March 2018

Summary of VELMA modeling projects and partners in Region 10

Puget Sound, WA	Problem	Partners
[1]Seattle urban watersheds	1) Less impermeable surfaces→less floods, WWTP overflow 2) Reduce storm water contaminants→less salmon mortality	City of Seattle, King County, EPA Region 10
[1,2]Nisqually Community Forest	Watershed restoration → salmon recovery within the context of working forests	Nisqually Tribe, State of WA (Departments of Ecology and Natural Resources), local communities, EPA Region 10
[1,2]Tolt River Watershed	Optimize ecosystem service tradeoffs → salmon, clean drinking water, flood protection, hydro power, forest products, recreation, cultural benefits, resilience to climatic extremes	Snoqualmie Tribe, State of WA (DNR and Dept of Ecology), King County, Seattle Public Utilities, Seattle City Light, Towns of Carnation and Snoqualmie, EPA Region 10
[1,2]Puget Sound National Estuary (in development)	Address 25 ecosystem recovery targets identified for the Puget Sound National Estuary and its 19 contributing sub-basins (http://www.psp.wa.gov/vitalsigns/index.php). WED and several collaborating organizations will use a whole-basin (13,000 sq. mi.) modeling approach that links several existing models: terrestrial ecohydrology (VELMA), ocean circulation & biogeochemistry (Salish Sea Model), and ocean food webs (Atlantis).	**Modeling partners:** Pacific Northwest National Laboratory, NOAA, The Nature Conservancy, Long Live The Kings, EPA Region 10 Seattle. **Other partners:** local, state, federal and tribal restoration planners engaged in terrestrial & estuarine ecosystem recovery throughout the Puget Sound basin.
[1,2]Puget Sound Near Term Action to engage state & local governments in developing model-based land and estuary management scenarios (pending)	WED, NOAA, TNC & LLTK modelers will work with the WA Dept of Ecology to engage Puget Sound Local Integrating Organizations (LIOs) to design terrestrial and marine restoration scenarios for terrestrial (VELMA) and marine (SSM and Atlantis) models. Alternative future scenarios will help LIO managers to play out ecological, social & economic consequences of different restoration choices across multiple scales.	Washington Department of Ecology, Puget Sound Local Integrating Organizations, Pacific Northwest National Laboratory, NOAA, Long Live the Kings, The Nature Conservancy, EPA Region 10, Puget Sound Partnership, University of Washington Center for Urban Waters
Coastal Oregon		
[1,2]Tillamook Bay National Estuary	Improve impaired estuarine water quality through restoration of contributing coastal watersheds (520 sq. mi.) → shellfish, salmon, recreation, drinking water, flood protection. Modeling approach will integrate cycling and transport of terrestrial nutrients and toxics to Tillamook Bay (VELMA) and the consequent circulation and fate of those materials within the estuarine-ocean system (CGEM).	Tillamook Bay National Estuary, Oregon Department of Fish and Wildlife, Oregon Department of Watershed Improvement, US Forest Service, Dairy & shellfish producers, Town of Tillamook, EPA Region 10
[1]Coastal salmon recovery planning (pending)	Assist Oregon Department of Fish and Wildlife in the use of VELMA for salmon recovery planning across coastal Oregon watersheds (>6,000 sq. mi.).	Oregon Dept of Fish and Wildlife, NOAA, EPA Region 10. VELMA team providing model training and consultation to ODFW (see VELMA Training, below).
VELMA Training		
[2]Online VELMA tutorials for EPA, state and community partners	Weekly live online VELMA tutorials and a supporting VELMA Community of Practice Sharepoint site are providing technical support for learning VELMA. There are about 30 participants at this point. Focus is water quality and quantity applications supporting National Estuary Programs.	Collaborators with EPA and local, state and federal organizations working in WA and OR

EPA Office of Research and Development – Research program affiliation

[1]Safe and Sustainable Waters Research Project 5.01A

[2]Sustainable and Healthy Communities Project 2.61

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VELMA ECO-HYDROLOGICAL MODEL, VERSION 2.0

Identifying Green Infrastructure for Enhancing Water Quality & Ecosystem Service Co-Benefits

Background

Sustainable supplies of clean water are vital to human health, local economies, recreational opportunities, and protection of aquatic habitat. Increasing pressures from population growth and land use change have compromised water quality of many U.S. rivers and estuaries. Projected changes in climate are expected to further impact water resources. As a result, many communities are exploring green infrastructure (GI) options for protecting water quality.

