OSU/PNNL Superfund Research Program Stakeholder Meeting

Notes and action items from our discussions on
Friday, January 29, 2021 from 10:00-1:00 pm (Pacific)

Thank you to those who were able to participate in our stakeholder meeting on Friday, January 29, 2021 from 10:00-1:00. The goals of this stakeholder meeting were i) to increase the research team's understanding of stakeholder needs, ii) to increase stakeholder understanding of our data, tools and resources, and iii) to accelerate delivery of data and knowledge to stakeholders for decision support. We enjoyed the opportunity to hear about your needs and interests and discuss ways in which they could be enhanced through partnerships. We plan to continue to build the environmental health literacy of stakeholders by helping you find state-of-the-art EHS information on demand. We hope that we accomplished these goals, and wanted to share some notes, for those who were not able to attend, and to provide documentation on the action items that we will be following up. In addition, the presentation slides that were shared during the event are included as a resource for your reference, with permission from the presenters.

Meeting Notes

The meeting started with an overview of the OSU/PNNL Superfund Research Program by our Director, Dr. Robyn Tanguay. Briefly, the OSU SRP studies the compositions of complex PAH mixtures, the ways in which those compositions change over time and during remediation, and the implications of PAH mixtures for human health. We aim to supply actionable information and tools that enable stakeholders to detect PAHs in the environment, to measure PAH concentrations, and to evaluate remediation strategies. Robyn presented the overarching Center goals, the expertise of our researchers, tools/resources/infrastructure available to our partners, and the data outputs anticipated from Center research. She also provided an overview of OSU's complimentary Center, the Pacific Northwest Center for Translational Environmental Health Research and discussed the accessibility of that Center to community needs and interests.

Fifteen stakeholders representing a variety of agencies, organization and community groups shared their needs and interests with Center researchers and other stakeholders. This provided an opportunity for robust information sharing through which many synergistic relationships began to emerge. The following is a brief recap of stakeholder interests, our discussions, and action items (**AI**) that were identified.

Tom Holdsworth, EPA Sustainable and Health Communities Research Program. Research interests/needs/coordination include: Passive sampling for bioaccumulation, novel pathway based approaches for assessing PAH hazards, development of tools/models to identify and characterize PAHs in groundwater and sediments, *In vivo → in vitro* extrapolation to prevent biotransformation, high throughput screening, characterizing PFAS an PAHs in biosolids, gas range organics/diesel range organics for petroleum spills, and phytoremediation. **AI** – Tom Holdworth would be the key contact for researchers.

Kira Lynch, EPA STL (Region 10). Research interests/needs/coordination include: PAHs are chemicals of concern (COC) on many of the large and complex sediments sites (19 (17.2%) of the R10 sites have PAH as a COC); PAHs almost always primary COC at wood treatment facilities and coal gasification sites; Primary HH exposure pathways direct contact, oral, and dermal; PAH exposures via drinking water aren't usually a concern because they are not very soluble; Seafood consumption is usually a minor pathway aside from some measurements in shellfish, and attempts to establish numerical relationship between sediment and shellfish concentrations have not been successful; and exposure pathways in aquatic organisms occur via respiration, the ingestion of food, sediments, suspended particles and dermal absorption from the surrounding water. **AI** – Request that all publications and sharing of OSU/PNNL SRP research intersecting with Superfund sites should be communicated with the Site Manager prior to publication or presentation **AI** – OSU/PNNL SRP researchers will provide translational clarity on how the OSU/PNNL SRP research can be used to support EPA Superfund decisions while ensuring that the public has clarity on the roles of both. **AI** – Kira Lynch will share the list of sites on Contaminants of Concern sites so that OSU/PNNL SRP researchers and other stakeholders can delineate those sites where PAHs are secondary to the COC driving decisions and identify co-contaminants of interest for potential mixtures studies.

Tony Barber, EPA (Region 10). Research interests/needs/coordination include: New and enhanced approaches and information for emerging contaminants of concern. New information and innovations for difficult cleanups. Tools for achieving environmental justice goals (ex. How to address communities downwind of wildfire-affected SF sites?). Open communication and coordination between policy makers, researchers, and project managers – especially on projects involving ongoing clean-up sites, community stakeholders, elected officials, and others. Dr. Kira Lynch (EPA Region 10) expanded that all decisions are made based on science but timing will sometimes force them to make a decisions and only data in IRIS will be used as the basis for decisions. **AI** – Dr. Barber will serve as a point of contact for regional project managers who can facilitate access to Superfund sites. Communicating with the project managers about your plans and findings can avoid confusion and ensure that the wrong conclusions are not reached. **AI** – OSU/PNNL researchers will work with EPA IRIS program to envision how the cutting edge data we produce can be integrated into the IRIS system. For example, we will share the zebrafish and human lung model toxicity and gene expression data for each PAH through our data-sharing portal. The new toxicity data collected for a diversity of PAH structures might be valuable for site-specific decisions.

Sheryl Stohs, EPA (Region 10, Environmental Justice Program). Research interests/needs/coordination and questions include: How can we capture variations in vulnerability at a geographic scale that allows us to prioritize communities for Superfund activity, enforcement and targeting? How do we strengthen the linkages between social vulnerability indicators and health risk using info-graphics to explain health risks, so that community involvement represents a clearer picture of impacts? How can we incorporate an equity and environmental justice lens in research and decision-making for the different EPA decision-making paradigms? What does this look like for emergency response and wildfire mitigation? How can we design environmental research studies/tools to better answer questions about the differential experience of social vulnerability and chemical stressors? How can we build trust in research processes that are inclusive of language differences, sometimes different cultural reference points, time/money to volunteer on stakeholder groups, etc.? **AI** – OSU/PNNL SRP Research Translation team will work with Sheryl and the Environmental Justice Program to co-develop materials with communities such as infographics. **AI** – Sheryl will share ideas for tools that communities can use, such as dashboards, for reporting back to communities in a user friendly manner. **AI** – Drs. Marcus and Buermeyer will follow up with Sheryl about 1) opportunities for trainees at the ATSDR Seattle office through the Internship Pathways Program, 2) for training and engagement in diversity, equity and inclusion issues, and 3) training on how to translate science from biochemical level to community level. They will also follow up with Sheryl on conducting a workshop on DEI activities as well as get more information from Sheryl on SIREN (Social Interventions Research and Evaluation Network) and their resources.

Kathleen Raffaele, EPA Office of Land and Emergency Management (OLEM). ***Note:*** *OLEM anticipates that its research priorities may change some in the coming year, based on priorities for the new Administration. Pending input from incoming leadership, we cannot, at this time, provide definitive input on our research priorities.* Points provided hereafter are general, based on ongoing research needs, with a focus on those relevant to the OSU/PNNL SRP. Research interests/needs/coordination for OLEM include: General needs in the area of Toxicology and Risk Assessment include: Chemicals found at contaminated sites, including degradation products; Chemicals without current toxicity values, including those with limited data; and Assessment of risk to vulnerable populations. In support of cumulative risk efforts at OLEM, there is a need for methods for grouping chemicals and understanding the impact of non-chemical stressors. Dose response relationships for effects of concern need to be comparable across chemicals, usable for chemical groups/cumulative risk assessment, and extrapolatable across different species/test systems. Other needs include translating hazard information across different types of toxicity testing systems and translating risk information across different types of systems (quantitation of exposure and adverse outcomes). General needs in the area of Exposure Assessment include exposure factors for soil and dust ingestion with particular attention to populations with potential for high exposure (e.g., tribal populations, subsistence fishers). Exposure evaluation methods are also needed for biomarkers of exposure, analytical methods in various media for contaminants of emerging concern, sensors and passive samplers. General needs in the area of Site Cleanup include methods development for bioavailability of organics and relative bioavailability to apply to toxicity values, validation/verification of clean-up and assessment technologies which should aim to be generalizable and scalable. Finally, research translation is always desired from SRP center activities to OLEM. The ability to group contaminants is of high importance given the lack of empirical data for many chemicals. **AI** – OSU/PNNL SRP researchers will share information when data from our center activities is accessible. Given that this data needs to be reliable and legally justifiable, continued communication with OLEM and new

communication with IRIS leaders will be initiated to ensure translation of our data to policy and decision makers.

