Ecological Risk Assessment 101

PPAT Meeting

June 2, 2020

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What is Ecological Risk Assessment?

- The process for evaluating how likely it is that the environment may be impacted as a result of exposure to one or more environmental stressors such as chemicals, land change, disease, invasive species, and climate change.

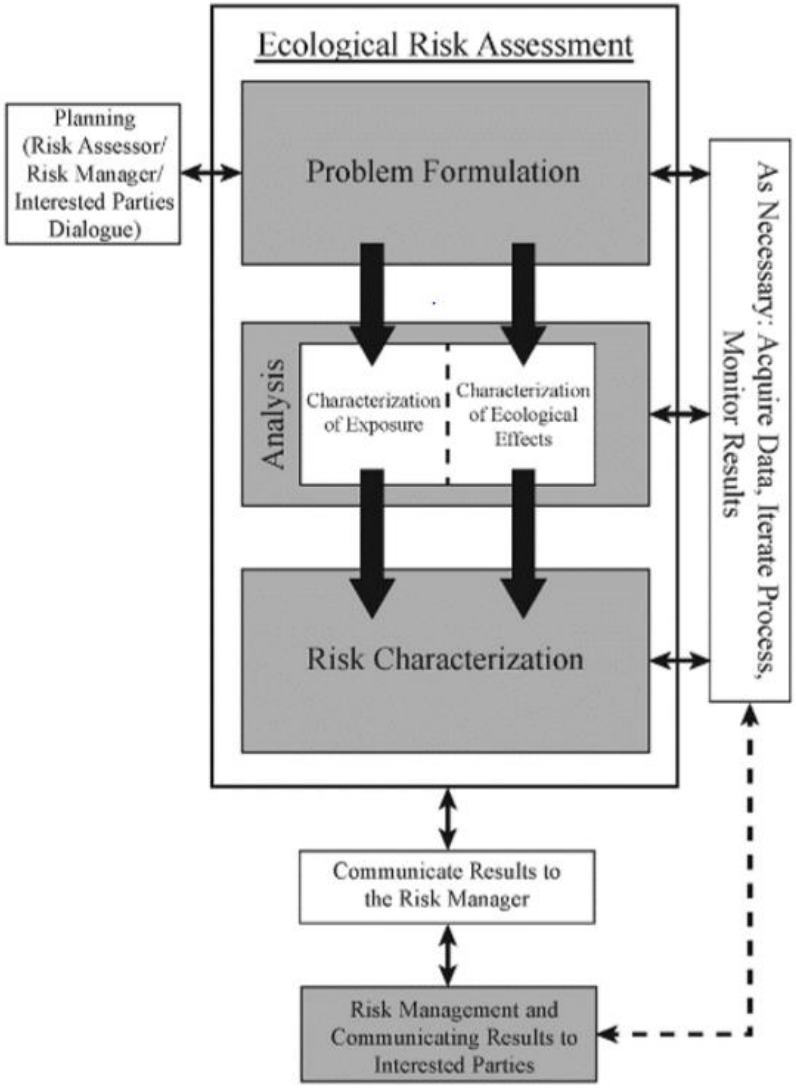
- EPA Guidance for Conducting an Ecological Risk Assessment

https://www.epa.gov/risk/conducting-ecological-risk-assessment

How is an ERA Structured?

1) **Planning**
   - Define purpose, scope, and technical approaches
2) **Problem Formulation**
   - Define assessment endpoint to identify ecological entity that is important to protect
3) **Analysis**
   - Identify sources of exposure and ecological responses to stressors
4) **Risk Characterization**
   - Estimate risk posed to ecological receptors and identify uncertainties

Ecological Risk Assessment Framework



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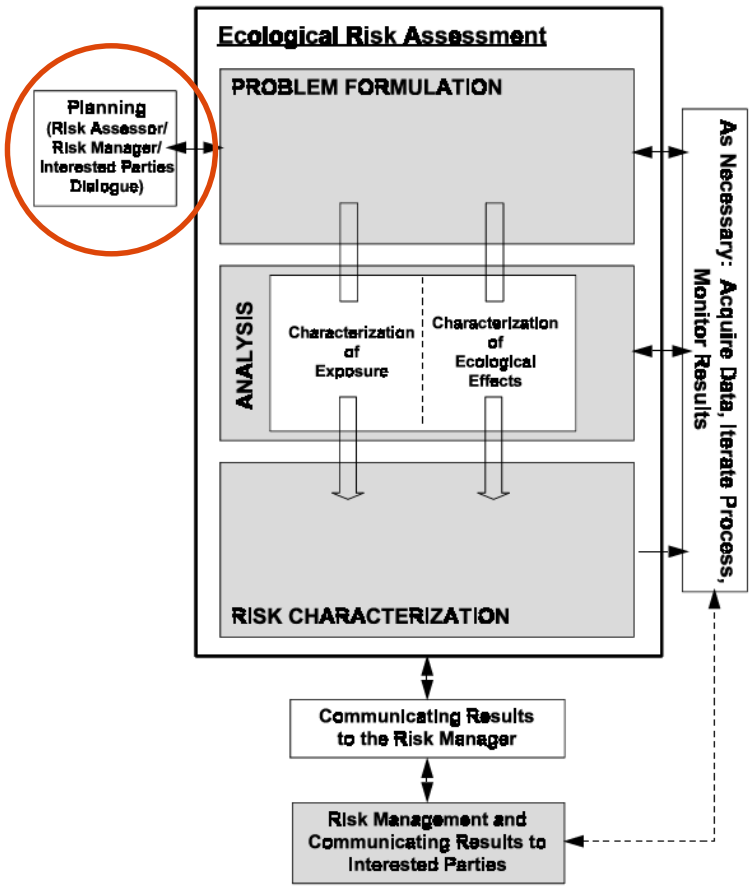
Step 1: Planning



