Tradeoffs in Sediment Management Workshop

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AGENDA

• Introduction	• 30 min
• Unit 1 - Study vs. action	• 30 min
• Break	• 10 min!!
• Unit 2 - Technology limitations vs. risk based goals	• 30 min
• Unit 3 - Short-term impacts vs. long-term risk reduction	• 30 min
• Break	• 10 min!!
• Unit 4 - Cost vs. degree of protection	• 25 min
• Unit 5 - Finality vs. long-term management	• 25 min
• Conclusions	• 10 min

Objectives and Methods

- The workshop will use group discussions
  - Looking for extensive class participation
- The focus will be on sediment site project management and decision-making
  - How to manage complexities and uncertainties to move a project forward
  - How to use site-specific information to make balanced response decisions
  - How tradeoffs can inform/support project decisions
- The issues are complex
  - No right or wrong opinions

Introduction

EPA's Program Expectations

- National Contingency Plan
  - Broad, risk-based framework
  - EPA balances remedy selection between two opposing views
    - Full restoration → cost not a concern
    - Protect by controlling exposure → cost important
- 11-Principles policy for contaminated sediments
  - Stakeholder involvement
  - Sound scientific framework
  - Decision framework → risk management goals

Risk-Based Decision Making for Sediment Sites

- EPA's programs are risk-based
  - Reducing the risks from contaminated sediment sites is EPA's goal
  - This basis may conflict with some other stakeholder expectations
  - These conflicting objectives increase the difficulty of decision-making and can stall progress or lead to unnecessary action
- EPA does not have a presumptive remedy for contaminated sediment
  - Sediment guidance encourages combined approaches
  - Mass removal does not necessarily equate to risk reduction

Primary Goal

For Sediment Sites

Develop a conceptual site model that considers key site uncertainties and use it within an adaptive management approach to control sources and to implement a cost-effective remedy that will achieve long-term protection while minimizing short-term impacts.

Why We Face Tradeoffs in Decision Making

- Sediment sites have many uncertainties
  - Processes affecting exposure levels & risk
    - Contaminant stability in sediments
    - Internal and external sources
    - Bioavailablity
    - Scales of exposure integration
    - Natural recovery processes
  - Effectiveness of available options
    - Ability to achieve desired outcome
    - Collateral impacts

Why We Face Tradeoffs (cont.)

- There is general agreement to use “sound science” but fundamental areas where the science needs to advance
- There is a lack of information on what works, what doesn’t and why
  - Early on the learning curve for these sites
  - Cleanup work in aquatic environments can be difficult
- How best to apply the NCP balancing criteria is not clear
  - Sediment guidance discusses the nine criteria

Why We Face Tradeoffs (cont.)

- Sediment site cleanups can be very costly
- There are often widely differing views on what is “best” for the site
  - Remedial goals
  - Basis and objectives of the response
  - Individual biases
- There is sometimes a culture of risk avoidance in decision-making
  - Difficulty in dealing with uncertainties
  - Fear of “failure”

Tradeoffs are Not Always Necessary

- Tradeoffs at contaminated sediment sites may not be necessary or useful when:
  - Stakeholders agree on the course of action
    - Science is clear and/or outcome is reasonably certain
  - There are no choices of management options
  - The cost of assessing and resolving tradeoffs is high relative to the cost of the work
- Some situations may require an immediate response

Study vs. Action

UNIT 1

Study vs. Action

- Tradeoffs are made when extensive study is occurring vs. implementation of action
- Basic needs:
  - Valid conceptual site model
  - Good understanding of remedial options and likely outcomes
- Questions to ask in balancing approaches:
  - How much information is needed?
  - What is the best way to obtain it?
  - Can approaches be combined for better outcome?

Why Studies Take a Long Time

- Sites are often large
  - Scale of studies → spatial and temporal
  - Costs of investigations
- Sites are often complex
  - Inadequate conceptual site model
  - Unclear DQOs
  - Difficulties in interpreting data
- Sources are sometimes difficult to identify and/or control
- Methods/expectations can change over time
  - Need to deal with older information

Contaminant Stability in Sediments

- Studies at sediment sites often evaluate sediment stability
  - Erosion and deposition rates
- The key question is <u>unacceptable</u> contaminant mobility, not sediment stability, per se
  - Transformation and movement of contaminants
- These are important analyses to evaluate MNR, capping, and behavior of dredge residuals
  - Disruption from natural and human causes
  - Empirical field methods
  - Modeling if appropriate

Contaminant Stability (cont.)

