EPA United States Environmental Protection Agency

Remediation to Restoration to Revitalization (R2R2R): Tools to Support Remedy Decisions

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US EPA Office of Research and Development
EPA Tools and Resources Webinar
November 14, 2018

Goal of R2R2R

Remediation to *Restoration* to *Revitalization*

To help transform remediation projects into sustainable revitalization of the surrounding community by maximizing the positive *societal* and *environmental* outcomes.

Great Lakes Areas of Concern

- Great Lakes **Areas of Concern** (AOC) are communities with severely impaired coastal aquatic ecosystems
- Removing these impairments is an EPA priority under the **Great Lakes Water Quality Agreement**
- Impairments include harmful algae blooms, excess nutrients and sediments, contaminated sediments, fish consumption advisories, and habitat loss
- AOCs are communities recognized and organized by EPA that have to make decisions on how to restore beneficial uses

Great Lakes RESTORATION

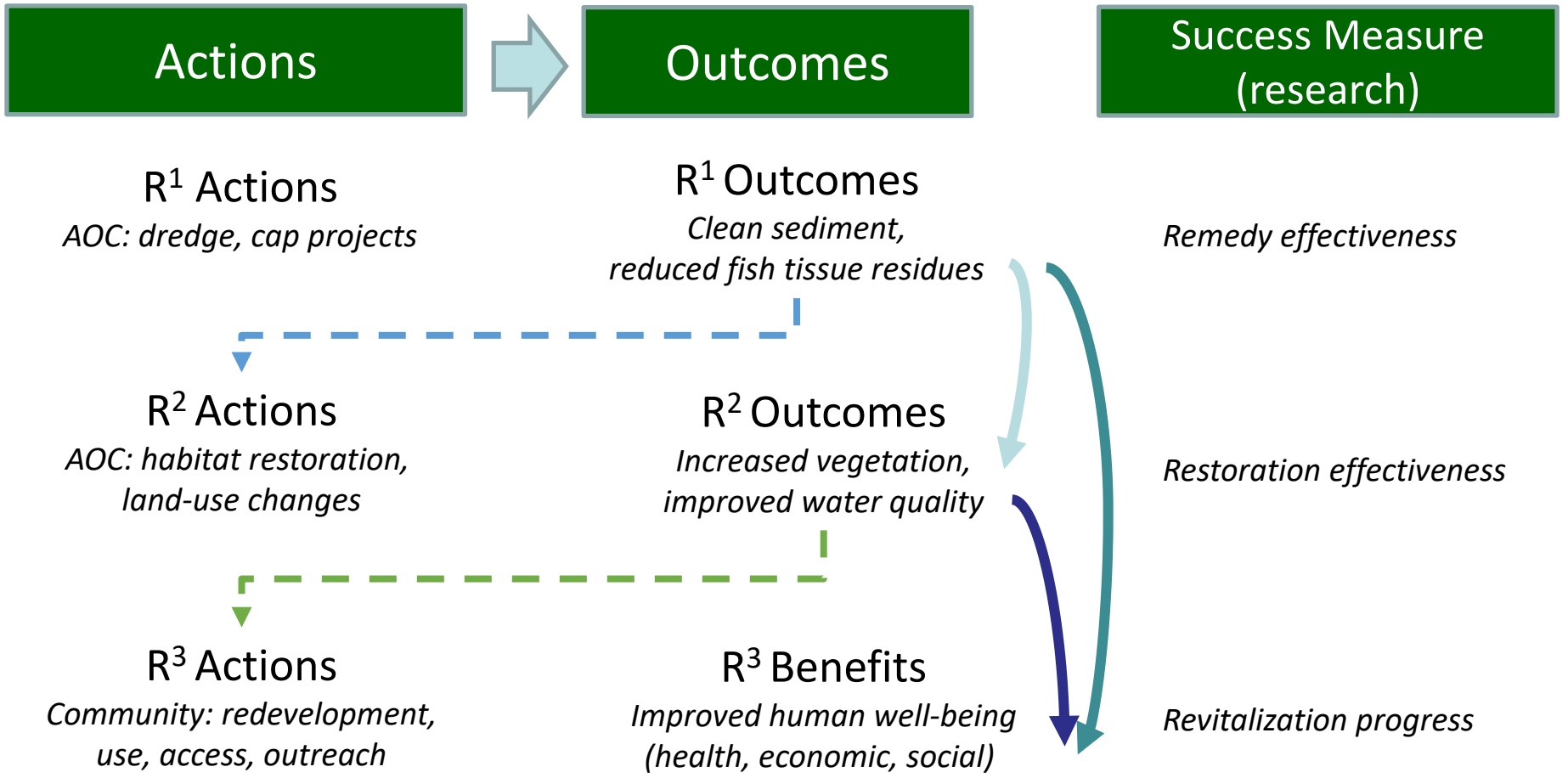
"We're committed to creating a new standard of care that will leave the Great Lakes better for the next generation."

The R^3 Paradigm:
"Its not just sediment remediation"

Remediation → **R**estoration → **R**evitalization

Courtesy M. Tuchman, S. Cieniawski

The R^3 Paradigm



R1 – Remedy Effectiveness

Why Remedy Effectiveness

- Provide decision makers with information about the outcome of the remedy (adaptive management)
- Measure risk reduction
- Improve remedy practice through time
- Communicate change to the public

Goal

Develop physical, chemical, and biological measures to determine remedy effectiveness

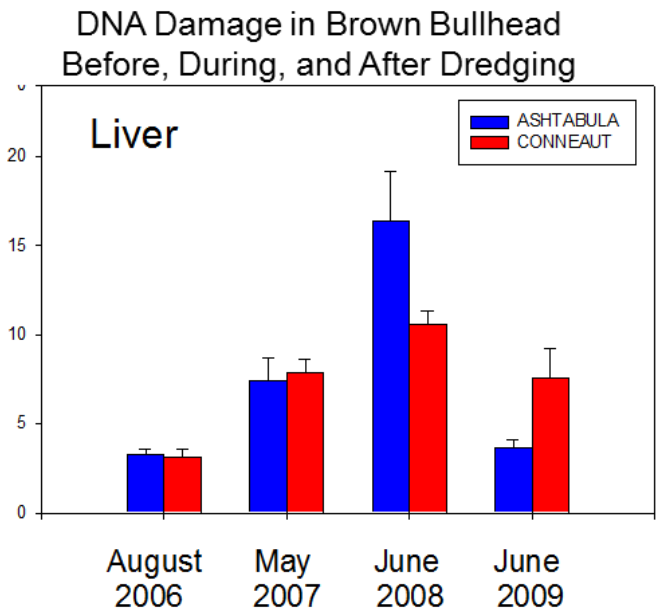
- *Physical*: bathymetry, sediment transport, particle tracking
- *Chemical*: chemical analyses of water and sediments, sediment core profiling, passive samplers, chemical forensics
- *Biological*: tissue concentration through the food web, DNA damage in fish (tumor indicator), ecological integrity, and sediment toxicity

