



Can we have healthy living environments in mining-impacted river basins?

*A teaching case study in the Coeur d'Alene Basin, USA*

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If you use our case, we'd love to hear from you. Please contact us at

[cwardropper@uidaho.edu](mailto:cwardropper@uidaho.edu) with specific case questions, answer keys, or the mock dataset we use for the Beach Mapping Exercise (Exercise 1). See case teaching notes and activity guide for additional information

## Day 1: Introduction to the Coeur d'Alene Basin

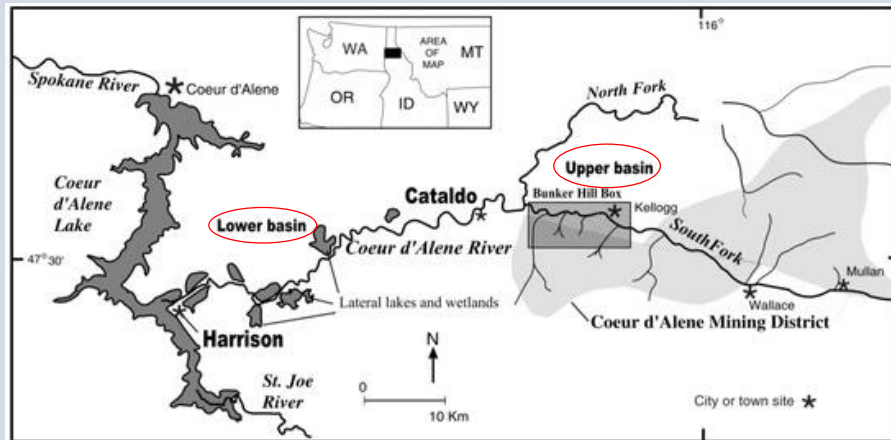
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Students should come to class having read Gustavson et al. 2007 and the EPA (2012) Record of Decision. In addition they will have completed the Institutional Analysis Worksheet for the Basin.

Please see activity guide and teaching notes for additional details. Email the authors for original powerpoint slides.

# Coeur d'Alene Basin



(Langman, Torso, Moberly, 2018)

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- Students will have already read background on the case
- Biophysical overview of system
- A sub-basin of the CRB, the CdA Basin encompasses 3,800 km<sup>2</sup>, with elevations ranging from 1,460 meters in the headwaters to 650 meters at the CdA Lake surface [5]. The Basin is often divided into three distinct areas, the upper, middle, and lower basins. The upper basin drains into the middle basin at the confluence of the North and South Forks of the CdA River, where several of the former mining sites are situated (Figure 2) [27]. Downstream from the site, the middle basin enters the lower reaches of the CdA River where it drains an 80 km<sup>2</sup> area to its end at the dam controlled, glacial Lake CdA. (Torso et al. manuscript in progress). Early mining practices led to widespread metals contamination.

## Unit Overview

4 Activities:

- Beach Mapping Activity
- Stakeholder Rainbow Analysis
- Public Hearing
- Risk Communication Messaging

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Provide an overview of the four activities in the unit. Highlight that the activities focus around the idea of risk. Ask students to define risk. Emphasize that risk is primarily defined as a lack of certainty. If an action is certain to have a particular outcome, it is not a risk.

# Primary Toxic Metal Transport Pathways

1) Flooding+ steep hydraulic gradient



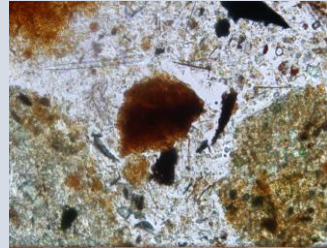
(CH2MHILL, 2018)

2) Stream bank erosion



(Langman, Torso, Moberly, 2018)

3) Biogeochemical reactions



(Langman, Torso, Moberly, 2018)

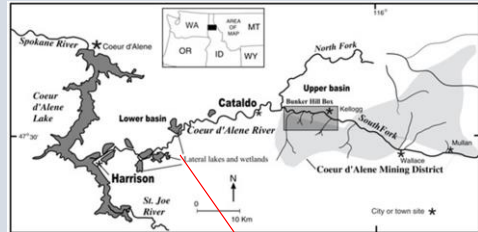
5

Animated

Upper Basin to lower Basin, metals have dispersed throughout the basin through these three primary means of transportation. The complexity makes it difficult to manage. Briefly describe each of these

