



# ***Ecological Risk Assessment***

Office of Pesticide Programs  
U. S. Environmental Protection  
Agency



# *What is an Ecological Risk Assessment?*

- Evaluates risk to wildlife, aquatic organisms and plants, including Federally threatened and endangered species.
- Based on
  - peer reviewed methods and models
  - best available scientific and commercial data





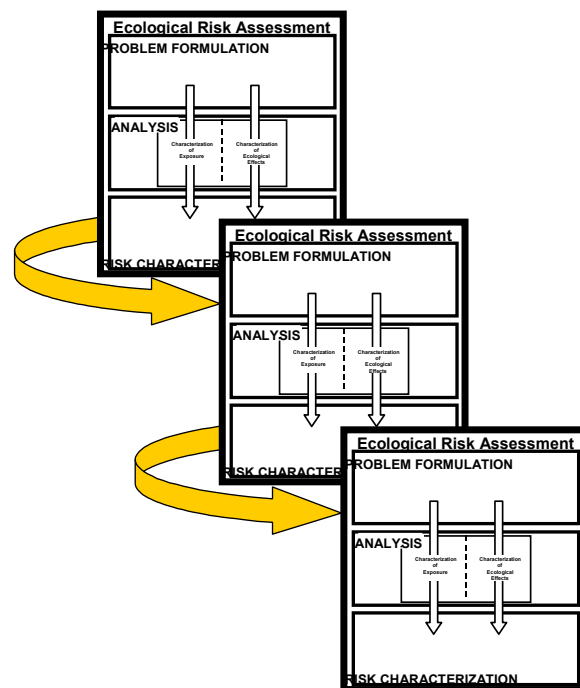
# Overview of Assessment Process

- “Overview Document”: Describes the scientific processes used for EPA pesticide risk assessment
  - [www.epa.gov/oppfead1/endanger/consultation/ecorisk-overview.pdf](http://www.epa.gov/oppfead1/endanger/consultation/ecorisk-overview.pdf)
- EPA’s “Guidelines for Ecological Risk Assessment” and “Risk Characterization Handbook”
  - [www.epa.gov/ncea/ecorsk.htm](http://www.epa.gov/ncea/ecorsk.htm)



# *Tiered Assessment Process and Risk Management Decisions*

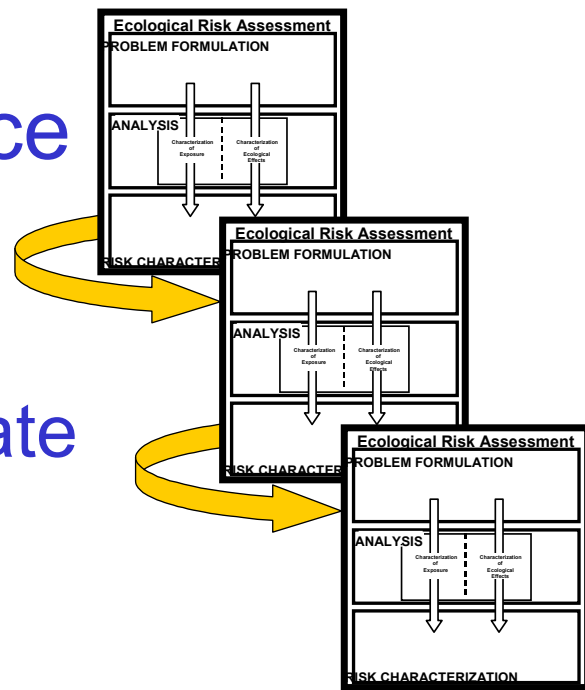
- **Baseline Assessment**
  - Low spatial and temporal resolution
  - General assessment endpoints
  - Deterministic (risk quotient)
  - Points toward refinements