- Remedial actions often consider sediment stability under the long-term effectiveness and permanence criterion
  - Need to focus on contaminant risk
- RPMs need to balance:
  - Systems are often variable in degree of sediment stability AND degree of contaminant stability
    - Contaminants in sediments are often in depositional areas
  - Uncertainties of contaminant stability vs. uncertainties of remedial outcome
  - Ability to monitor and mitigate potential stability loss and impact on risk outcome

Balancing Study and Action

- Develop a sound conceptual site model
- Use a weight of evidence approach
- Use a phased approach
- Apply a consistent standard of review to information developed
  - Balanced treatment of all available data

Phased Approach

- A phased approach is consistent with CERCLA and the NCP
  - Superfund typically conducts work in phases
    - Operable units
    - Interim remedies
    - Removal actions
    - Pilot studies
- A phased approach can:
  - Allow progress and develop information concurrently
  - Provide information to support future decisions
- Adaptive Management is an approach that might be useful at complex sites

What is Adaptive Management?

- Learning by doing
  - Involves careful **<u>implementation</u>** of a plan of action
  - It actively compares policies and practices
  - Future decisions incorporate results/outcome
  - Negative or unexpected outcomes are not deemed “failures” → they are managed
- Structured approach to:
  - Address uncertainty
  - Make decisions in the face of uncertainty
  - Improve decisions in an iterative manner by acquiring knowledge to reduce uncertainty

UNIT 1 - Study vs. Action

- Examples of less effective balance of tradeoffs
  - Studies conducted without being designed to answer a fundamental site question
  - Study for decades with limited or no progress towards risk reduction
  - Rushed decisions made without sound science
    - Political, community, or other pressures
- Examples of effective balance of tradeoffs
  - A truly phased approach
    - Combine site progress with ability to get quality data
    - Information from first steps influences later steps

UNIT 1 – Hypothetical Problem

- Freshwater river
  - 20 miles long
  - 200 - 1000 ft. wide
  - About 10,000,000 CY of sediment
  - River net depositional
    - Some areas with no deposition
    - Sediment thickness 0 - 10 ft.
- DDT is contaminant of concern
  - Fish bioaccumulation drives risk
  - Fish advisory is in place - “eat none”
- Source - an industrial facility along river
  - Some plant cleanup is needed - surface soil and groundwater
- EPA costs - approximately $10,000,000 to date
  - A viable PRP is not performing work

UNIT 1 – Hypothetical Problem (cont.)

- Initial characterization was 15 years ago
  - Sediment transects every 1/3 - 1/2 mile
    - One or two samples per transect (100 total)
    - Samples taken over entire sediment depth or top 3 ft. (whichever less)
  - Fish composite samples at three locations
- Main RI work was 10 years ago
  - Sediment samples – mostly biased sampling in "hotter" areas
    - Cores - sediments generally more contaminated with depth (150 locations, 500 samples)
  - Some additional transects with "surface" samples of top 6 inches
    - Nine transects, 3 samples per transect
  - Limited floodplain sampling (one composite at 25 locations)
  - Water column sampling - center channel every 1/2 mile
  - Fish composite samples at five locations

UNIT 1 – Hypothetical Problem (cont.)

- Additional work in the last 5 years
  - Limited confirmation of RI data
    - Focus on 4-mile stretch near plant and "hot spots"
      - Some "hot spots" contain consistent levels of DDT and sediment volume, some have significantly different values
      - 4-mile stretch is the most contaminated
      - Fish tissue levels remain essentially the same
    - Detection limits lower than previous work
    - A 25-year flood occurred since the main RI
  - FS being drafted
    - Alternatives address entire site
    - Includes extensive modeling of alternatives
      - Uses remedy effectiveness assumptions from other sites
    - Remedy costs range from $10 million (MNR) to $750 million

UNIT 1 - Questions for the Groups

- How should the older and newer data be used?
  - What might the consistent fish data indicate?
  - How should we evaluate the inconsistent sediment data in the latest sampling?
- What are the best possible next steps for the case study?
  - If a ROD is a targeted commitment, how does this factor into our evaluation?
- If a phased approach is considered:
  - What might be a good next phase?
  - What are the pros/cons to a phased approach?