Tim Frederick, EPA (Region 4). Dr. Frederick is in charge of implementation and scientific support for the 8 states that comprise EPA Region 4. Research interests/needs/coordination for Region 4 include: the analysis of metals data, the need for PAH data to be made available and to acquire data for PAHs without values. **AI** – EPA has communities of interest that could benefit from scientist participation; e.g., Work Groups for Risk Assessment, hydrologists and implementing. If there is an interest in participation, Tim Frederick will serve as a resource to get involved. **AI** – OSU/PNNL SRP researchers will pursue KC Donnelly to support SRP Trainees to go to federal partners and build collaborations and networks.

Jim Markweise, EPA, Pacific Ecological Systems Division. Dr. Markweise presented the background and mission of Pacific Ecological Systems Division (PESD) in Corvallis, OR. He highlighted PESD's efforts in monitoring effects of wildfire in water and air. They are employing visualization tools in support of Ecosystem Land Management Assessment that can model differences in approaches to wildfire management options. Through the Wildland Fire Leadership Council, the models illustrate how prescribed fires may modify the impacts of wildfires. This type of modeling improves our understanding of prescribed fire costs and benefits. Efforts are also underway to utilize modeling tools to link enhanced air monitoring with wildfire air quality impacts. PESD is working with OR Governor's Wildfire Response Council to share fire related data beyond the EPA. **AI** – OSU/PNNL SRP will host Dr. Markweise for a seminar at OSU to enhance interactions among OSU faculty and EPA PESD.

Mark Johnson, EPA, Pacific Ecological Systems Division. Dr. Johnson presented his research on remediating contaminated tailings, soils and sediments. His presentation focused on strategic interventions to promote soil revitalization. Research interests/needs/coordination include: developing soil amendments (biochar) for *in situ* remediation at contaminated sites, reducing exposure pathways, and rejuvenating contaminated sites and restoring ecosystem functions, with a primary focus on metals but some with organic contaminants. **AI** – OSU/PNNL SRP will host Dr. Johnson for a seminar at OSU to enhance interactions among OSU faculty and EPA PESD. **AI** – Mark Johnson and Michael Pouncil (Portland Harbor Community Advisory Group) will follow up offline about remediation efforts that they are engaged in. **AI** – Mark will follow up with Sheryl Stohs about the use of biochar in cold regions, such as Alaska where Sheryl had initiated an Environmental Justice project using a biochar system. **AI** – Given the interest in comparing and contrasting bioremediation bench tests being done in Portland Harbor to those in Alaska and Oregon, the OSU/PNNL Research Translation team will host a zoom meeting with interested parties to begin sharing methods and efficacy.

David Farrer, Oregon Health Authority. Questions posed by the OHA include: While we are learning more about which chemicals (including PAHs) are being emitted from Oregon facilities, how can we share information about those chemicals with the superfund program to jumpstart research on the ones lacking toxicity information? Can the program begin to look at the toxicity of these additional PAHs and/or coordinate such research with partner research institutions? OHA is interested in how we can connect interested communities with research opportunities related to PAHs. Every 3 years, Oregon's industrial air toxics regulating program (Cleaner Air Oregon) reviews all of the toxicity reference values used for regulated air contaminants. This process includes a public petition process, where anyone can submit information about chemical toxicity that might help ensure our regulatory values reflect the best current science. Graduate students and other researchers at OSU are welcome to contribute to that process. OHA has an interest in the relative potency of PFAS species – this information would help OHA to address PFAS as a class in terms of policy and regulation in drinking water and other media. OHA has an updated webpage for Portland Harbor: https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/TRACKINGASSESSMENT/ENVIRONMENTALHEALTHASSESSMENT/Pages/phsite.aspx OHA also has a specific page for Cathedral Park https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/TRACKINGASSESSMENT/ENVIRONMENTALHEALTHASSESSMENT/Pages/Cathedral-Park.aspx **AI** – Discuss how OHA can connect OSU centers (SRP and EHSC) with communities engaged in environmental health research. **AI** – Drs. Craig Marcus and Andrew Buermeyer (OSU SRP) will continue conversations and planning with OHA on how our graduate students can contribute to Cleaner Air Oregon, potentially through externships. SRP Trainees have an interest in participating.

Jennifer Peterson, Oregon Department of Environmental Quality (ODEQ). ODEQ interest and needs are within the cleanup program related to human health and ecological exposure and toxicity. They are interested in analytical methods and an increase in data for unknown mixtures, such as total petroleum hydrocarbons.

Susan MacMillan, Air Toxics Science and Policy Analyst, ODEQ. Dr. MacMillan filled in some thoughts in addition to what David Farrer and Jenn Peterson presented. She provided a description of needs/interests of Air Toxics Science and Policy (DEQ) and the interest of the Cleaner Air Oregon on diesel emissions.

Rhonda Kaetzel, ATSDR. ATSDR needs/interests include: community engagement at Superfund sites, medical surveillance of cancer clusters (17 in development, 5 have been finalized). The PAH toxicity profile has not been updated since 1989, so we need a reason to update it. ATSDR needs to know the relative potency factors. They also have a need for science translation to doctors and health care providers who work with communities of concern for toxic exposures. **AI** – OSU/PNNL SRP Research Translation team will follow up with research translation support; in particular, materials that stress sources for translation to doctors and their patients. **AI** – Kim Anderson will collaborate on bringing wristband exposure evaluations into regulatory use.

Cassie Cohen, Executive Director, Portland Harbor Community Coalition. The Portland Harbor Community Coalition began in 2012 to elevate the voices of affected communities. An example of Urban Natives who cannot use Cathedral Park for rituals due to contamination of the site. The coalition engages community participatory research can enrich and influence science with lived experiences. the EPA Portland Harbor Superfund Site Community Involvement Plan (based on community, tribal, and partner interviews) and includes an Environmental Justice section starting on page 35 that discusses some of what Cassie is covering too - Link: https://semspub.epa.gov/work/10/100261772.pdf

AI – OSU/PNNL Research Translation team will work with the PHCC on translational materials as needs arise. In addition, the Pacific Northwest Center for Translational Environmental Health Research can provide community based research options which are not focused on PAHs.