Measure pre-, during, and post remedy

Study Area – Ottawa River

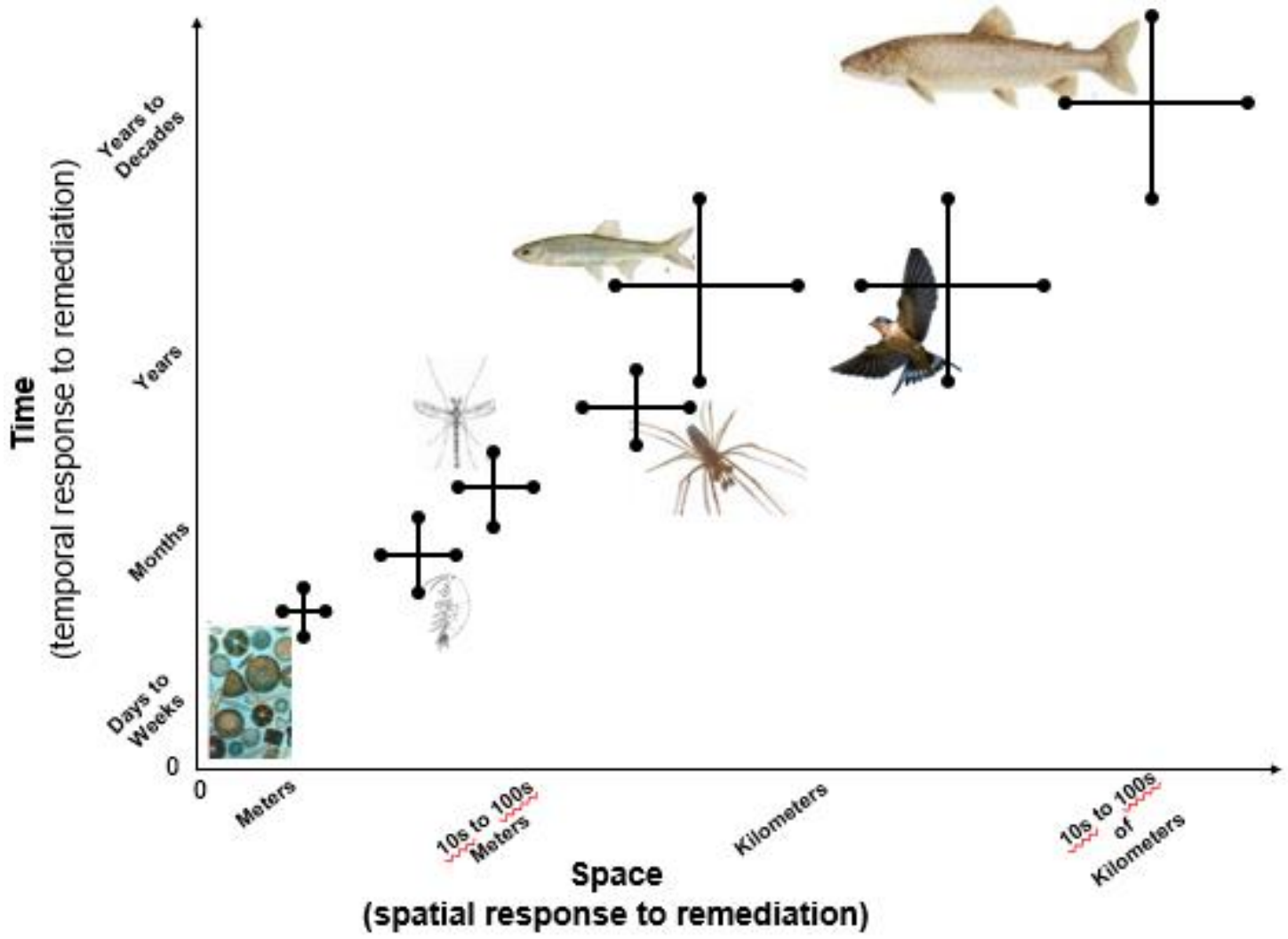
Biological Lines of Evidence (LOE) to assess Remedy Effectiveness

Current Practice	Innovative Practice
Fish tissue for human and wildlife consumption	Benthic body burden, Short lived adult fish (minnows)
Sediment toxicity and bioaccumulation testing	Benthic Tissue Concentrations
Benthic survey	Alternate and surrogate bioaccumulation measures (SPMEs, Tenax, etc.)
	DNA damage, “omics”
	Riparian indicators
	Bivalve uptake
	OEPA Lacustrine Index of Biotic Integrity (LICIC), Dredged and Non Dredged

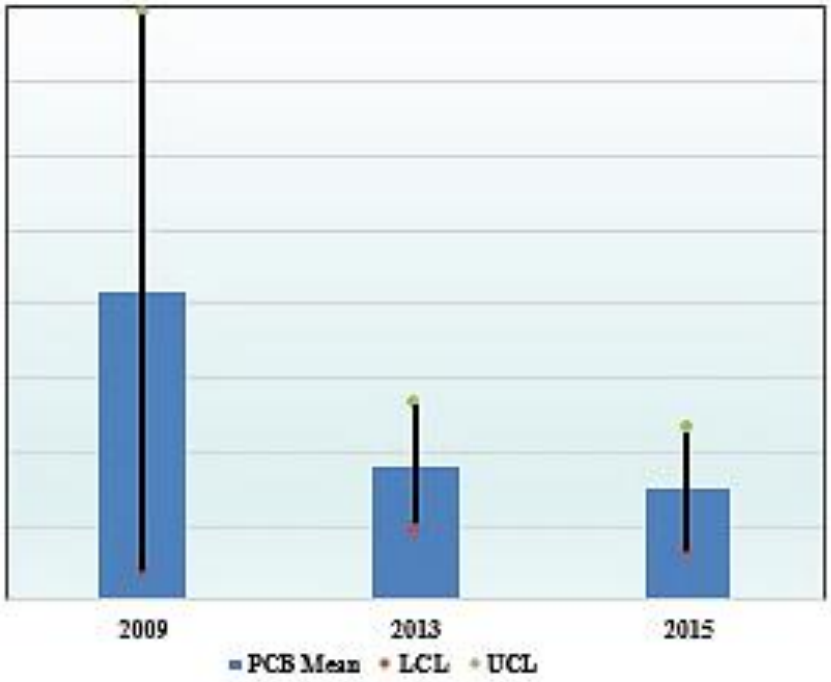


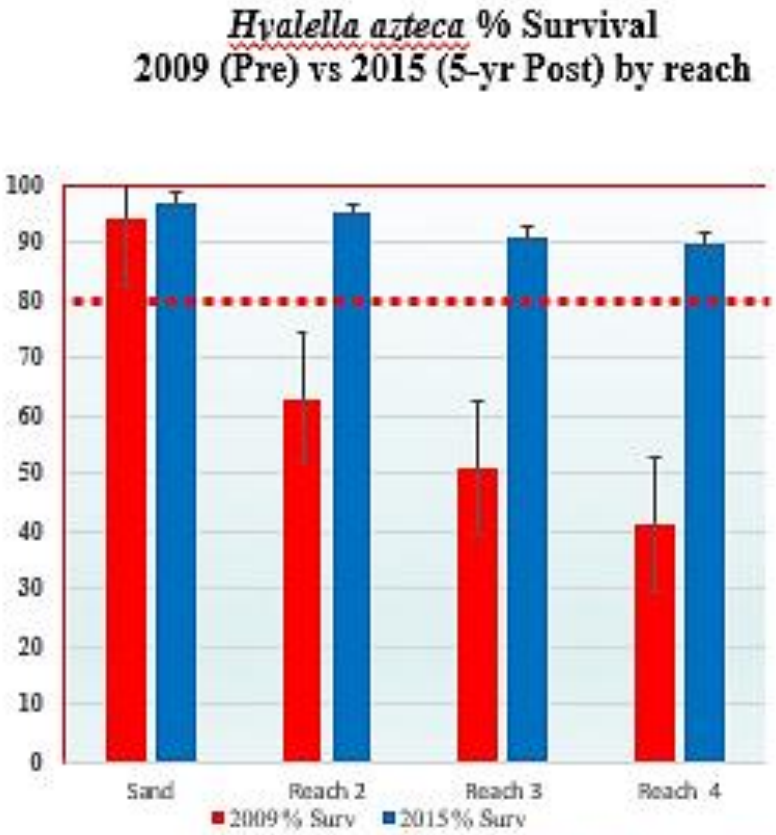
Mills, M., J. Schubauer-Berigan, Jim Lazorchak, K. Fritz, J. Meier, H. Thurston, S. Pala, E. Foote, AND P. Sokoloff. 2012 Annual Report to Characterize the Ottawa River Using Physical, Biological, and Chemical Lines of Evidence. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-18/219, 2018.

Conceptional Model for Food Web



Sediment and Sediment Toxicity Pre- vs Post-Dredge





Sediment polychlorinated biphenyl compounds (PCBs) and toxicity declined post-dredging

