

# A Framework for Endstate Planning for the Impacts of Contamination and Cleanup on Ecological Receptors



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# THE PROBLEM

- There is concern over environmental contamination
- Assessment and Remediation costs can be large
- Remediation decisions depend upon damage assessment, future land use, and risk
- Frameworks and tools are required to assess impacts
- The public is interested in ecological assessment



# OBJECTIVES

- Examine the context for incorporating ecosystem exposure and ecological risk into endstate planning
- Review tools and approaches for ecoreceptors needed to select appropriate endstates
- Weigh options at the Department of Energy sites.



# THE DOE PERSPECTIVE

- Cold War Legacy Wastes
- 113 sites in 34 states that contain chemical & radiological wastes
- The technologic or economic feasibility of reaching a given level of exposure reduction constrains the endstate options.



# THE DOE CLEANUP CHALLENGE

- Office of Environmental Management (EM; 1989)
- Compliance Driven: Comprehensive Environmental Response & Liability Act (CERCLA), the Resource Conservation & Recovery Act (RCRA), the triparty compliance agreements,
- EM task represents 20% of the world's remediation costs
- In many cases, the costs of cleanup far exceed economic value of the land.
- Future land uses for DOE include industry, recreation, residential, and wildlife refuges.



# WHY IS DOE UNIQUE?

- More sites in more states
- Larger, more complex sites ecologically
- Significant ecological resources (regionally, nationally)



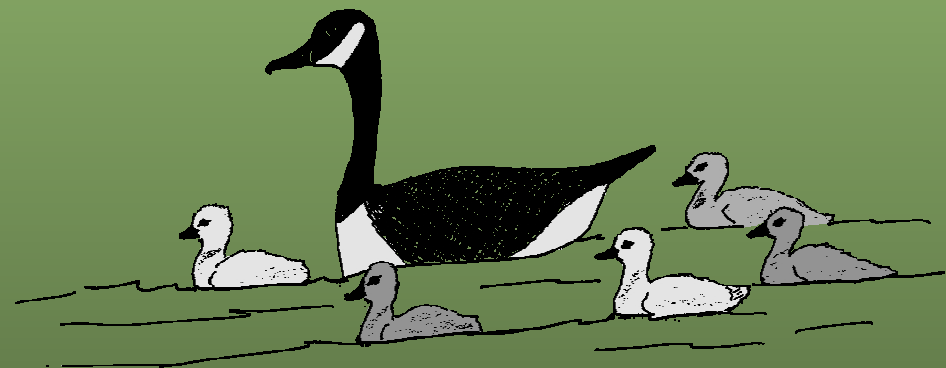
# ECOLOGICAL RESOURCES ON DOE LANDS

DOE's stewardship program was announced in 1994 (DOE Order 430.1), with the goal of achieving sustainable development through ecosystem management, including management of its lands as valuable national resources



