Ecosystem Services Tools & Approaches to Support Remediation to Restoration to Revitalization

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Approaches to create new and improved methods, data sets, and knowledge from existing methods

Evidence linking environmental conditions of restored sites to human health and well-being

Methods to demonstrate linkage between remediation/restoration and revitalization (R2R2R)

Approaches to simplify ecosystem services (ES) assessments

Efficiently communicating to the public how these cleanups will benefit their communities by adding approaches that start from community priorities/goals
The “Story Arc” for SHC 9.2

ES: Ecosystem Services
Transferring ES for Decision Support

**Partner Need:** More formal approaches for integrating ES benefits into *restoration decision making*

**How:** Synthesize decision support elements from coordinated case studies

**Develop** interactive *science communication* resources

**Focus** on utility & transferability of practical strategies:

- Between impaired communities
- Across different issues of concern
Case Studies focused by issue/context

Ada, OK
- Stakeholder engagement
- Trade-offs

Water Resource; Multi-use

Tillamook Bay, OR
- Quantitative Data & Modeling
- Inform Cause & Effect

Shellfish Habitat/Forestry

Duluth, MN/Superior, WI
- Stakeholder engagement
- ES Endpoints in Decision Process

R2R2R

Mobile Bay, AL
- ID important ES
- Project Planning & Assessment

Stream Restoration

San Juan, PR
- Stakeholder engagement
- ES for Restoration Responses

Urban Wetlands
Understanding Decision Contexts

Improve client utility – Ethnographic methods

- Used to identify & characterize barriers & constraints faced by partners, communities, & ORD
- Knowledge can be applied to improve client experience & utility

“What context” – How

- Unpack the “black boxes” of actors, values, & program goals
- Map opportunities & barriers to help manage what cannot be controlled

Example in R2R2R

- Success may look different to different actors
- Expected outcomes may vary across programs, states, or cities
Past ES in Contaminated Sites Work

- **2016 RESES project:** ORD; RPMs (Remedial Project Managers); STLs (Superfund Technical Liaisons)
  - **Applied Lessons** from Green & Sustainable Remediation (GSR) approaches
  - **Provides:** RPMs understanding of ES; Guidelines for considering ES; Overview of potential tools
  - **Can inform steps:** Decision context; Stakeholder engagement; Alternatives analyses; Best Management Practices

- **No one tool meets all needs**

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**Ecosystem Services at Contaminated Site Cleanups**

- **Coeur d’Alene River, ID**
  - Watershed scale site
  - Undeveloped; mining
  - Rocky Mountain west

- **Lower Darby Creek Area Philadelphia, PA**
  - Smaller site
  - East Coast urban setting
Past ES in Contaminated Sites Work

ES Classification System

Target Journal: *Environmental Science & Technology*
Past ES in Contaminated Sites Work

Step 1: Identify Site-specific ES
Step 2: Quantify Relevant ES When Possible
Step 3: Examine how Cleanup Activities Affect ES
Step 4: Identify & Implement BMPs

Outcome: Minimize Impact to ES and Optimize ES

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Minimize Impact to ES and Optimize ES

BMP Table & ES

Target Journal: Environmental Science & Technology
New “Retrospective” Research

- **Retrospective analysis** of ES and remedial BMPs employed
- **By:**
  - Using a “lessons-learned” approach
  - Drawing conclusions about changes in ES as result of cleanup
  - Drawing conclusions about potential for improving ES for site reuse
  - Advancing generalizable guidelines for considering ES, including:
    - Effective communication of ES concepts
    - Involving the public in site decisions

Current Plans: 2 Sites

**Selection Criteria:**
- Data availability & access
- Type of site cleanup
  - Different contaminants
  - Histories
  - Ecosystems
- Stakeholders identified & engaged
Ecosystem Services and Translational Science

Translation or development of methods, knowledge, data sets, and tools to facilitate application of ecosystem services and their benefits as decision support in remediation, restoration, or revitalization contexts.

Co-developed Vision using a Steering Group

- RPMs and project managers are busier than ever
- Work within existing processes
- Sustainability and greener cleanups concepts exist
- May not be high priority
- Use a Workshop Approach for “Targeted Learning”
- ORD: ES concepts; Partners: Contam. Sites; All: Translational Science
Workshop I - Processes & ES Tools (Summer ’20)

- Cleanup Processes/Frameworks
  - Superfund; Brownfield; RCRA

- ES Assessments (value added)
  - Concepts, strategies, & tools
  - Relevance for existing processes
  - Assumes can identify crosswalks to be developed

Workshop II - Elements & Crosswalks (Spring ’21)