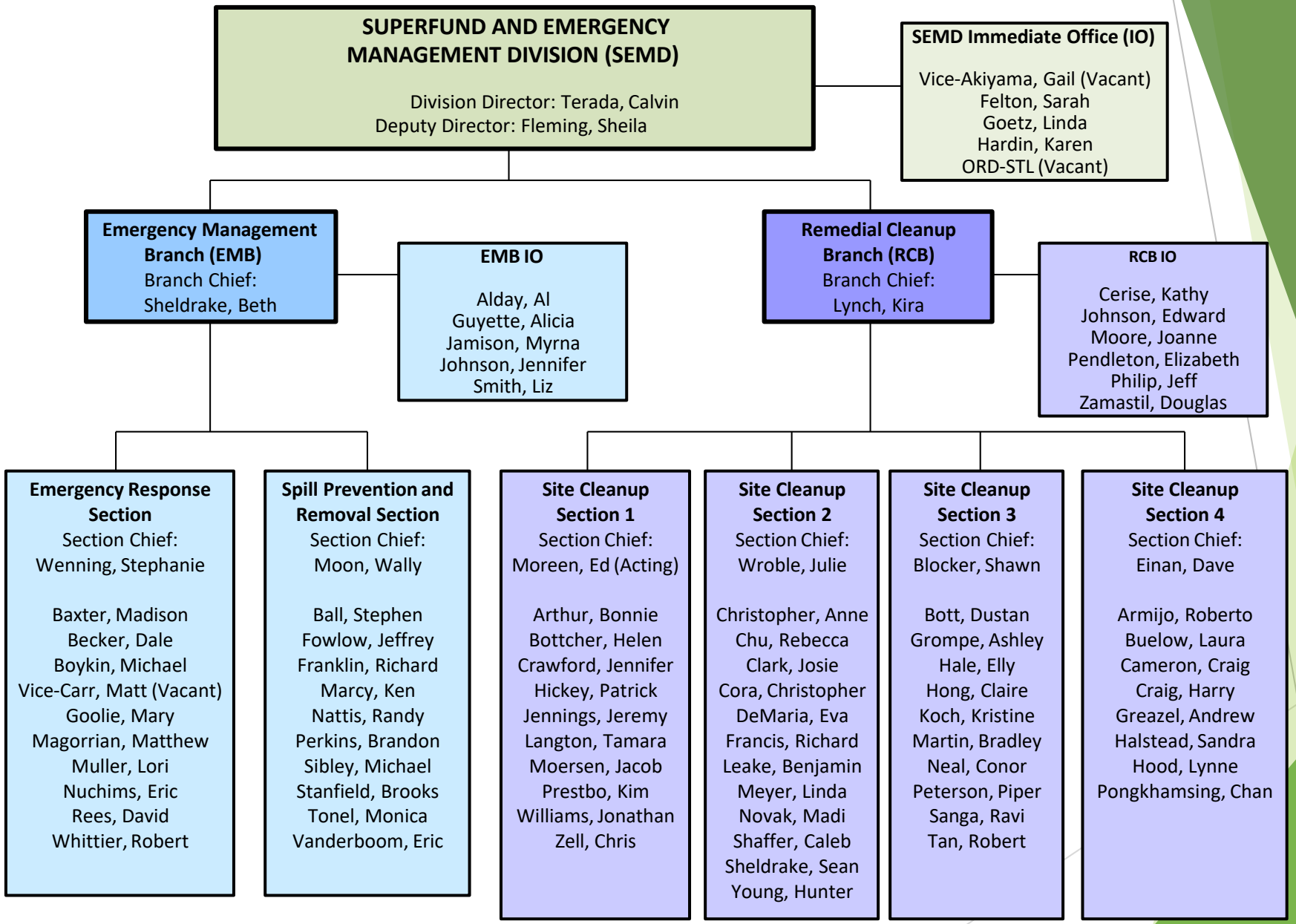
Michael Pouncil, Portland Harbor Community Advisory Group. The Portland Harbor Community Advisory Group was established to work with the EPA and community members in areas of concern. The goal is to build bridges to community members and fill gaps in knowledge to address community concerns. Please visit the PHCAG at http://www.willametterivercleanup.com and https://youtube.com/channel/UCkfzIQNJK1FGjS4zmXbVTpw. Michael posed the question of how the community fits into the co-production of knowledge and collaboration through the Pacific Northwest Center for Translational Environmental Health Research. The Center has a Community Engagement Core which is prepared to facility interactions of community members/groups with the Center team. The Center also has a pilot project program that can be used to initiate community engaged research. **AI** – Michael will follow up with Mark Johnson about remediation efforts that they are both working on. **AI** – Molly Kile, the Pilot Project lead, will share pilot project opportunities with community groups. There is currently an open call for pilot projects, please visit https://ehsc.oregonstate.edu/pilot for more information. Diana Rohlman can share an example of a new community-engaged project that was just initiated.

Rob Neely, Office of Responses and Restoration, NOAA. NOAA is working with other natural resource trustees -- five tribes, the U.S. Department of the Interior and the State of Oregon -- to resolve natural resource damages associated with the releases of hazardous substances at the Portland Harbor Superfund Site. Natural resource damage assessment, or NRDA, is separate and distinct from the cleanup process in that it seeks to compensate the public for injuries to natural resources, including the loss of the resources themselves (e.g., organisms, habitats) and losses of human uses of those resources. The public is compensated via projects that focus on ecological habitat restoration, for example, or on improved access to the use of the resources, or both. Though the NRDA and cleanup processes are complimentary, the former does *not* focus on addressing risks to human health and the environment posed by hazardous substances whereas the latter -- the cleanup process -- does. The Trustee Council is currently negotiating settlements with a number of potentially responsible parties while simultaneously conducting scientific studies in anticipation of litigation with non-settling parties. In addition, the Trustee Council has partnered with third party restoration bank developers to complete three habitat restoration projects in or near the Portland Harbor site, and a fourth is near completion. More information on the NRDA process for Portland Harbor is available on the Trustee Council's website: https://www.fws.gov/portlandharbor/

At the end of our guest speakers' presentation, and the discussions that followed, we opened several zoom breakout rooms for smaller groups to have more in-depth discussions and follow-on planning for effective bi-directional communication and coordination among stakeholders and SRP researchers. A room was set up for stakeholders to meet with students for internship opportunities or collaborative research ideas. All of the **AI**'s that were identified will be added to a list and will follow-up actions will be planned accordingly

R10 Superfund and Emergency Management Division Overview

Presented by Kira Lynch



Revision Date: 01/19/2021

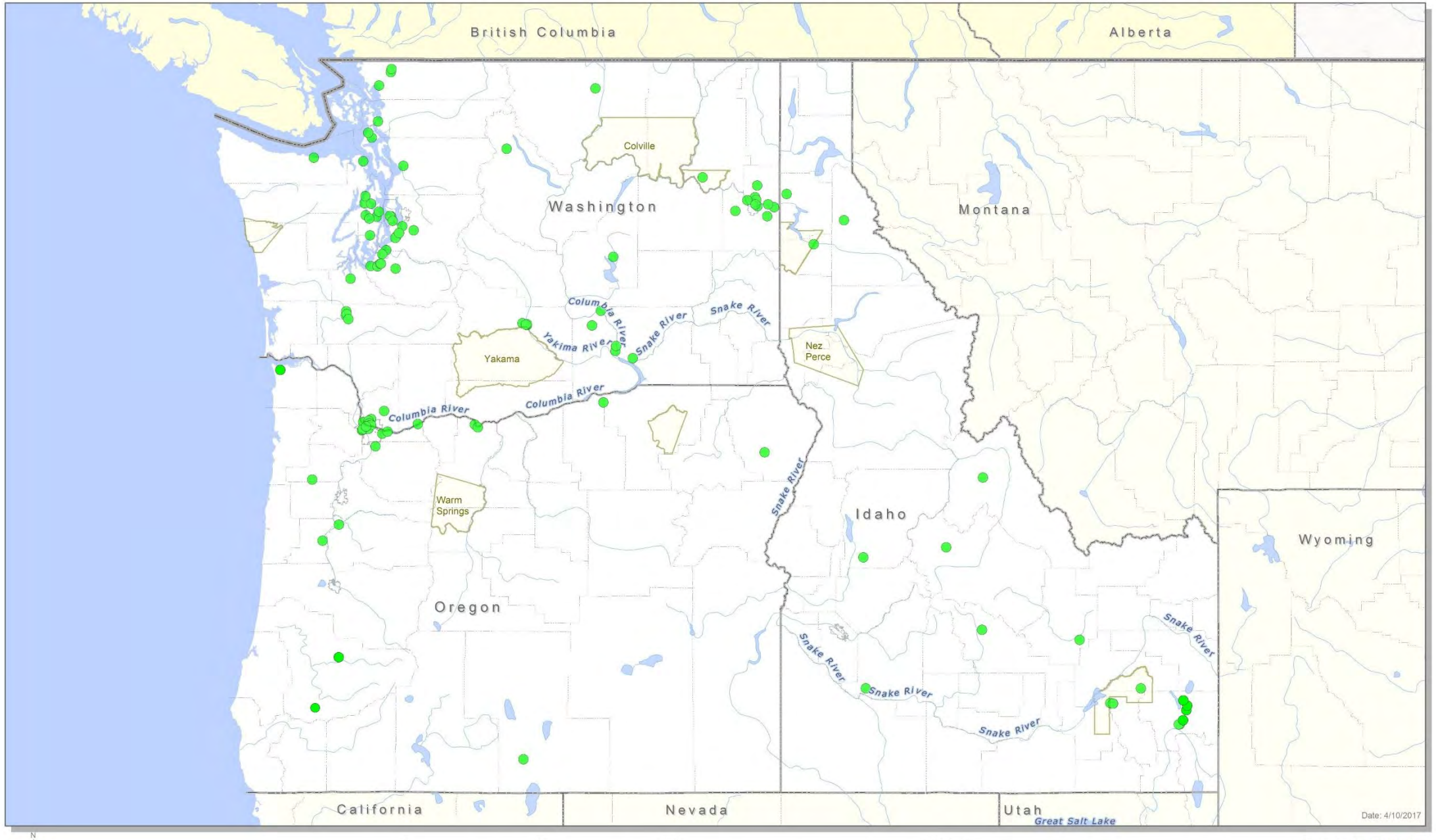
Statutes and Programs

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) = Superfund
- National Contingency Plan (NCP); Oil Pollution Act; National Response Framework and Stafford Act
  - Site Assessment
  - Remedial Cleanup Program
  - Federal Facilities Program
  - Emergency Management and Response Program
  - Homeland Security Preparedness and Disaster Response under FEMA
  - Oil Spill Planning, Prevention and Response

