Problem Formulation: Endpoints and Conceptual Models for Assessing and Managing Risks from Resuspension

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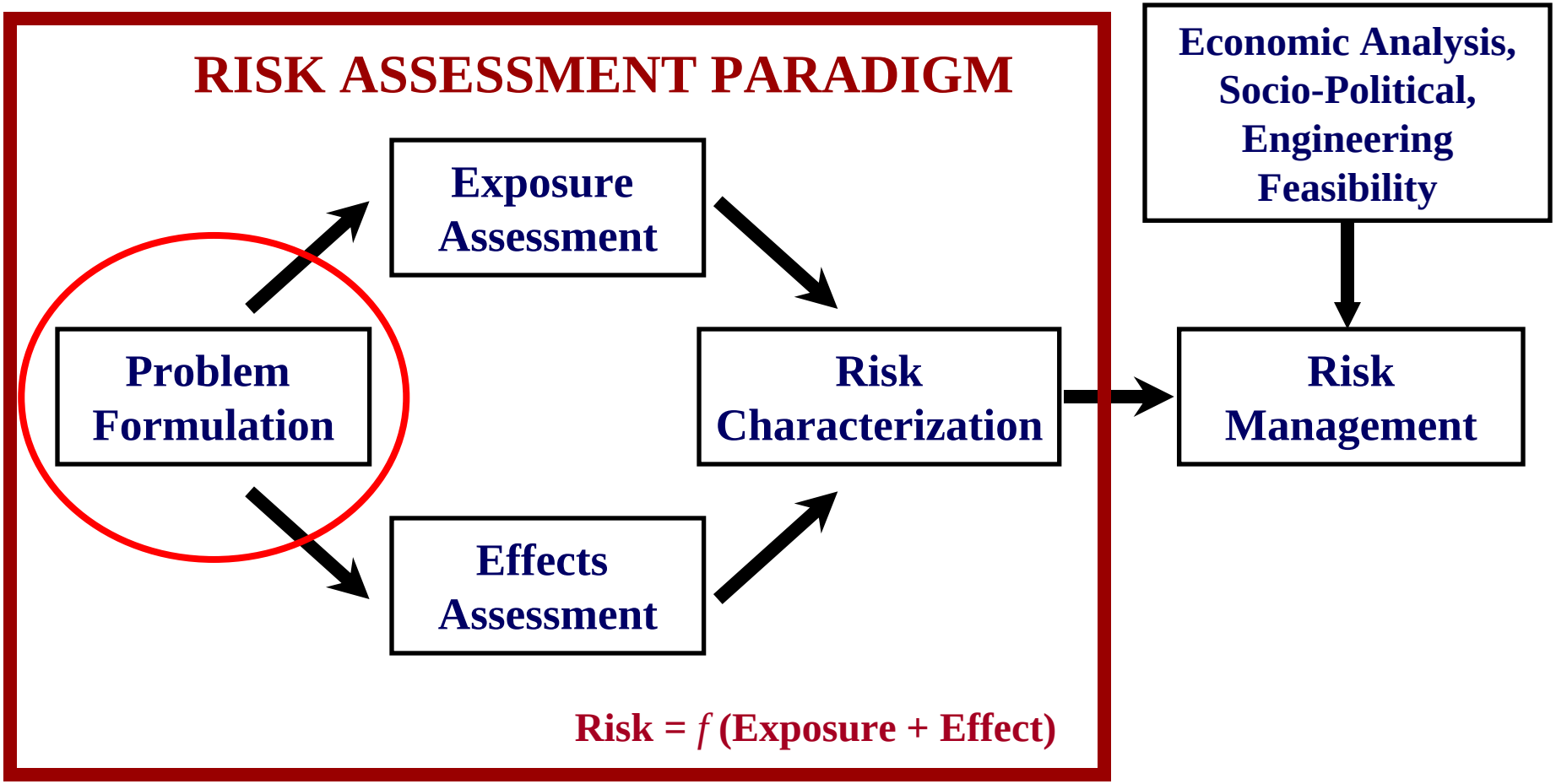
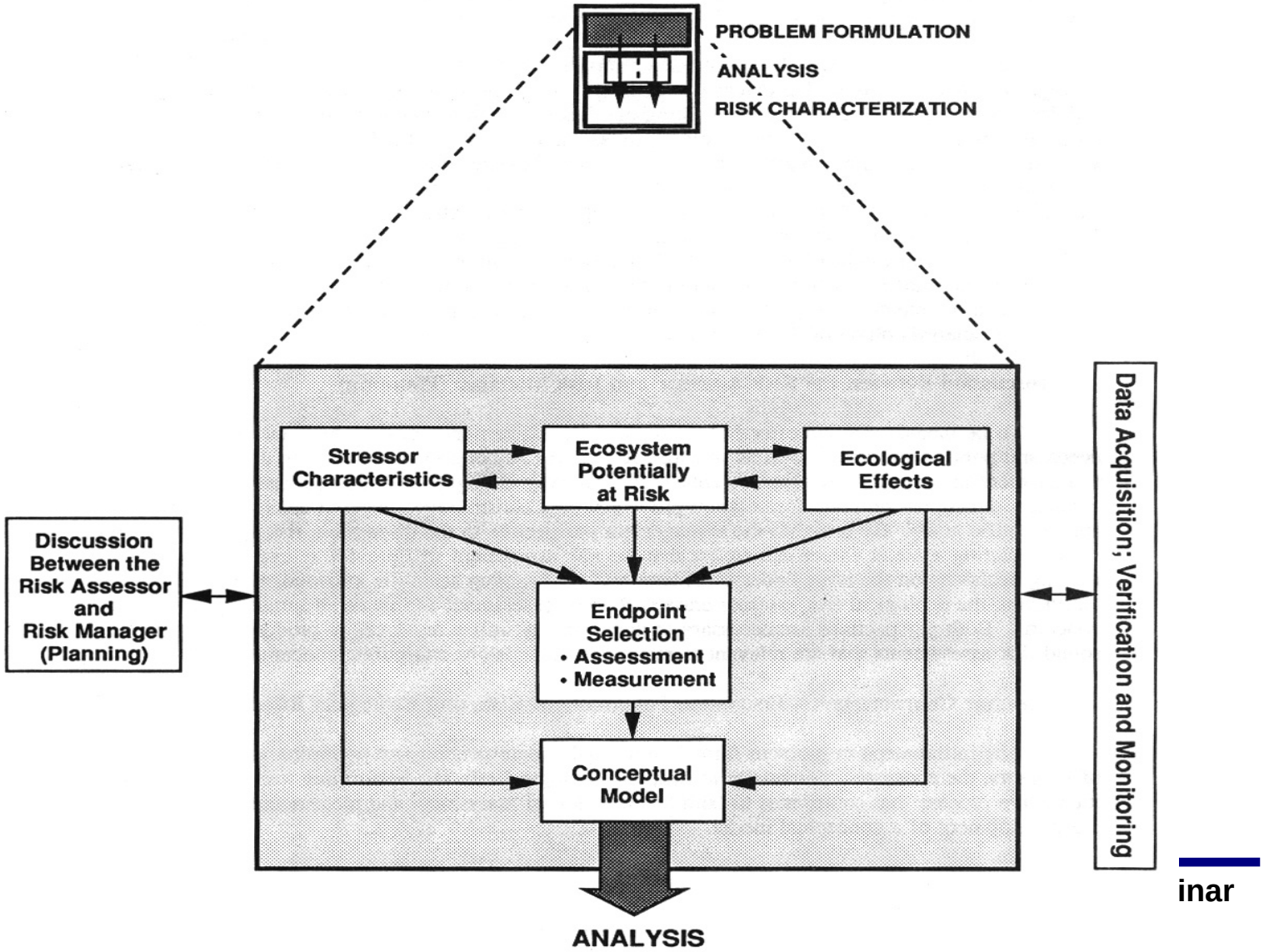
Objectives