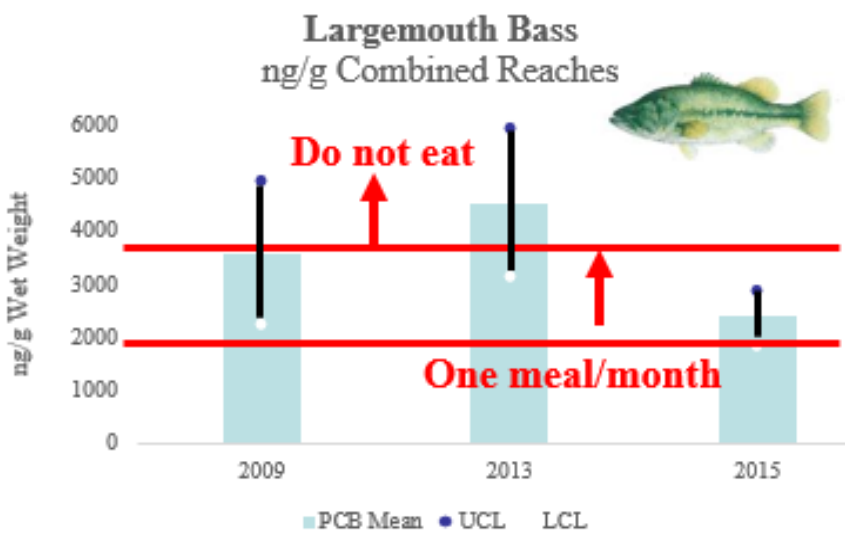
80% Acceptable Survival Criteria

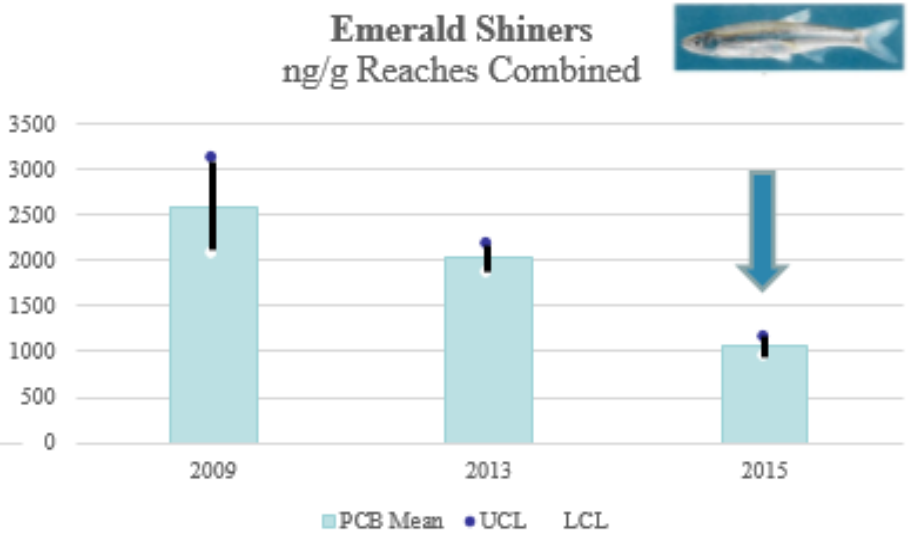
LCL – Lower Confidence Limit, **UCL** – Upper Confidence Limit

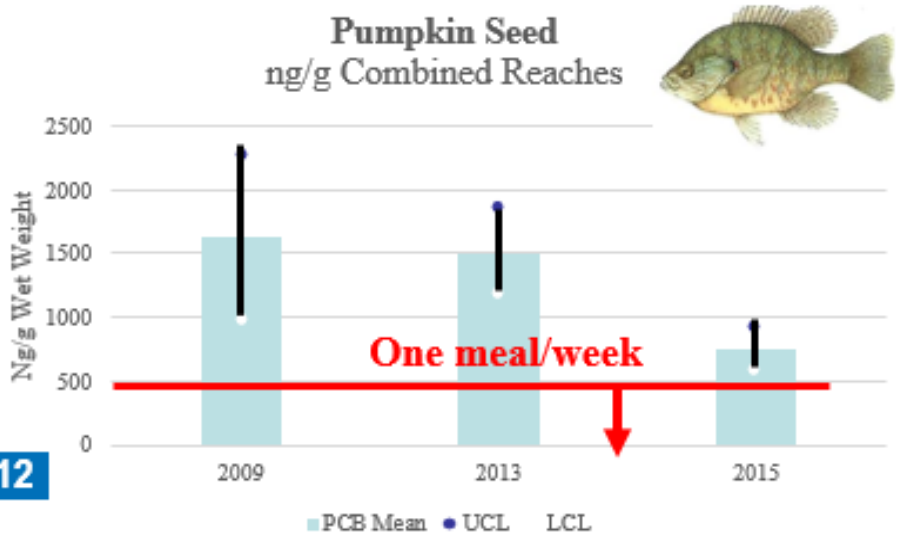
Aquatic Food Web Results

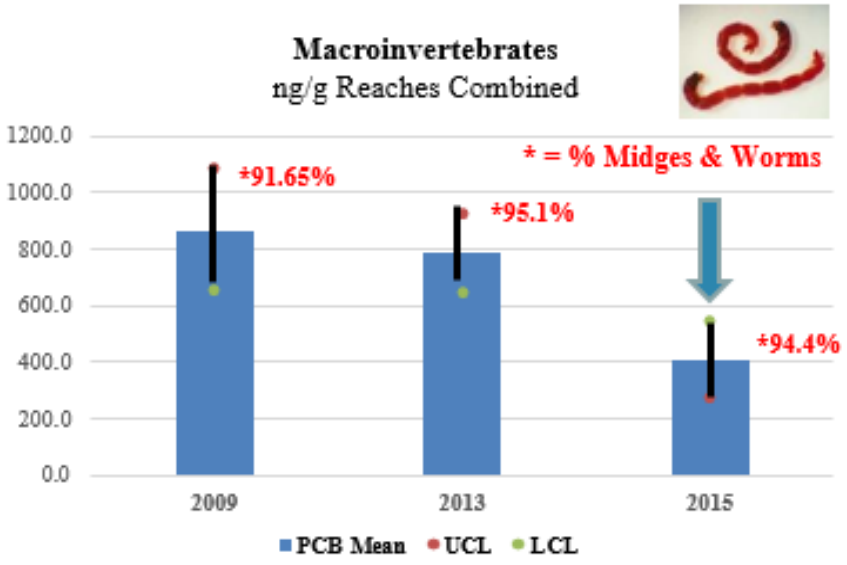
Tissue ng/g Wet Wt, 2009 (Pre) vs 2013 vs 2015

PCB fillet consumption advisories converted to whole fish (1.83)



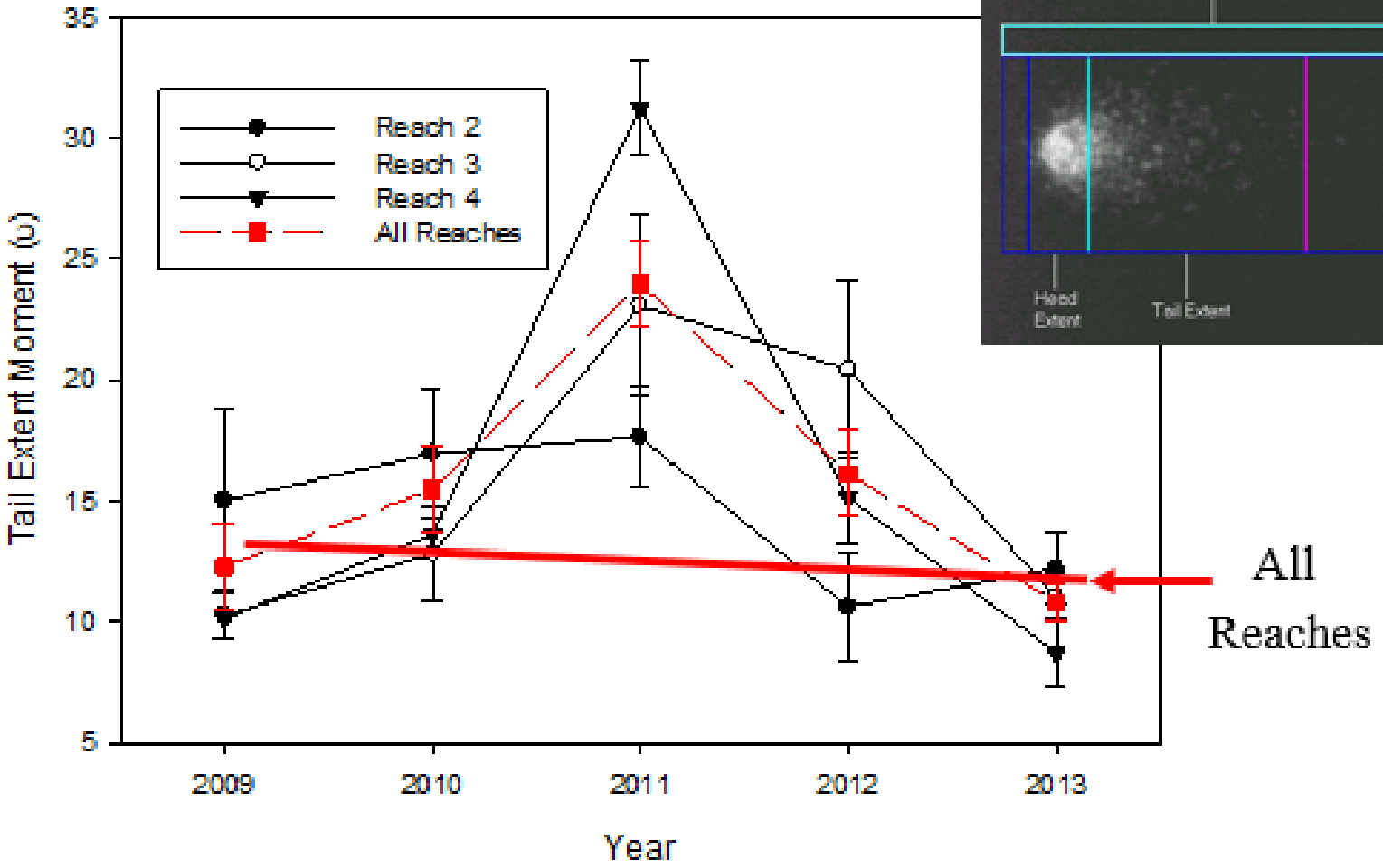






Results: DNA Damage
Tail Extent Length Comet Assay

DNA damage in Ottawa River bullheads declined 5-years post-dredge



Impact

- **Remedy effectiveness is an approach to improve confidence about remedy success**
  - Informs project decisions throughout process
  - Ecosystem-based: physical, chemical and biological
  - Multiple lines of evidence
- **Remedy effectiveness assessment is scaled to the project**
  - Reach-scale vs project-scale
  - Anticipated long-term clean up goals would be met approximately 10 years post remedy (2020)