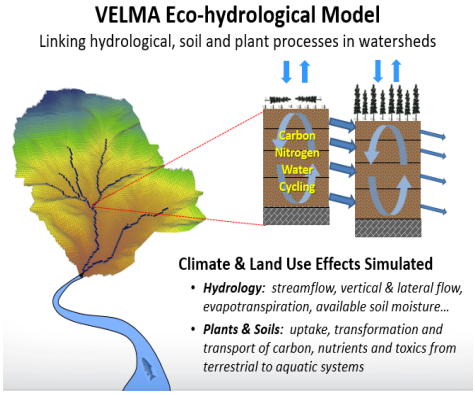
GI involves the establishment of riparian buffers, cover crops, constructed wetlands, and other measures to intercept, store and transform nutrients, toxics and other contaminants that might otherwise reach surface and ground waters.

Although many communities and landowners are already using or planning to invest in GI, sufficient data often do not exist to make informed decisions about where, how much and what kinds of GI will be required to meet water quality goals at local and regional scales. In particular, it has been difficult to identify general rules that can be applied to any given location or set of conditions. Social and economic considerations also cloud the picture, as stakeholders are often in disagreement on the effectiveness and need for riparian buffers. Tradeoffs in land-use (e.g. agricultural demand vs. water quality) often drive the debate and decision making process. Thus, there is a clear need for scientifically defensible tools that stakeholders can use to predict trade-offs and estimate benefits of GI options appropriate for specific regions, habitats and conditions.

VELMA predicts the effectiveness of alternative green infrastructure scenarios for protecting water quality, and also estimates potential ecosystem service co-benefits and tradeoffs.

Approach

We developed an enhanced version (2.0) of the VELMA eco-hydrological model to help communities, land managers, policy makers and other decision makers assess the effectiveness of GI options for improving water quality of streams, rivers and estuaries. VELMA (Visualizing Ecosystem Land Management Assessments) predicts how natural and engineered GI options control the fate and transport of water, nutrients and toxics across multiple spatial and temporal scales – from plots to basins, from days to centuries.



VELMA also quantifies how different GI strategies affect ecosystem service co-benefits and tradeoffs – that is, the ecosystem's capacity to simultaneously provide clean water, flood control, food and fiber, climate (greenhouse gas) regulation, fish and wildlife habitat, etc.

These GI model enhancements include (1) major changes to the biogeochemical and hydrological submodels; (2) addition of a graphical user interface with powerful visualization capabilities; (3) a detailed user manual to assist novice and experienced model users in developing scenarios and applying VELMA for planning, policy and scientific applications; and (4) recoding the model in Java Eclipse to better support open source (community) model development.

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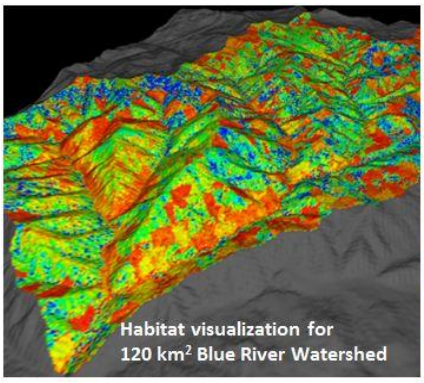