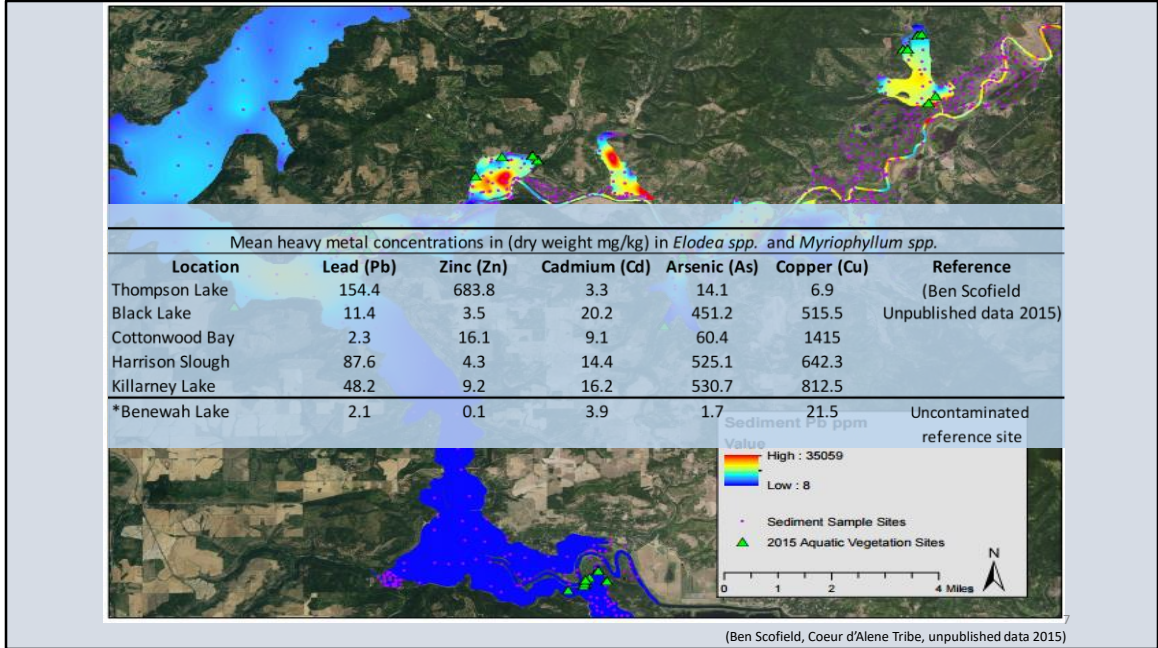
# Secondary Metal Transport Pathways

- Lateral Lakes system
  - 11 eutrophic floodplain lakes
  - Holding sink for heavy metals
- Seasonal and hydrologic flux
  - Lake turnover mobilizes metals
  - Internal loading of metals
    - Biogeochemical cycling



Source: United States Geological Survey

Optional slide: Lower Basin – Lateral lakes to lake CdA

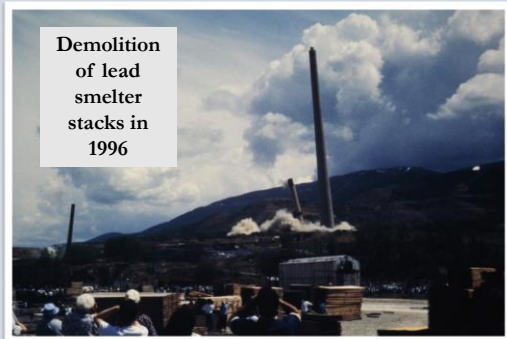


### Animation

Past research on metal (Pb) contamination concentration in bed sediments of CdA river basin

- Horowitz, 1995; Sprenke et al., 2000; Brookstrom, 2004; CdA Tribe, 2015
- This study will take this research a step further and analyze the confirmed contaminated biomass for HM release
- Use this slide to introduce the beach map activity (see teaching notes and activity guide). Make students aware of the reason for continued alarm regarding metals contamination in the Basin as well as the extensive science and management activities. Introducing this activity early in the unit will help students to stay on task.

## Modern Risks



Demolition of lead smelter stacks in 1996

Designation of Superfund site followed by clean-up activities and socio-economic struggles.

Source (left): USEPA  
Source (right): Idaho Fish and Game



“A particularly deadly season for swans” in the Cd’A River Basin- April 2019

Legacy mining impacts lead to ecological and human health concerns



*Photo of a dredge constructed at Caltaldo Mission which removed an estimated 34.5 million U.S. tons of tailings, which were deposited in a tailings pond (NRC 2005)*

-Toxic metals deposited in lateral lakes, wetland areas, and lake Coeur d’Alene, ~3,800 km<sup>2</sup>

- Once among world’s richest deposits of lead, zinc, antimony and silver (Sprenke et al., 2000)
- Lead smelter contaminated air and hill slopes

**Children living below poverty line in older housing are at greatest risk of health effects. Adults are also impacted.** (Canfield et al. 2003)

