Bharathidasan University

Programme: MSc Environmental Science and Sustainable Management

Course Title: ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Course Code: 21PGCC04

Unit- II Types of EIA and Ecological Impacts

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Introduction

- Eventual goal of much environmental toxicology is ecological risk assessment (ERA)
- Developed as a management tool to aid in making environmental decisions (area of much uncertainty)
- Estimates risk of producing new product, releasing a pesticide or effluent into the environment, etc.
- May not be scientific → assessment endpoints often set by societal perceptions and values

Purpose of ERA

- Purpose is to enable risk managers to make informed environmental decisions.
- Conducted to transform scientific data into meaningful information about the risk of human activities to the environment.

EPA/630/R-95/002F
April 1998

Guidelines for Ecological Risk Assessment

(Published on May 14, 1998, Federal Register 63(93):26846-26924)

Risk Assessment Forum
U.S. Environmental Protection Agency
Washington, DC

Note: full text of above contained in Appendix B (p. 419 -463)

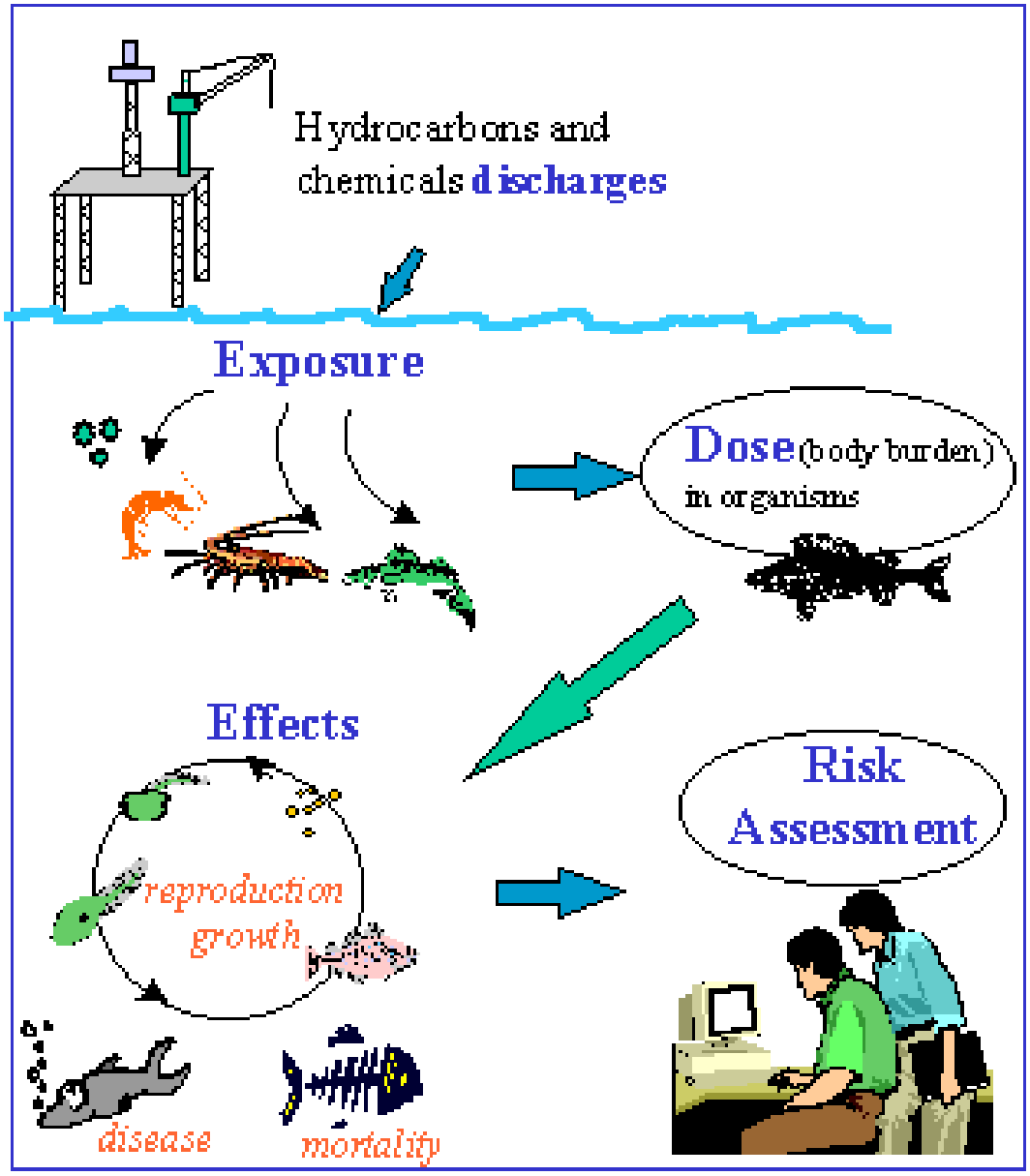
Framework for Environmental Risk Assessment