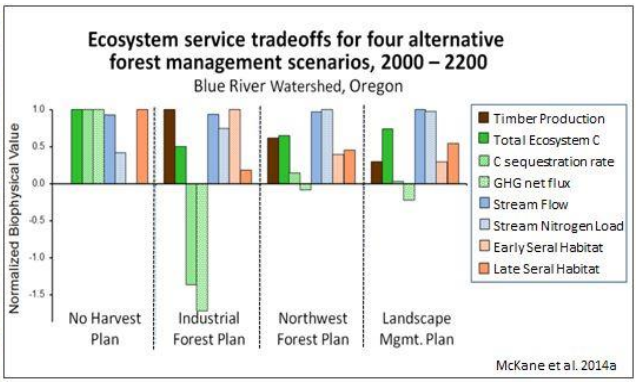

Results

VELMA 2.0 has been validated for GI in the Pacific Northwest and Chesapeake Bay (Abdelnour et al. 2011, 2013; McKane et al. 2014a, b). These applications focus on the use of riparian buffers, cover crops and other GI practices in agricultural and forest watersheds. Results illustrate how stream nutrient loads can be significantly reduced by locating riparian buffers in areas with shallow groundwater flow, and by maintaining buffer widths above nutrient-specific "breakthrough" thresholds. Results also illustrate how once-effective riparian buffers can fail, depending upon contaminant loads, soil properties, changes in climate and other factors.

VELMA 2.0 has also been used to quantify ecosystem service co-benefits under alternative GI strategies, including greenhouse gas mitigation, enhancement of fish and wildlife habitat, among others (McKane et al. 2014b).

Significance

VELMA 2.0 advances GI and ecosystem service assessments in a number of ways:

(1) Provides advanced visualization capabilities for assessing the effectiveness of GI strategies for improving water quality of streams, rivers and estuaries.

(2) Supports quantification of ecosystem service co-benefits and tradeoffs associated with alternative GI and climate change scenarios.

(3) Provides a transferable framework for making consistent comparisons of GI benefits across habitats and ecoregions. The aforementioned GI demonstrations for the Pacific Northwest and Chesapeake Bay watersheds are included with the VELMA 2.0 package (McKane et al. 2014a).

(4) VELMA is being linked with other tools, such as the BlueSky and BenMap air quality models, to better understand ecological, economic and human health tradeoffs associated with alternative decision scenarios, such as when and where to conduct rangeland prescribed fires for particular fuel load and atmospheric conditions (collaborative project with EPA Region 7).

VELMA Users

The VELMA 2.0 software and user manual are designed for several kinds of user groups, based on experience and need:

- **Group 1:** User describes questions and goals, VELMA team does the rest. Example: EPA clients (Regions, Office of Water, Office of Air and Radiation) who require information on potential effects of a policy change on water quality and ecosystem service tradeoffs.
- **Group 2:** User assembles GIS data, creates GI and climate scenarios, runs simulations and analyzes data. VELMA team provides model input files and calibrated parameters. Example: federal and state land managers, tribes, watershed councils and other community groups with sufficient GIS expertise.
- **Group 3:** User works independently to assemble model input files, calibrate parameters, and analyze model output. Example: academics and other professionals with expertise in hydrology, biogeochemistry and GIS methods.

References:

Abdelnour et al. (2011). Catchment hydrological responses to forest harvest amount and spatial pattern. Water Resources Research, 47(9).

Abdelnour et al. (2013). Effects of harvest on carbon and nitrogen dynamics in a Pacific Northwest forest catchment. Water Resources Research, 49(3).

McKane et al. (2014a). Enhanced version of VELMA eco-hydrological modeling and decision support framework to address engineered and natural applications of green infrastructure for reducing nonpoint inputs of nutrients and contaminants. Report ORD-010080, US EPA, Washington, DC.

McKane et al. (2014b). Sustainable and Healthy Communities Pacific Northwest Demonstration Study. Report ORD-007386, US EPA, Washington, DC.

VELMA WEBSITE:
https://www.epa.gov/water-research/visualizing-ecosystem-land-management-assessments-velma-model-20