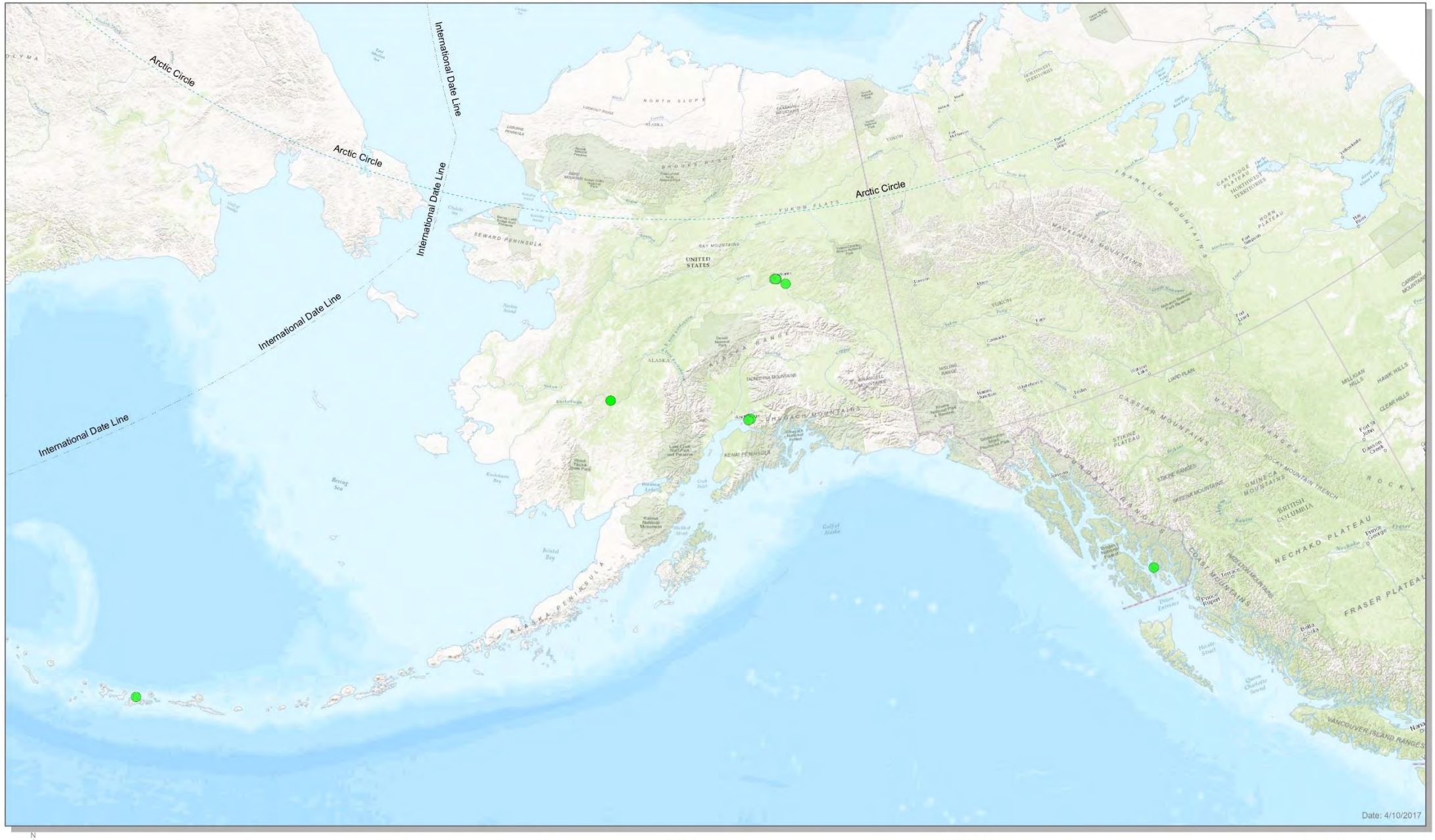
National Priority List (NPL) Sites

- 108 Proposed, final and deleted NPL sites
  - Alaska – 9; 3 deleted
  - Idaho – 12; 3 deleted
  - Oregon-19; 5 deleted
  - Washington – 68; 22 deleted
- Currently working on 2 additional partial deletions
- We incorporate reuse plans into cleanup actions

NPL and NPL-Equivalent Sites for OR, ID and WA



NPL and NPL-Equivalent Sites in Alaska



PAH - Contaminant of Concern

- PAHs are COCs on many of the large and complex sediments sites
- 19 (17.2%) of the R10 sites have PAH as a COC
- PAHs almost always primary COC at wood treatment facilities and coal gasification sites
- Primary HH exposure pathways direct contact, oral, and dermal
- PAH exposures via drinking water aren't usually a concern because they are not very soluble
- Seafood consumption is usually a minor pathway aside from some measurements in shellfish, and attempts to establish numerical relationship between sediment and shellfish concentrations have not been successful
- Exposure pathways in aquatic organisms occur via respiration, the ingestion of food, sediments, suspended particles and dermal absorption from the surrounding water

Anthony Barber

Region 10

Major components of EPA Superfund program within the organization:

- EPA Administrator
  - Office of Research & Development
    - Pacific Ecological Systems Division
  - Office of Land & Emergency Management
  - other HQ offices
  - 10 Regions (our NW is #10)
    - SF & Emergency Management Division
    - Oregon Operations Office
    - Regional Administrator's Division

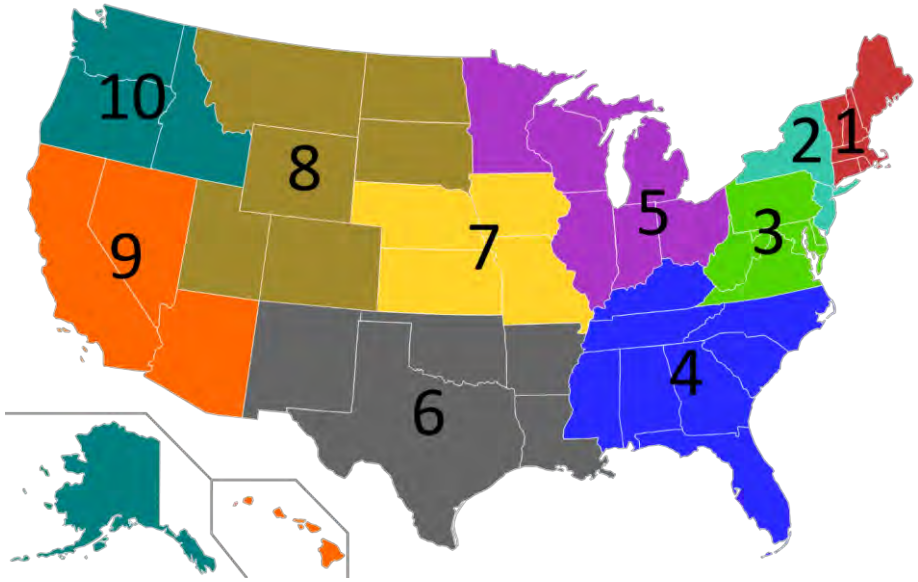
Research

Policy

Program Implementation

Cross-program Coord. and Relations

Community Involvement
Environmental Justice
Tribal Assistance



Interests, in general:

- New and enhanced approaches and information for emerging contaminants of concern.
- New information and innovations for difficult cleanups.
- Tools for achieving environmental justice goals (ex. How to address communities downwind of wildfire-affected SF sites)
- Open communication and coordination between policy makers, researchers, and project managers – especially on projects involving ongoing clean up sites, community stakeholders, elected officials, and others.