R2 – Restoration Effectiveness

Why Restoration Effectiveness

- Provide decision makers with information about the outcome of the restoration (adaptive management)
- Measure change in ecological health
- Improve restoration practice through time
- Communicate change to the public

www.epa.gov/great-lakes-aocs/chambers-grove-habitat-restoration-st-louis-river-aoc

Goal

Develop tools and approaches to assess habitat restoration in AOCs

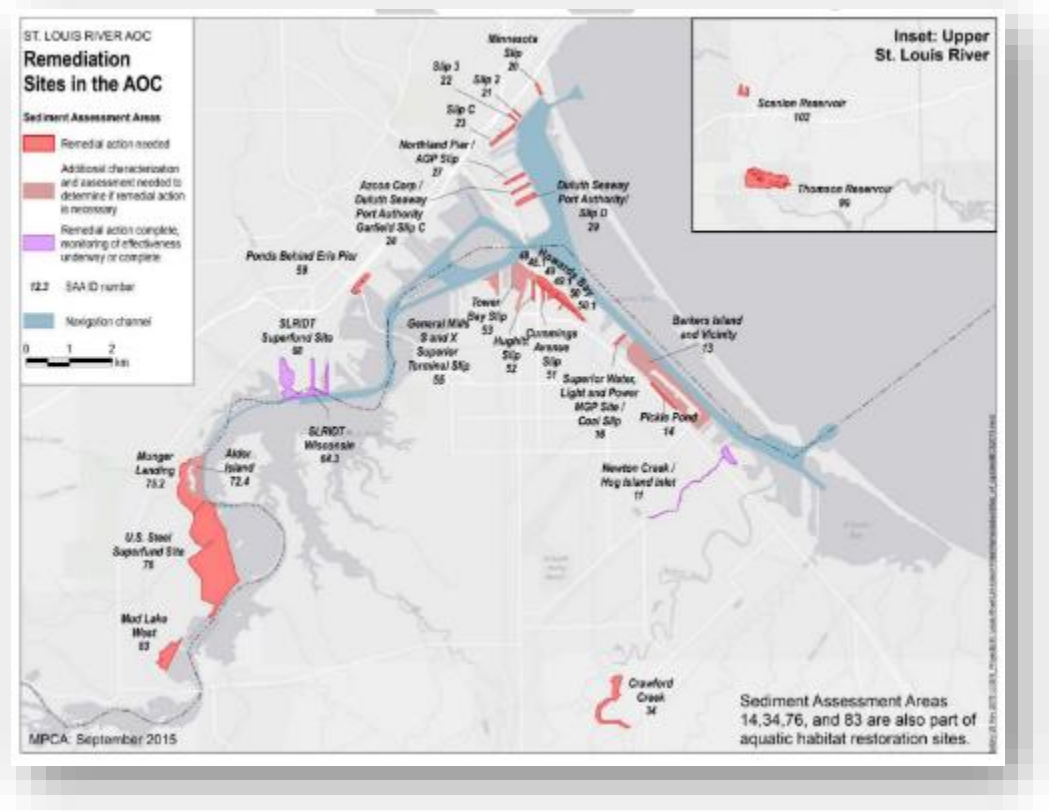
- Appropriate targets
- Relevant metrics
  - Program goals
  - Ecological integrity
- Responsive at the project-scale (time, space)
- Responsive to project activities

Restoration Effectiveness for sediment remediation and wetland restoration: PCBs in fish tissue

Develop a “surgical” tool to identify and diagnose project-scale impairment

Process - St. Louis River AOC

- Choose wetland-dependent fish species (project-scale)
- Characterize reference conditions
- Determine target concentration
- Develop approach to relate sediment quality and habitat to bioaccumulation

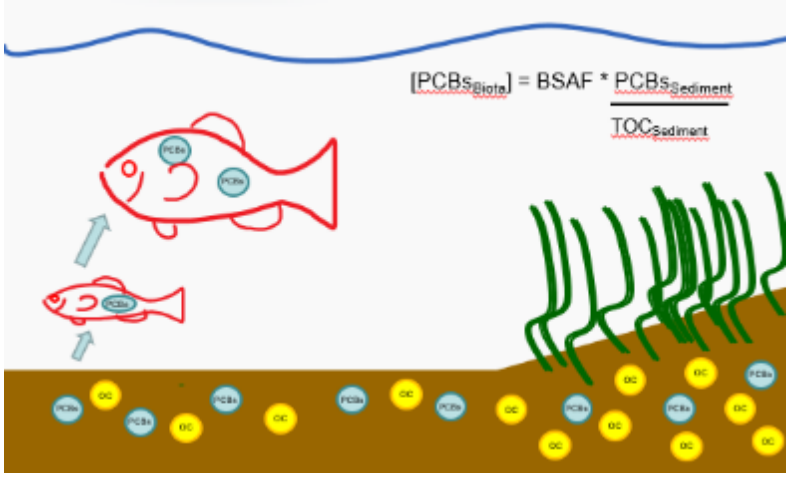


St Louis River Area of Concern (AOC) indicating sediment remediation and assessment needs (Sept 2015)

Site Assessment

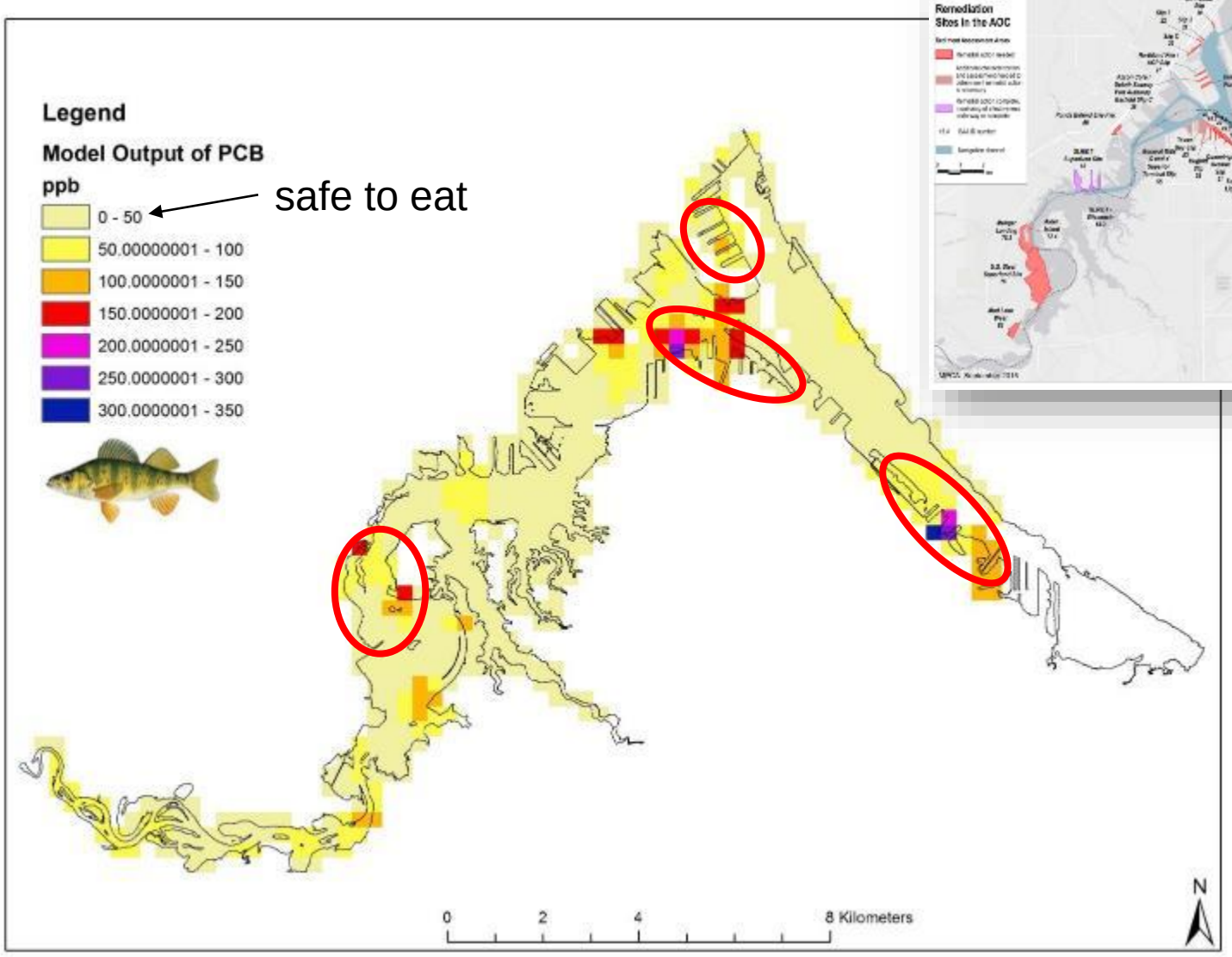
Biota-Sediment Accumulation Factor (BSAF) model