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October 10, 2014

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ECOSYSTEM SERVICES COORDINATED CASE STUDY: PACIFIC NORTHWEST

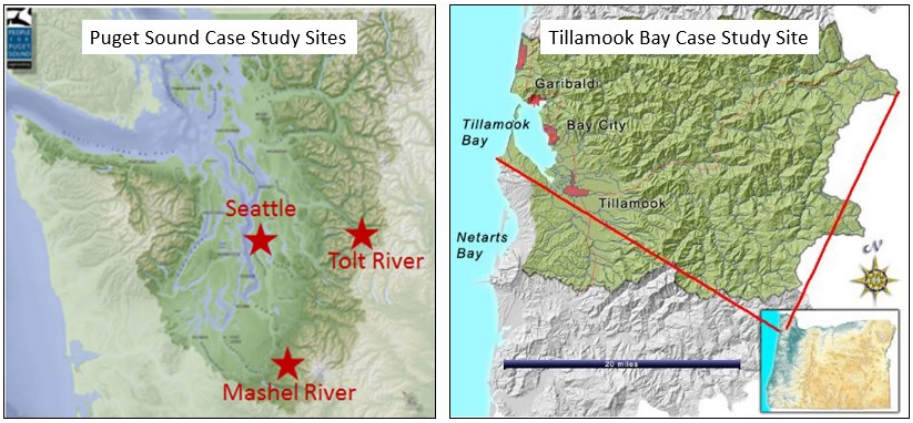

Figure 1. PNW case study sites in the Mashel and Tolt River watersheds in Washington's Puget Sound Basin, and in Oregon's Tillamook Bay estuary. [A separate but associated project is being conducted in urban watersheds in Seattle, WA].

Background

The Pacific Northwest (PNW) is the setting of one of five coordinated case studies (CCS) within the Sustainable and Healthy Communities Research Program's Community-Based Final Ecosystem Goods and Services project. The CCSs are applying principles of structured decision-making to develop approaches and tools to integrate ecosystem goods and services (EGS) concepts into community-level decision-making.

The PNW case study will work closely with stakeholders throughout the region to provide systems-based tools. The primary goal is to assist local, state, and federal jurisdictions seeking to evaluate how alternative decision options affect EGS, in particular, the final ecosystem goods and services (FEGS) that directly influence human health and well-being.

Issue

The PNW is a region of diverse and highly valued natural resources that provide a variety of ecosystem goods and services vital to human well-being. However, these resources and services are being strained by population growth, land use change, climate change, and other stressors. This has fundamentally altered the natural functioning of ecosystems and their capacity to sustainably provide essential goods and services for communities. Provisioning of clean drinking water, flood protection, fish and shellfish habitat, and recreational and cultural opportunities have been significantly degraded in many locations. Economic and sociological impacts have been especially damaging to rural communities dependent on the once thriving fishery and forest industries.

Many PNW communities, tribes, and State agencies are seeking assistance for mitigating and/or adapting to projected changes in climate and land use.

The PNW case study includes three distinctly different watersheds, two in Washington's Puget Sound Basin and one on the Oregon coast (Figure 1). While each of these involves a unique set of stakeholders and watershed impairment issues (see below), results suggest that community-based restoration goals can be addressed through a common decision support approach that uses a transferable set of modeling tools.

Decision context

The PNW case study will identify ecosystem-based management solutions that consider the linkages between terrestrial and aquatic systems for whole watersheds. Stakeholder partners are directly involved in developing alternative model-based decision scenarios. Scientists with EPA's Office of Research and Development (ORD) are working with these stakeholders to demonstrate and transfer tools and/or information that can be used to assess scenario outcomes. The primary objective is to develop practical strategies that stakeholders can implement to achieve their

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economic, human health, and cultural goals.

For the Tolt and Mashel River watersheds in Puget Sound, research will focus on identifying forest management practices that most effectively restore populations of endangered salmonids, while also providing clean drinking water, forest sector jobs and cultural benefits for local tribes and communities. For the Tillamook Bay watershed, research will focus on identifying floodplain, urban, and forest management practices that most effectively reduce inputs of nutrients, sediments, and fecal matter to the estuary, and how these practices can be prioritized to best protect multiple objectives – human health, shellfish production, and sustainable local economies.

Figure 2. The Tolt River provides critical salmon habitat and 1/3 of Seattle's drinking water. Source: Seattle.gov

Objectives and measures of success

ORD scientists are working with case study stakeholders to identify (1) impairments to intermediate EGS and FEGS deemed essential to community well-being; and (2) methods and measures for restoring those services at relevant spatial and temporal scales. Methods and measures range from empirical field and laboratory studies (e.g., sampling and analysis of stream nutrients and pathogens) to application of systems-based watershed, and estuarine/ocean models (VELMA – https://www.epa.gov/water-research/visualizing-ecosystem-land-management-assessments-velma-model-20; and the Coastal General Ecosystem Model, or CGEM). These methods and models are being used to quantify impacts of land use and climate on a comprehensive suite of ecosystem services provided by terrestrial, stream, and estuarine habitats.