-Previously risk assessment seen only as hazard assessment and fate

-But above not easily separated in ecological systems → when release chemical starts to change ecosystem while ecosystem is changing chemical

- Need to go beyond and predict probability of ecological effects of chemical or action

Environmental risks in the sea



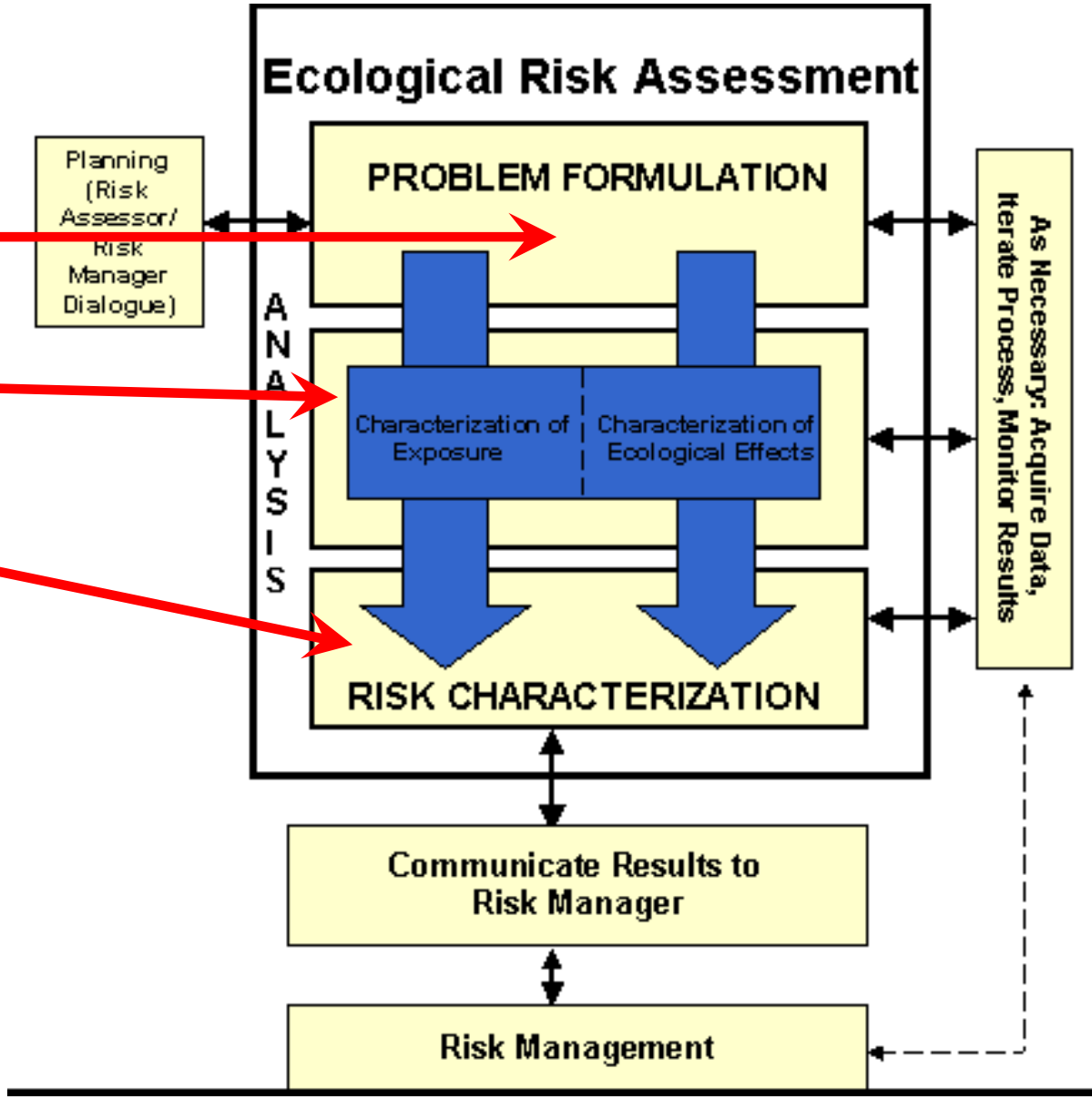
- Interaction among risk assessors, risk managers, and interested parties all phases of an ERA is critical to ensure that the results can be used to support a management decision.