Technology Limitations vs. Risk Based Goals

UNIT 2

Risk Based Goals

- Goals for sediment cleanups are site-specific
  - Consistent with EPA's Superfund approach
  - Can result in apparent differences between sites
  - Should be expressed as a range of values
    - NCP balancing criteria need to be considered before setting final cleanup levels
- Goals have not always been transparent
- Goals have been set based on:
  - Sediment concentration
    - Total
    - Surface
  - Sediment mass
    - Mass removal does not necessarily equate to risk reduction
  - Fish tissue concentration

Risk Based Goals (cont.)

- Sediment concentration goals often based on expected resulting biological concentrations
  - Need to link sediment goals to risk endpoint
- Different areas of a site may have different exposure potential
  - Remedial goals should reflect this
- Baseline ecological risk assessment approaches are becoming more standard
  - However, there are many complexities around setting ecological goals
- Superfund goals can conflict with other goals
  - Not natural resource restoration goals
  - Can sometimes conflict with health agencies' fish consumption advisory approach

Technology Limitations

- Goals at some sites may not be attainable with any technology
  - Site conditions affect outcome
  - Technology effectiveness has often been assumed
- A comprehensive review of technology effectiveness and risk reduction at completed sites is lacking
  - Analysis tends to be anecdotal
  - Analysis does not always focus on key risk objectives
  - There is a strong vested interest to declare “success”
- Technology limitations should be considered when establishing site-specific cleanup goals

Each Technology has Limitations that Affect Risk Outcomes

- Dredging
  - Dredge material management
  - Residuals
  - Resuspension
  - Disruption of ecosystem
- Capping
  - Leaves contaminants in place
    - Risk of future releases if cap not maintained or if contaminants move through cap in significant amounts
  - Disruption of ecosystem
- MNR
  - Leaves contaminants in place
  - Time to reach remediation goals
    - Longer reliance on institutional controls

UNIT 2 - Technology Limitations vs. Risk Based Goals

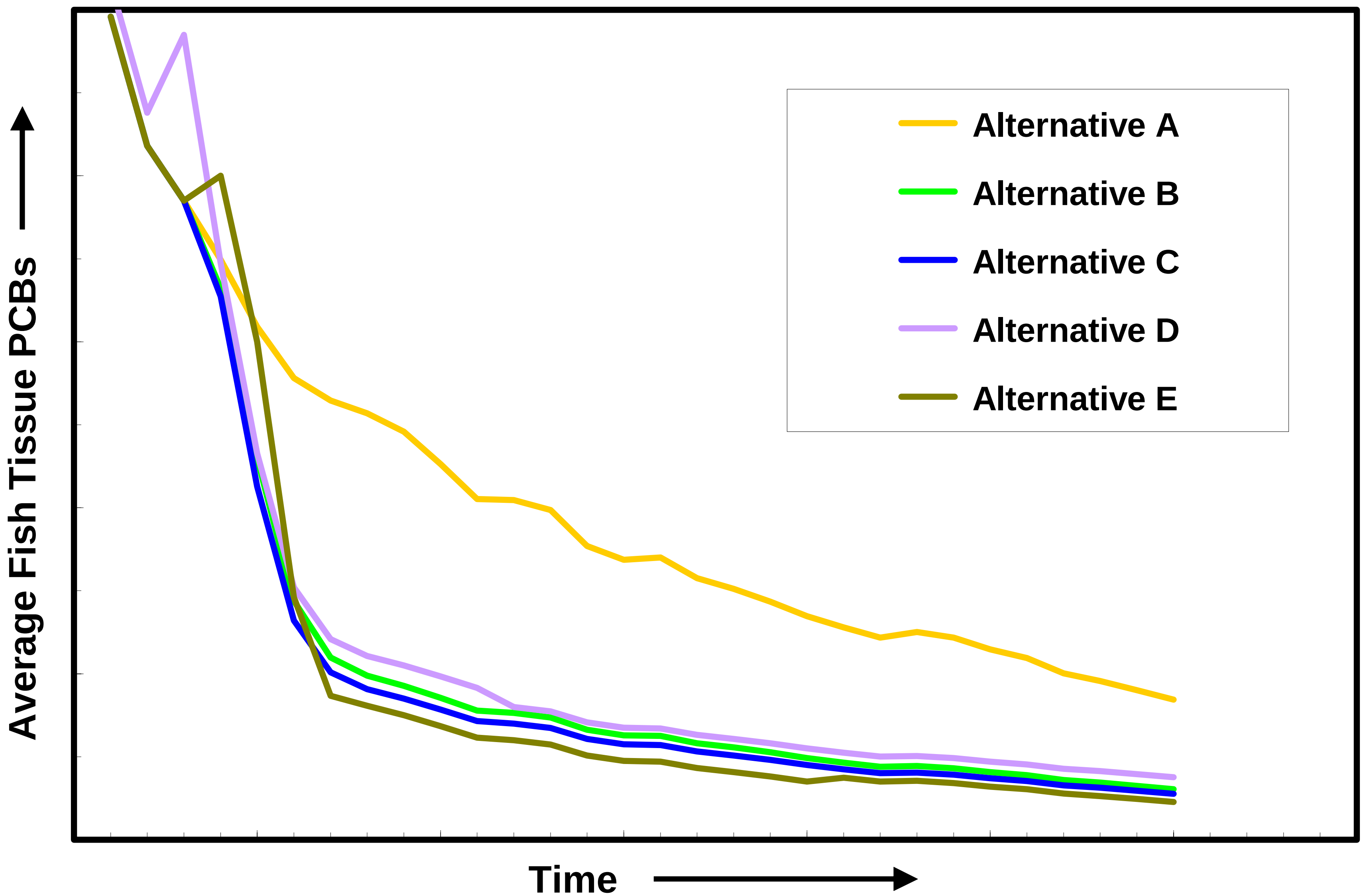
- Examples of less effective balance of tradeoffs
  - Unsupported assumptions of what technologies can do leading to remedies that don't reduce risk
  - Site goals that are unclear, unrealistic, or not based on risk reduction
  - Failure to measure remedy performance
- Examples of effective balance of tradeoffs
  - Establishment of key risk-based parameters and measurement of the trends over time
    - Focus on system-wide performance
  - Use of pilots or other studies to establish realistic, site-specific technology expectations