Impact

VELMA and CGEM are being applied in collaboration with case study community groups, tribes, and natural resources agencies of the States of Oregon and Washington seeking to address restoration of hydrological and ecological processes critical to salmon and shellfish recovery, and more broadly, to the functioning of entire watersheds and the final ecosystem goods and services they provide.

Model results and training in the use of these tools are being provided to stakeholders to help them identify practical watershed management strategies for mitigating and adapting to changes in climate and land use. Stakeholders are currently using VELMA to address their objectives, such as the establishment of a Nisqually Community Forest that sustainably supports local forest-sector jobs, recreation, and tourism – see https://www.epa.gov/sciencematters/epa-research-august-1-2017.

Visualization training is a key part of our ongoing stakeholder engagement efforts. For example, VELMA incorporates various visualization tools – charts, graphs and animations – designed to help stakeholders evaluate and communicate complex model outputs in ways that are intuitively useful for environmental decision making.

Figure 3. Dairy lands and Tillamook Bay estuary. Source: TillamookBay.org

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Partners: Washington Department of Natural Resources; Washington Department of Ecology; Nisqually Land Trust; Nisqually Tribe

Challenge: Improve watershed condition for salmon recovery, clean drinking water and other ecosystem services

Resource: EPA watershed restoration planning tools (VELMA, Penumbra) and technical support

"Guided by sophisticated new modeling from the Environmental Protection Agency's Western Ecology Division in Corvallis, combined with modeling used by the Nisqually Tribe for salmon recovery, the community forest's management team will selectively thin the property's timber stands to encourage old-growth forest characteristics and increase stream flow during the fall spawning season…"
– Nisqually Land Trust Executive Director, Joe Kane

Intensive forest management in the Pacific Northwest during the past century has emphasized clearcutting on short harvest intervals (40-50 years). This highly profitable practice has converted the region's vast pre-settlement old-growth forests to young forest landscapes. This has fundamentally changed the functioning forest watersheds and their capacity to sustainably provide essential ecosystem services for local and downstream communities. Provisioning of drinking water, flood protection, fish and wildlife habitat, and recreational and cultural opportunities have been significantly degraded in many places.

That's why EPA researchers are working with the Nisqually Community Forest (NCF) to improve forest management and help threatened fish and wildlife recover. The NCF is a group of local communities in southern Puget Sound aimed at acquiring private forest industry lands from willing sellers. The NCF is a working forest, owned and managed for the benefit of local communities.

"We have the unique mission of using working forestry to achieve local conservation, cultural, and economic goals, such as salmon recovery, job creation, and educational and recreational opportunities. Revenue isn't our primary focus," said Bryan Bowden, President of the Nisqually Community Forest Board of Directors. "Our goals are environmental stewardship, recreation and local family-wage jobs. Any proceeds from forest management will be used to support these goals" (http://nisquallylandtrust.org/our-lands-and-projects/nisqually-community-forest/).

EPA ORD has developed and transferred modeling tools to NCF to support their salmon-recovery planning in the Mashel River watershed, a once prime salmon producing sub-basin of the Nisqually River west of Mount Rainier. NCF staff are currently using EPA's Visualizing Ecosystem Land Management Assessments (VELMA) watershed simulator to quantify long-term effects of alternative forest management and climate scenarios on important salmon habitat and water quality variables. A key NCF goal is to design sustainable management plans that emphasize forest thinning and robust riparian buffers, a strategy shown by VELMA simulations to restore greater summer stream flow favorable to salmon spawning and rearing. Other ongoing NCF projects using VELMA include prioritization of land acquisitions, and development of long-term management strategies for increasing watershed resilience to climatic extremes and disturbance events, including droughts, floods and wild fires.