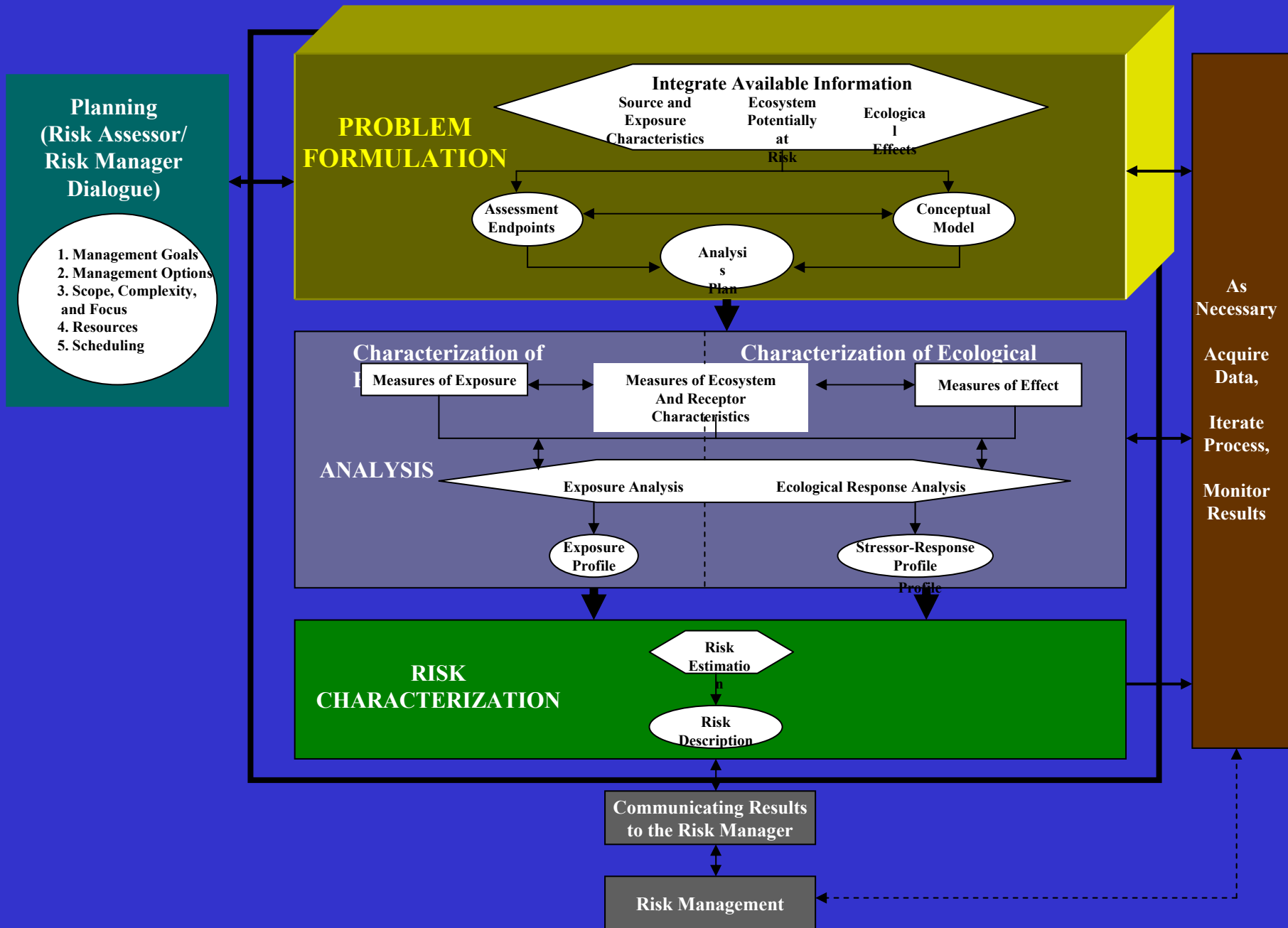


# Tiered Assessment Process and Risk Management Decisions

- Refinements and lines-of-evidence
  - Site-specific resolution
  - Species/habitat-specific endpoints
  - Use all the available data to generate exposure and species-sensitivity distributions.
  - Probabilistic tools and methods address magnitude and likelihood of risk with a measure of uncertainty



# FRAMEWORK FOR ECOLOGICAL RISK ASSESSMENT





# ***Components of an Ecological Risk Assessment: Problem Formulation***

- Provides foundation for the assessment
- Articulates purpose of the assessment
- Defines the problem and data gaps
- Proposes the conceptual model
- Develops a plan for analyzing the risk
  - Management goals
  - Resources
  - Scope, complexity, and focus of the assessment



# ***Problem Formulation: Source & Exposure Characteristics***

- Defines the federal action
- The product labels, and in some cases use information, define:
  - Potential use sites (*i.e.* specific crops and representative locations)
  - Maximum and, if available, typical use rates
  - Minimum and, if available, typical application intervals
  - Allowable application methods, *etc.*