- Because of the diverse expertise required (especially in complex ecological risk assessments), risk assessors and risk managers frequently work in multidisciplinary teams.

Schematic of Framework

ERA includes three primary phases:

1. Problem formulation
2. Analysis
3. Risk characterization



Outline of Phases of an ERA

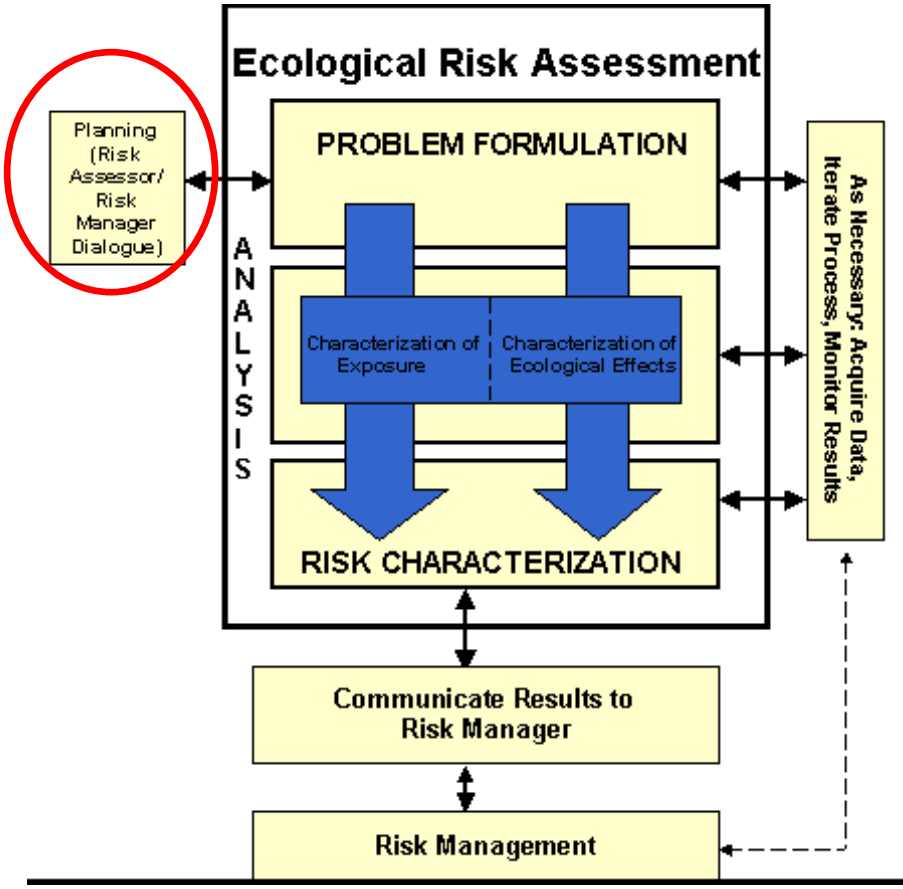
1. Problem formulation
   - Beginning of dialogue between risk managers and risk assessors.
   - Selection of assessment endpoints (what is important?)
   - Risk assessors evaluate goals
   - Prepare the conceptual model
   - Develop an analysis plan.

2. Analysis phase
   - Assessors evaluate exposure to stressors and the relationship between stressor levels and ecological effects.

3. Risk characterization,
   - assessors estimate risk through integration of exposure and stressor-response profiles,
   - describe risk by discussing lines of evidence and determining ecological adversity, and prepare a report.