WED Researchers presenting at workshop July 20-21 to Washington tribes, state offices & EPA Region 10 > News You Can Use, July 2017 / EN – engagement and assistance to states and tribes <

The Tolt River watershed provides critical salmon habitat, forest products and 1/3 of Seattle's drinking water (Seattle.gov)

A WED watershed modeling team has been working with the Snoqualmie Tribe Environmental and Natural Resources Department to develop VELMA watershed model simulations of the effects of historical and future restoration and land use practices on streamflow, stream temperature, and other habitat characteristics affecting threatened salmon populations in the 100-square mile Tolt River watershed in Washington state. To date, the WED group has fully calibrated the watershed model to simulate Tolt river flows with a high degree of accuracy under current and historical conditions and practices, and is in the process of simulating long-term responses to specific watershed restoration practices conducted by the Snoqualmie Tribe and partners.

On July 20-21 WED Researchers Bob McKane, Allen Brookes and ORISE Fellow Jonathan Halama will be attending a workshop at the Tolt River site in Carnation, WA, to present and discuss modeling results with the Snoqualmie Tribe and other Tolt River watershed stakeholders and land managers, including the Washington Departments of Ecology and Natural Resources, U.S. Forest Service, City of Seattle, King County, and representatives of the Northwest Indian Fisheries Commission. The workshop is being co-organized by the Snoqualmie Tribe, EPA Region 10 and WED.

The purpose of this 2-day workshop is two-fold. First, on Day 1, the modeling team will perform its second site visit to the watershed, this time focusing on the upper Tolt watershed and key features of interest for modeling work, such as instream and riparian habitat conditions, upland habitat, gage sites, and public use amenities (the Tolt supplies about 30% of Seattle's drinking water). Second, on Day 2, the team will present model results and invite feedback on progress to date, including effects of land use practices on water temperature and low and peak flows – all critical salmon habitat variables. Plans for including an assessment of the cultural benefits of wild salmon recovery for local tribes will also be discussed. A final modeling report due this fall will summarize final model results and recommendations for improving salmon habitat while balancing tradeoffs for existing land use priorities in this multi-jurisdiction watershed.

Abstract for the Salish Sea Ecosystem Conference, April 4-6, 2018

An integrated environmental and human systems modeling framework for Puget Sound restoration planning

Robert McKane[1], Jonathan Halama[1], Paul Pettus[1], Bradley Barnhart[1], Allen Brookes[1], Kevin Djang[2], Tarang Khangoankar[3], Isaac Kaplan[4], Chris Harvey[4], Phillip Levin[5], Emily Howe[5], Michael Schmidt[6], Raphael Girardin[6]

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Local, state, federal, tribal and private stakeholders have committed significant resources to restoring Puget Sound's terrestrial-marine ecosystem. Though jurisdictional issues have promoted a fragmented approach to restoration planning, there is growing recognition that a more coordinated systems-based restoration approach is needed to achieve recovery goals. This presentation describes our collaborative effort to develop and apply an integrated environmental and human systems modeling framework for the Puget Sound Basin, inclusive of all marine and land areas (1,020 and 12,680 sq. mi.). Our goal is to establish a whole-basin systems modeling framework that dynamically simulates biophysical interactions and transfers (water, nutrients, contaminants, biota) across terrestrial-marine boundaries. The core environmental models include a terrestrial ecohydrological model (VELMA), an ocean circulation and biogeochemistry model (Salish Sea Model), and an ocean food web model (Atlantis). This environmental subsystem will be linked with an agent-based modeling subsystem (e.g., Envision) that allows human decision-makers to be represented in whole-basin simulations. The integrated environmental and human systems framework aims to facilitate discourse among different stakeholders and decision makers (agents) and enable them play out the ecological, social and economic consequences of alternative ecosystem restoration choices. All of these models are currently being applied in Puget Sound, but they have not yet been integrated. The linked models will better capture the propagation of human impacts throughout the terrestrial-marine ecosystem, and thereby provide a more effective decision support tool for addressing restoration of high priority environmental endpoints, such as the Vital Signs identified by the Puget Sound Partnership (http://www.psp.wa.gov/vitalsigns/). Our overview will include examples of existing stand-alone model applications, and conceptual plans for linking models across terrestrial-marine boundaries. The Puget Sound multi-model framework described here can potentially be expanded to address the entire Salish Sea transboundary ecosystem (https://www.eopugetsound.org/maps/salish-sea-basin-and-water-boundaries).