Planning

- Who/What/Where is at risk?
- What is the environmental contaminant of concern?
- Where do these environmental hazards come from?
- How does exposure occur?
- How does an organism uptake and process the chemical?
- What are the ecological effects?
- When will a contaminant cause a toxic effect?

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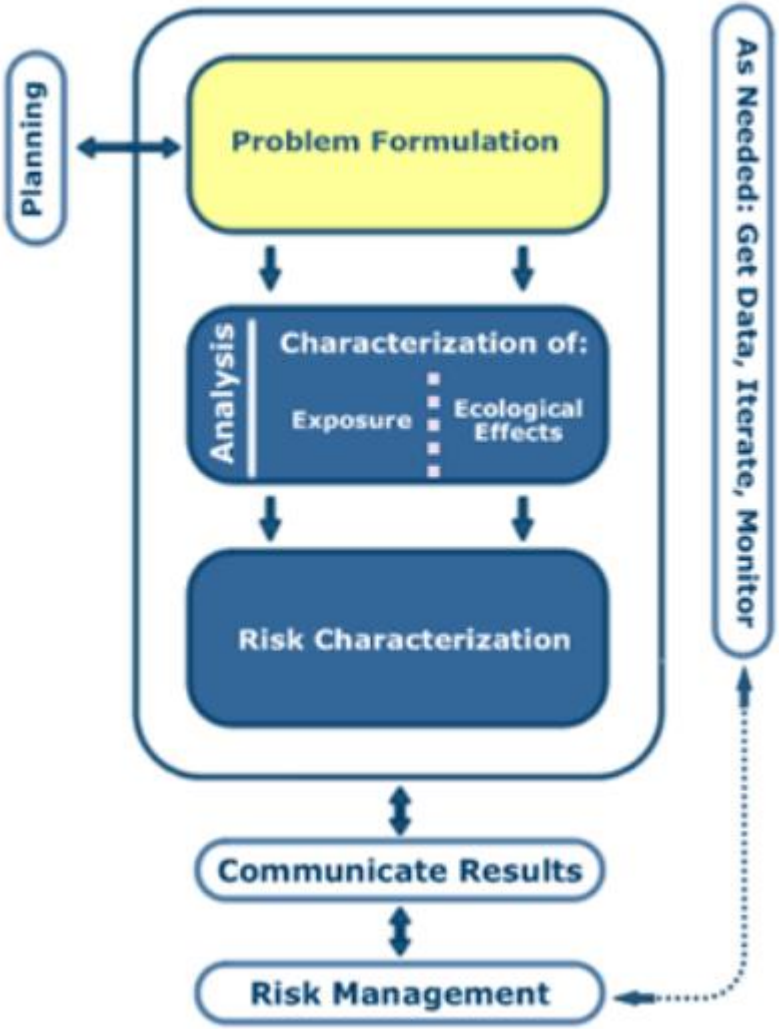
Step 2: Problem Formation



Problem Formulation:

- Identify an ecological attribute we want to protect
  - Species? Functional group? Community? Ecosystem?
- Specify how to measure that endpoint
  - Relevant, measurable characteristics of valued resources and their attributes

Step 2: Problem Formation
Examples of Assessment Endpoints

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- Abundance and spatial extent of striped bass juveniles
- Abundance and distribution of native oysters
- Diversity and abundance of rare or threatened and endangered species
- More abundant recreational opportunities (e.g., boating, fishing, swimming)

The more explicit the assessment endpoint, the more risk analyses are likely to be useful

Step 2: Problem Formation
Assessment Endpoints

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- Valued ecological resource
- Explicitly defined so that it provides a clear focus for the assessment
- Provides a link between measurable endpoints and the steps necessary to achieve the management goal
- Represents a combination of a valued resource and ecologically relevant characteristics
- Selected based on their relevance to management objectives, susceptibility to stressors of concern, and ecological importance