**At Superfund sites, toxic metals contaminate surface water, groundwater, soil, air, and buildings** (Amin et al. 2018)

**Lead most commonly absorbed through ingestion of contaminated materials**



(Needleman 1992)

Mining is a source and cause of persistent and severe soil and water pollution  
Pb is widely prevalent in severely contaminated areas of the US—about 50% of  
Superfund sites have Pb as a contaminant

Also, a popular news headline lately given the crisis in Flint, Michigan and a recent  
results from a longitudinal study on Pb exposure which suggested that lower levels of  
Pb contamination than previously thought were associated with chronic health  
problems including cardiovascular disease and hypertension. Bottomline, it is  
important that we learn how to live with lead in our environment. Easily avoidable  
with proper precaution. Without proper precaution it have the potential to deepen  
existing disparities even further because Superfund sites are often situated near  
marginalized populations. Over 500,000 former and active mining sites in the U.S.  
[http://blowhardwindbag.blogspot.com/2016/02/normal-0-false-false-false-en-us-x-  
none.html](http://blowhardwindbag.blogspot.com/2016/02/normal-0-false-false-false-en-us-x-none.html)

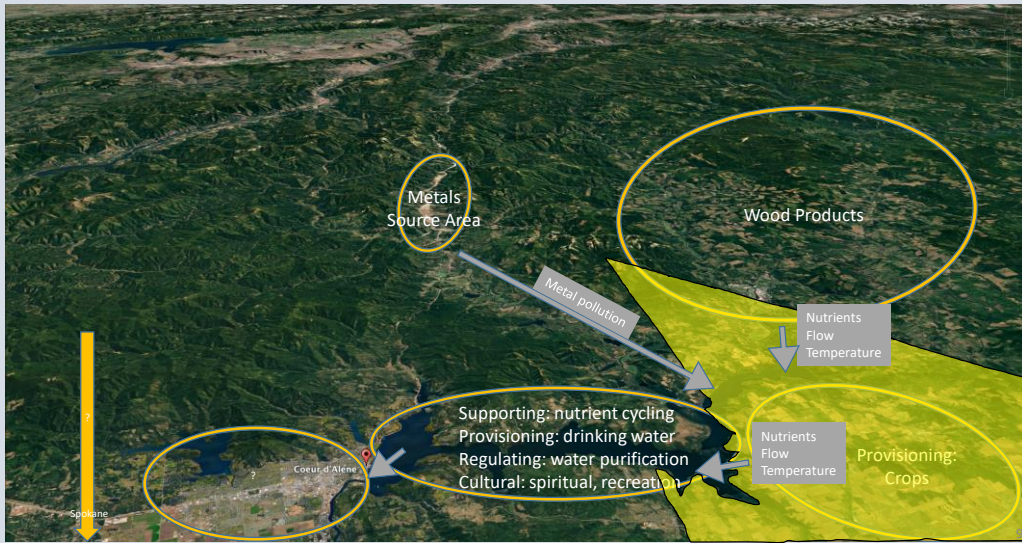
- Mine tailings were dumped directly into river
- Basin was unable to support aquatic life

Characterize vulnerability populations as children, pregnant women, and people who  
work or recreate frequently

Mention that over 7,000 properties have been remediate and briefly describe what  
remediation entails.

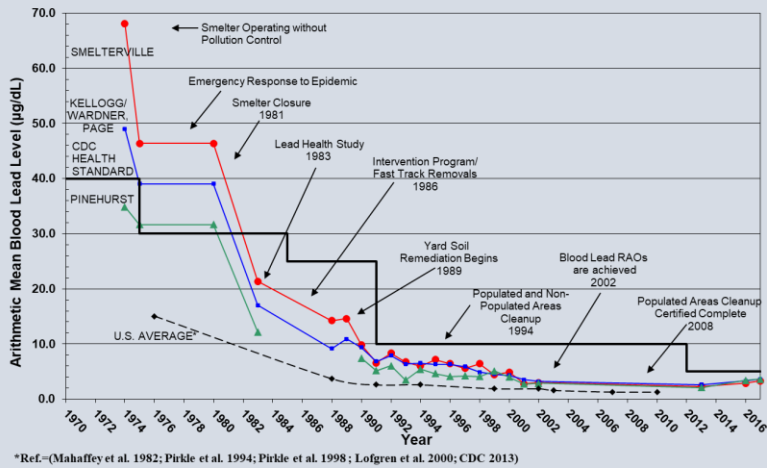
mining waste was dumped directly into the region's water bodies, creating streams  
unable to support fish or other aquatic life and filling sediments and soils with so  
many metals that they were toxic to waterfowl.