# ***Problem Formulation:***

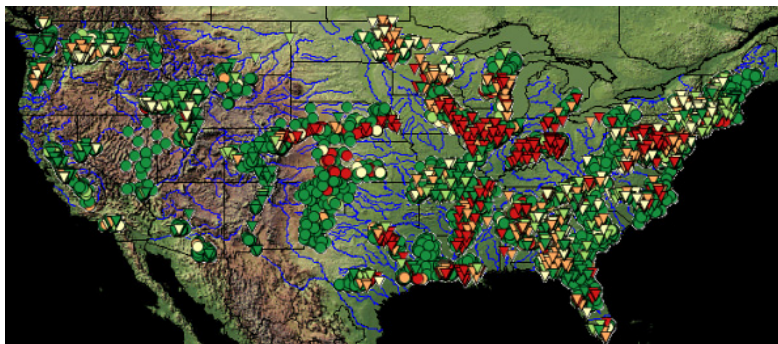
## ***Part 158 – Exposure Information***

- Hydrolysis
- Photodegradation
- Aerobic Soil Metabolism
- Anaerobic Soil Metabolism
- Aerobic/Anaerobic Aquatic Metabolism
- Leaching-Adsorption/Desorption
- Laboratory Volatility
- Accumulation in Fish
- Field Volatility
- Field Dissipation
- Bioaccumulation in Aquatic Non-Target Organisms



## ***Problem Formulation: Open Literature- Exposure***

- Physical-chemical properties
- Degradation and metabolism
- Fate and transport properties
- Controlled field studies address fate and transport
- Monitoring data (e.g., USGS, State programs)





# ***Problem Formulation: Part 158 – Acute and Chronic Effects Information***

Tests required to evaluate effects on non-target (surrogate) organisms are arranged in a hierarchical or tiered system progressing from laboratory to field studies.

## **Terrestrial wildlife**

- Terrestrial plants
- Birds
- Terrestrial insects
- Mammals

## **Aquatic Wildlife**

- Aquatic plants
- Aquatic invertebrates
- Fish



# ***Problem Formulation: Eco-toxicity Data and Endpoints***

Birds (includes reptiles and terrestrial-phase amphibians)	Avian acute oral Avian sub-acute dietary Avian reproduction	71-1 71-2 71-4	LD50 LC50 NOAEC/LOAEC
mammals	Rat acute oral Rat 2-generation reproduction	81-1 83-4	LD50 NOAEC/LOAEC
freshwater fish (includes aquatic-phase amphibians)	Freshwater Fish Fish Early Life and Aquatic Invertebrate Life Cycle Fish Full Life Cycle Study	72-1 72-4 72-5	LC50 NOAEC/LOAEC NOAEC/LOAEC
freshwater invertebrates	Freshwater Invertebrate	72-2	EC50
estuarine/marine fish	Estuarine/marine Fish	72-3	LC50
estuarine/marine invertebrates	Estuarine/marine Invertebrate	72-3	LC50
aquatic and terrestrial plants	Tier 1 Seedling emergence Tier 1 Vegetative vigor Tier 1 Aquatic plant growth Tier 2 (same studies)	122-1a 122-1b 122-2	EC25/EC50/NOEC/IC50
terrestrial insects	Honeybee acute contact Toxicity residues on foliage Field Pollinator Study	141-1 141-2 141-5	LC50 LC50 LC50