Step 2: Problem Formation
Measurement Endpoints

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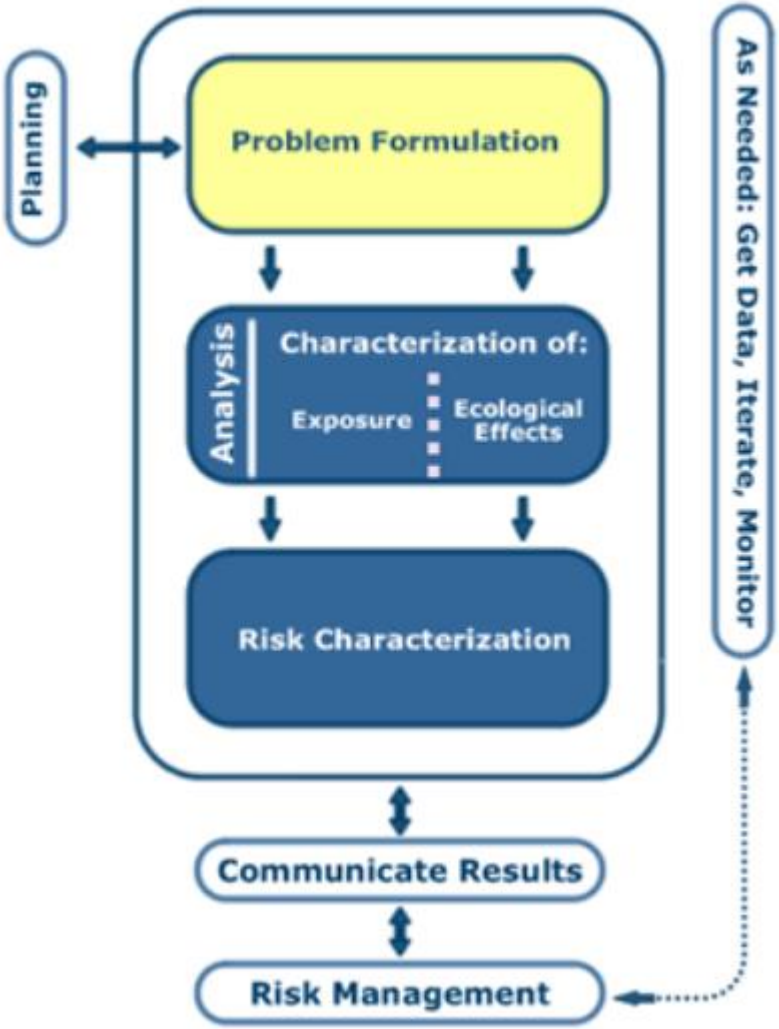
- Measurable attribute of the assessment endpoint
- May use a surrogate indicator for the assessment endpoint in order to have a measurable endpoint for risk analyses.

Examples

Assessment Endpoint	Measurement Endpoint
Diverse pelagic fish community	Fish IBI, metrics
Abundant striped bass juveniles	CPUE of striped bass juveniles in surveys
Estuarine benthic macroinvertebrate community integrity	Diversity of benthic species; proportion of sensitive taxa or species having certain biological traits
Abundant healthy eel grass beds	Aerial coverage of eel grass from satellite images

Step 2: Problem Formation (continued)



Problem Formulation:

- Conceptualize what we know, what we think we know, and what we want to know
  - Source
  - Stressors
  - Receptors
  - Potential exposure
  - Predicted Ecological Effects