## Complex issues in the CDA Basin



The layers in the Basin culminated and lead to many different issues. There are a lot of activities going on in the Basin. The upper basin is an important source area for metals. Wood products are extracted from the St. Joe river. The CdA Tribe produces crops and uses water for cultural and spiritual purpose. The city of CdA is growing rapidly and thrives on recreation and amenities. The lake is a giant repository of metals. As the lake warms and nutrient levels increase, water purification concerns emerge around groundwater quality. The issues carry on downstream to Spokane and beyond.

## Bunker Hill Box Average Blood Lead: 1974-2017



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Overall , the situation has improved. The blood lead levels demonstrated in the 1970s were among the highest ever recorded in children. This is where we introduce CERCLA and discuss how levels have started to level out in the Valley. The risk is less visible?

## Silver Valley Historic Mining District

- Communication of toxic metal exposure risk is a global issue
- Cd'A was once among world's richest deposits of lead, zinc, antimony and silver (Sprenke et al., 2000)
- Lead smelter, zinc processing plant, extensive rail system
- Second largest Superfund designation (1983)
- Region continues to cope with the impacts
- Largest residential population living within a Superfund
- Popular recreation area and proud mining culture

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In the early 1980s, a fire in the baghouse of the primary smelter created one of the most significant blood lead poisoning events in children in the history of the US. The ideas for this study developed following a visit by the PHD blood lead health specialist. unique challenges in tracking Pb exposure issues in the Basin. Millions of remediation dollars have been spent. Remediated yards, municipalities, infrastructure. Goal today is to minimize health risk and to promote community development

Proud mining history

Over 7,000 yards remediated

Slow economic growth and social, economic and cultural disparities persist

Persistent health disparities

Cash incentives for blood lead testing

Define study area a little better.

More info: Sprenke, K. F., Rember, W. C., Bender, S. F., Hoffmann, M. L., Rabbi, F., & Chamberlain, V. E. (2000). Toxic metal contamination in the lateral lakes of the Coeur d'Alene River valley, Idaho. *Environmental Geology*, 39(6), 575–586.

## Beach Mapping Activity

3 parts of the activity:

- 1) Bring in the dataset to ArcMap online
- 2) Filter and plot points to explore where contamination occurs
- 3) Explore the cost of riprapping the contaminated beaches



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Pass out handout and describe beach mapping activity. Allow students to work on the activity for the remainder of the class period. Specify the due date for the activity. Ask whether students have experience using mapping software.

## Introduction

- Recreation sites present a unique set of issues for environmental managers
- Removing contaminated soil and replacing it with clean soil is not an effective remediation strategy on its own.
- Recreation sites can be remote, hard to access, and spread out. Imagine the challenge of cleaning up a 200-acre recreation area.
- The Basin Environmental Improvement Project Commission (BEIPC) relies on multiple approaches for remediation and restoration at recreation sites.
- The overall goal of clean-up activities at recreation sites is to address and manage human health risks from exposure to lead and other toxic metals while maintaining the benefits of recreation for people's health and the local economy.

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### Animations

Extra details (also included in the handout)

In addition to remediation techniques, the approach relies on community outreach and education to help people manage health risks while recreating. Early in the environmental clean-up, a 72-mile strip of contaminated decommissioned railroad along the river was converted to a paved recreational trail, but the area around the bike trail is still contaminated because it is within a flood zone. The trail offers excellent recreation opportunities but also makes accessing beaches, which contain contaminated sediment, easier. People can also access beaches by boat. BEIPC must balance tradeoffs between public health concerns and new economic development.

## Scenario

- Spring flood events leave beaches covered in highly contaminated sediment for multiple years in a row.
- The Panhandle Health District tested lead levels with their handheld XRF (a device used to test for lead) that exceeded 20,000 parts per million (ppm) lead at several popular beaches.
- Unfortunately, beaches are popular summer hangouts for residents and out-of-town visitors.
- Business owner exploring the feasibility of building a recreation outfitter which would allow kayaking and tube rentals.
- DEQ seeking to remediation assistance

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### Animations

While the addition of the outfitter would help boost the local economy, it would also make the contaminated beaches more accessible. These concerns have prompted the Idaho Department of Environmental Quality (IDEQ) to request remediation assistance from the EPA.