Anthony Barber

EPA Region 10

Director, Oregon Operations Office
Disaster Recovery Coordinator/Lead
Co-Chair Regional Science Steering Council
Regional Executive Lead for Forestry

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RESEARCH USING AN ENVIRONMENTAL JUSTICE LENS

Sheryl Stohs, PhD
R10 Environmental Justice Program
stohs.sheryl@epa.gov

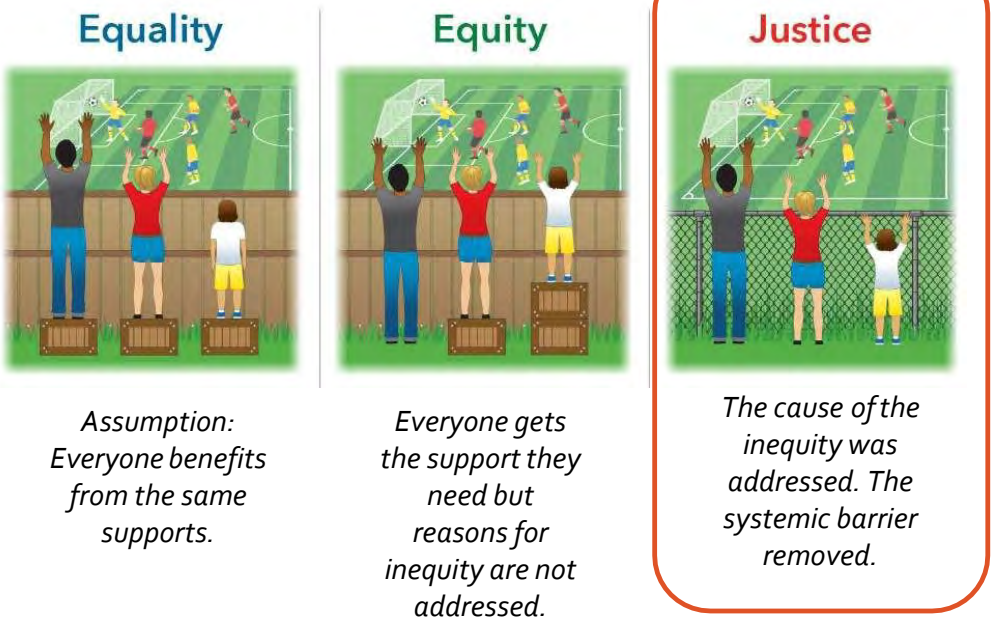
US EPA – REGION 10

History of Environmental Justice (EJ)

History of EJ

- Examples of injustice are embedded throughout the laws, policies, and practices of the government's structures and systems.

- Examples include:
  - Redlining / segregation
  - Siting facilities
  - Access to loans / lack of fair housing practices
  - Access to education
  - Lack of voting rights / voter suppression



EPA

INCORPORATING ENVIRONMENTAL JUSTICE GOALS

- EJ Integration at EI
- Engaging
  External Stakehold
- Support and Enga
  Communities with
  concerns

CONSIDERATIONS FOR DEVELOPING RESEARCH TOOLS WITH AN EJ LENS:

- How can we capture variations in vulnerability at a geographic scale that allows us to **prioritize communities** for Superfund activity, enforcement and targeting?
- How do we strengthen the linkages between social vulnerability indicators and health risk **using info-graphics** to explain health risks, so that community involvement represents a clearer picture of impacts?
- How can we incorporate an **equity and environmental justice lens** in research and decision-making for the different EPA decision-making paradigms? What does this look like for emergency response and wildfire mitigation?
- How can we design environmental research studies/tools to better answer questions about the differential experience of **social vulnerability and chemical stressors**?
- How can we **build trust** in research processes that are inclusive of language differences, sometimes different cultural reference points, time/money to volunteer on stakeholder groups, etc.?

EPA Pacific Northwest Fire Research

James Markwiese, Ron Waschmann, Bob McKane,
Renee Brooks, Nathan Schumaker, Mussie Beyene, Jana Compton, Joe Ebersole, Amalia Handler, Ryan Hill,
Scott Leibowitz, Jiajia Lin, Jim Kaldy, Cheryl Brown, Steve Pacella, Peter Beedlow, Alan Thornhill

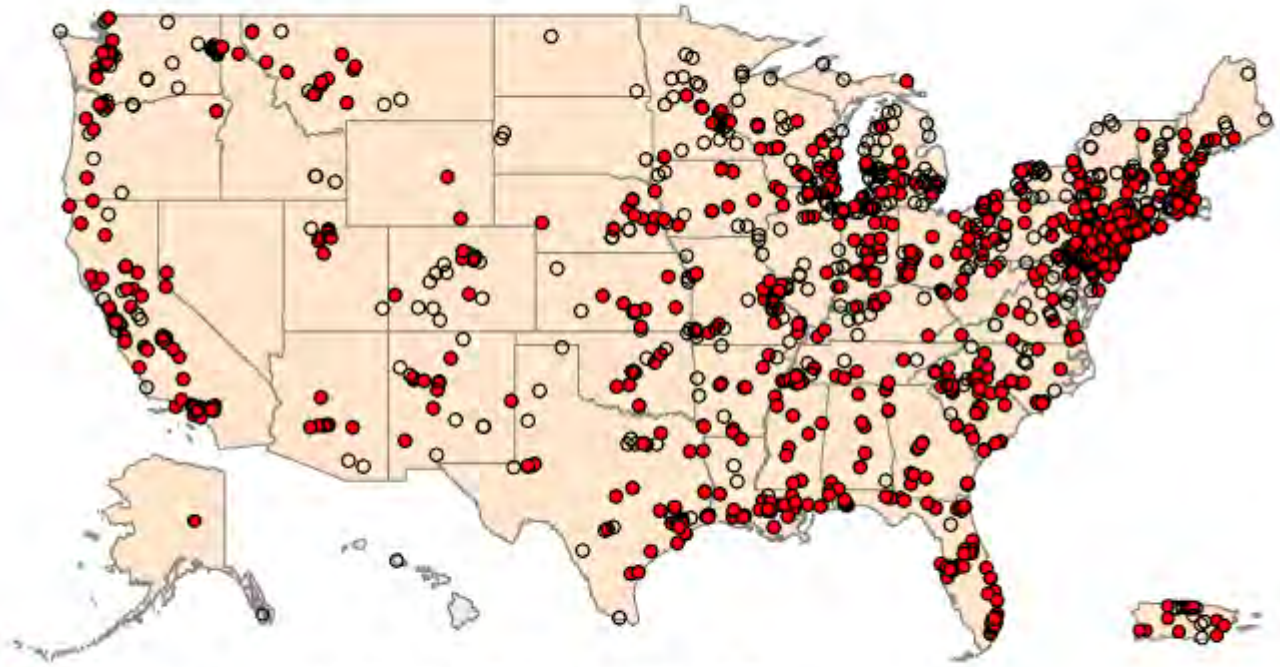
US Environmental Protection Agency
Center for Public Health and Environmental Assessment

Pacific Ecological Systems Division

OSU Superfund Stakeholders, 29Jan21

EPA, Superfund and Wildfire

Superfund Sites Located in Areas that May Be Impacted by Flooding, Storm Surge, Wildfires, or Sea Level Rise



● Potentially impacted sites (945) ○ No impact identified (626)

Sources: GAO analysis of Environmental Protection Agency, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, and U.S. Forest Service data; MapInfo (map). | GAO-20-73

PESD Research Collaborations

The Pacific Ecological Systems Division (PESD)

Strategically located on the US west coast

Responding to high-priority research needs for wildfire impacts to human health and the environment

Co-locating ODEQ PM SensOR and air toxics monitoring station, fire Mn spike

State of Oregon Department of Environmental Quality

Revising stream classification for aquatic life use

Forest droughts
Watershed vulnerability

AirNow

PESD among first ORD locations to regularly share air quality data with larger AQM network

PESD

OR Governor's Wildfire Response Council

USFS PNW Research Station

ORD

CESER – Todd Luxton, post fire mercury analysis in water
CEMM – Amara Holder, shared and co-located particulate sensors
CPHEA – Ian Gilmour toxicological analysis of smoke particulate matter
– VELMA modeling for Wildland Fire Leadership Council prescribed fire study