- Potential ES Elements

- ES Assessments (value added)
  - Focus on Decision Points (who, what, when, how)
  - Existing; new opportunities
  - Future efforts; Case Studies
Cleanup Processes/Frameworks

➢ Regulatory Processes
  • CERCLA Pipeline
  • Brownfields process
  • RCRA Corrective Action Process
  • Beneficial Use Impairment (BUI) process

➢ Other Relevant Frameworks
  • Ecological Risk Assessment
    • (BERA; SLERA)
  • ASTM Greener Cleanups BMP
  • 4-Box ES “Consideration” (RESES)

CERCLA: Comprehensive Environmental Response, Compensation, & Liability Act (Superfund)

RCRA: Resource Conservation & Recovery Act
Workshop I – ES Tools

- Classification System
- Library for Coding & Searching FEGS
- Published models for estimating ES
- What to measure?
- FEGS Units
- FEGS Project Scoping
- Stakeholder Engagement
- Spatial datasets
- Visualizations
- Published models for estimating ES
- NESCS Plus
- FEGS Scoping Tool
- Enviro Atlas
- EcoService Models Library
- FEGS Metrics Report
- EnviroAtlas
- EcoService Models Library (ESML)
### Crosswalk – Example ES Activities with Generic ERA Phases

<table>
<thead>
<tr>
<th>ERA Phases</th>
<th>Example EGS Topics and Activities</th>
<th>Some Potential EPA EGS Tools</th>
</tr>
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</table>
| Planning and Scoping | - Identify EGS in site landscape | - FEGS Scoping Tool<sup>*</sup>  
- FEGS Classification System  
- National Ecosystem Services Classification System (NECS) |
| Problem Formulation | - Describe EGS benefits  
- Estimate magnitudes of EGS benefits  
- Incorporate EGS into conceptual site model (CSM) | - FEGS Scoping Tool<sup>*</sup>  
- EcoService Models Library (ESML)  
- Eco-Health Relationship Browser  
- EnvirosAtlas  
- Decision Analysis for a Sustainable Environment, Economy, and Society (DASEES)<sup>†</sup> |
| Analysis | - Evaluate potential EGS/site contaminants connectivity  
- Evaluate potential effects of site contaminants on EGS  
- Evaluate EGS condition (functionality, impairment level)  
- Evaluate EGS resilience/vulnerability to site contaminants  
- Calculate EGS cost savings and other benefits  
- Assess EGS capacity (type, temporal, seasonal)  
- Assess EGS importance to stakeholders  
- Assess EGS maintenance effort and cost  
- Identify key features or parameters to protect EGS benefits | - EcoService Models Library (ESML)  
- EnvirosAtlas  
- EPA H2O Tool  
- Rapid Benefit Indicators (RBI) Approach  
- Visualizing Ecosystem Land Management Assessments (VELMA) Model  
- Causal Analysis/Diagnostic Decision Information System (CADDIS) |
| Risk Characterization | - Compare costs and benefits of EGS  
- Characterize site contaminant threats to EGS  
- Characterize EGS impairment level by site contaminants | - EcoService Models Library (ESML)  
- EnvirosAtlas  
- EPA H2O Tool  
- Rapid Benefit Indicators (RBI) Approach |
| Risk Communication | - Articulate EGS benefits and costs | - All of the above |

<sup>*</sup> From U.S. EPA 1998.  
<sup>†</sup> Descriptions and links available at: [https://www.epa.gov/incco-research/ecosystem-services](https://www.epa.gov/incco-research/ecosystem-services)  
<sup>‡</sup> Beta version - not yet publicly available.
**Workshop II – Potential Crosswalks**

**Message:** ORD’s EGS Tools Inform All Steps of Structured Decision Making

- **Monitor success (DASEES; triggers)**
- **Monitor ecosystem services & well-being impacts (EPFs; EBFs; EnviroAtlas; HWBI)**
- **Learn (adaptive management)**

**Implement, Monitor, and Review**
- **Compare alternatives (DASEES; consequence tables)**
- **Evaluate trade-offs (direct ranking; swing weighting; cost-benefit analysis)**

**Define Objectives**
- **Build conceptual models (DASEES, DPSIR, System Sketch)**
- **Identify ecosystem services that may be impacted (FEGS-CS)**
- **Identify stakeholders (FEGS-CS Beneficiaries; FEGS Scoping Tool)**
- **Identify potential health impacts (HIA, Eco-Health Browser)**

**Develop Alternatives**
- **Identify ecosystem services objectives and measures (FEGS; EnviroAtlas; RBI)**
- **Identify well-being objectives and measures (HWBI; TEV)**
- **List & organize objectives (DASEES; objectives hierarchy)**