- Overview of problem formulation
- Overview of conceptual models

Risk Assessment Overview



Problem Formulation Overview



Problem Formulation Goal

The goal is to define the ecological relationships to be evaluated, then plan how to evaluate them. Any deficiencies in problem formulation will compromise all subsequent work on the risk assessment.

<u>Defining the problem is extremely important</u>.

What is Problem Formulation?

Components:

- **Site characterization**
  - **Document current conditions**
  - **Determine nature and extent of stressors**
- **Identify receptors and endpoints**
- **Completed exposure pathways**
  - **receptor can contact stressor**
- **Conceptual model**

Ecological Endpoints

- **Assessment Endpoints**
- **Measurement Endpoints**

Assessment Endpoint:

An explicit expression of the environmental value that is to be protected**, operationally defined by an ecological entity and its attributes (USEPA 1997)**

Criteria:

- **Ecological Relevance**
- **Societal Values**
- **Susceptibility to stressor**

What are We Trying to Protect?

- **Level of biological organization**
  - **Species, community, ecosystem**
- **Which components of ecosystem could be adversely impacted (3 groups)**
  - **Organisms living in sediment**
  - **Pelagic organisms**
  - **Consumers of aquatic life**
- **Species (lethal and sublethal endpoints such as avoidance, growth, prey capture)**

Assessment Endpoint Examples

- **Protection of winter flounder eggs from burial by resuspended sediments**
- **Protection of submerged aquatic vegetation from shading caused by dredging resuspension**
- **Protection of oysters from adverse impacts due to dredging resuspension**

Measurement Endpoint

A measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint (USEPA 1997)

Measurement endpoints are often expressed as the statistical or arithmetic summaries of the observations that comprise the measurement

Measurement Endpoints for Resuspension

Relative to assessing risk

- **Suspended solids concentration**
- **Light penetration**
- **Turbidity**
- **Sedimentation**
- **Net deposition**
- **Temp, salinity, flow speed and direction**
- **Chemical concentration in water column (dissolved and total)**

Resuspension Effects

Relative to assessing risk

- **Physical abrasion of filtering and respiratory organs**
- **Clogging of filtering and respiratory organs**
- **Smothering (e.g., eggs)**
- **Shading (e.g., SAV)**
- **Productivity**
- **Prey capture and avoidance**
- **Recognition of reproductive cues**

Conceptual Model

The conceptual model describes a series of working hypotheses of how the stressor(s) might affect ecological components (USEPA 1997)

Conceptual Model

- **Written and visual representation of predicted relationships between ecological entities and the stressors to which they may be exposed**

- **Typically consist of**
  - **Source(s)**
  - **Release mechanism(s)**
  - **Transport mechanisms**
  - **Receptors**

Resuspension Sources

Primary Sources

- **Dredge and attendant vessel movement**
- **Dredge-head movements**
- **Overflow**
- **Fall back of loosened sediments not captured**
- **Washing (e.g., sloughing of sediment from bucket)**
- **Silt curtain debris removal and management**

Secondary Sources

- **Prop wash from dredge, tugs and other attendant vessels**
- **Spuds**
- **Anchors**