VELMA
Visualizing Ecosystem Land Management Assessments

PESD Fire-Water Research

Watershed resiliency

Stream beneficial use

Water quality, rivers sampled

- Heavy metals
- Nutrients
- Turbidity

Harmful algal blooms

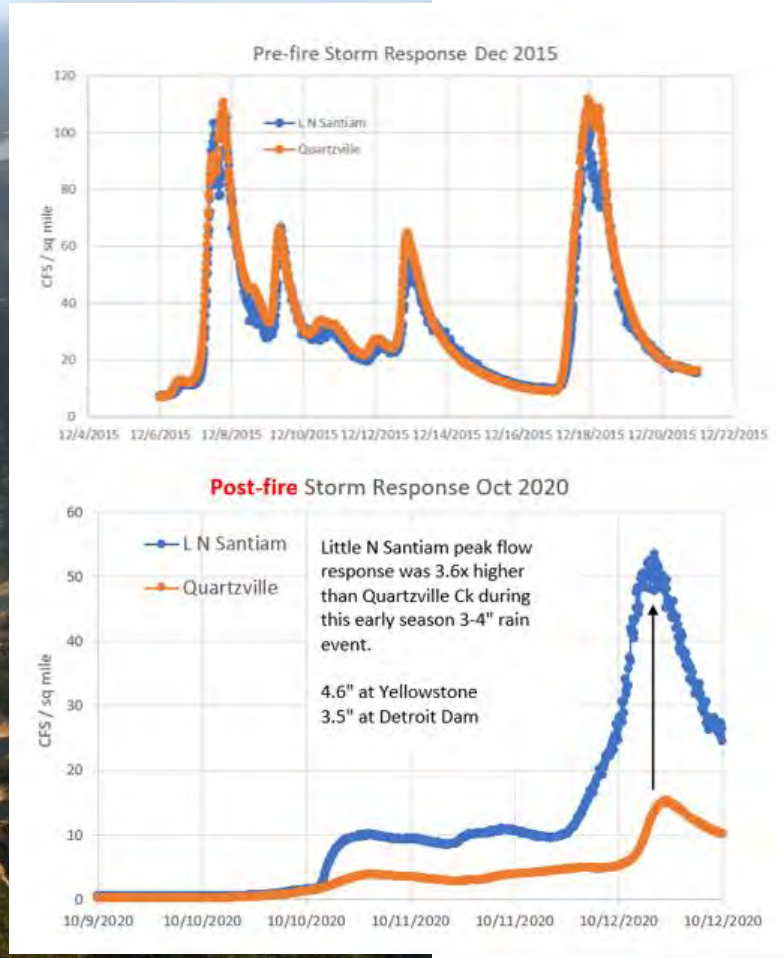
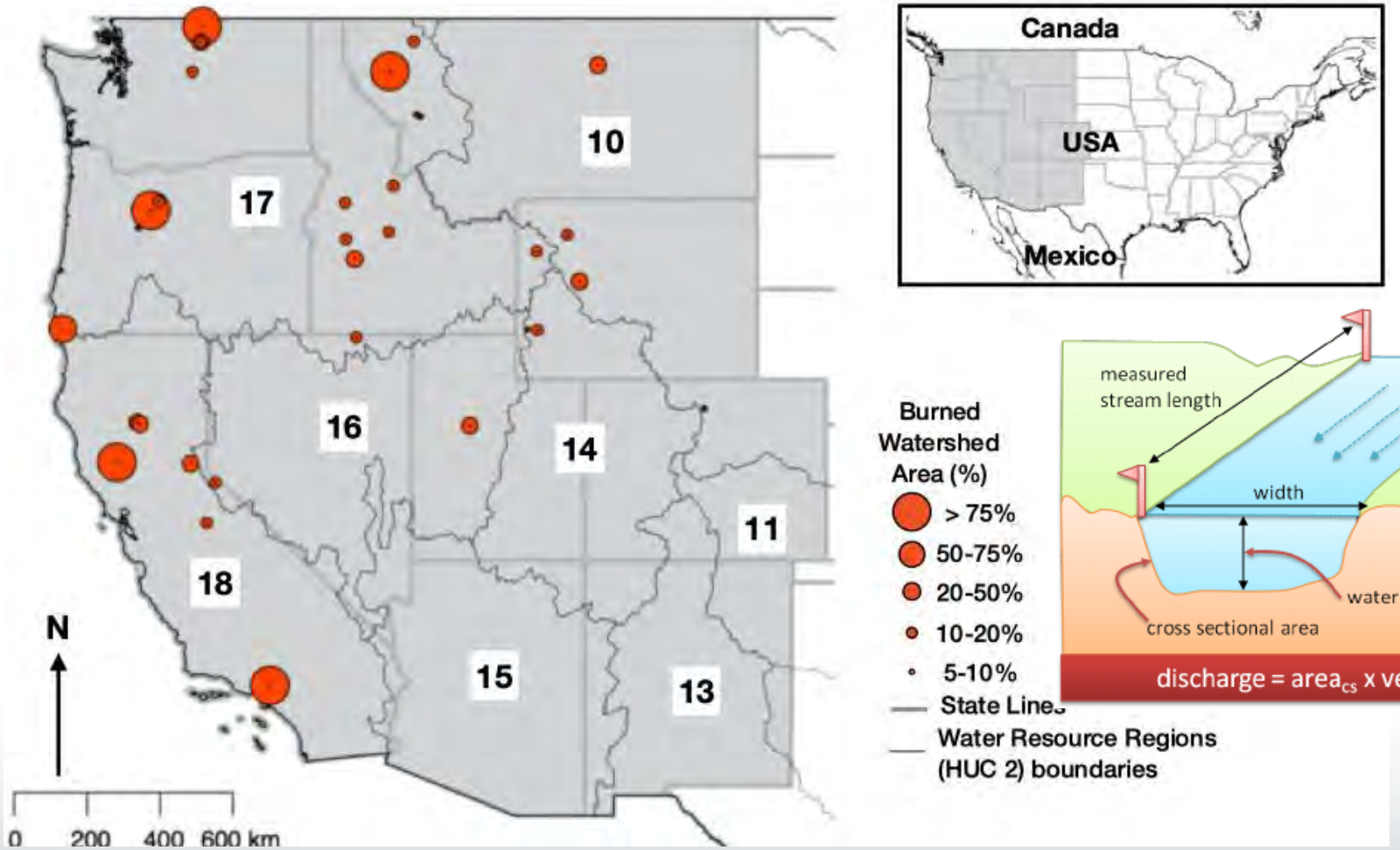


photo: Jeff Peterson, EPA Office Water

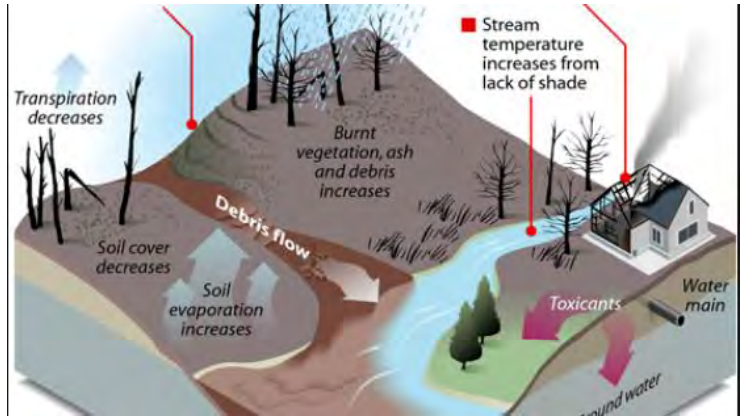
Existing data across large scales

Impacts of Wildfires on Stream Water Quality and Quantity in the Western United States