- Goal: Create a geospatial model of fish tissue concentration based on sediment characterization data
- Use BSAF model to predict fish tissue concentration
  - BSAFs are empirically determined
  - From EPA BSAF database for Yellow Perch
- Model surface sediment PCBs and total organic carbon
- Model fish home range, habitat preference
  - Life-history
  - Habitat use



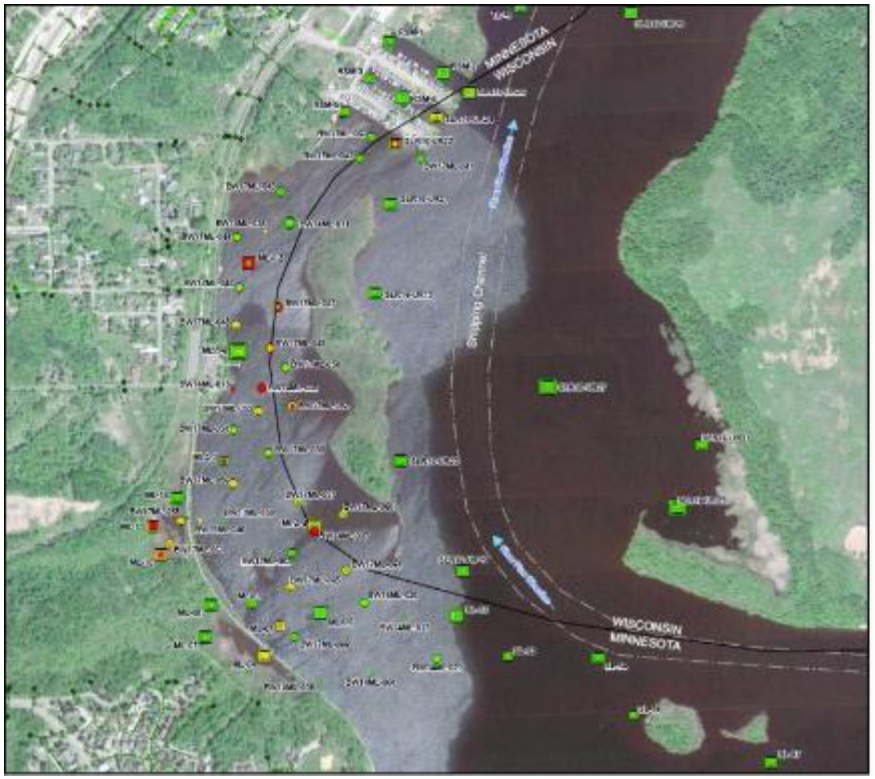
Easy to use, publicly available database:
https://archive.epa.gov/med/med_archive_03/web/html/bsaf.html

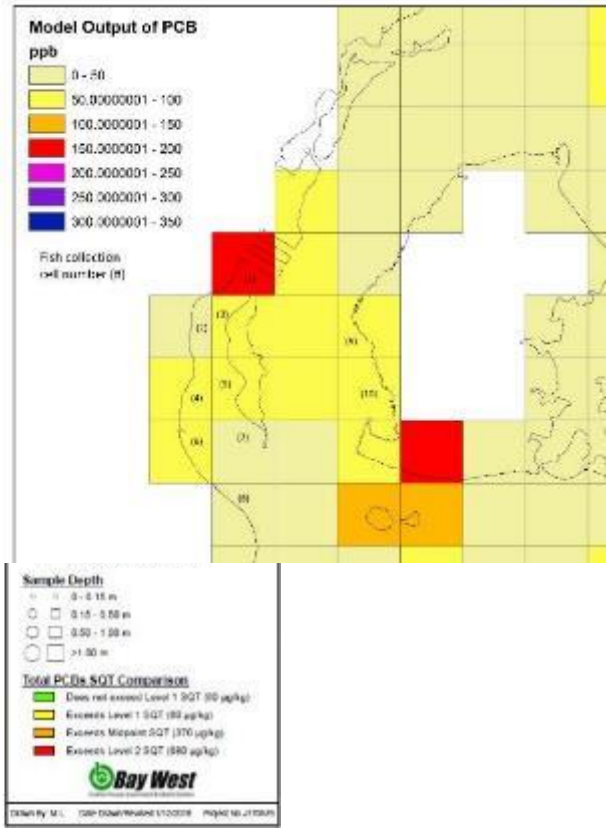
BSAF Model Projected PCBs in Yellow Perch tissue



Output undergoing 2018 update. Please do not cite.

Munger Landing Assessment

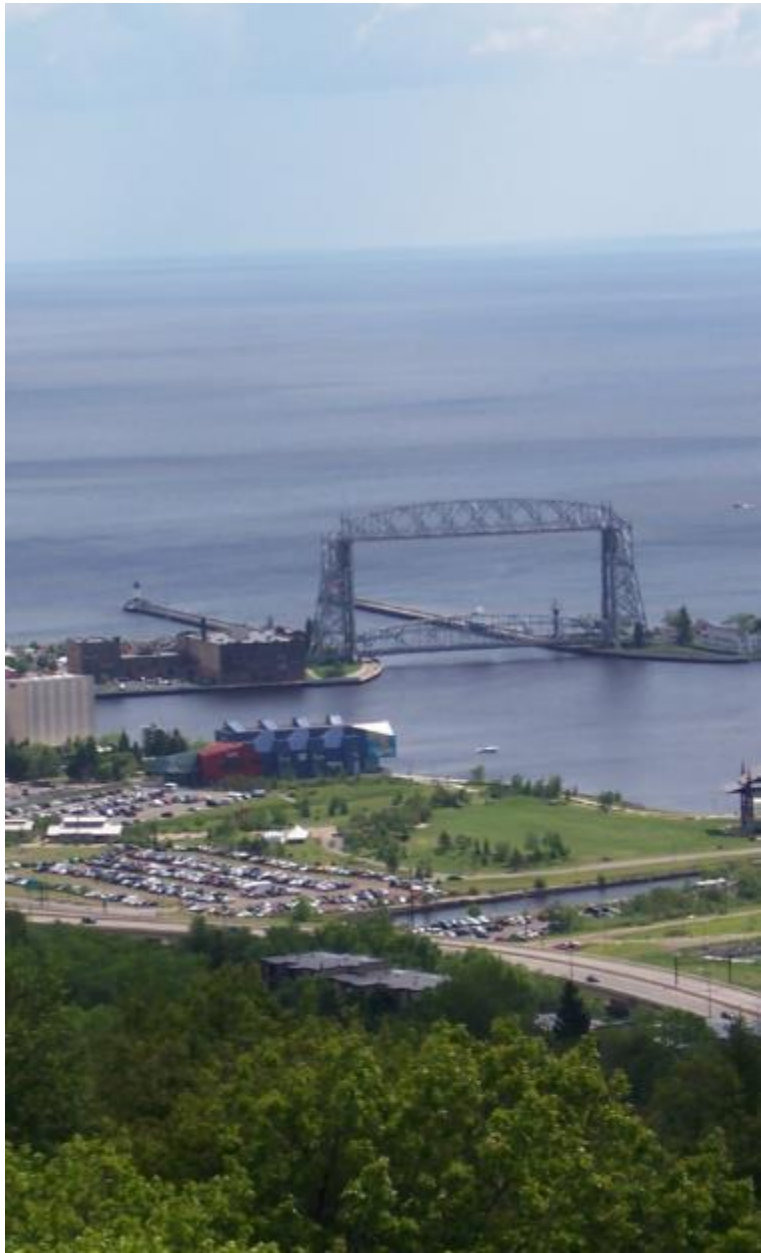




- 2018: Minnesota Pollution Control Agency (MPCA) and Wisconsin Department of Natural Resources (WI DNR) requested BSAF model for St. Louis River AOC
  - Evaluation remediation alternatives
  - Support sediment quality targets, project effectiveness
- Novel approach for AOCs; initial development at multiple remediation sites