Target Session: *Modeling change in the transboundary Salish Sea*

Session Chair: Dino Marshalonis, U.S. Environmental Protection Agency

Session Code: DATA2

The Salish Sea ecosystem is a transboundary area of ecological, social and economic significance shared by Canada and the US. The ecosystem extends from Johnstone Strait north of the north end of the Strait of Georgia in British Columbia, Canada, to the south end of Puget Sound in Washington State, U.S., west to the mouth of the Strait of Juan de Fuca where it meets the Pacific Ocean and east to the land and rivers that drain into these coastal waters. At a very fundamental level, taking effective action for ecosystem recovery requires either mechanistic understanding about how ecosystem components

(physical processes, social processes, biological processes, species, habitats, food webs, etc.) respond to management action or, in the absence of such knowledge, models that approximate how the ecosystem (or process, species, habitat, etc.) is likely to respond to management actions, which can be subsequently verified against real-world observations. In addition, prioritizing actions requires the ability to assess tradeoffs among multiple possible actions. The purpose of this session is to learn more about transboundary ecosystem models currently in development and explore applications of modeling tools toward understanding important drivers of change in the ecosystem including climate change, potential pressures of land cover changes, and cumulative impacts of pressures from multiple projects in the international Salish Sea ecosystem. This session is a companion to the session "Integrated coastal climate change modeling for Salish Sea planning," (CLIMATE3), which focuses on physical modeling. This session seeks presentations specifically related to models of social-ecological processes in the Salish Sea.

Abstract for the Salish Sea Ecosystem Conference, April 4-6, 2018

Urban watershed modeling in Seattle, Washington using VELMA – a spatially explicit ecohydrological watershed model

Brad Barnhart[1], Robert McKane[1], Paul Pettus[1], Jonathan Halama[1], Paul Mayer[1], Allen Brookes[1], Kevin Djang[2]

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[2]CSRA, Corvallis

Urban watersheds are notoriously difficult to model due to their complex, small-scale combinations of land use, impervious surfaces, and management practices that affect the hydrologic system. For this project, we utilize EPA's Visualizing Ecosystem Land Management Assessments (VELMA) model, which is a spatially explicit (i.e., gridded) ecohydrological watershed model, to simulate watershed-scale hydrologic discharge and nutrient concentrations for several urban stream systems in Seattle, Washington, including Thornton Creek, Piper's Creek, Longfellow Creek, and Taylor Creek. 1-m land use classification is used to distinguish four cover types, including roads, buildings, trees, and grass. After model calibration and validation, we construct scenarios of hypothetical green roof implementations and simulate their impacts on watershed-scale discharge. Results show that VELMA is capable of simulating the impacts of targeted green infrastructure management practices to reduce peak stream flow events. These results suggest that VELMA or similar grid-based watershed models can facilitate the prioritization of urban water infrastructure to improve water quality in urban streams leading to Puget Sound.

Target Session: *Modeling change in the transboundary Salish Sea*

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A Multi-Model Framework for Simulating Ecological, Economic and Human Health Tradeoffs Associated with an Array of Rangeland Burning Practices

Background

The Central Great Plains Flint Hills ecoregion in Kansas is an economically and ecologically important area encompassing the largest (12,000 square miles) remaining tallgrass prairie ecosystem in North America. Historically, frequent wildfires were essential to the development and maintenance of the native prairie ecosystem, and prescribed fires are today routinely used to control invasive woody species and improve forage production for the multi-billion dollar beef-cattle industry.

Unfortunately, grassland burning also releases harmful pollutants such as ozone and particulates into the atmosphere, often leading to air quality problems for several communities across a multi-state area. Consequently, Region 7 is faced with multiple stakeholder groups seeking to determine when, how and why to burn. Balancing the ecological, economic and human health effects of rangeland burning is proving to be a major sociological and regulatory challenge.

Prescribed fires in Flint Hills grasslands

Thus, the Flint Hills region presents trade-offs between agricultural practices, cultural values, and health and safety considerations -- rural communities and ranchers that value their heritage which relies on the economic and ecological benefits of the tallgrass prairie; and downwind urban communities that under certain conditions are exposed to harmful air pollution generated from grassland burning practices.