Contaminant Release Mechanisms

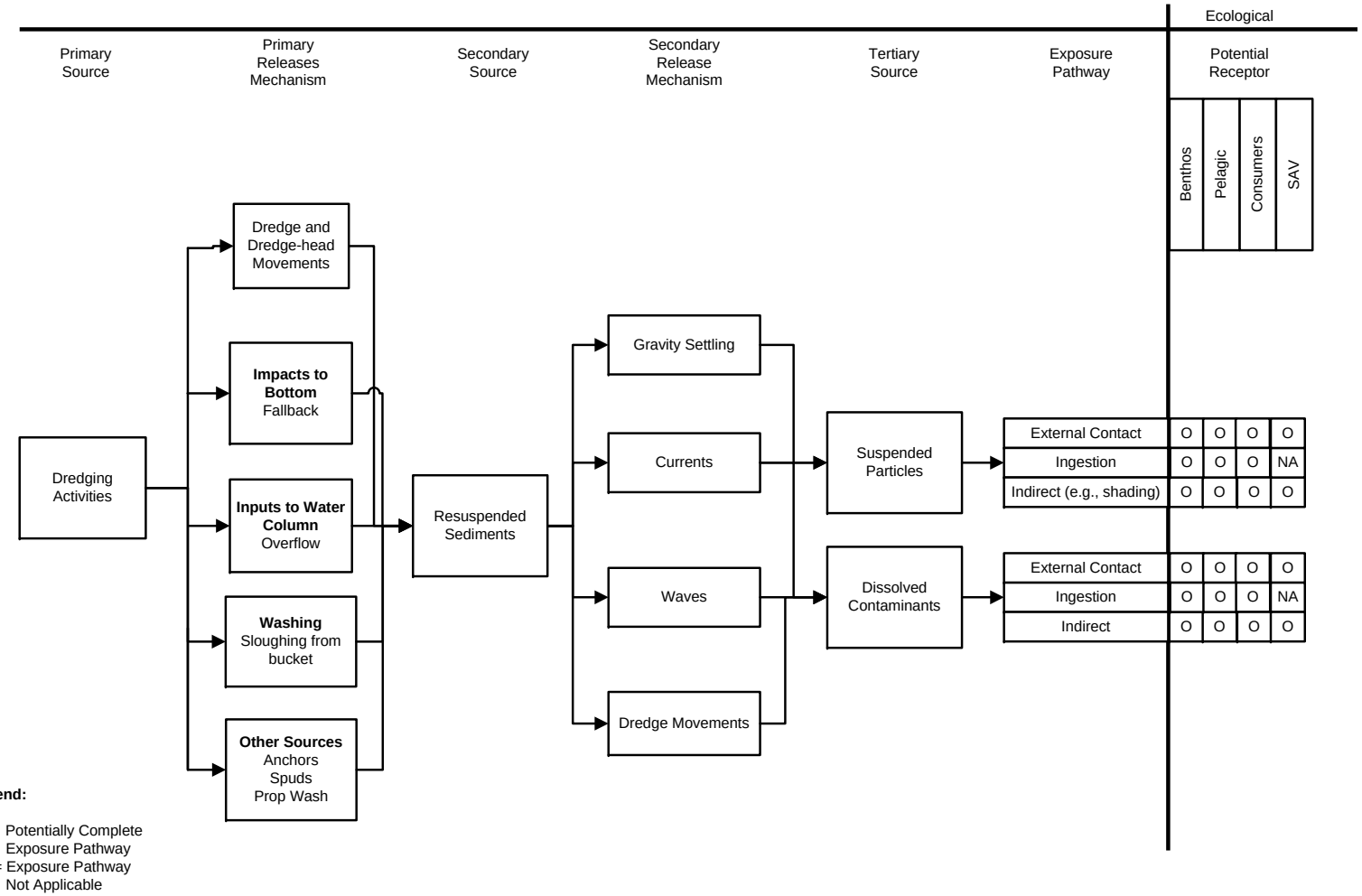
- Desorption from suspended particles
- Sediment pore water expulsion
- Volatilization to air
- Particulate, colloidal, dissolved, volatile fractions
- Residuals
  - Densification of high solids concentration layer
  - Molecular diffusion
  - Advection of groundwater
  - Bioturbation

Resuspended Sediment Transport Mechanisms

- Transport (and Exposure) varies by zone:
  - Initial mixing (minutes)
  - Near field (up to 1 hr)
  - Far field (hours)
- Movements from dredging operations
- Gravity settling/deposition
- Currents
- Waves
- Exposure as a series of repetitive pulses

Conceptual Model for Resuspended Sediments

Conceptual Model for Sediments Resuspended as a Result of Dredging Operations – Physical Stressors