# ***Problem Formulation: Open Literature Effects Data– ECOTOX***

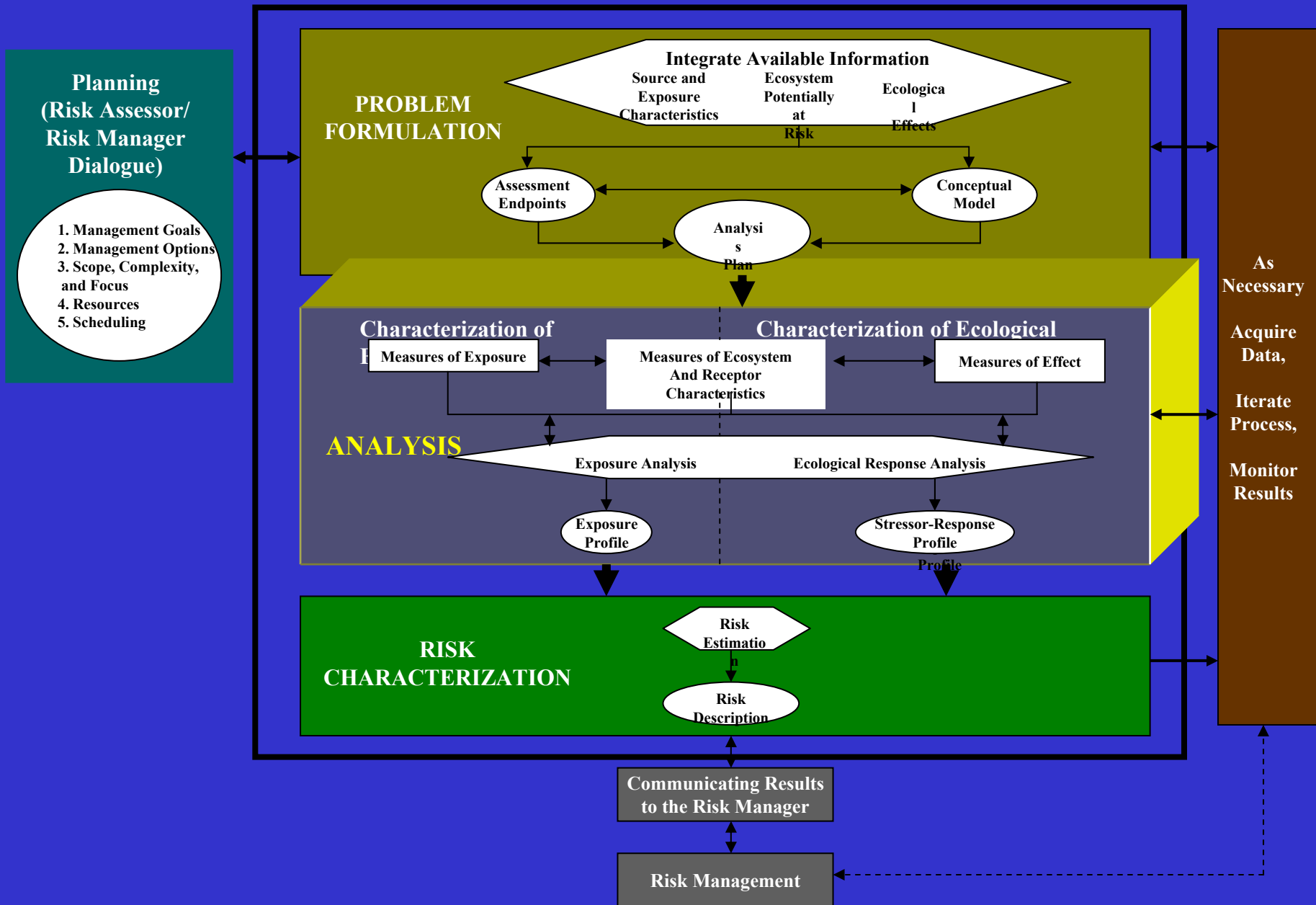
- Developed and maintained by USEPA/ORD ([www.epa.gov/ecotox/](http://www.epa.gov/ecotox/))
- Has the capability to locate publicly available toxicity data for aquatic and terrestrial organisms
- Composed of single chemical data (laboratory and field studies) from peer-reviewed literature, Federal agencies, labs, and the international community
- OPP has issued guidance outlining evaluation criteria to ensure the best available data are used



# ***Problem Formulation: Assessment Endpoints***

- Valued entity (receptor)
- Attribute or characteristic that is important to protect and is potentially at risk
- Ecologically relevant
- Susceptible to potential stressor (pesticide)
- Relevant to management goals

# FRAMEWORK FOR ECOLOGICAL RISK ASSESSMENT





# ***Components of an Ecological Risk Assessment: Analysis***

- Critical review of exposure and effects data
  - Data requirements
  - Public literature
- Effects and Exposure characterizations
  - Toxicity endpoints
  - Exposure Modeling
  - Field data/monitoring