Beef cattle – a multi-billion dollar industry

Smoke over Kansas City, MO, April 2003

Approach

To assist rangeland managers, local and state officials, and other stakeholders in finding solutions to the trade-off challenges, EPA Region 7 and the Office of Research and Development are collaborating with the State of Kansas and Kansas State University to establish a user-friendly air quality modeling and visualization tool set. The air quality modeling component is similar to the current web-based burn management tool at the State of Kansas' www.ksfire.org website, but is being adapted to utilize grassland biomass and fuel load predictions, generated by an eco-hydrologic model (VELMA; Abdelnour et al. 2011,2013), for alternative burning scenarios.

The intent of this linkage is to help stakeholders explore ecological and air quality tradeoffs for both actual and hypothetical changes in the location, timing and frequency of rangeland fires.

Additional visualization modules are currently being added to the tool set, including a human health and economic impacts tool (BenMAP; www.epa.gov/air/benmap) and a wildlife population model (HexSim; www.hexsim.net) for assessing greater prairie chicken responses to burning practices.

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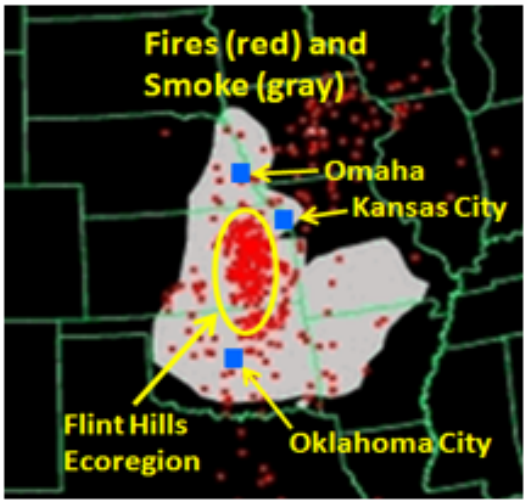
Greater prairie chickens

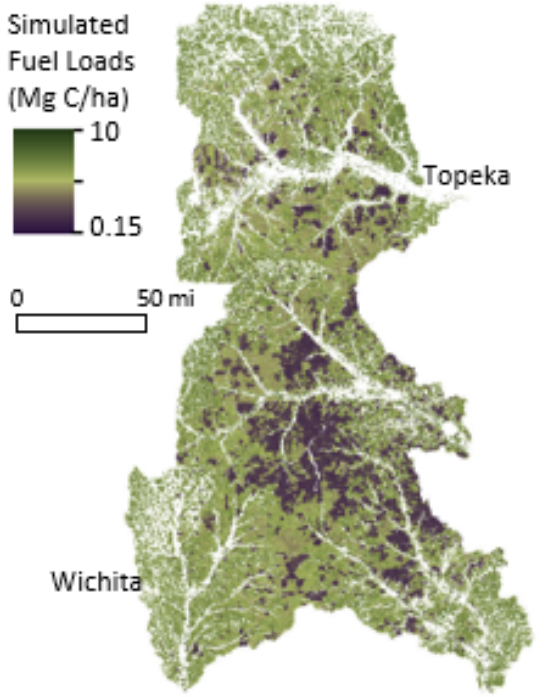
Results and Impact

Tangible products of this research will include computer-generated visualizations of predicted changes in rangeland productivity and air quality that stakeholders and decision-makers can use to identify potential "best case" scenarios for land management that strike a balance between the environmental, human health and economic objectives of rural and urban communities.

This research will also support environmental assessments of interest to a variety of EPA programs, such as the Sustainable and Healthy Communities Research Program, Safe and Sustainable Water Research Program, Office of Air, and Office of Water.



Regional spread of smoke from rangeland fires on April 14, 2014 (NOAA imagery)



Simulated spatial pattern of surface fuels for the 10,000 square mile Flint Hills tallgrass prairie ecoregion in eastern Kansas. Spatial variability is associated with antecedent burns, grazing, climate and topographic position.

Acknowledgements

This project was funded in part through EPA's Regional Applied Research Effort (RARE) Program, which is administered by the Office of Research and Development's (ORD) Regional Science Program.

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