**Clarify Decision Context**
- **Diagram cause/effect (DASEES; Bayesian belief networks; influence diagrams)**
- **Find quantitative models to estimate impacts under alternatives (ESML; EPFs & EBFs)**
- **Estimate ecosystem services impacts (JVS; EPA H2O; VELMA; BioMap; InVEST; SfA; i-Trec; ARIES)**
- **Quantify economic impacts (TEV; willingness to pay)**
- **Explore health, well-being impacts (HIA; Eco-Health browser; HWBI model)**

**Estimate Consequences**
- **Identify means to achieve objectives (DASEES; means-ends network)**
- **Identify ecosystem services as means to achieve economic, health, well-being objectives (FEGS, Eco-Health Browser, Services → HWBI)**
- **Identify possible responses & actions (HIA; DPSIR)**

**“Rosetta Stone” Concept**
With these anticipated results:

- **The Agency** will be able to:
  - Increase project team member knowledge/toolkit on environmental benefits of cleanups
  - Enhance existing Green & Sustainable Remediation efforts with addition of ES dimensionality

- **States, Communities, and PRPs** will be able to:
  - Identify/examine new ways to describe benefits of cleanups
  - Improve communication of successful cleanups having environmental components

- **ORD/Scientists** will be able to advance:
  - Capacity to “Speak OLEM”
  - Translational science and communication efforts on the utility of ES concepts
  - The science leadership role in incorporating environmental benefits for contaminated cleanups
Impact of ORD Work

ES Applications in Case Study
“…one of the best demonstrations of state-provincial partnership I have seen is some time – perhaps ever!”

Bob Lambe, Executive Secretary, Great Lakes Fishery Commission

Ecosystem Services in Contaminated Sites
“Very helpful listing and description of specific tools and resources.”

Chuck Maurice (STL)

“… this paper will be a good resource for RPMs motivated to attempt to consider ES.”

Hilary Thornton (RPM)

“… have laid out a great integrative systems approach. … will be an important contribution for furthering ES usage in the Agency.”

Bruce Duncan (RSL)
EPA Strategic References:


Cleanup-relevant Frameworks:

- Beneficial Use Impairment for the Great Lakes AOCs: https://www.epa.gov/great-lakes-aocs/beneficial-use-impairments-great-lakes-aocs
- CERCLA Cleanup Pipeline and RCRA Corrective Action Process (Freed et al., 2020 presentation “Translational Science, Ecosystem Services, and Environmental Law and Governance”)
- Ecosystem Services at Contaminated Site Cleanups. EPA 542-R-17-004. https://www.epa.gov/sites/production/files/2017-09/documents/ecosystem_services_at_contaminated_site_cleanups_ef_issue_paper.pdf
- USEPA. 2020. Greener Cleanups: https://www.epa.gov/greenercleanups
Translational Science References:


ORD ES Relevant Frameworks & Tools

- EnviroAtlas: [https://www.epa.gov/enviroatlas](https://www.epa.gov/enviroatlas)
- EcoService Models Library: [https://www.epa.gov/eco-research/ecoservice-models-library](https://www.epa.gov/eco-research/ecoservice-models-library)
- Rapid Benefits Indicators Approach: [https://www.epa.gov/water-research/rapid-benefit-indicators-rbi-approach](https://www.epa.gov/water-research/rapid-benefit-indicators-rbi-approach)
- NESCS Plus – building blocks (tool to be released Summer 2020):
  - [https://www.epa.gov/water-research/rapid-benefit-indicators-rbi-approach](https://www.epa.gov/water-research/rapid-benefit-indicators-rbi-approach)
ORD & Translational Science

SHC 9.2 Team

SHC 9.2 “placement” in StRAP Conceptual Diagram

Approach to the transition between ES for environmental decision making to ES for contaminated site applications

History of Ecosystem Services Consideration in Contaminated Sites

Examples of 4 process frameworks for contaminated cleanups
**Translational Science Definitions**

**Translational Science**: “The field of investigation which seeks to understand the scientific and operational principles underlying each step of the translational process.”

**Translation**: “The process of turning observations in the laboratory, clinic, and community into interventions that improve the health of individuals and the public.”