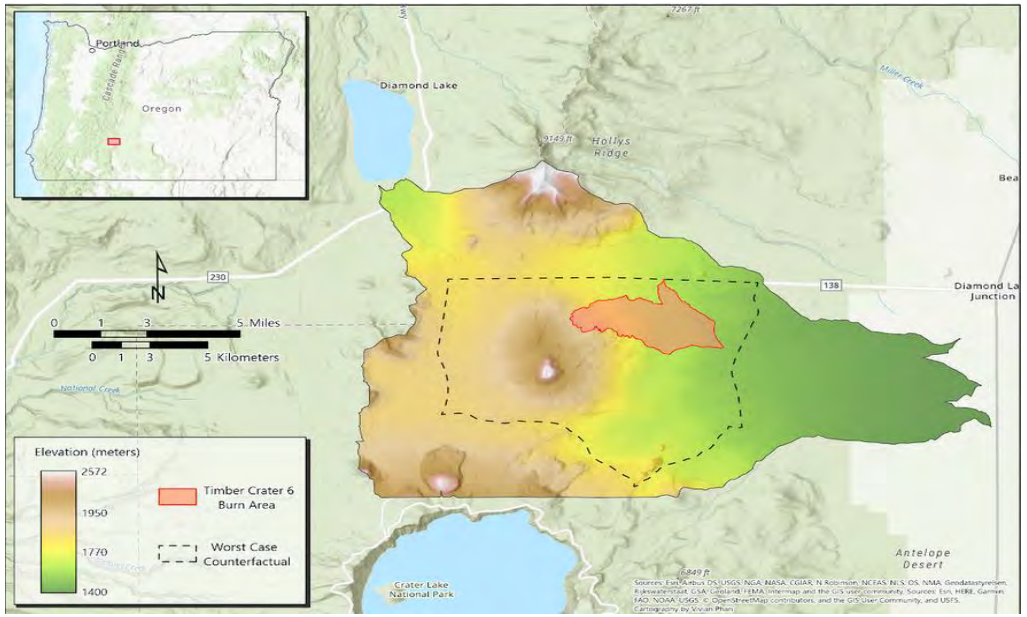
Wildfire Air Quality Impacts

Visualizing Ecosystem Land Management Assessments



Modeling prescribed fire vs wildfire

Timber Crater 6 Fire (2018), Crater Lake National Park, Oregon



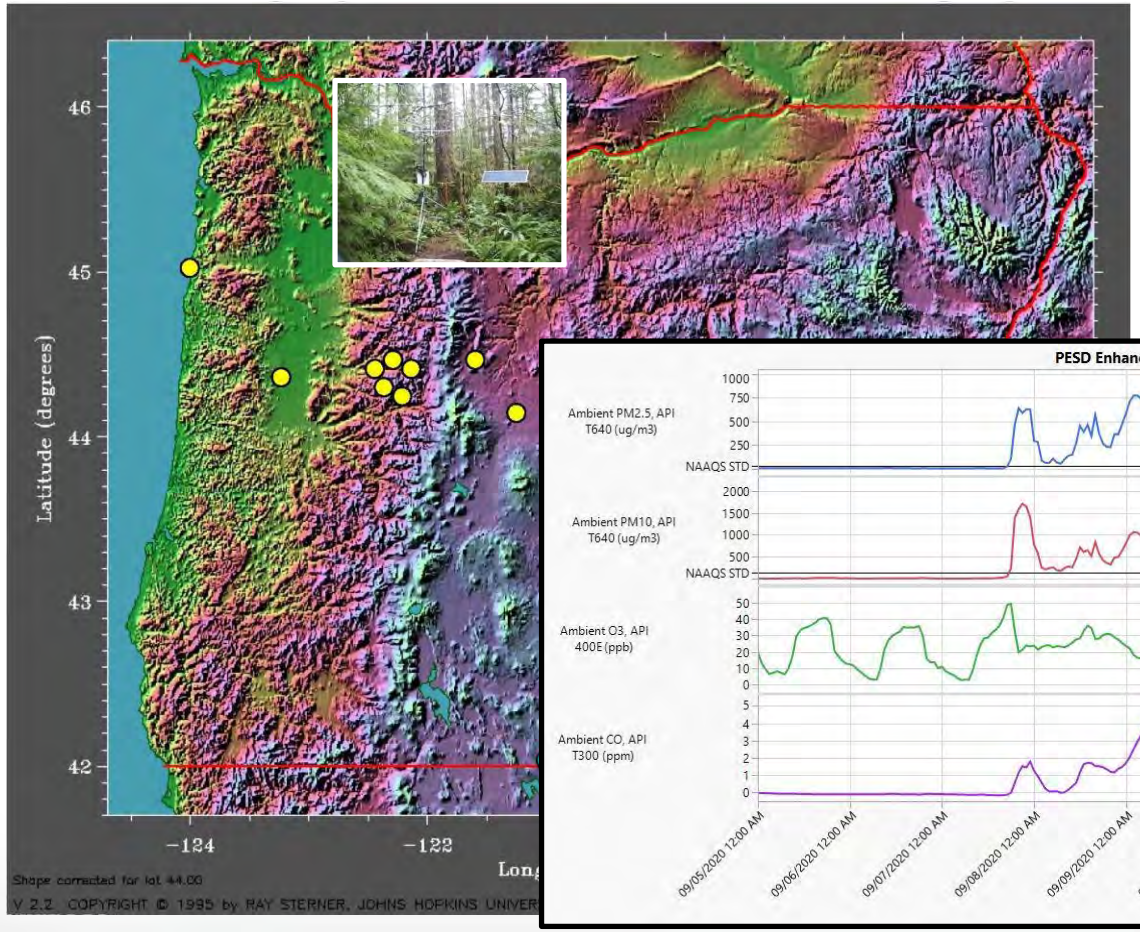
Wildland Fire Leadership Council (WFLC)

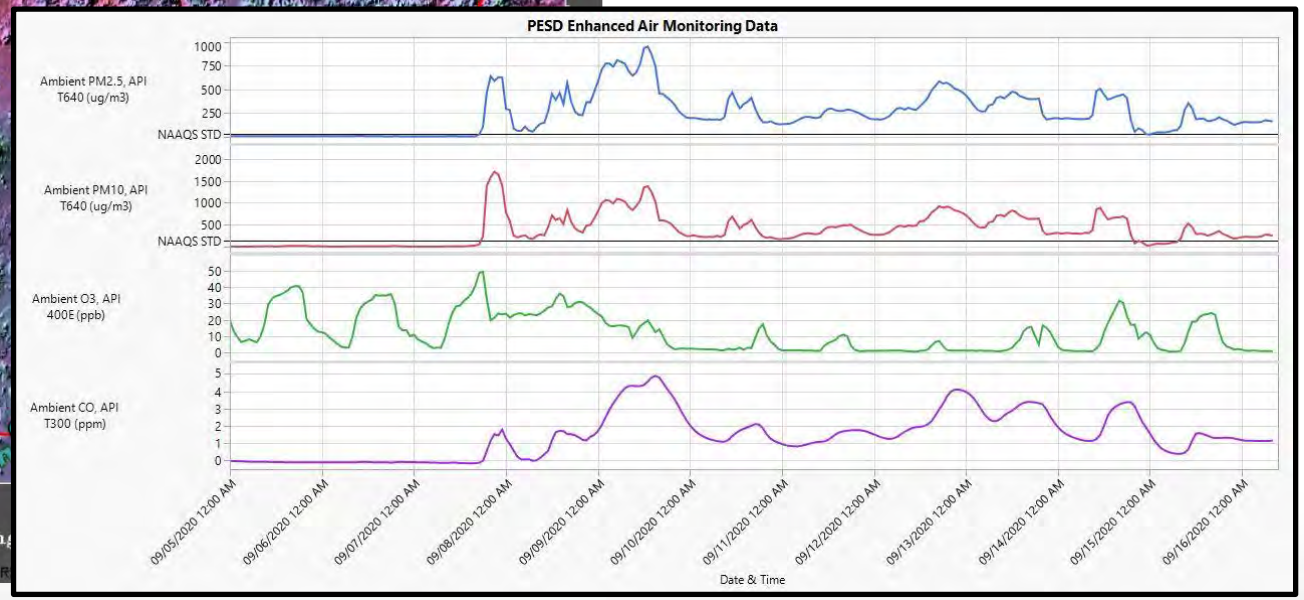
- Improve understanding of prescribed fire costs and benefits

Comparative Assessment of the Impacts of Prescribed Fire Versus Wildfire (CAIF): A Case Study in the Western U.S.