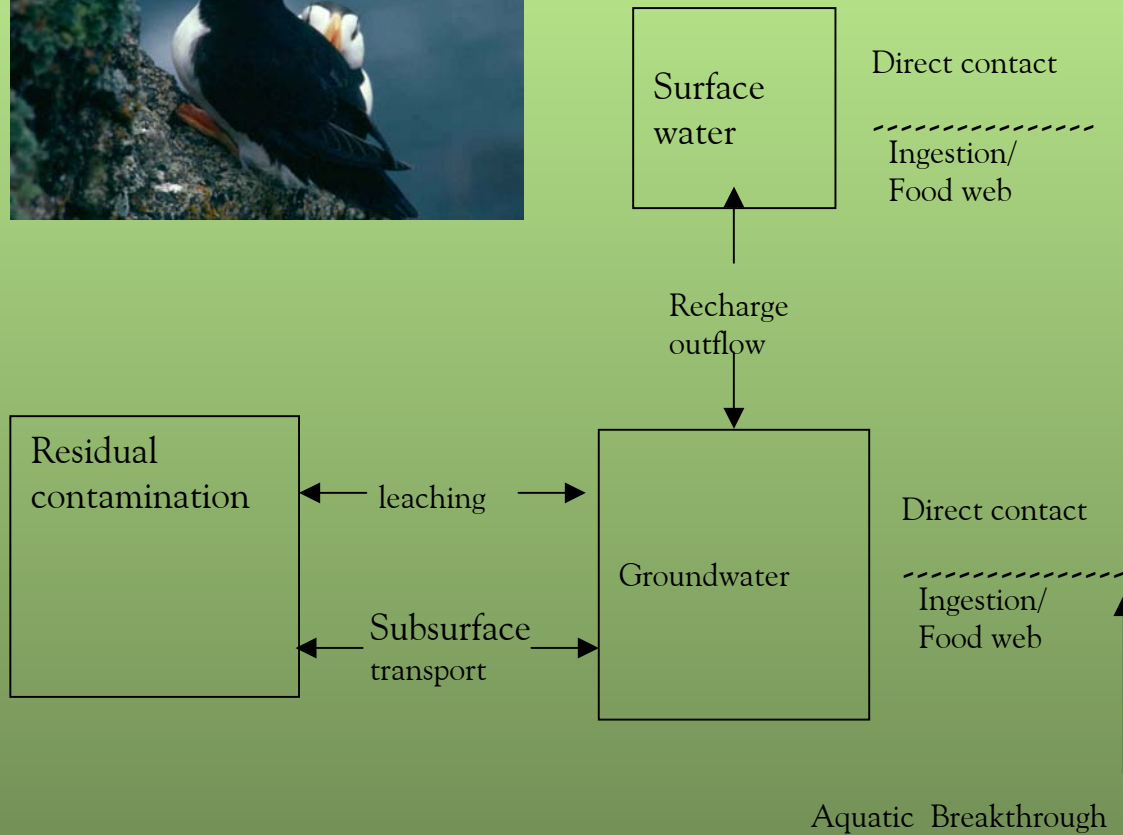
# ECOLOGICAL RISK TOOLS: AN OVERVIEW

- Ecological risk assessment: evaluates the current or potential damage to ecosystems and their biota
- Axes for tools:
  - 1) source to receptor pathway,
  - 2) cleanup to long-term stewardship
  - 3) regulatory to divergent stakeholder needs
  - 4) risk assessment, risk management, risk communication