Problem formulation

- Start of iterative process of defining the question under consideration
- Directly affects the scientific validity and policy-making usefulness of the ERA
- Composed of several six subunits



1. Discussion between risk assessor and risk manager

- Sets boundaries created by societal goals and scientific reality (data)
- Consolidates ambiguous goals
  - Protection of endangered species
  - Protection of fishery
  - Preserve structure and function of ecosystem

2. Stressor characteristics?

- Can be biological, physical, chemical
- Characterized by
  - intensity (conc. or dose)
  - duration
  - frequency
  - timing
  - scale — Spatial aspect

Temporal aspects

3. Ecosystems Potentially at Risk?

- Difficult to address → transport often difficult to predict
- Need to look at
  - Abiotic-biotic factors
  - History
  - Size
  - Geographic relationships

4. Ecological Effects?

- Includes any impact upon any level of ecosystem
- Derived from hazard assessment (acute/chronic toxiciy) and consideration of:
  - Biotransformations
  - Biodegradation
  - Reproductive effects
  - Predator-prey interactions
  - Production
  - Community biomass
  - Anything which has a direct role in the functioning of the ecosystem

5. Endpoint selection

- Most critical aspect of problem formulation → sets stage for remainder of process
- Two types of endpoints
  - Assessment endpoints
    - Set by ecological relevance, policy goals/societal values (i.e. protect ecosystem structure/function)
    - Often can only infer from measurement endpoints
  - Measurement endpoints
    - Measurable factors that respond to stressors and describe characteristics of ecosystem important to assessment endpoints
    - Design and selection based on relevance, practicality, etc

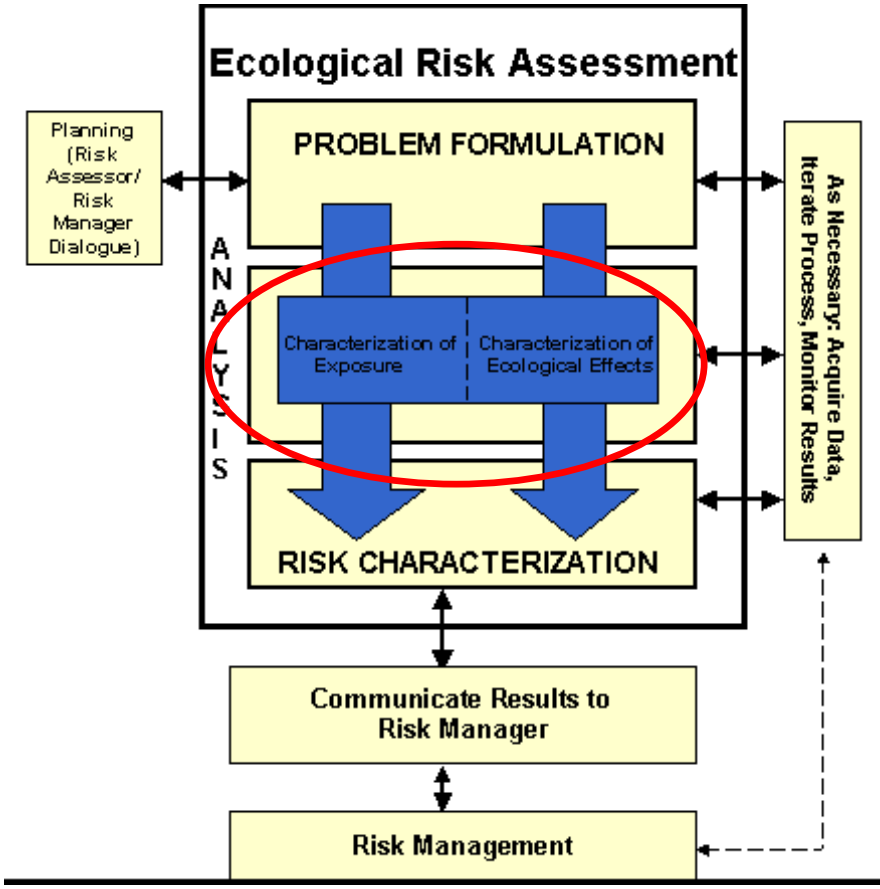
6. Conceptual Model

- Framework into which data are placed
- Defines how data will be interpreted (what is likely to be affected:
  - Migratory birds?
  - Temporary pond amphibians?
  - Etc