Impact

- The BSAF model successfully diagnosed problem spots (e.g., Munger Landing)
  - Not obvious from typical screening approach
  - Defines sediment risk
- BSAF model has multiple potential applications
  - Initial project screening
  - Develop an appropriate remedy target
  - Estimate a project's potential impact to improve the quality of the fishery, risk reduction to public
  - Track progress toward target



R3 – Revitalization

Health Impact Assessment (HIA)

HIA is a process that uses *scientific data, health expertise and public input* to factor public health considerations into the decision making process

- HIAs give decision makers the information they need to consider health in pending programs, policies, plans and projects
- Conducted and communicated in advance of a decision
- Identifies and evaluates public health consequences of a pending decision
- Develops and provides recommendations intended to shape the final proposal based on health protection and health promotion
- Brings together environmental science, public health science, and social science

Health

"A state of complete physical, mental, and social well-being; not merely the absence of disease and infirmity."

- Preamble to the Constitution of the World Health Organization

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"I don't know why I don't care about the bottom of the ocean, but I don't."

Charles Saxon, New Yorker

Health Impact Assessment (HIA)

How does the proposed project, plan, policy, program

Affect

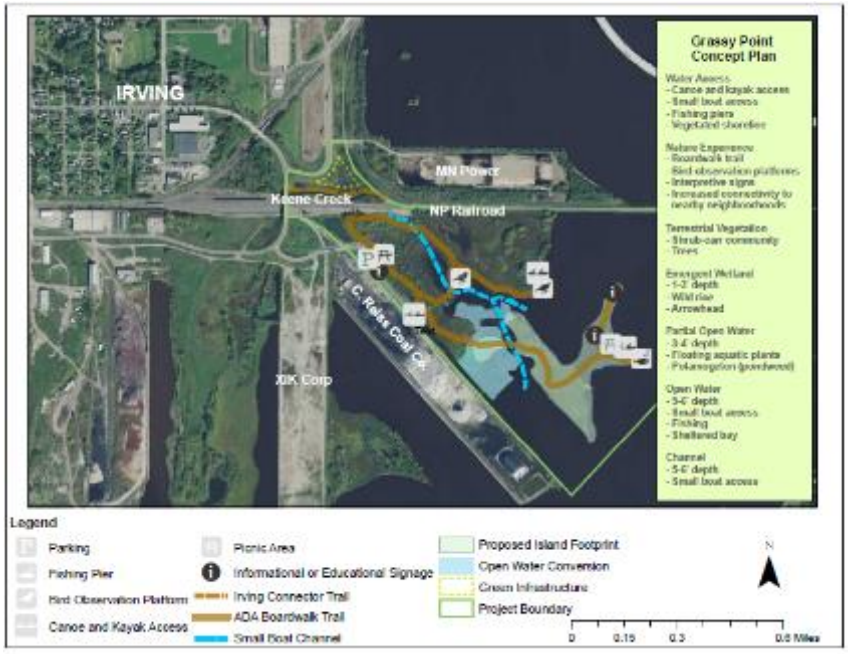
Determinants of Health

Lead to health outcomes

Provide recommendations

Health Impact Assessment

- Project: 200 acres, 350K cubic yards sediment, $14M
- Goals:
  - Remove wood waste
  - Cover contaminated sediments, restore two coastal wetland ecosystems
  - Improve amenities (board walks, trails, water access for recreation, interpretative signage)
- Decision makers
  - MN DNR: Habitat restoration
  - City of Duluth: Park improvements