Step 2: Problem Formation Conceptual Model

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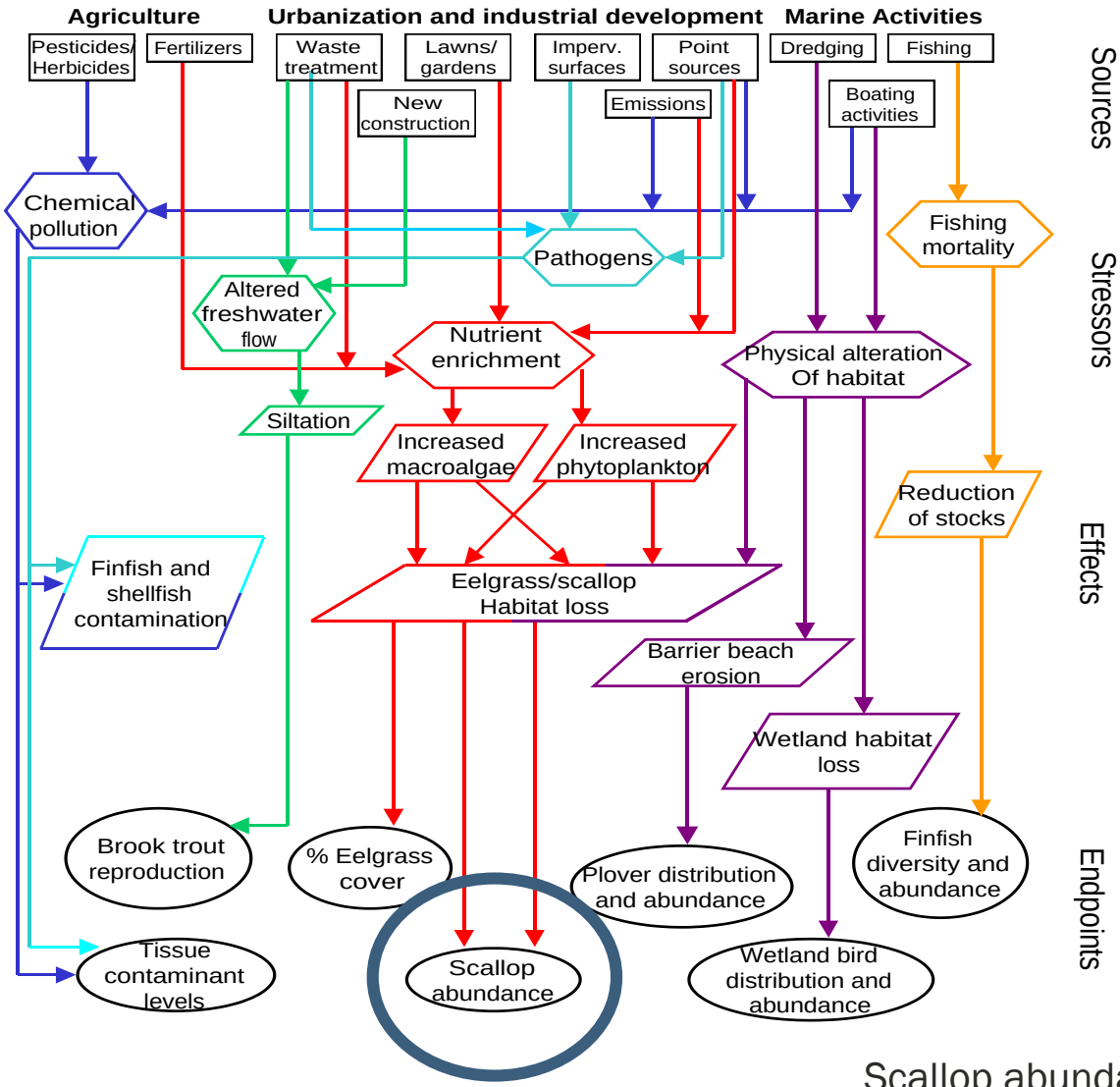
- Describes pathways between:
  - human activities (**sources of stress**)
  - **stressors** (may be physical, chemical, or biological)
  - **assessment endpoints**
- Should yield predictions or risk hypotheses of how human activities affect the valued ecological resources
- Based on ecological experience and best professional judgment

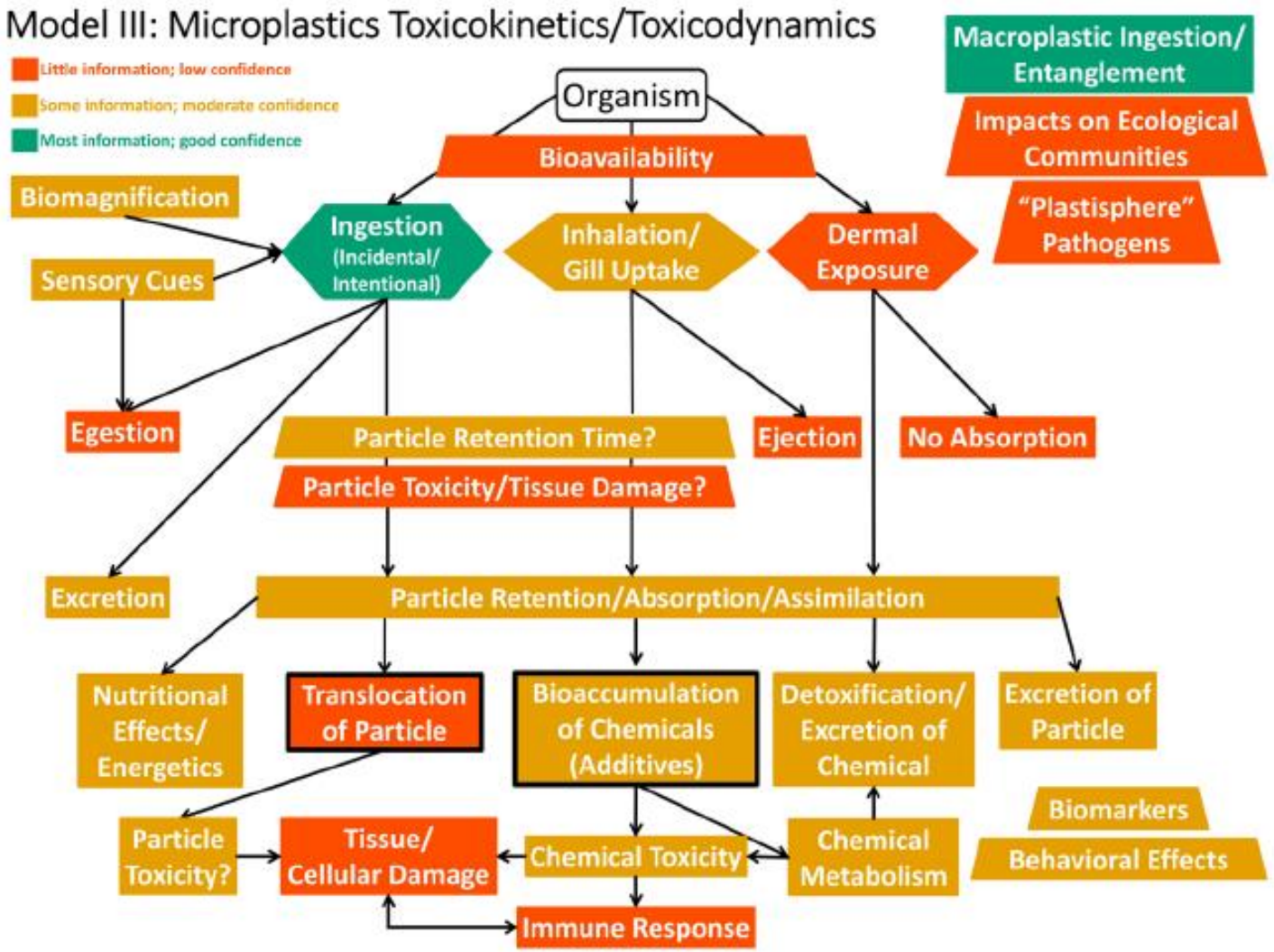
- **May be assessment endpoint – focused [what stressor(s) most responsible for risk to valued resource?] OR**
- **May be stressor-focused [e.g., What is the ecological risk of chemical X at my site or in general? – may have multiple assessment endpoints] OR**
- **May be both stressor and assessment endpoint focused**