## Wrap-Up

- Watch “The American Pollution Story”
- Meet in the library for next class
- As you watch, consider the following quote:

“The latency phase of risk threats is coming to an end. The invisible hazards are **becoming visible**. Damage to and destruction of nature no longer occur outside our personal experience in the sphere of chemical, physical or biological chains of effects; instead they strike more and more clearly our **eyes, ears and noses**.”—Ulrich Beck, *Risk Society: Towards a New Modernity* (Beck, 1992, p. 55)

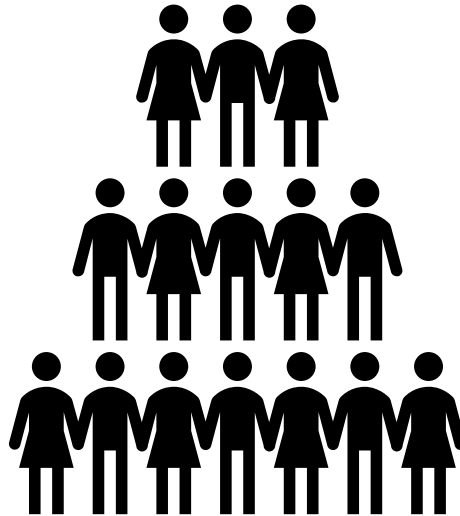
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Save a few minutes to make sure that student know how to access the film.

Our class goes to the library the next class period for background on using ArcGIS online.

## Day 2: Introduction to Stakeholders

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Students should come to class having watched the American Pollution story and will also need their laptops in class.

Leave time for a partial work day on beach map activity

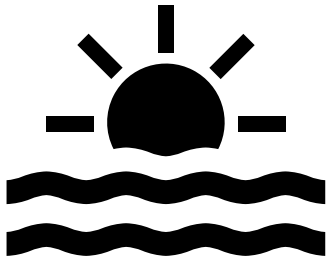
## Discussion

- Who is a stakeholder? Who is not a stakeholder?
- What aspects of risk are visible? Invisible?
- Who were the primary stakeholders presented in the American Pollution Story?
- Did you find any of the perspectives in the video surprising?
- Are stakeholders entitled to equal representation on issues that affect them?

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Begin discussion by reminding students who stakeholders are.

The term stakeholder first appeared in 1708 to refer to a person who holds take in a bet. Today it commonly refers to any group or individual who can affect, or is affected by, the achievement of a corporation's person. In natural resource management the term has been modified further to refer to natural resource users and managers. After having this discussion it may be of interest to discuss why the evolution and the application of the term stakeholder may be problematic for some groups. The most helpful definition for resource management may be a "person who owns a problem" this definition originated in Checkland 1981. Emphasize the in health risk communication a stakeholder is defined as "any persons or group of persons whose lives could be impacted by a given risk" (Selnow et al. 2009).



## Work on Beach Map Activity

Provide about 45 minutes of this class for working on the beach mapping activity. This should allow students the time to complete most of the activity.

## As you read Metcalf et al.

- “The role of trust in restoration success: public engagement and temporal and spatial scale in a complex social-ecological system”
- Create a list of stakeholder groups
  - Describe the vulnerabilities that each group experiences
- What recommendations for public engagement are included in the article?

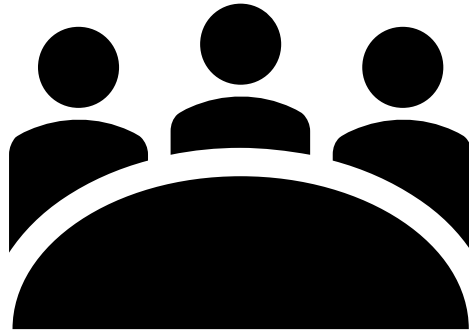
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Encourage students to think about examples from the video as well. The Metcalf piece includes perspectives from stakeholder groups that are similar to the groups in the CdA.

Explain to students that the next class will begin with a discussion of this article and the beach map activity

**Day 3: stakeholder  
analysis and  
introduction to  
public hearing  
activity**

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Students should come to class having read Metcalf et al. 2015

## Discussion: Beach Map Activity

- What are some issues with the dataset you were provided? Consider the source and method of data collection.
- Do you think the proposed remediation project is a good idea? Consider the social, cultural, and ecological implications of the project.
  - What additional information or data would help you to defend your position?
- How much will the project cost?

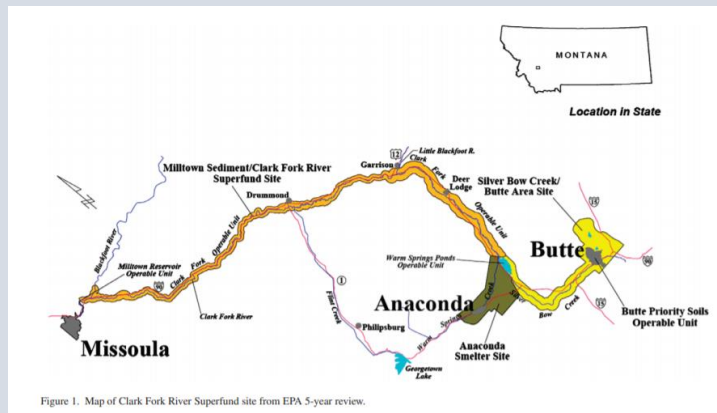
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### Animations

Take notes on the blackboard.