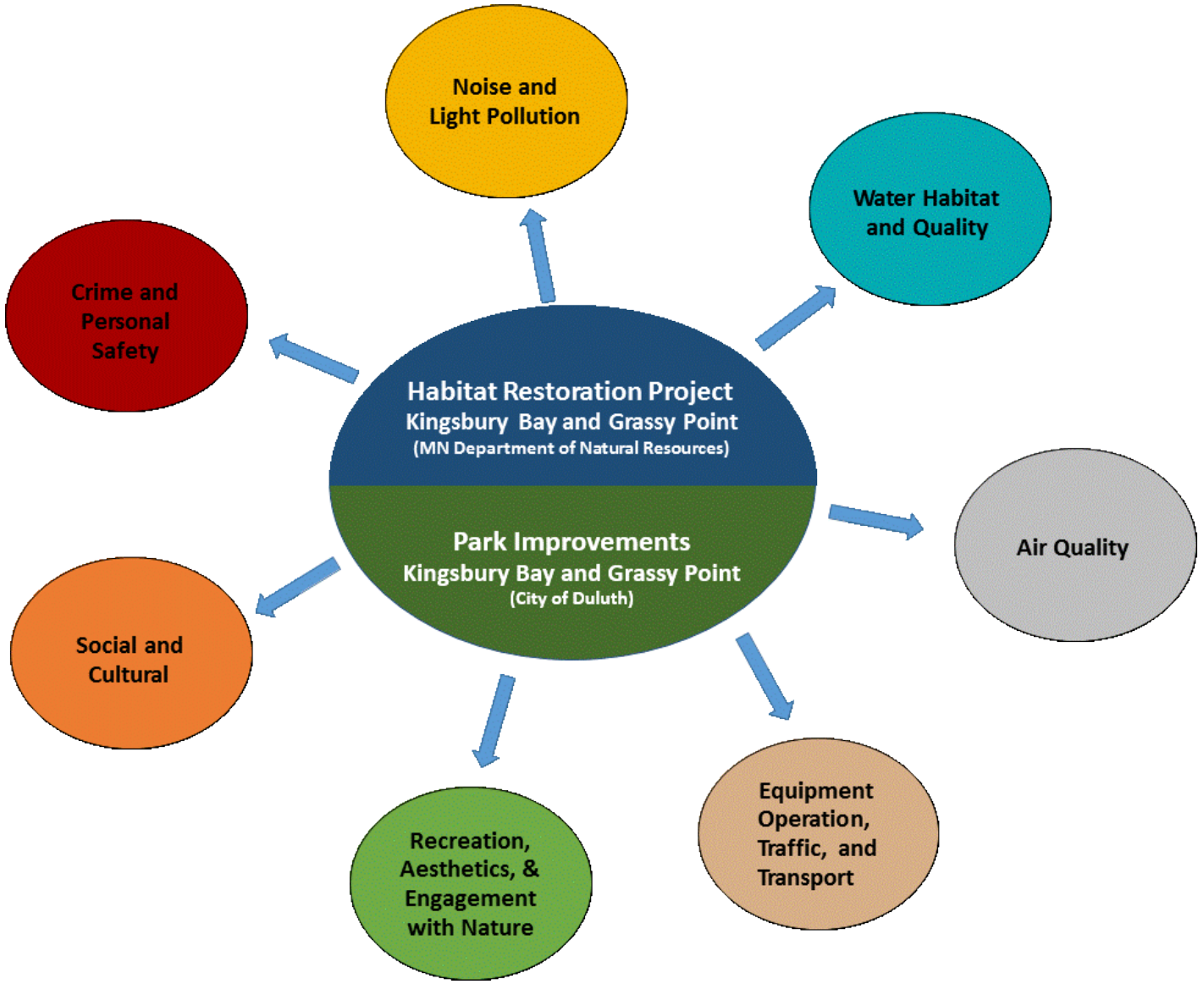


Pathway Development

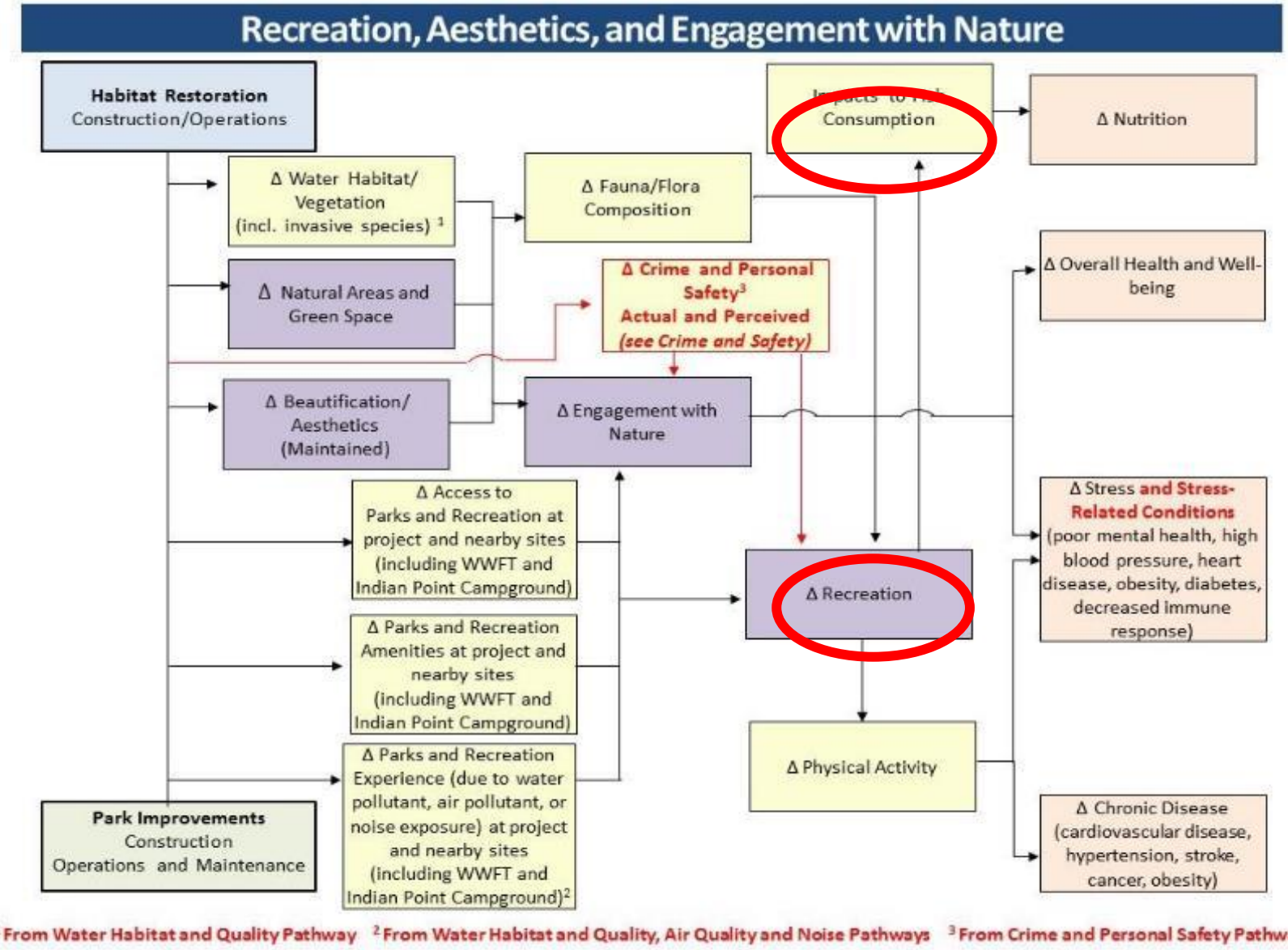
HIA began with knowledge co-production

- Participatory mapping for HIA
- Engage in conversation around the restoration sites
- Used maps to capture different types of knowledge based on relationships to the river
  - Traditional
  - Professional
  - Local
  - Scientific
- Used maps and literature to identify seven health topics ("pathways") to assess

Health Pathways

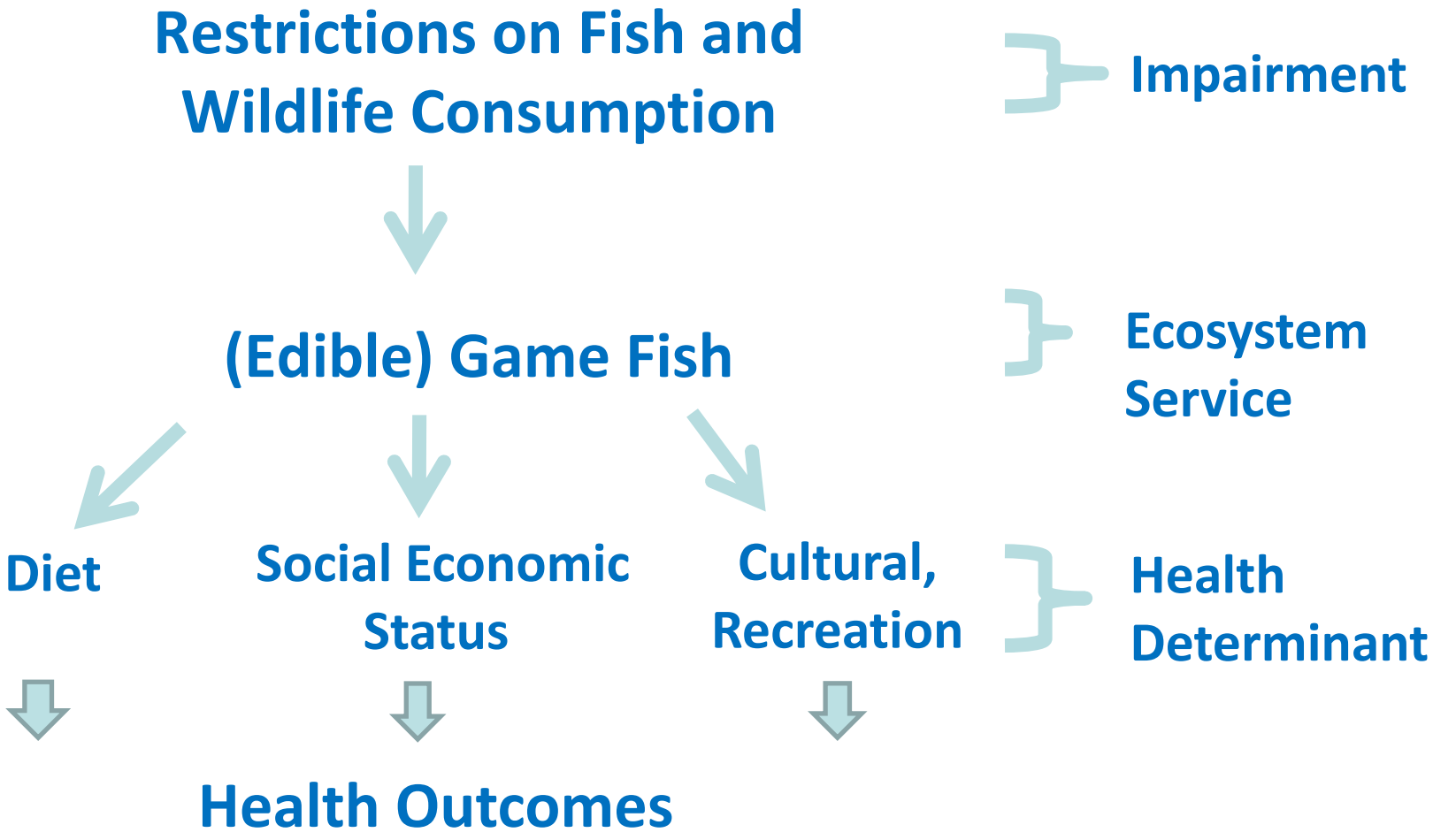


Social and Cultural Pathway



[1] From Water Habitat and Quality Pathway [2] From Water Habitat and Quality, Air Quality and Noise Pathways [3] From Crime and Personal Safety Pathway