Endpoint Focused Conceptual Model



Scallop abundance Waquoit Bay, MA

Stressor Focused Conceptual Model



From: EPA microplastics expert workshop June, 2017

Stressor and Assessment Endpoint Focused Conceptual Model

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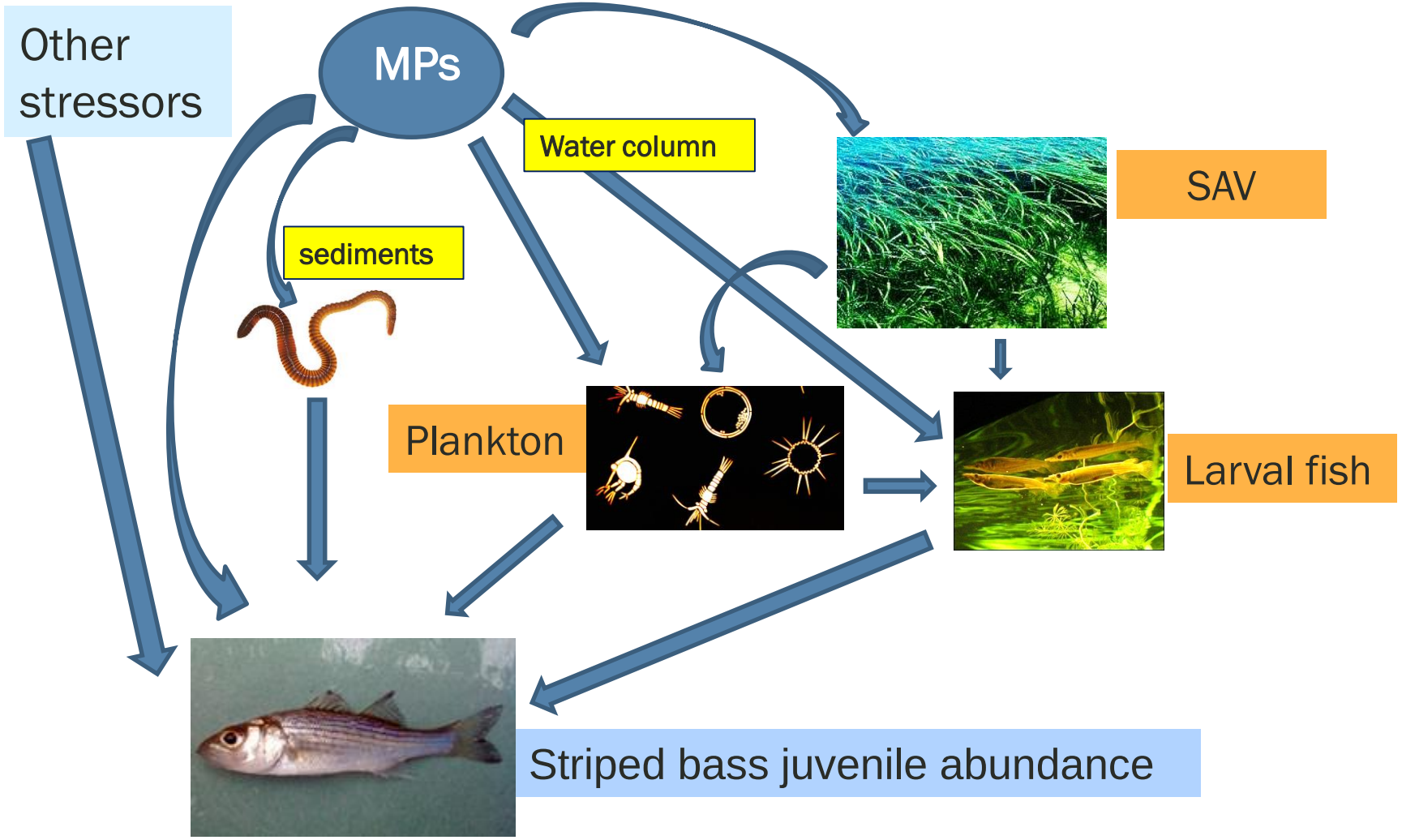