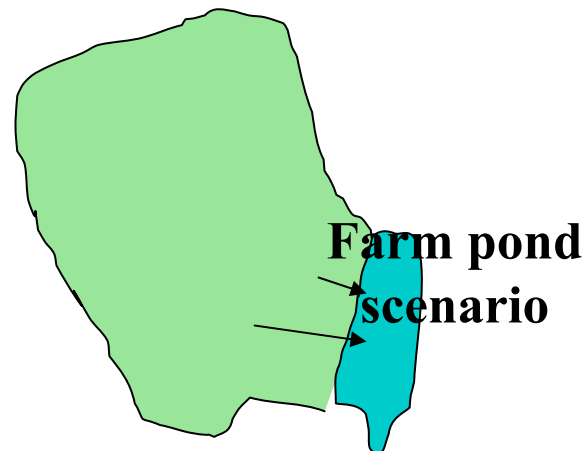




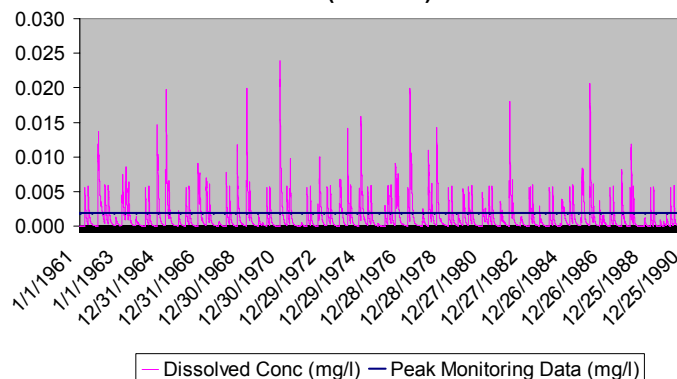
# ***Analysis:***

## ***Characterizing Aquatic Exposure***

- Computer simulation models estimate exposure by calculating estimated environmental concentrations
- Models used to evaluate runoff and spray drift
- Rationale for selection of model scenarios is documented
- Water monitoring data may also be considered, if available



**California Vegetable Scenario PRZM/EXAMS vs. Peak Concentration Detected in all Monitoring Data (NAWQA)**





# ***Analysis:***

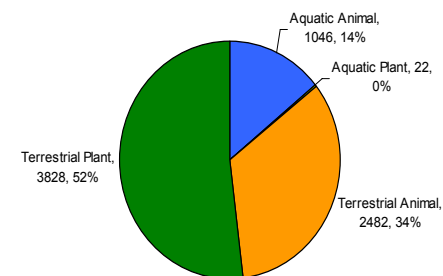
## ***Characterizing Terrestrial Exposure***

- Standard approved model (TREX) used to estimate potential exposures to terrestrial animals (birds, mammals, insects)
- Estimates of pesticide residues on wildlife food items are based on the Kenaga monogram (Hoerger and Kenaga, 1972; Fletcher et al., 1994) adjusted by application rate and depend on:
  - the food item (fruits, seeds, etc)
  - wildlife diet (herbivores, insectivores, granivores).
  - size class (13, 35, 1000 grams)
- Includes field studies, if available



# Characterizing Effects-- Incidents

- Incident data are used in risk assessments to provide evidence that risk predictions are supported by actual effects in the field
- Reported incidents likely represent a small fraction of actual incidents that occur...
  - An absence of evidence cannot be used as evidence of absence
  - Information in the database cannot be used to quantify the level of risk