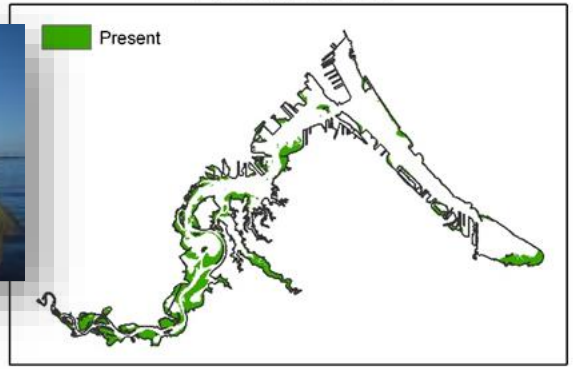
Bringing it all together…



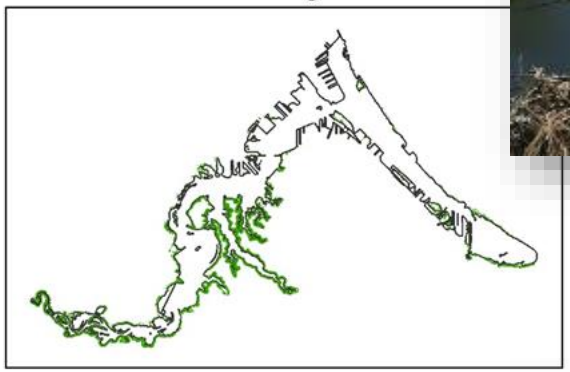
Mapping Ecosystem Service Indicators

United States Environmental Protection Agency

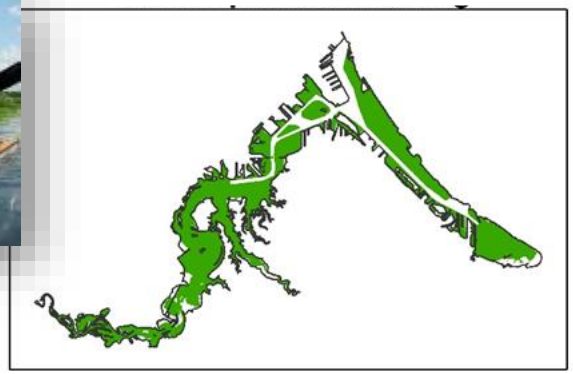
Game fish habitat

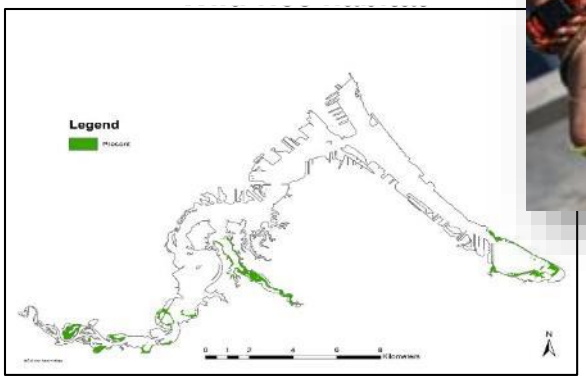


Bald Eagle habitat



Human-powered boating





Wild rice habitat

Angradi et al. 2016. JGLR.

Ecosystem services are the biophysical outputs of ecosystems that directly contribute to the well-being and social welfare of humans.

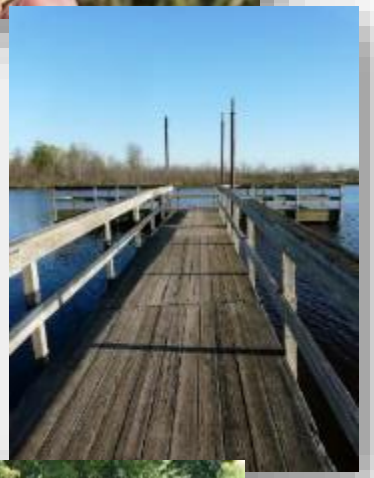
Health Impact Summary

Long-term effects on health determinants from the project include:

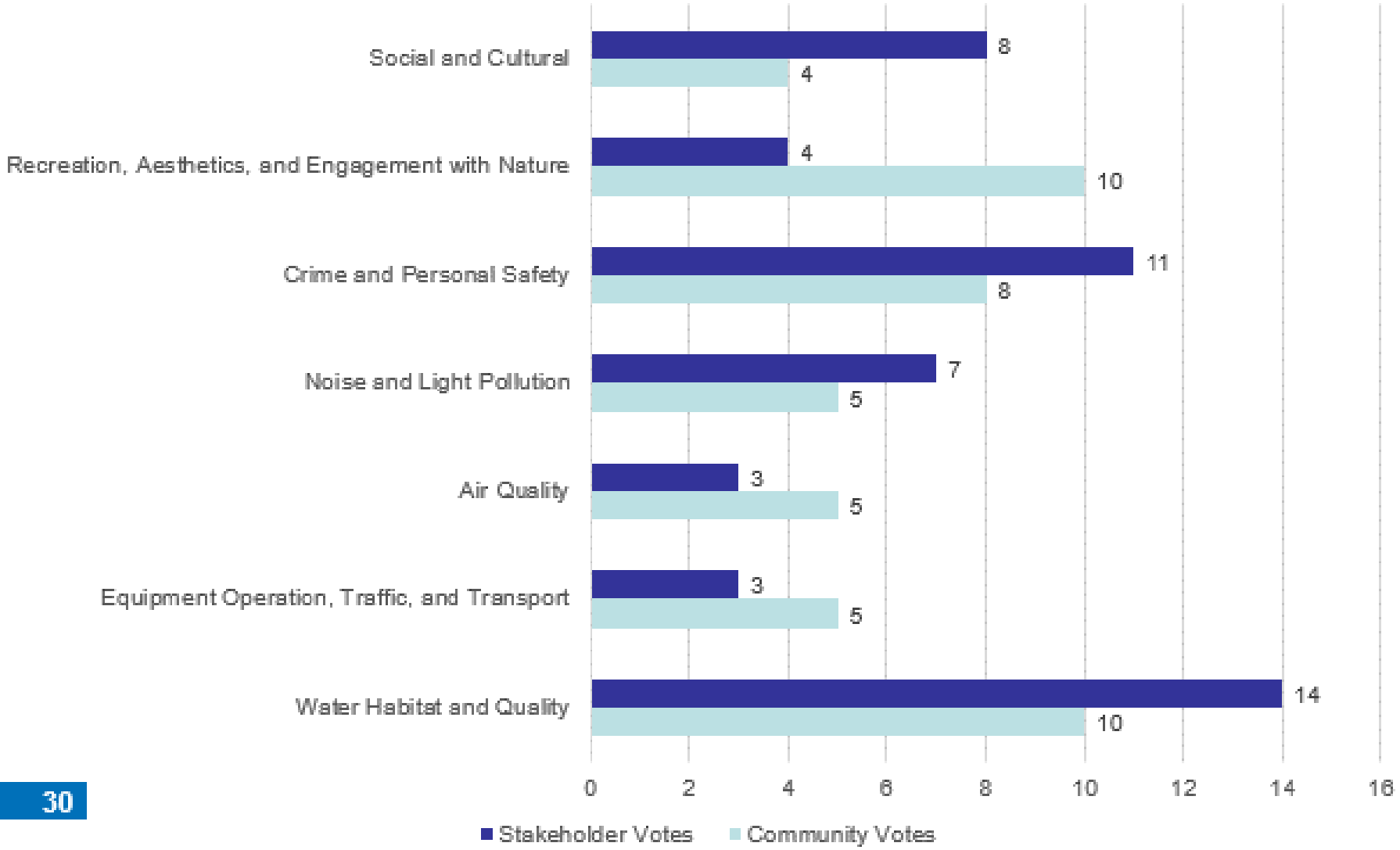
- Improved water quality and green space
- New space for recreational opportunities, cultural value, and spiritual reflection
- Increased social cohesion
- Potential improvements in safety and security

Together, these benefits can improve a variety of health outcomes:

- Decrease risk of injury and illness
- Improve nutrition
- Reduce stress, stress-related conditions, and chronic disease
- Improve overall health and well-being



Prioritization of HIA Recommendations



Impact

- Improves health-related outcomes of the project
- Provides science-based information to justify the project on the basis of health (permitting)
- Early participation in the process = ***input shaped the health determinants evaluated in the assessment***
- Evaluation based on themes or determinants **MOST important to community and stakeholders**
- The result was a larger range of recommendations considered and the inclusion of voices that might normally be marginalized

www.epa.gov/healthresearch/health-impact-assessments

Summary

- ***Remedy effectiveness*** provides an ecosystem-based approach to determine remedy success
  - Informs project decisions
  - Physical, chemical, biological – multiple LOE
  - Compatible with restoration effectiveness
- ***Restoration effectiveness*** can help identify site-scale vs system-scale effects
  - Tailor work to the most relevant habitat impacts
  - Diagnose hotspots
- ***Revitalization*** is an opportunity to rethink how the community relates to its local environment
  - Health Impact Assessment supports decision makers to improve health outcomes
  - The process is designed to be equitable, just and inclusive
  - Pathways are rooted in community values

Photo credit: US FWS

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218-529-5420

Acknowledgements

Jim Lazorchak, Ken Fritz, Marc Mills, Lawrence Burkhard, Tom Hollenhorst, Flo Fulk, Katie Williams, Ted Angradi, Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, Ohio Environmental Protection Agency, Fond du Lac Band Natural Resources, Bad River Band Natural Resources, City of Duluth, EPA ORD research teams, EPA Great Lakes National Program Office, and EPA Region 5.