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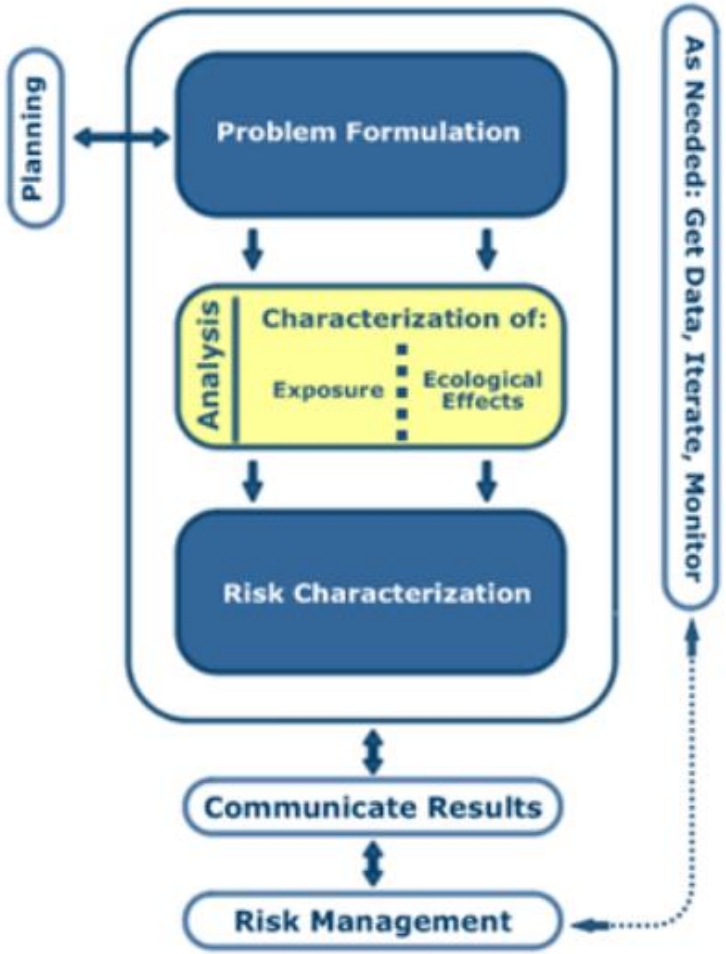
Step 3) Risk Analyses