**ORD and Solutions-Driven Research**

ORD is adopting a 3-pronged strategy for solutions-driven research:

1) Apply principles of solutions-driven research broadly across ORD’s six national research programs;

2) Conduct pilot translational science projects that apply and evaluate methods of solutions-driven research that address well-defined and unmet needs of partners and stakeholders;

3) Conduct case studies of previous and current research activities that embody the principles of solutions-driven research, which will help inform a list of best practices

**SHC 2019-2022 StRAP**. EPA 601K20004 March 2020
ORD Team

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Partners/Collaborators

- RSLs/STLs
- EPA Regional Superfund and RCRA Corrective Action Programs
- RSMs
- OLEM: OSRTI & OBLR
- GLNPO
- NEPs
- OW
- OECA/OSRE
- Others
SHC 9.2 Placement in the SHC StRAP

Contaminated Sites

Natural Disasters
Extreme Weather Events

Materials Management

Clean and Safe Environment
- Land
- Surface Water & Sediments
- Ground Water

Restored Sites
- Ecosystem Goods & Services
- Health Promotion
- Economic

Causal Links, Production Functions

Collaborators, Stakeholders, Customers for Translation
- Federal
- State
- Tribe
- Community
- NGO
- Industry
- Academia

Revitalized Communities
- Environmental Quality
- Health and Wellbeing
- Socio-Economic Vitality
- Community Resilience
- Equity

Measures: Indicators & Indices
Application of ecosystem services tools and approaches in support of R2R2R decision making including:

- Assessments of methods for quantifying and mapping ecosystem services in different decision contexts

- Evaluation of potential application of methods to support decision making in remediation, restoration, or revitalization contexts

- Translation or development of methods, knowledge, data sets and tools to facilitate application of ecosystem services and their benefits as decision support in remediation, restoration, or revitalization contexts
Transitioning between StrAPs

ES for CBDS/EBM → ES for Cont. Sites

Approaches Considered

CBDS = Community-Based Decision Support
EBM = Ecosystem Based Management
Cont. Sites = CERCLA: Superfund/Brownfields Remediation → Restoration → Revitalization

EPA Strategic Plan Objective 1.3

“One of EPA's top priorities is accelerating progress on Superfund sites.”

Superfund Task Force Recommendations, Strategy 2

“EPA can play a significant role in helping communities realize the associated health, economic and social benefits that accompany Superfund site redevelopment.”
Green & Sustainable Remediation (GSR)

- 2008 – Green remediation program to reduce environmental footprint of site cleanups
- 2012 – Methodology for Understanding and Reducing a Project’s Environmental Footprint
- 2013 – Standard Guide for Greener Cleanups
  - Core element: Protect Land and Ecosystems

Risk Assessments

- 2015 – Ecosystem services as assessment endpoints in ecological risk assessment

Ecosystem Services (ES) for Contaminated Sites
ES to inform Contaminated Site Cleanup Processes

- 2017 – *Engineering Forum Issue Paper: Ecosystem Services at Contaminated Site Cleanups*
  - Engagement with the public and stakeholders about anticipated future ecological use
  - Replicable, defensible selection of greener cleanup BMPs
  - Can inform environmental decision-making at different parts of clean-up process
  - Transparent documentation of the ecosystem conditions on the site “before and after” cleanup
  - Communication of the benefits & societal relevance of ecological risk-based cleanups
Cleanup Process Frameworks (some)

CERCLA Cleanup Pipeline

Stage 1: Developing Remedial Action Objectives
- Preliminary Assessment
- Site Inspection
- Remedial Investigation
- Feasibility Study
- Proposed Plan
- Remedial Action Objectives

Stage 2: Remedy Selection
- Remedial Design
- Remedial Action
- Construction Completion
- Remedy Selection
- Final Cleanup Decision

Stage 3: Remedy Implementation
- Operators and Maintenance
- Five-Year Review
- Site Detection

Stage 4: Long Term Stewardship

Brownfield Assessment-Cleanup-Reuse Process

- Site Assessment
  - Identify property
  - Conduct All Appropriate Inquiry
  - Public Participation
  - Seek Technical Assistance

- Site Investigation
  - Apply for Brownfield Cleanup Funding
  - Seek Technical Assistance

- Cleanup Design & Implementation
  - Public Participation
  - Select Cleanup Based on Proposed Reuse
  - Engineering Controls/Institutional Controls
  - Public Participation

- Redevelopment (Reuse Drives Cleanup)
  - Key Players
  - Local leaders, government
  - State/Tribal Response

- Evaluate Current Conditions to Determine Status of BUIs
- Remove Beneficial Use Impairment
- Consult the Public
- Propose BUI Removal Where Assessment Shows Beneficial Use Restored

- Beneficial Use Impairment (BUI) Removal Process
- Implement Management Actions to Address BUIs
- Assess Impact of Management Actions on BUIs

RCRA Corrective Action Process

- Initial Site Assessment
- Site Characterization
- Interim Actions
- Evaluation of Remedial Alternatives
- Remedy Implementation
- Tracking Process
- Long Term Care
ORD ES Tools/Contaminated Sites

**NESCS Plus Webtool**

Pending Release Multi-application Functionality

**EcoService Models Library**

2019 Case Applications

**Ongoing Landfill Cleanup Application**

**FEGS Scoping Tool**

Past and Current Applications