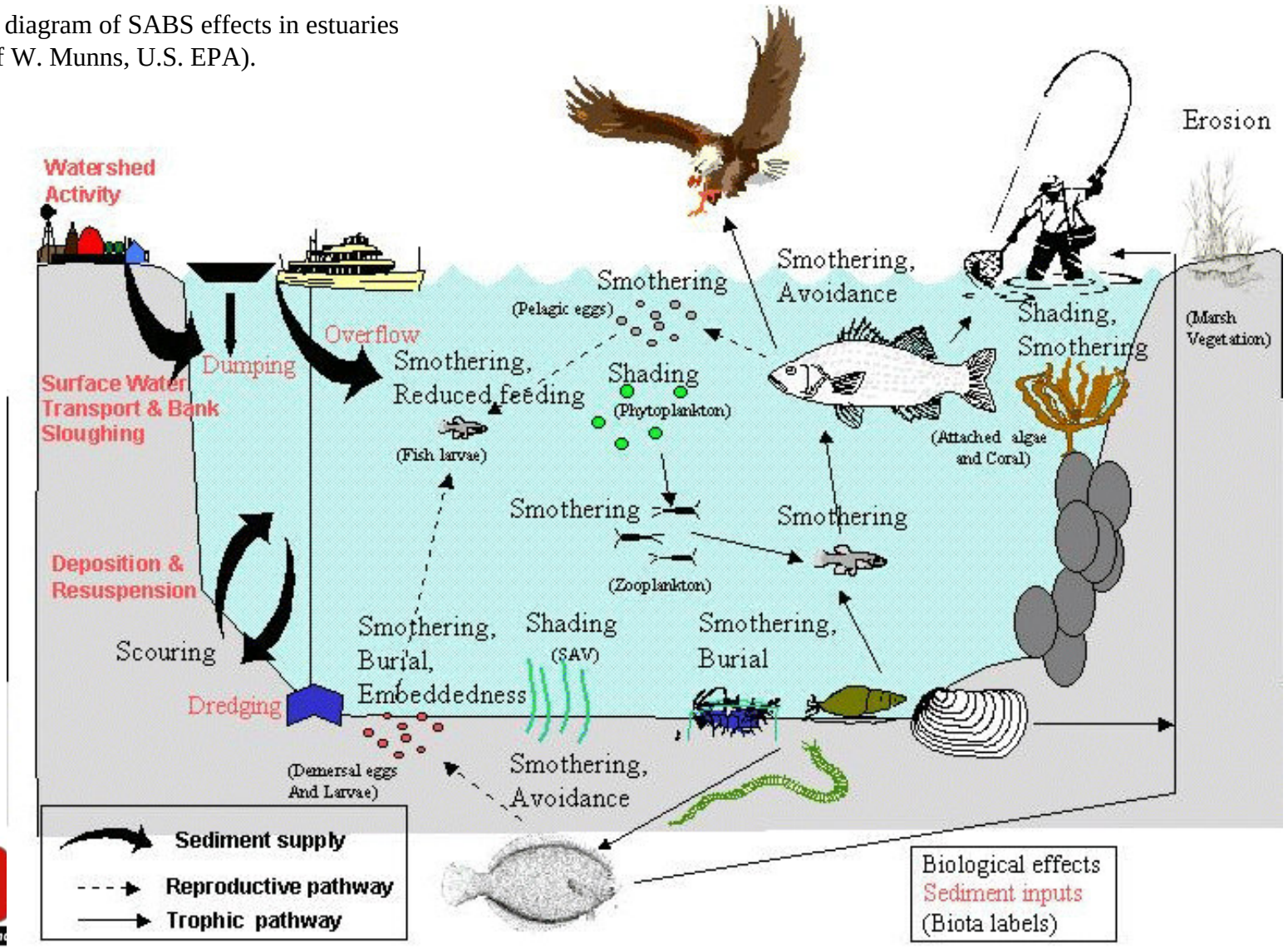


Legend:

O = Potentially Complete Exposure Pathway
NA = Exposure Pathway Not Applicable

Example Conceptual Model Diagram

Conceptual diagram of SABS effects in estuaries (courtesy of W. Munns, U.S. EPA).