Note: all above subject to revision based on collected information from data acquisition, verification, monitoring (DVM)

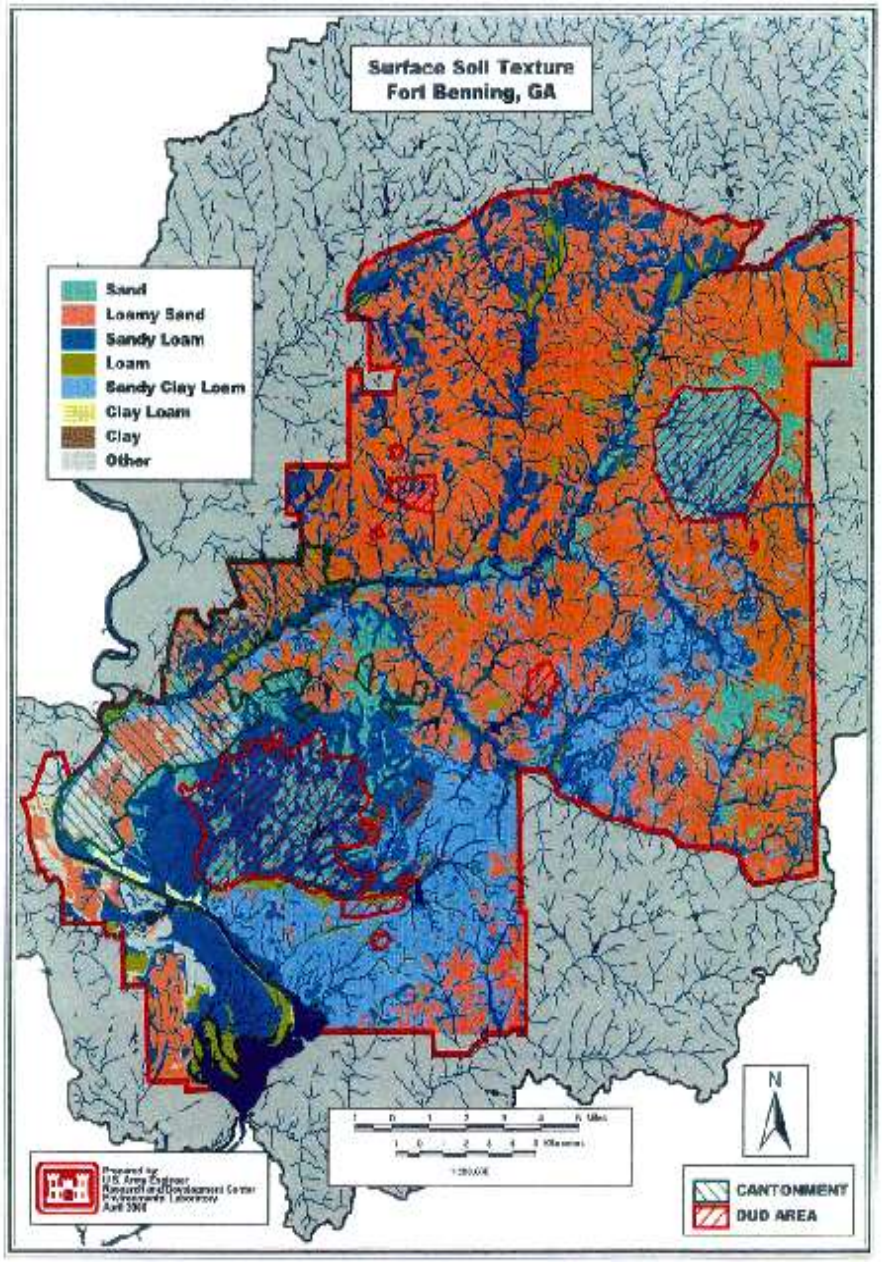
Analysis

- Comes into play as problem formulation is completed
- Most important part → characterization of ecosystem(s) of concern
- Composed of five subunits



1. Ecosystem Characterization

- Often difficult to perform because
  - Ecosystem no longer there?
  - Boundaries?
  - Climate changes?
  - Biotic interactions?