Begin introduction to the public hearing by discussing the beach map activity. Students should have turned in the map. Compare the costs that the students came up with. Emphasize that the activity was a very simplified introduction to restoration. The Clark Fork introduction helps emphasize the simplifications.

# Clark Fork Overview



*Metcalf et al. 2015*

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Watch the 8-minute video: <https://idfg.idaho.gov/blog/2017/11/restoring-clark-fork-delta>

The Clark Fork is the largest river by water volume in Montana

Largest Superfund complex in the United States

The Superfund complex is comprised of four separate Superfund sites designated to address over 100 years of damage and contamination resulting from historic copper mining in Butte, Montana



## Discussion: Metcalf et al.

- List the primary stakeholder groups
- What are some of the vulnerabilities these groups experience? What do these groups care about?
- What recommendations for public engagement are included in the article?

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Groups may include: High school students, Idaho Fish and Game, Academics, Utility Companies, Volunteers, Montana Department of Environmental Quality, Montana's Natural Resources Damage Program, Montana Fish Wildlife and Parks, federal agencies (e.g. Environmental Protection Agency and National Park Service), the Confederated Salish and Kootenai Tribes, NGOs (e.g. Trout Unlimited, Clark Fork Coalition), community groups (e.g. Clark Fork River Technical Advisory Committee and Watershed Restoration Council), numerous communities and landowners, and myriad consultants and restoration businesses

## Findings from Metcalf et al.

Build trust by:

- Utilize multiple forums for engagement and communication
- Engage the public and key stakeholders at the outset of the project when key decisions are still being made
- Ensure meaningful engagement
- Build strategies to sustain public engagement and communication
- Trial with small-scale pilot projects first

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Worth noting that with Superfund sites, private landowners in MT are required to allow remediation but not restoration. This is not the case in Idaho. Remediation is not required.

## Introduction to Public Hearing Assignment

### Overview:

- Develop a 200-word testimony
- Present your testimony during a mock public hearing
- Develop a 500-word summary of the perspectives

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Introduce the public hearing activity using the next few slides. Explain how students will play different roles. Explain that the next class period will introduce them to public hearings. Pass out hand out.

## Scenario: Riprapping Public Beaches



*Photo source: NY Magazine*

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Public beaches along the South Fork of the Coeur d'Alene River, have recently become a heated public health debate. Spring flood events have left several beaches covered in highly contaminated sediment for multiple years in a row. The Panhandle Health District tested lead levels with their handheld XRF (a device used to test for lead) that exceeded 1,000 parts per million (ppm) lead at several popular beaches.

Unfortunately, these beaches are popular summer hangouts for residents and out-of-town visitors. In addition, a business owner is exploring the feasibility of building a recreation outfitter which would allow kayaking and tube rentals. While the addition of the outfitter would help boost the local economy, it would also make the contaminated beaches more accessible. These concerns have prompted the Idaho Department of Environmental Quality (IDEQ) to request remediation assistance from the EPA.

In addition to the scenario, give students some background about why riprapping is often considered a remediation option (erosion control, safety). There are of course also downsides to riprap, for example rocks can become homes for unwanted animals and people can injure themselves climbing on riprap.

Photo 1:

[http://nymag.com/intelligencer/2007/02/beware\\_of\\_riprap\\_in\\_greenpoint\\_1.html](http://nymag.com/intelligencer/2007/02/beware_of_riprap_in_greenpoint_1.html)

## Discussion

- Who are the primary stakeholders in the Silver Valley?
- Spend a few minutes positioning the stakeholders on the rainbow diagram on the next slide
- Consider how riprapping the beaches affects each stakeholder group and how each stakeholder group affects the riprapping project
- Identify vulnerabilities for each group

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Write a list of stakeholders on the whiteboard. These should be similar to the roles described in the activity book. After developing a list of stakeholders, assign students their groups and roles in the public hearing. Use the handout corresponding with this activity