# GENERAL CSM:



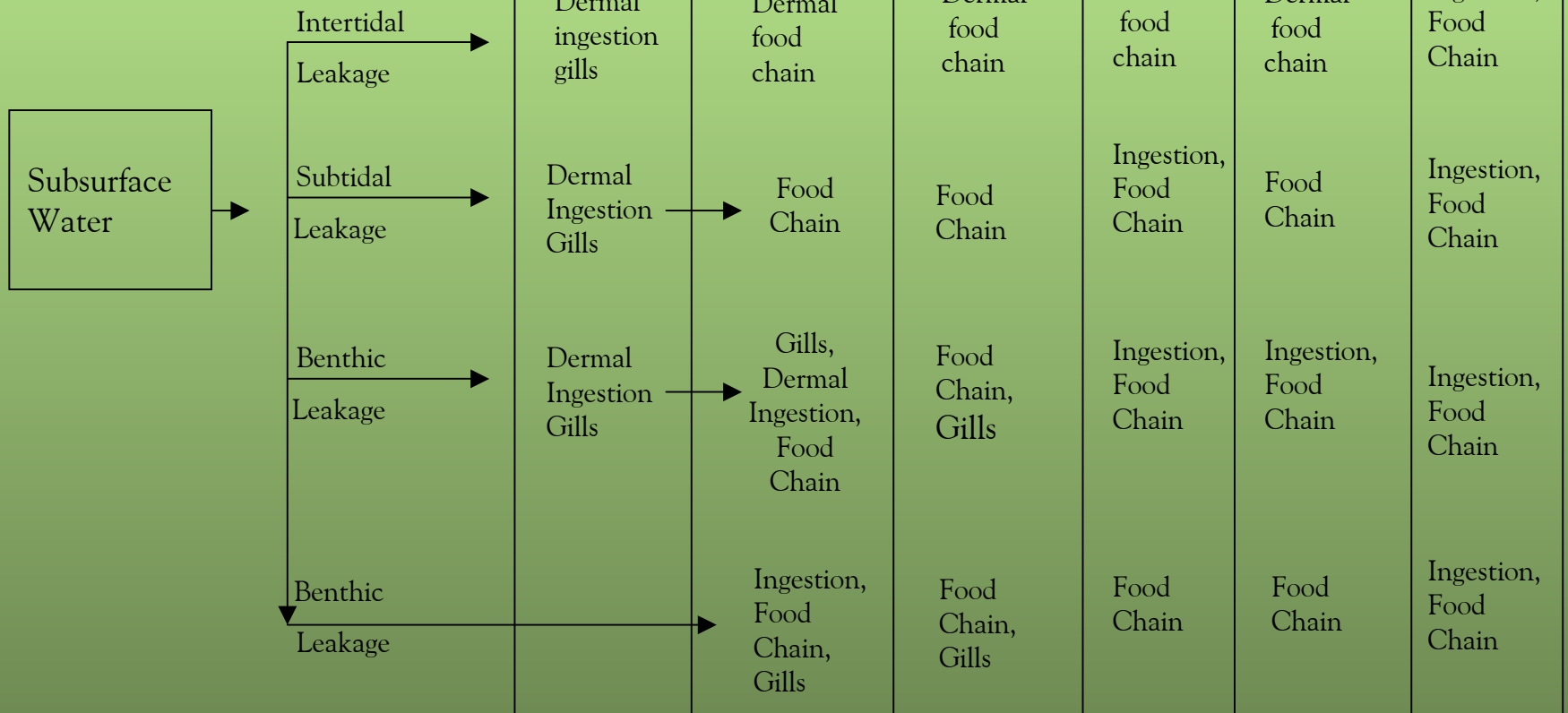
Stealth resident	Ecological	
	Terrestrial	Aquatic
Dermal Ingestion	Dermal Ingestion	Dermal Ingestion
Dermal Ingestion	Dermal Ingestion	Gills Dermal Ingestion
Dermal Ingestion	Dermal Ingestion	Gills Dermal Ingestion

General CSM for contaminated surface and subsurface soil (after DOE 2004).

# AN EXPANDED CSM:

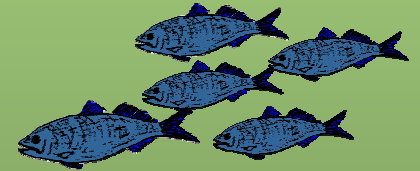


## Receptors



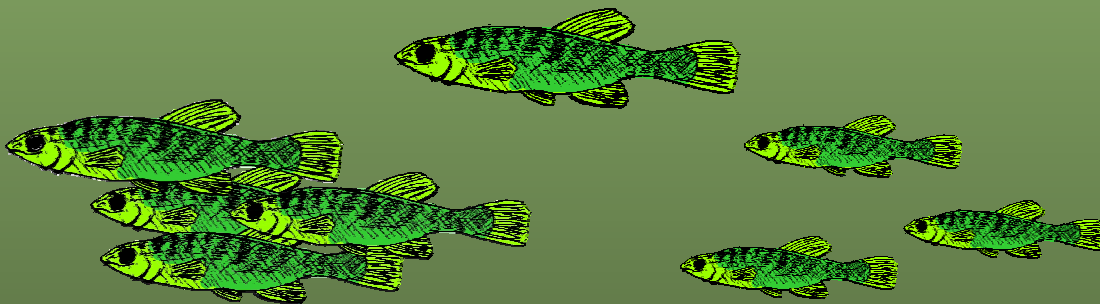
# INCORPORATING ECOLOGY AND ECOLOGICAL RISK INTO ENDSTATE PLANNING & LONG-TERM PROTECTION

- **Map contaminant patterns** in relationship to ecosystem types, sensitive species distribution and sensitive habitats.
- **Understand contaminant movement** within a context of ecosystem structure & function.
- **Identify sensitive species** or ecosystems of concern.
- **Develop bioindicators** of ecological and human health, from individuals to landscapes.
- **Develop bioindicators** of ecosystem functioning (e.g. species diversity, productivity, invasives).
- **Institute biomonitoring plan** that evaluates the efficacy of clean-up, remediation, and restoration.
- **Institute a biomonitoring plan** before, during, and after clean-up and remediation/restoration that can assess changes in ecological health before they are irreversible or have cascading effects.
- **Institute a biomonitoring plan** that is sufficient for long-term stewardship, meeting the needs of DOE, regulators, tribal nations, and other stakeholders.
- **Develop all phases to include hypothesis-testing, adaptive management, and iteration**, to disseminate knowledge complex-wide, to integrate stewardship and restoration goals and performance measures.