2. Stressor characteristics and evaluation of relevant effects

- Chemical properties?
- Toxicity?
- Usually evaluate from published data
- May do own tests but expensive → only do if absolutely necessary

3. Exposure analysis

- Determine environmental concentration
  - Difficult → end of pipe →biotransformation → media heterogeneity → now how much toxic stuff is there?

  - Non-point sources can be even more difficult
    - Where to measure?
    - When to measure?

4. Ecological response analysis

- Most difficult stage of ERA because as test system becomes more environmentally realistic the ability to accurately predict effects decreases
- Can use
  - Toxicity data
  - Microcosms
  - Field data/observations
  - Etc.

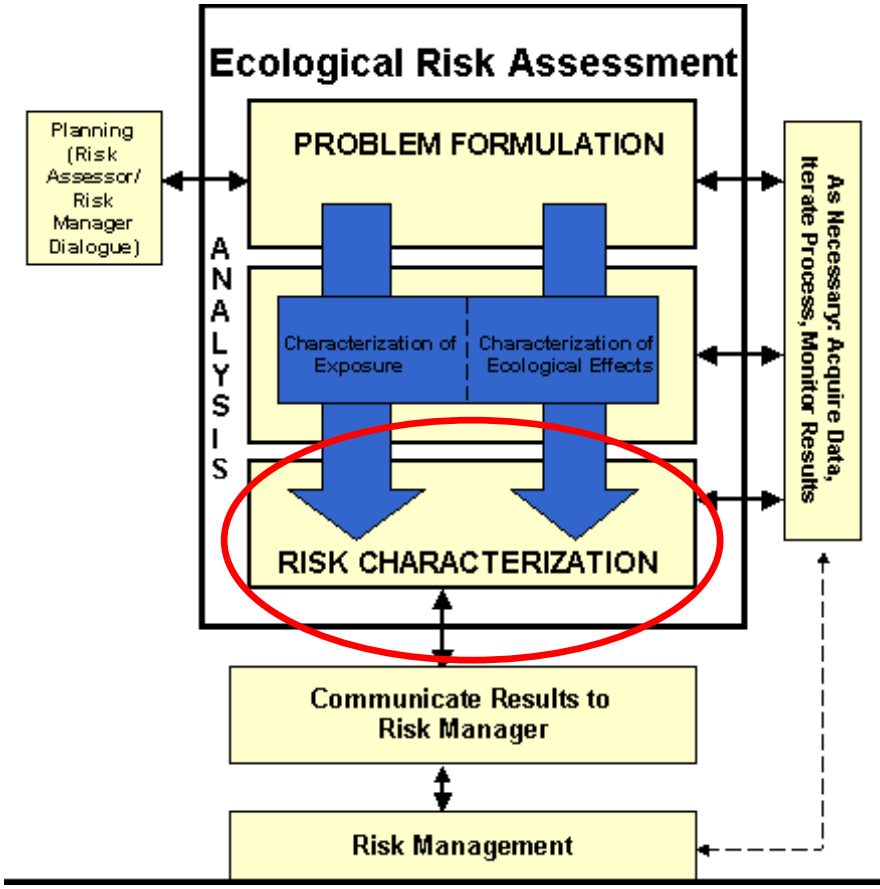
5. Stressor/response analysis

- Analogous to dose/response but using single species toxicity to extrapolate to population/community level responses
- Have to take other (natural) stressors into account

Note: DVM critical for best results

Risk Characterization

- Final stage of an ERA
- Combines ecological effect and environmental concentration to provide likelihood of effects given distribution of stressor within ecosystem
- Composed of two parts:



1. Risk estimation

A. Integration
   1) Integrate exposure with toxicity
   2) Use quotient method of estimating environmental risk

B. Uncertainty analysis – how much confidence (certainty) in data/information
   1) Can have formal mathematical analysis or informal "best guess" analysis

Quotient Method

$$\text{Quotient} = \frac{\text{Expected environmental concentration}}{\text{Concentration producing an unacceptable environmental effect}}$$