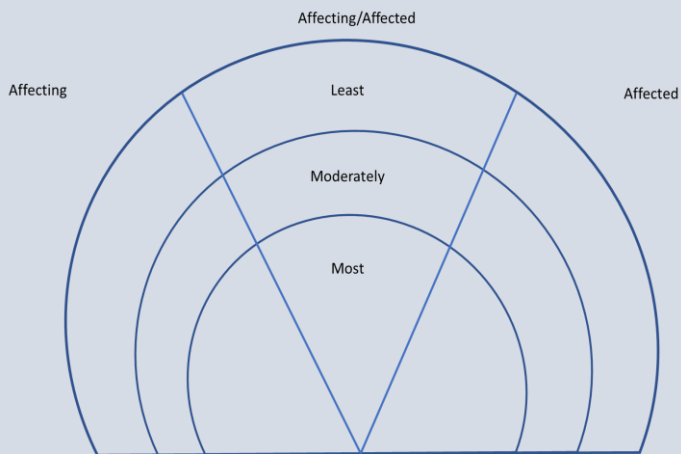
## Stakeholder Groups

- EPA
- IDEQ
- Public Health District
- Tribal Member
- Residents
- Recreationists

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These should be similar to the lists that students have come up with in discussion.

# Stakeholder Analysis Activity



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## Worksheet

If a stakeholder is someone who owns a problem they can be both affected or affecting the problem.

Pass out the worksheet associated with the activity to allow students to determine how each of the stakeholders in the Silver Valley fit into the chart.



## Discuss

- How are different stakeholder groups affect or are affected by changes to the public beaches?
- What are the primary vulnerabilities experienced by each group?

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Recommend taking notes on the whiteboard.

**Day 4:  
Introduction  
to public  
hearings**

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Students should come to class having read introductory materials about public hearings. Include partial work day. The next class period should be the public hearing. Read McComas, K. A. (2003).

## Public Meeting v. Public Hearing

- What is the difference?
- A public meeting is a meeting in which business is conducted by a public body. This may or may not include participation by the public.
- A public hearing is a special type of public meeting for the purpose of the governing body accepting **public comment and testimony** on local legislation.

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### Animations

The important part of this discussion is to highlight that the public actively participate in public hearings.

Related blogpost: <http://plannersweb.com/2013/05/top-10-mistakes-meetings/>

## Common issues in public hearings

- Getting political
- Having a predetermined outcome
- Fear of disagreeing
- Being unprepared
- Conflicts of interests
- Improper 'ex parte' disclosure
- Improper notice of meeting

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Additional resources: Related blogpost: <http://plannersweb.com/2013/05/top-10-mistakes-meetings/>

This list of issues applies to people delivering testimony and people facilitating the meetings. These have a lot of overlap with the Metcalf piece. Encourage students to refer back to the Metcalf piece when developing their testimonies.

## Watch sample of public hearing

- Which testimony is most compelling?
- Were certain words or ideas biased or unequal?
- Why might external meeting facilitators be helpful in some situations?
- What can be done to ensure that the perspectives of the primary stakeholders are included in the hearing?
- <https://www.youtube.com/watch?v=HR9FbwzSHDk>

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Write a list of stakeholders on the whiteboard. These should be similar to the roles described in the activity book. After developing a list of stakeholders, assign students their groups and roles in the public hearing.

This activity will take about 30 minutes. The remainder of the class is for preparing testimony for the hearing.

## Day 5: Public Hearing

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No slides provided for the public hearing, see teaching notes/activity guide.

## Day 6: Risk Messaging



Students should come to class having read Witte et al. 2001 Chp 1. They will also complete the final activity for the unit in class (risk communication activity)

Begin this discussion by reflecting on the public hearing.

Background image from:

<http://painepublishing.com/measurementadvisor/how-risk-communications-is-different-from-public-awareness-and-crisis-communications/>

## Discussion: Public Hearing

- Did you notice any of the common issues with public hearings materialize in the hearing?
- What elements of public discourse were missing from the discussion?
- How do you think an actual public hearing would differ from our class experience?

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Exclusions might include stakeholder groups, ecosystem consideration, funding, planning/policy process. Students should think about the Clark Fork project specifically



## Awareness v. Risk Communication

- What is the difference?
- World Health Organization: “Risk communication refers to the exchange of **real-time information, advice and opinions** between experts and people facing threats to their health, economic or social well-being. The ultimate **purpose of risk communication** is to enable people at risk to take informed decisions **to protect** themselves and their loved ones.”

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Includes animation

Optional opportunity for discussion of differences between awareness and risk communication. Good opportunity to set up the final activity.