# COMPONENTS OF ECOLOGICAL ASSESSMENT

- Ecological characterization (ecosystem structure, biodiversity assessment, and vulnerability analysis).
- Environmental characterization (contaminants in media).
- Exposure assessment (target species and pathways),
- Indicator species and biomarkers identification
- Biomonitoring and surveillance, including data management and analysis.



# ECOLOGICAL CHARACTERIZATION

- **VULNERABILITY ANALYSIS:**

applying special software (i.e. Ramas) which estimates the probability that the species will become extinct in the local area, if no management intervention is offered.

- **UNIQUENESS ANALYSIS:**

Comparing species diversity onsite, with comparable habitats offsite. The species lists are then compared to determine the proportion of each taxon that is unique to the onsite facility. Can be done with habitats and species groups.

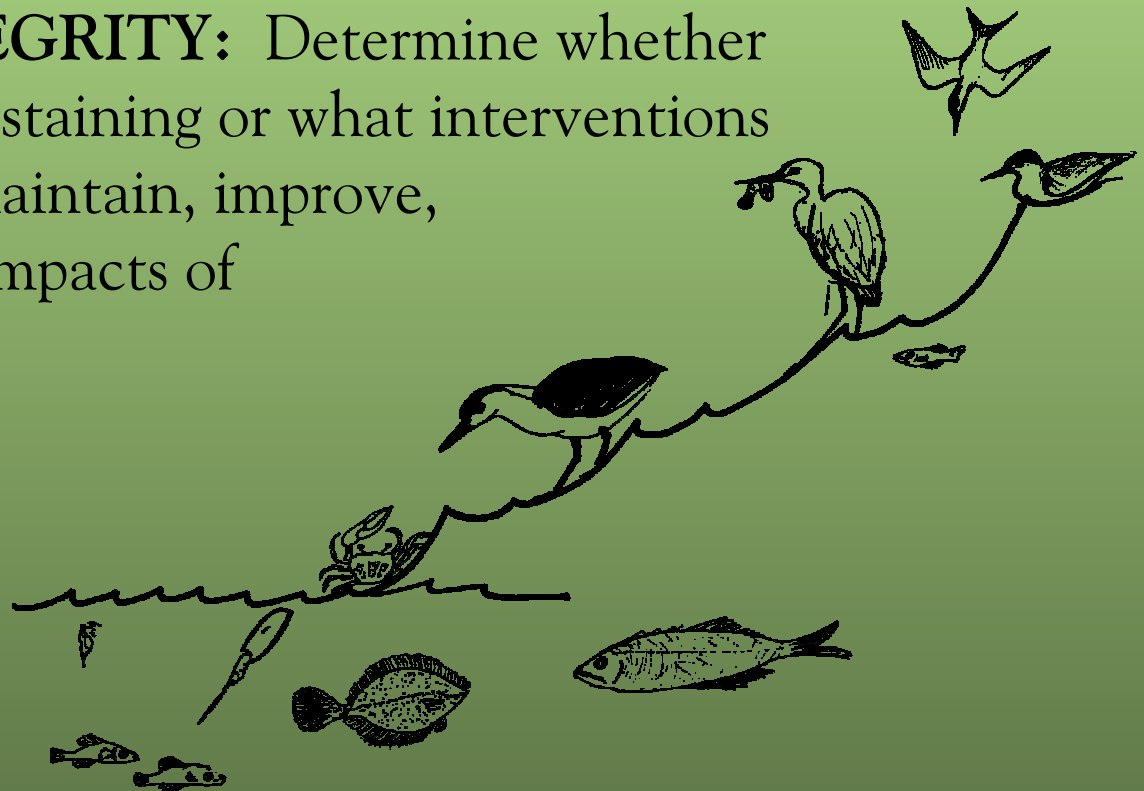


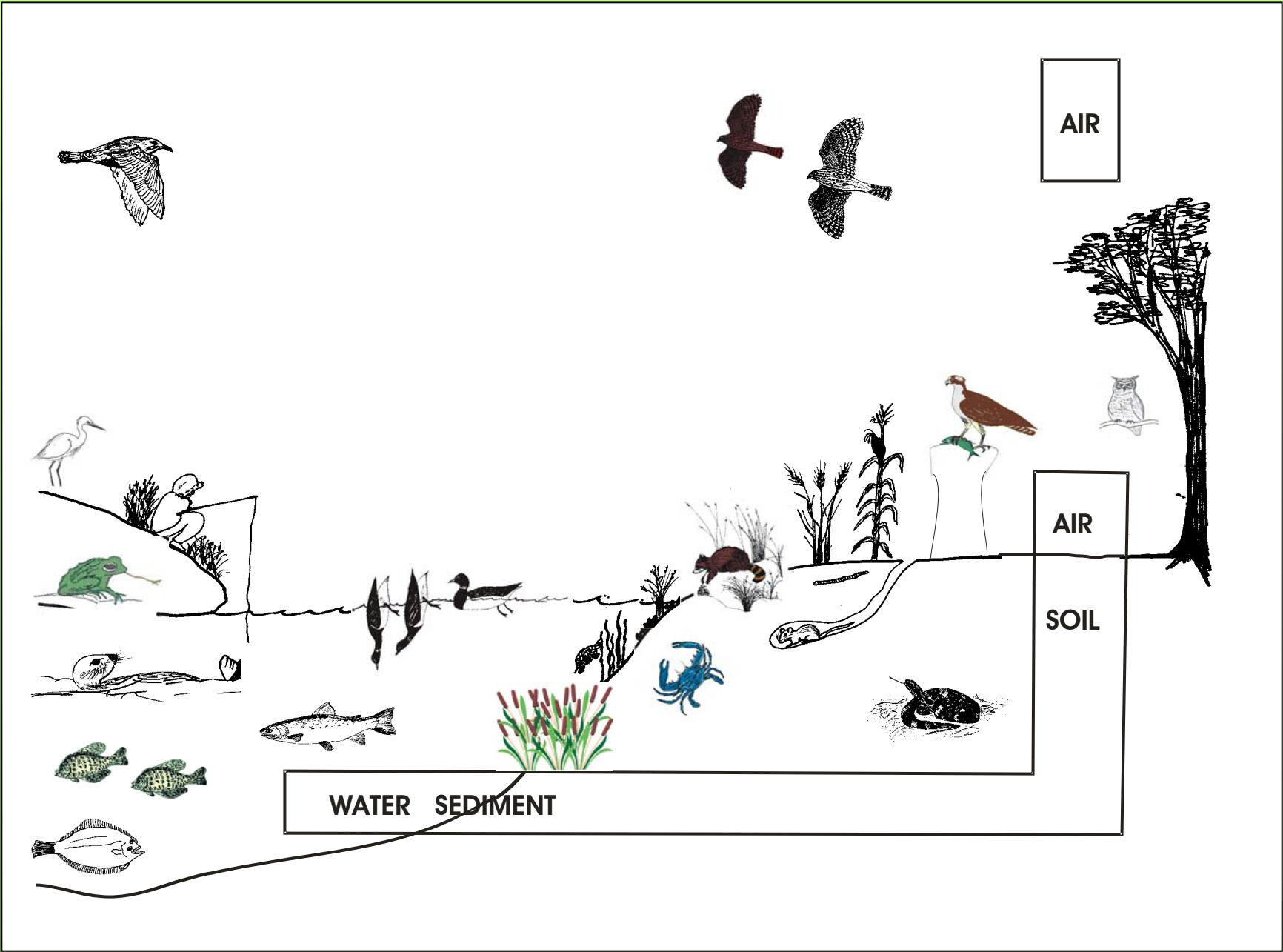
# ECOLOGICAL CHARACTERIZATION(cont)

- **TROPHIC OR FOOD WEB ANALYSIS:**

Mapping the energy flow from the primary consumers, through the herbivores to the carnivores. Includes detritivores and decomposers

- **ECOSYSTEM INTEGRITY:** Determine whether the ecosystem is self-sustaining or what interventions might be required to maintain, improve, or protect it from the impacts of remediation itself.