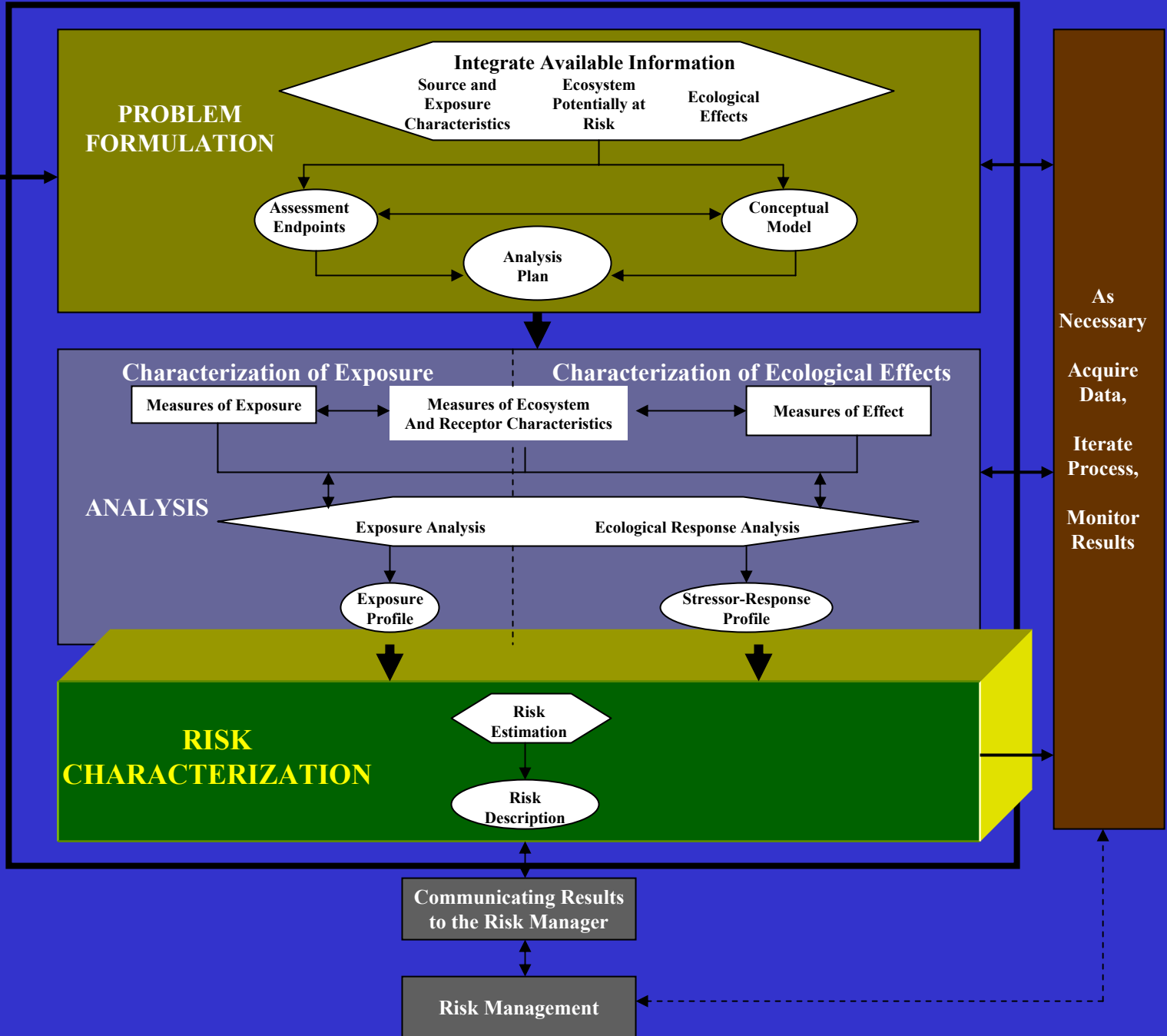
# ***Characterizing Effects***

- **Evaluates pesticide levels observed in controlled studies, which cause mortality and reproductive/ developmental effects**
- **Describes the direct and indirect effects a pesticide might have on organisms**
- **Includes the following characteristics:**
  - **Affected entities**
  - **Nature and intensity of effects**
  - **Recovery**
  - **Causality**
  - **Relation to assessment endpoints**
  - **Uncertainty**

# FRAMEWORK FOR ECOLOGICAL RISK ASSESSMENT

**Planning  
(Risk Assessor/  
Risk Manager  
Dialogue)**

1. Management Goals
2. Management Options
3. Scope, Complexity, and Focus
4. Resources
5. Scheduling





# ***Components of an Ecological Risk Assessment: Risk Characterization***

- Final step in the risk assessment process
- Integrates and synthesizes effects and exposure characterizations into an overall conclusion (risk estimation)
  - $RQ = \text{exposure/toxicity}$ . Compared to “level of concern”
  - Magnitude and likelihood of effect
- Description of assumptions, limitations, and uncertainties
- Is complete, informative, and useful for decision makers