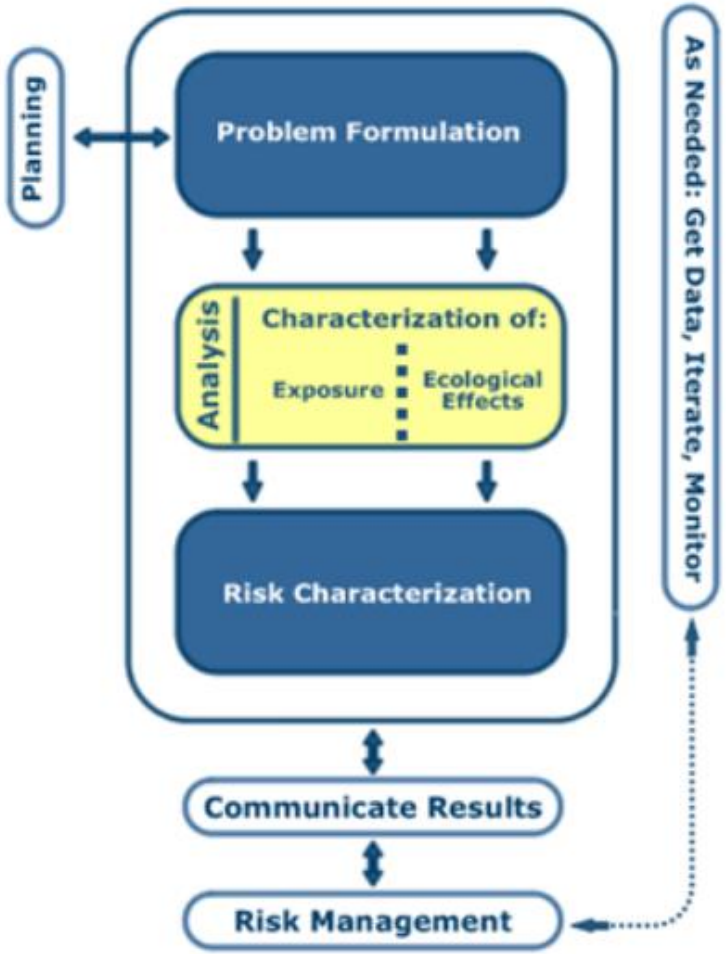
Analysis

- Predict ecological responses
  - What plants and animals are exposed?
  - What is the magnitude of exposure?
  - Is that exposure likely to cause harmful ecological effects?



Step 3) Risk Analyses (continued)

- Identify risk hypotheses or testable linkages between sources, stressors and assessment endpoints
- Identify appropriate ways to analyze linkages or hypotheses
- Implement analysis plan and interpret results of analyses
- Often an iterative process as results are obtained; not necessarily linear process



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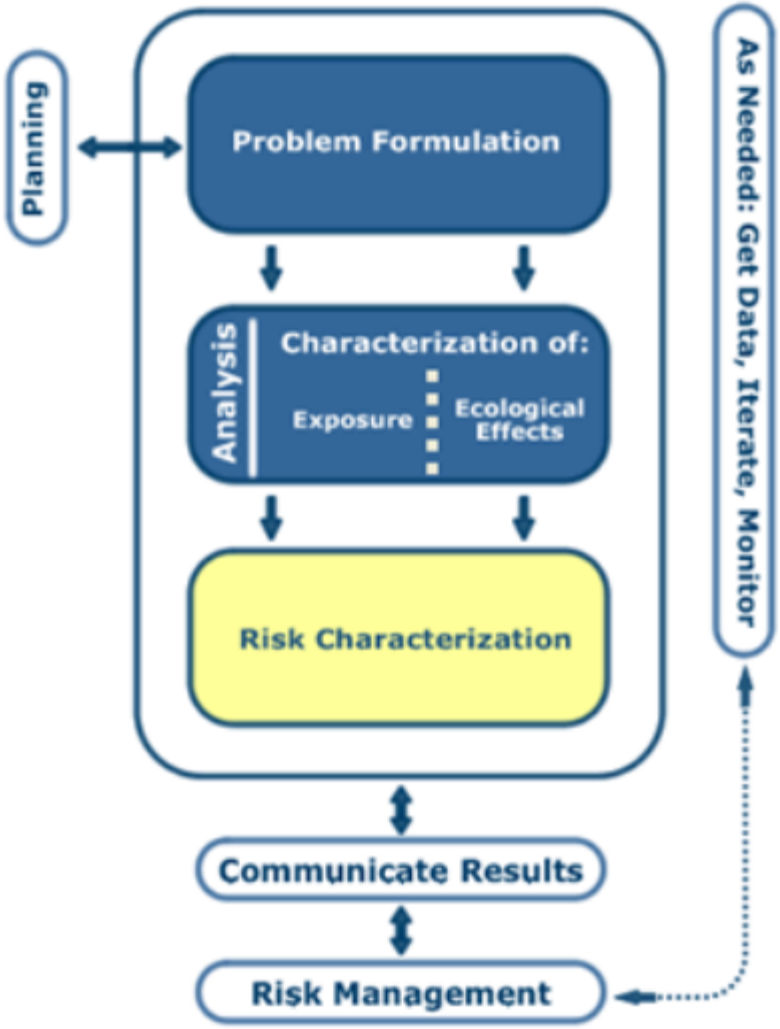
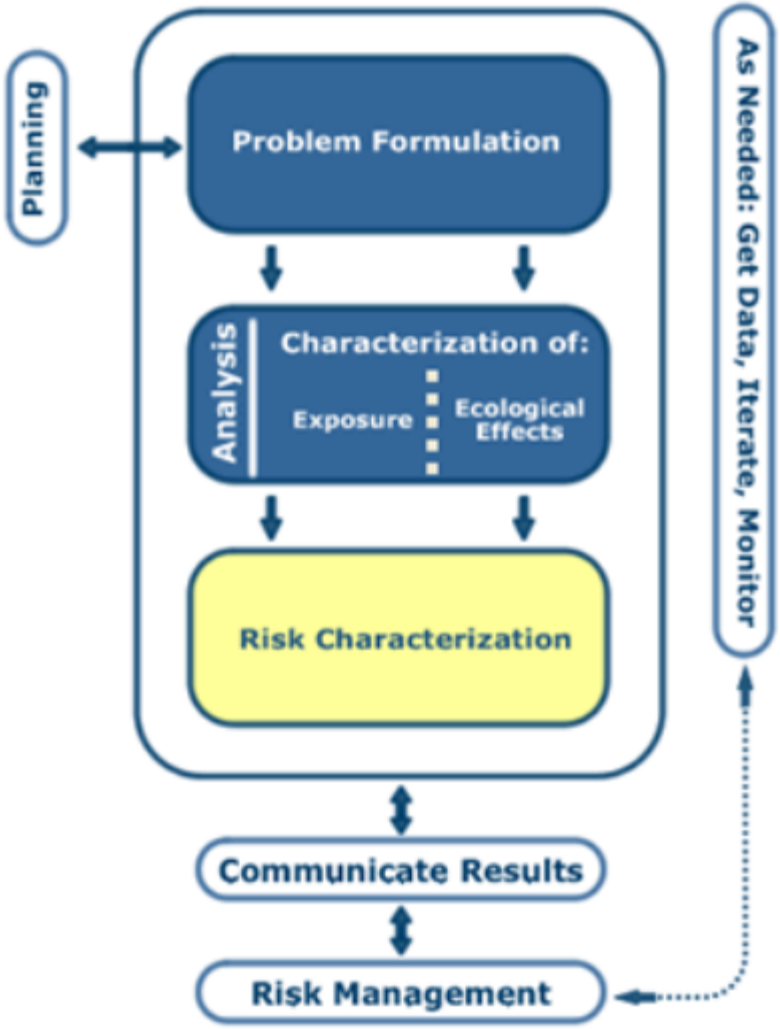
Step 4) Risk Characterization