# ENVIRONMENTAL CHARACTERIZATION

- Measure contaminant levels in environmental media
- Determine Exposure pathways
- Conduct Exposure assessment





# FEATURES OF BIOMONITORING PLAN

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## Biological Relevance

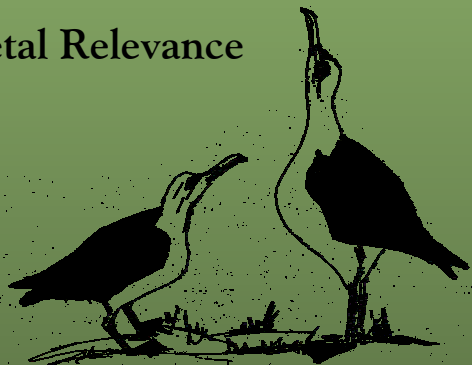


- \* Exhibits changes in response to stress
- \* Changes can be measured
- \* Intensity of changes relate to intensity of stressors
- \* Change occurs when effect is real
- \* Changes are biologically important and occur early enough to prevent catastrophic effects

## Methodological Relevance

- \* Easy to use in the field
- \* Easy to analyze and interpret data
- \* Measures what it is suppose to measure
- \* Useful to test management questions
- \* Can be used for hypothesis testing
- \* Relates to DOE cleanup activities
- \* Relates to regulatory requirements

## Societal Relevance



- \* Of interest to the public
  - \* Easily understood by the public
  - \* Transparent to the public
  - \* Measures related to human health or ecological integrity
  - \* Addresses regulatory mandates
  - \* Cost-effective
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# ECOLOGICAL RISK, STAKEHOLDERS & EVALUATION

- Ecological risk is science-based, with little input from the public or other stakeholders.
- Need to include Regulators, Land/resource managers, Public
- Need to understand ecological services ecosystems provide
- Need to include aesthetic and existence values



# TOOLS FOR HUMAN DIMENSION

- Questionnaires that assess 1) demographics, 2) resource use (recreational rates), 3) consumption patterns, 4) environmental concerns and perceptions in general, 5) environmental concerns about DOE lands, and 5) future land use preferences.

- 1) How will the public use the resources on the land if available;
- 2) How will resource use put people at risk,
- 3) Are particular people at more risk than others
- 4) Does the temporal pattern of risk vary with season or year
- 5) What are their environmental concerns in general, and about a given DOE site,
- 6) How do people value different ecological resources,
- 7) What are the preferred land uses
- 8) Do different groups value future land uses differently
- 9) How do preferred land uses relate to resource