# ***Risk Estimation: Direct Acute and Chronic Effects***

## **Acute Effects RQ (fish and invertebrates):**

1-in-10 Year Peak Water Concentration = RQ

most sensitive organism LC50 or EC50

## **Chronic Exposure RQ (invertebrate):**

1-in-10 Year 21-day Average Water Concentration = RQ

aquatic invertebrate chronic toxicity NOEC

## **Chronic Exposure RQ (fish):**

1-in-10 Year 56-day or 60-day Average Concentration =RQ

fish early life stage or full life cycle toxicity NOEC



# ***Risk Characterization: Risk Description***

- Integrate:
  - Information on where the pesticide is used
  - Local use practices
  - Biological requirements and habits of species
  - Geographic features that influence exposure
  - Incident information
  - Monitoring data



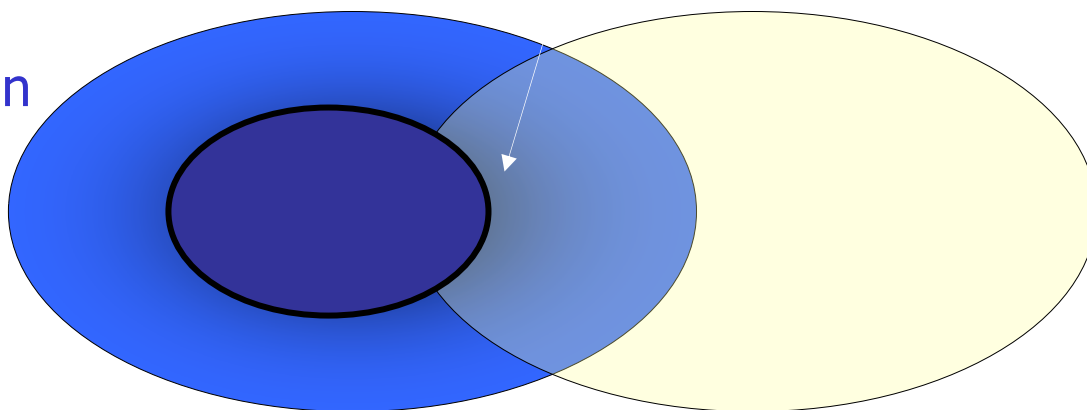


# *Risk Characterization: Risk Description*

Iterative Process –  
Increasingly Spatially and Temporally Explicit  
Assessments

Area exceeding level of concern

Stressor  
distribution



Receptor  
range



# ***Surrogacy Assumptions***

- Toxicity testing does not include all species of birds, mammals, or aquatic organisms.
- Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States.



# Surrogacy Assumptions

Birds (includes reptiles and terrestrial-phase amphibians)	Acute and sub-acute	<ul style="list-style-type: none"> <li>•upland game bird (bobwhite quail),</li> <li>• a waterfowl (mallard duck),</li> <li>•a songbird (zebra finch)</li> </ul>
mammals	acute	<ul style="list-style-type: none"> <li>•Norway rat</li> <li>•House mouse</li> </ul>
freshwater fish (includes aquatic-phase amphibians)	acute	<ul style="list-style-type: none"> <li>•warm water (bluegill sunfish)</li> <li>•cold water (rainbow trout)</li> </ul>
freshwater invertebrates	acute	<ul style="list-style-type: none"> <li>•water flea</li> </ul>
estuarine/marine fish	acute	<ul style="list-style-type: none"> <li>•Sheepshead minnow</li> </ul>
estuarine/marine invertebrates	acute	<ul style="list-style-type: none"> <li>•Crustacean (mysid shrimp)</li> <li>•Mollusk (eastern oyster)</li> </ul>
aquatic plants	acute	<ul style="list-style-type: none"> <li>•Green algae (one species)</li> <li>•Blue green algae (one species)</li> <li>•Vascular plant (duckweed)</li> <li>•Freshwater diatom</li> <li>•Marine diatom</li> </ul>
terrestrial plant	acute	<ul style="list-style-type: none"> <li>•Monocotyledonous (4 species)</li> <li>•Dicotyledonous (6 species)</li> </ul>



## ***Uncertainties***

- Are surrogate species reasonable representatives?
- Do mortality, reproduction and growth represent a reasonable range of effects on which to gauge ecological impacts?
- Can laboratory effects be readily extrapolated to field effects?



## *Uncertainties*

- Toxicity studies are typically conducted on technical grade active ingredient (TGAI). Formulated end-products may be more or less toxic than TGAI.
- Mixtures not evaluated at this time (methods under development)



# ***Risk Management Decision Framework***