Risk Characterization

- Integrates exposure and effects
- Estimate ecological risk
  - Acute vs chronic effects?
  - Severity of effects?
  - Duration of effects?
  - Risk to one or many species?

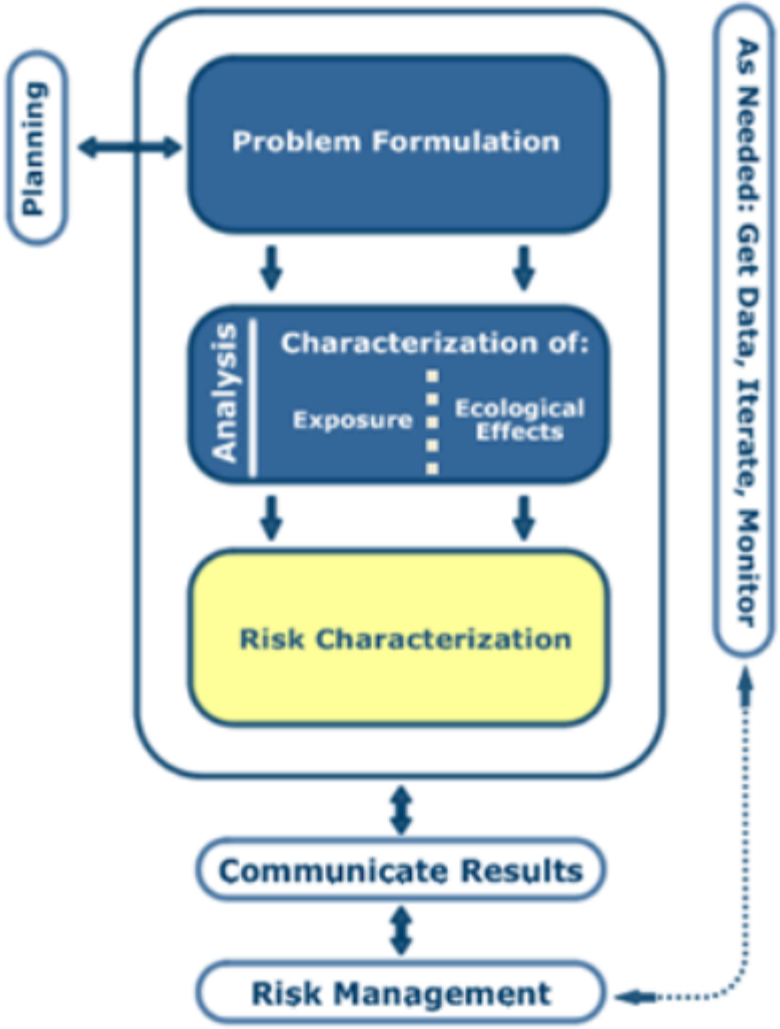
Step 4) Risk Characterization (continued)



Risk Characterization

- Traditionally relies on known effect thresholds (e.g., LC50s, NOECs), species sensitivity distributions, minimum levels for sustained population survival and reproduction
- Identify strength of relationships derived from analyses
- Identify uncertainties, data gaps, confounding factors

Step 4) Risk Characterization (continued)



- Principles of a Good Risk Assessment
  - Transparency
  - Clarity
  - Consistency
  - Reasonableness

Application of ERA Process to Microplastics in the Potomac

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- Select an assessment endpoint
- Select microplastic type
- Analyze potential ecological linkages

Thank You!