More info: <https://www.who.int/risk-communication/background/en/>

## Hazard v. Outrage

- “the Golden Rule for risk managers is: always focus on the linked hazard-plus-concern” (Leiss 2003, p. 369).
- Hazard = technical analysis + risk calculation
- Outrage= lay public’s concern about a risk issue  
(Sandman 2000)

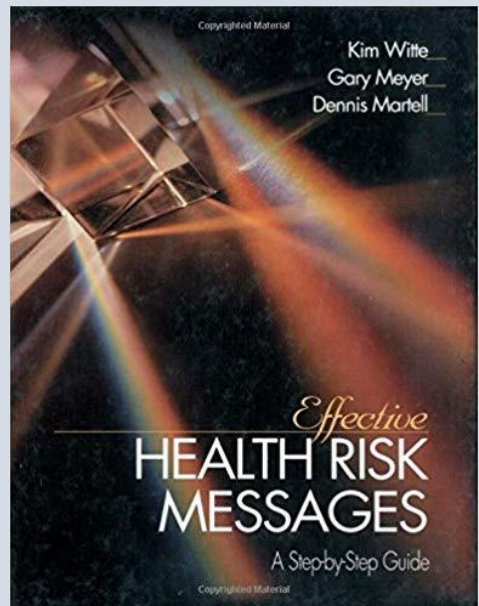
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Risk communication often involves socio-political issues that conflate the actual biophysical problem.

# Health Risk Messaging

Health risk communication model that emphasizes:

- Dialogue
- Conflict resolution
- Consensus-building
- Relationship development among the parties involved with or affected by the risk



## Risk Communication Challenges

- Response has primarily focused on safe recreation within the Bunker Hill Superfund Site
- People over report doing health-protective behaviors
- Growing lack of awareness about legacy mining waste issues
- Resistance to acknowledging health issues



Example of non-health protective behavior  
Source: Panhandle Health District

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### Animations

These points summarize the primary risk management challenges in the Silver Valley. The photo shows people leaving clothing out directly on contaminated soil. A person is taking a metals measurement with an XRF device.

Discuss new signage/handwashing stations

Recreation strategy: <https://www.deq.idaho.gov/media/60179045/cda-recreation-strategy-1016.pdf>

## Initial signage

- Clear message
- Simple declarative statements about suggested behaviors
- What issues might arise with these signs?



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## Animations

The issues are listed in the next few slides. List possible issues on a whiteboard.

## Issues with initial signs

- Difficult to see
- Often ignored
- Not Tailored
- One-way communication



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Animations, yellow arrow points to one of the original signs. The sign is hidden in the shade and people have beached their boats. This area of beach is particularly contaminated.

Photo credit, Panhandle Health District

## Activity: Risk Communication Scenario

- IDEQ has noticed that people ignore posted signs
  - They need ideas for new warning signs
- You are a contractor trying to win the bid to develop the new signs
- Your sign designs will include a brief slogan as well as a visual

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Introduce the public hearing

## Activity

- Work with a partner to create a slogan that is both sensitive to the historical context and issues and alerts people about the health risks of lead contamination.
- Share your slogan and ideas for improving risk communication with with the class

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Pass out handout and read through scenario as a class. This activity is completed in class.

“The IDEQ has read through the public hearing responses and is now beginning planning stages for the beach riprap project. They are looking for ideas for new signage to be posted at all the beaches that will be riprapped. You and your partner are a contractor trying to win the bid to develop the signs. Sign designs should include a brief slogan as well as a visual. If you cannot produce the visual, you can describe it instead. The IDEQ has noticed that in the past people have failed to notice signs. As a result, they have asked contractors to include a brief strategy about how signs can be strategically placed to draw more attention. You should include a brief description of how you would suggest overcoming the challenge when presenting your sign.”

Integrate the recommendations from the class discussion with the changes to signage implemented in the Basin.



## New Signs

- Initiated in 2017
- Include historical context
- Handwashing Stations
- Contact Information
- Tips for protective actions
- Tailored to different audiences



# New Tailored Signage



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There is so much ground to cover so additional signs were designed to draw attention and inform the reader in a simple, straight forward way.

## Discussion

- What constitutes an effective risk communication strategy?
- How could health risk announcements fail to consider sensitivities of a vulnerable population?
- How could risk communication become more interactive?
- What challenges may prevent more interactive risk communication?

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Finish the unit with a discussion about the challenges and opportunities for risk communication in the CdA Basin.

## Additional References

Leiss, W. (2003). Searching for the public policy relevance of the risk amplification framework. In N. Pidgeon, R. E. Kasperson, & P. Slovic (Eds.), *The social amplification of risk* (pp. 355–373). Cambridge, United Kingdom: Cambridge University Press.

Sandman, P. (2000). Open communication. In E. Mather, P. Stewart, & T. Ten Eyck (Eds.), *Risk communication in food safety: Motivating and building trust*. East Lansing: National Food Safety and Toxicology Center, Michigan State University

Sellnow, T. L., Ulmer, R. R., Seeger, M. W., & Littlefield, R. (2008). *Effective risk communication: A message-centered approach*. Springer Science & Business Media.