Hypothetical Example

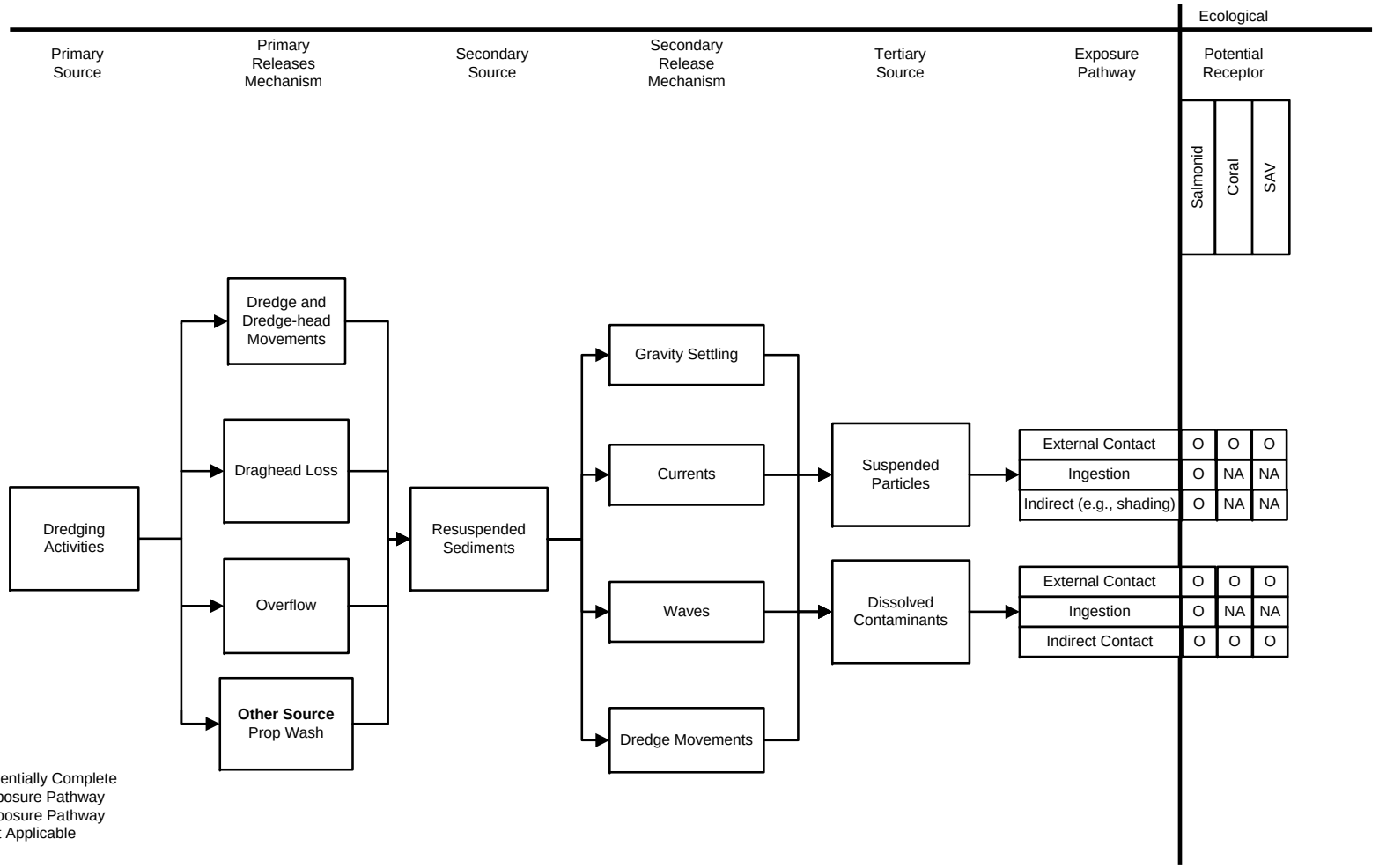
Problem Formulation
and
Conceptual Model

Problem Formulation

- **Problem statement**
  - **Protection of migrating salmonids, coral reefs and submerged aquatic vegetation (SAV) from adverse effects of resuspended sediments caused by dredging operations**
- **Receptors and endpoints related to suspension**
  - **Juvenile salmonids migrating downstream (physical abrasion, clogging of gills, plume avoidance)**
  - **Coral reefs (smothering, shading)**
  - **SAV (smothering, shading)**
- **Completed exposure pathways**
  - **Salmonid pathway complete via potential abrasion of gills**
  - **Coral reef pathway complete via smothering**
  - **SAV pathway complete via smothering**
- **Develop conceptual model**
  - **Hopper dredge with and without overflow scenarios**

Conceptual Model – Hypothetical Example

Conceptual Model for Sediments Resuspended as a Result of Dredging Operations – Physical Stressors for Hypothetical Hopper Dredge Example



Take Home Message

- **Defining the problem is extremely important**
- **Stressors can be physical, not just chemical**
- **Successful conceptual model development critical to defining and understanding problem**
- **Leads to appropriate level of evaluation**