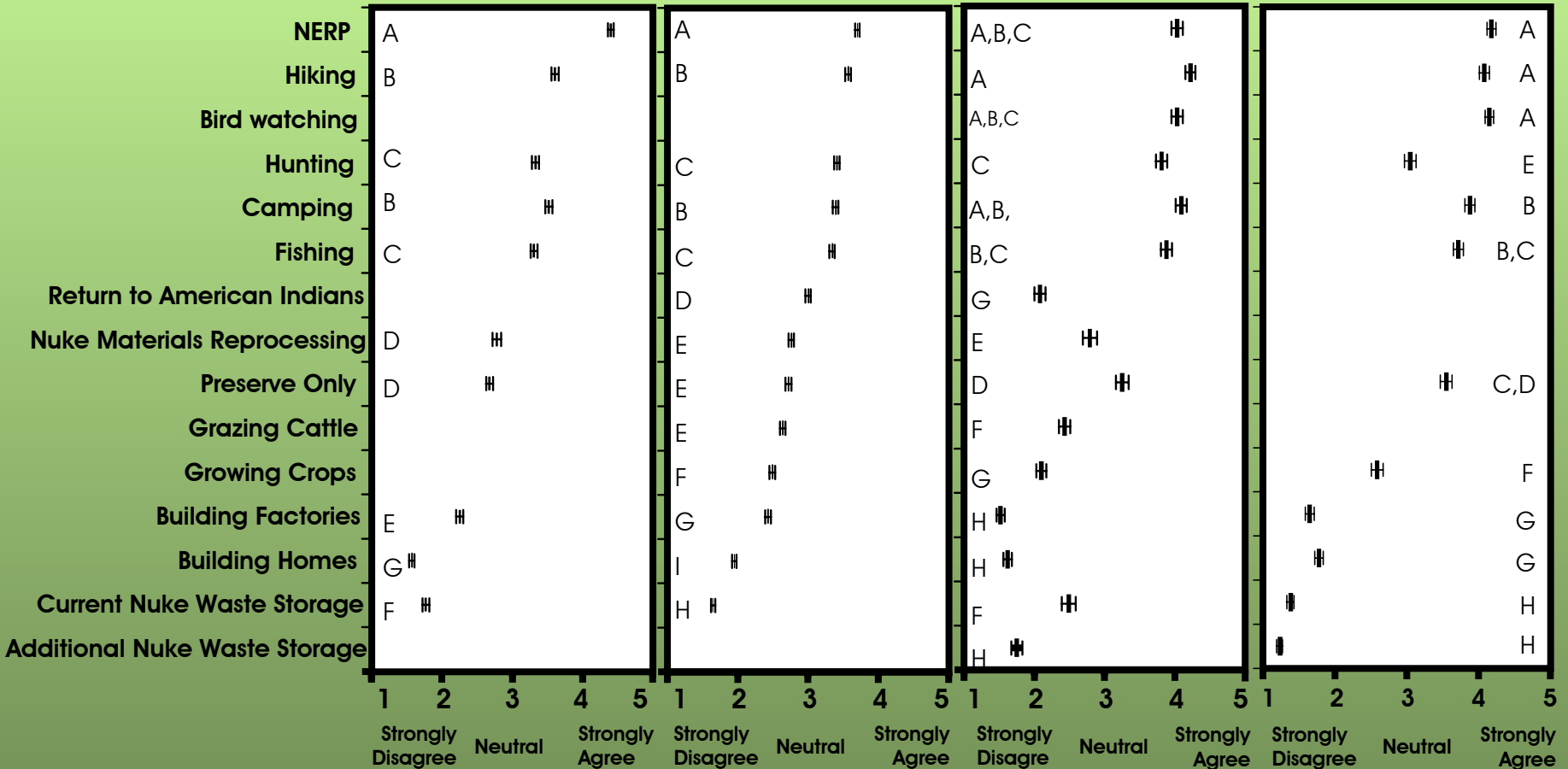


# SRS

# INEEL

# Los Alamos

# Brookhaven



Rating



# MANAGEMENT IMPLICATIONS

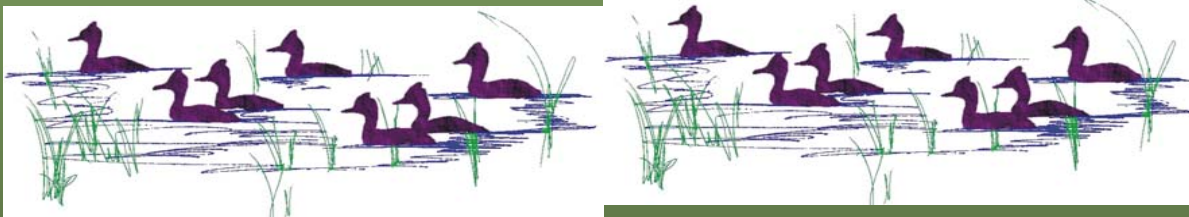
## ASSESSMENT:

- Assess current risk
- Assess resources at risk
- Assess pathways

## EARLY WARNING:

- Information
- Exclusion fishing/hunting zones

## SUSTAINABILITY:



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