Quotient	Risk
>1	Potential of high risk
~1	Potential risk
<< 1	Low risk

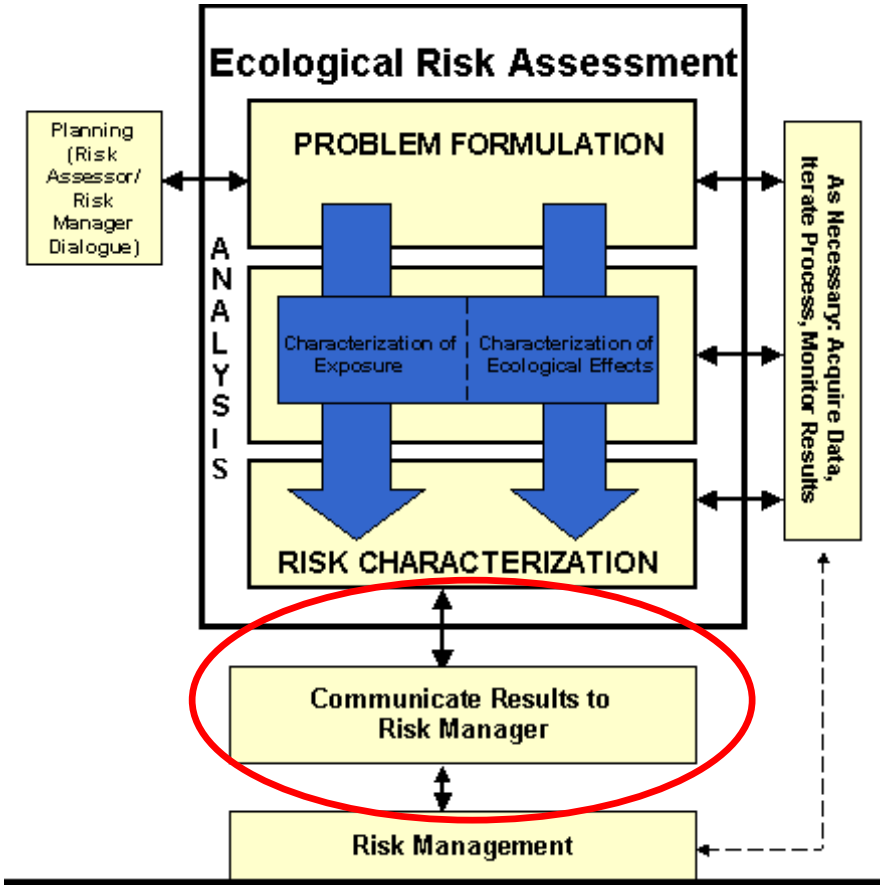
2. Risk description

- Ecological risk summary
  - "what are the potential effects and *do I believe them?*
- Interpretation of ecological significance
  - "how big a problem is this really going to be"

Discussion between Risk Assessor and Risk Manager

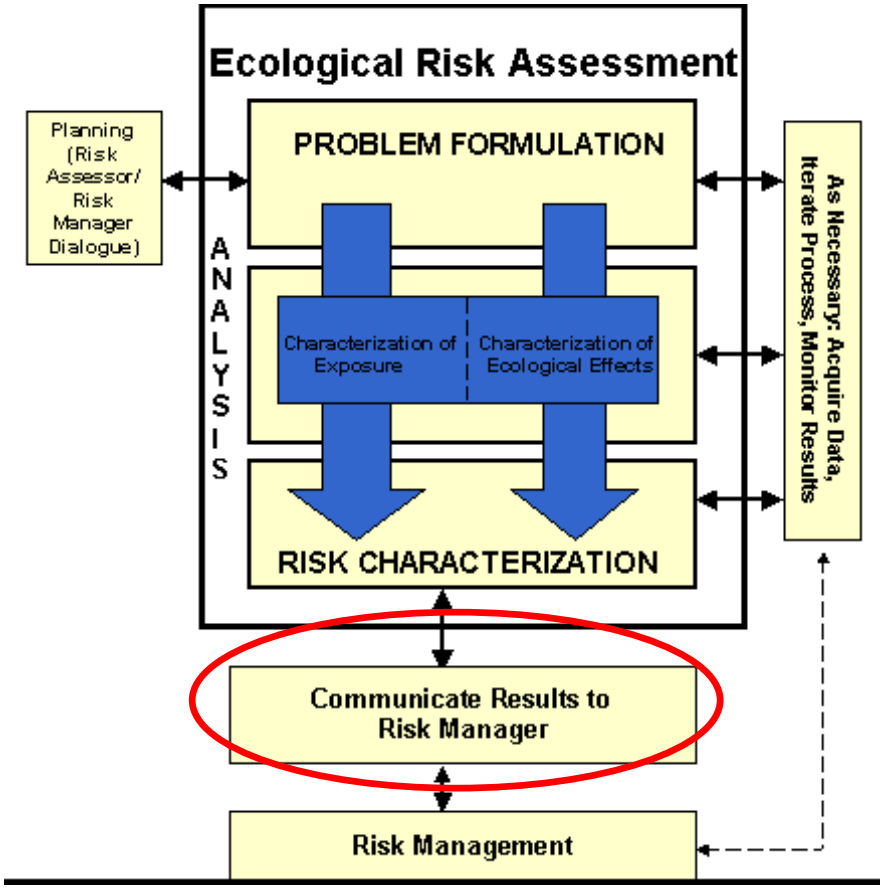
- Report from risk assessor to risk manager