Wildfire Air Quality Impacts

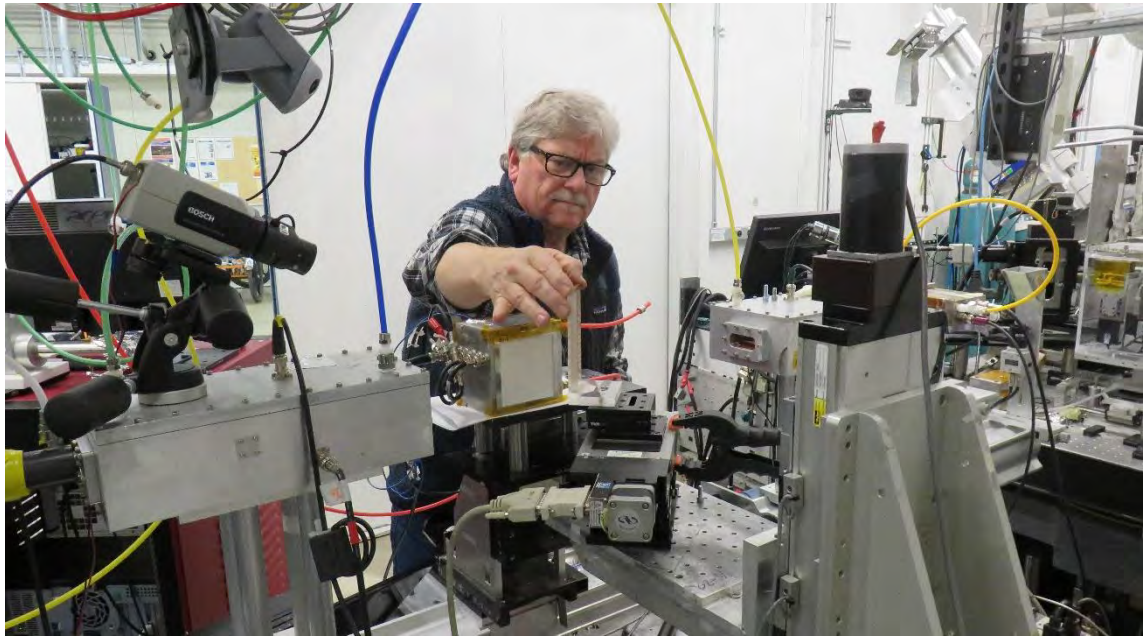
Enhanced Air Monitoring





Thank you

markwiese.james@epa.gov



OSU/PNNL Superfund Research Program Stakeholder Meeting

Friday, January 29, 2021

Mark G. Johnson, Research Soil Scientist
U.S. Environmental Protection Agency
ORD/CPHEA/PESD – Corvallis, Oregon

EPA Research on *in situ* Remediation of Contaminated Tailings, Soils and Sediments

Multiple problems exist at numerous sites

- Contaminated soils require intervention and remediation!
- There are 1300+ Superfund sites and approximately 500,000 abandoned mines across the U.S. that pose a considerable and pervasive risk to human health and the environment

Strategic use of biochar and other soil amendments at contaminated sites can address multiple problems

Biochar and other soil amendments

- Reduce contaminant exposure by limiting the exposure pathways and immobilizing contaminants by changing the chemistry of contaminated soils and removing contaminants from water
- Help restore soil quality and health of degraded soils
- Enable *in situ* site remediation, re-vegetation and revitalization, and reuse of contaminated soils
- Lead to sustainable site recovery while reducing the cost of remediation

Formosa Mine Superfund Site: Abandoned Cu and Zn Mine, Riddle, OR

What is Biochar?

- Biochar is carbon-rich solid derived by heating waste biomass in the absence of oxygen (pyrolysis)
- It is a porous solid with a number of beneficial properties that are can be used to sorb, complex or precipitate toxic contaminants in soil, sediments and water to:
  - Reduce hazards
  - Reduce exposure
  - Restore ecosystem function and services
- Biochar properties are tunable and are controlled by feedstock selection, pyrolysis conditions, blending and various methods of activation

EPA/ORD/SHC Research On Biochar and Soil Amendments

- Research is being conducted to engineer biochar to have specific remedial properties to address site specific contaminants and generally used with other appropriate soil amendments
  - Metal-contaminated mining residuals including: Zinc, Copper, Cadmium, Lead, Manganese
  - Lead-contaminated soils and sediments (From mining, smelting and industrial processes)
  - Phosphorus-contaminated soils on the Delmarva Peninsula to protect Chesapeake Bay water quality
  - Mercury-contaminated soils, wetlands and waters
  - DDT-contaminated soils and sediments
  - PFAS-contaminated soils
- Biochar is effective at reducing exposure to inorganic and organic contaminants
- Engineered Biochar provides a set of new, tunable materials that can be utilized in a variety of remedial situations
- Using biochar in remediation is meeting real environmental needs!

Biochar made from softwood chips

Solving the Problem: Start with the End in Mind

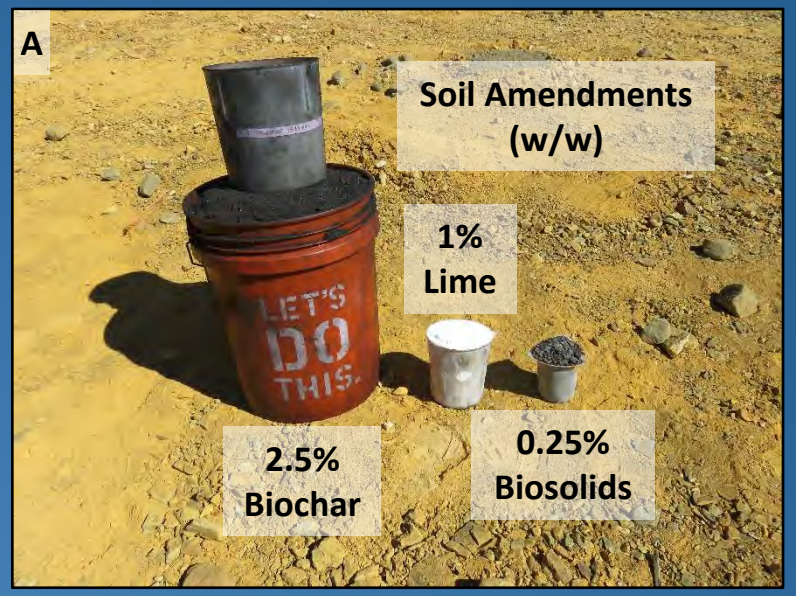
Before Amendments and Revitalization

After Amendments and Revitalization

Strategic Intervention to Promote Soil Revitalization Using Biochar and Other Soil Amendments

Formosa Mine Superfund Site, Riddle Oregon

Preparing the Formosa Site for Planting Trees



Tree growth since 2017

11.17.17

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OSU/PNNL Superfund Research Center Projects and Cores

Developing and Evaluating Technology to Measure PAH Fate and Exposures

Project Leader: Kim Anderson

The Anderson Project is working to understand where and how PAHs at Superfund sites are moving with the application of passive sampling wristbands to measure external PAH exposure for people near Superfund sites.

Predicting the Toxicity of Complex PAH Mixtures

Project Leaders: Robyn Tanguay and Lisa Truong

The Tanguay/Truong team is working to determine how transient embryonic developmental exposures to individual PAHs and PAH mixtures influence early development and adult cardiovascular fitness and neurobehavior. They are also evaluating the potential transgenerational impacts of PAHs and mixtures.

Linking PAH Exposure to Health Outcomes Using Human Primary *In Vitro* Models

Project Leaders: Susan Tilton and Dave Williams

The Tilton team is acquiring critical information about the toxicity of diverse PAHs and mixtures in a human-relevant, metabolically competent *in vitro* respiratory model. The research team will quantify the toxicity of PAHs and PAH mixtures in the human bronchial epithelial cell (HBEC) model, assess the role of metabolism on the toxicity of individual PAHs in 3D HBEC, and elucidate the mechanisms of PAH toxicity.

Elucidating Metabolic and Physicochemical Mechanisms of PAH Susceptibility in Toxicity Test Systems and Humans

Project Leaders: Justin Teeguarden, Jordan Smith

Drs. Teeguarden, Smith, Wright and El-Khoury are working to elucidate the molecular basis for susceptibility to PAH exposures. The Teeguarden team is defining differences in PAH metabolic capacity and PAH tissue distribution that could influence PAH susceptibility in humans, HBE cells, and zebrafish embryos. They will determine how toxic tissue doses in test systems compare to those experienced by humans.

Identification of Remediation Technologies and Conditions that Minimize Formation of Hazardous PAH Breakdown Products at Superfund Sites

Project Leaders: Staci Simonich and Lewis Semprini

The Simonich/Semprini team is developing methods and generating the data to identify and recommend remediation technologies that minimize formation of hazardous PAH breakdown products.

Support Cores:

Chemical Mixtures Core (Kim Anderson) **–** PAH standards, PAH mixtures, chemical analysis

Data Management and Analysis Core (Katrina Waters) **–** Data integration, data sharing, analytical tools

Research Experience and Training Coordination (Craig Marcus and Andrew Buermeyer) **–** graduate student externships/internships

Tribal-University Partnership (Molly Kile) **–** Indigenous risk assessment, building tribal capacity, building scientific cultural capacity

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