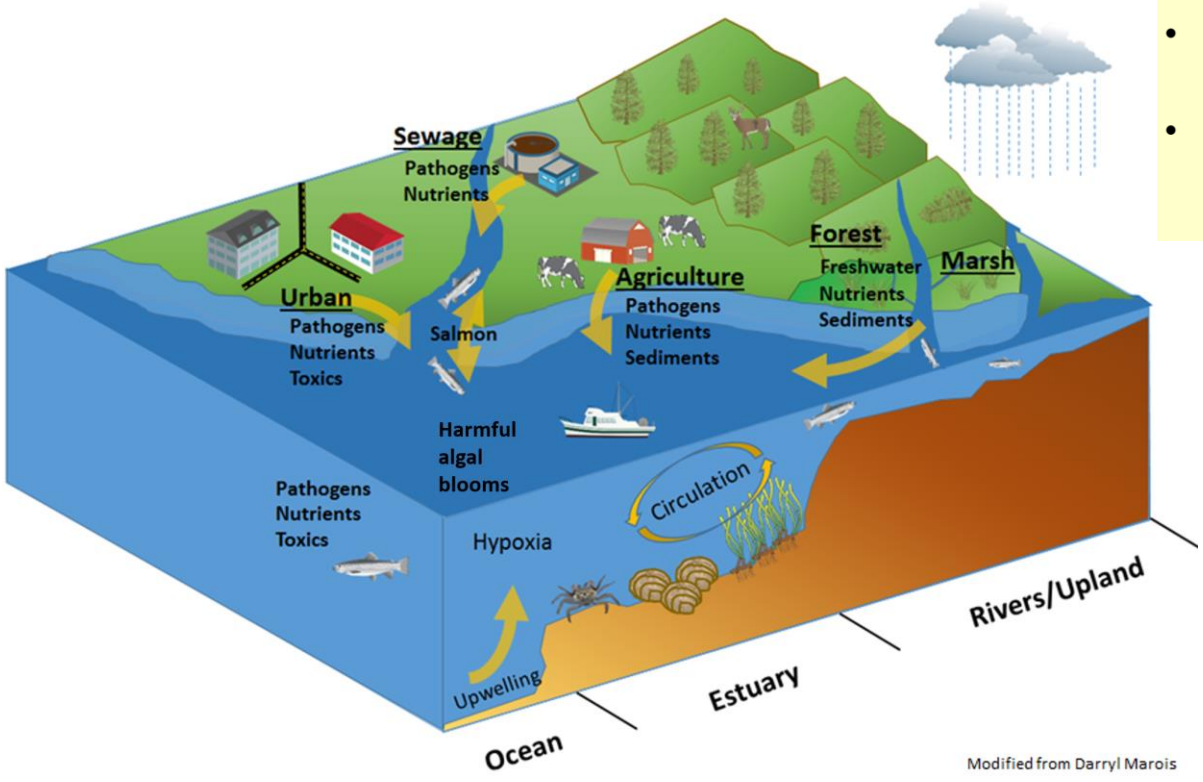
4) Propagation of uncertainty among submodels	Has model calibration reduced model uncertainty and its propagation among submodel components? *What model performance tests can help address these questions?*

and to linked external models



Modified from Darryl Marois

Integrated terrestrial-marine models are needed to

- Synthesize decades of terrestrial & marine data
- Identify comprehensive recovery solutions across habitats & scales…

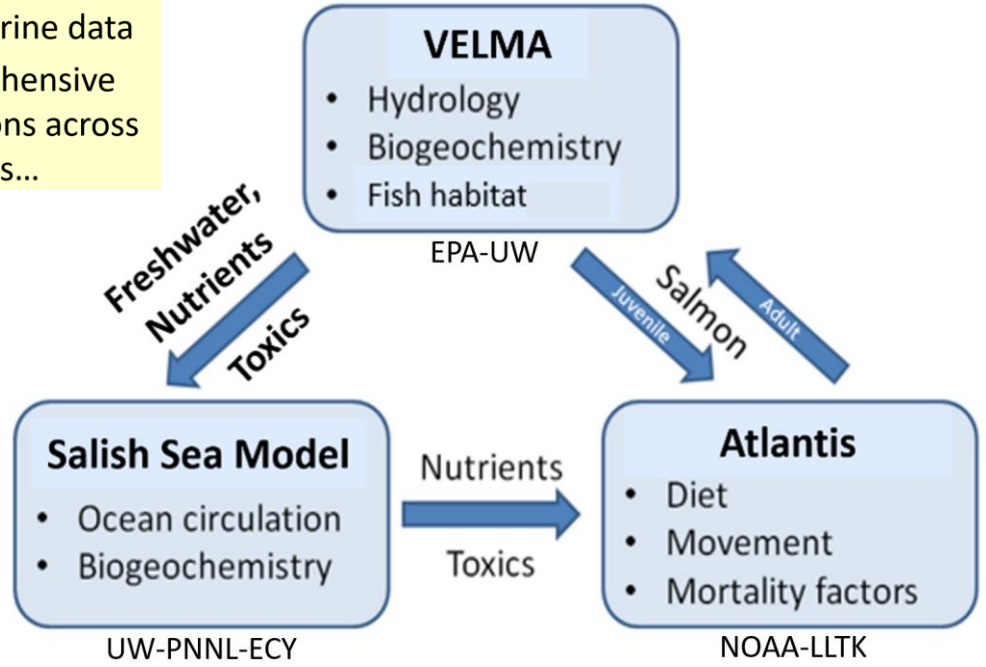


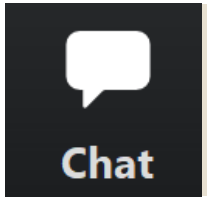
Image from: Vision Statement for a Puget Sound Basin Coupled Environmental and Human Systems Modeling Framework (2018 unpublished). Bob McKane, Tarang Khangaonkar, Isaac Kaplan, Chris Harvey, Hem Nalini Morzaria Luna, Tessa Francis, Phillip Levin, Emily Howe, Jesse Israel, Michael Schmidt, Jonathan Halama, Allen Brookes, Kevin Djang

Breakout: Watershed Modeling

General Q&A for Bob (5-10 minutes)

Open Discussion (15-20 minutes)

What watershed uncertainties are shared across different modeling efforts?



In the Chat: Who else should we engage in the next watershed modeling workshop either as participants or presenters?