- Risk manager may take information and perform a risk/benefit analysis



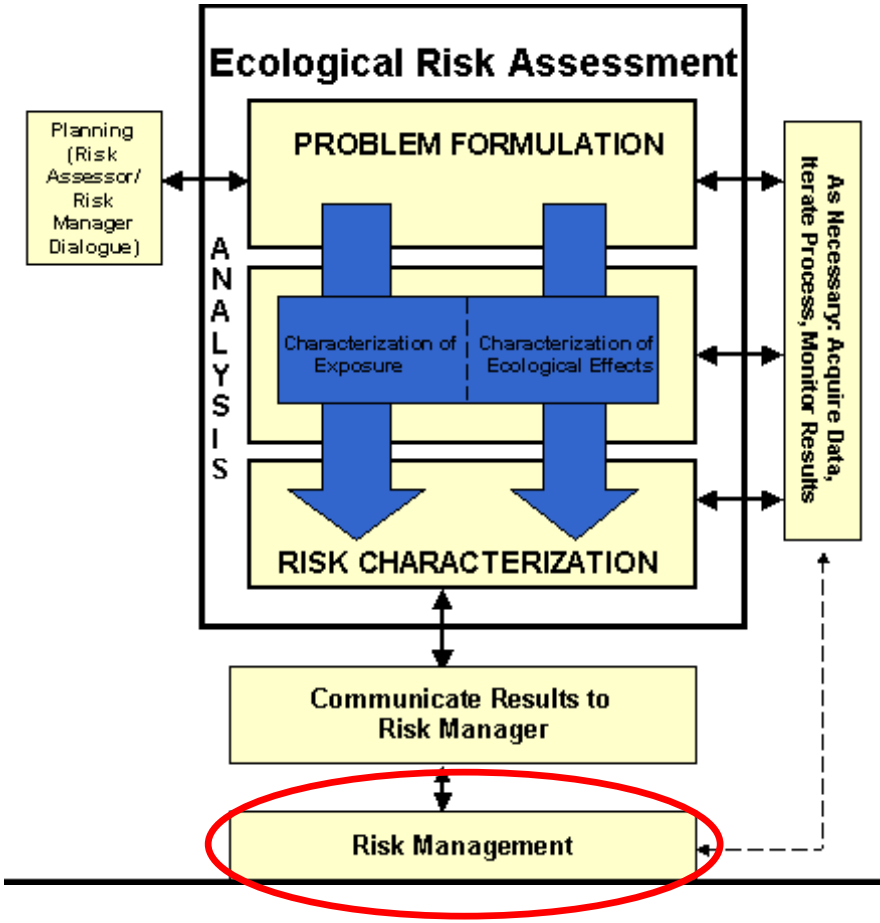
Discussion between Risk Assessor and Risk Manager

- Report from risk assessor to risk manager
- Risk manager may take information and perform a risk/benefit analysis→ is the economic benefit worth the environmental cost?
- Report may generate multiple vituperative displays of acrimony among interested parties



Risk Management

- Manage risk taking environmental, social, economic effects into account
- Management usually implemented in the form of policy and legislation



Monitor Results

- Usually need to implement an on-going monitoring plan to determine if management objectives are being met
- Often not performed as extensively as necessary until a problem arises