UNIT 2 – Hypothetical Problem

- Freshwater river
  - 4 miles long
  - ~ 300 ft. wide
  - ~ 1,000,000 CY of sediment
- Net depositional system
  - Average sediment depth - 2 ft.
  - Average deposition rate - 1 cm/yr
  - Average scour during 100 year flood - 0.1 cm
- PCBs are the contaminant of concern
  - Sources are controlled
  - Fish bioaccumulation drives risk
    - Trends indicate levels are declining
  - PCBs at surface - average 10 ppm
  - PCBs at depth - average 250 ppm
  - Contaminated sediment sits on bedrock

UNIT 2 – Hypothetical Problem (cont.)

- Five remedial alternatives developed
  - Alternative A - MNR
  - Alternative B - Cap > 5 ppm
  - Alternative C - Cap > 1 ppm
  - Alternative D - Dredge > 3 ppm
  - Alternative E - Dredge “hot spots” and cap entire river
- Modeling conducted to predict fish concentrations over time
  - No alternative meets EPA’s PRG
- Model assumes:
  - Dredging occurs in one season
    - Resuspension rates low
    - Residuals below 1 ppm
  - Capping is 90% effective
  - MNR uses 0.1 cm/yr deposition rate


Average Fish Tissue PCBs
Time
Alternative A
Alternative B
Alternative C
Alternative D
Alternative E

UNIT 2 - Questions for the Groups

- What might each remedial technology achieve at the hypothetical site?
- Given the projected fish tissue levels, how would EPA distinguish between the alternatives in meeting risk goals?
  - How should we reflect uncertainties?
  - How would we defend our selection?
  - Consider the reasonableness of the model assumptions and the effect on remedy expectations
- If dredging is selected and the residuals are similar or higher than current surface values, what will be done?
  - If capping/backfill is needed, should capping be selected as the remedy of choice?

Short-term Impacts vs. Long-term Risk Reduction

UNIT 3

Short-term Impacts

- All active remedies will have short-term impacts
  - Risks may be manageable, but should be understood
- What may seem to be a short-term impact might have longer-term consequences at large sites
- EPA's short/long-term effectiveness criteria better fit sites with a short construction period
  - Large sediment sites often involve lengthy cleanup
  - Effects may occur over many years
  - Effects may occur in different places in the system

“Short-term” Impacts - Ecosystems

- Both dredging and capping will affect the existing ecosystem
  - Removal or damage of the benthos and aquatic vegetation
  - Changes to fish habitat and feeding structure
- Often the recovery of the ecosystem has been assumed, in terms of both when and if
- System recovery should be assessed
  - How long will it take the system to recover?
  - Will there be permanent unacceptable changes to the ecosystem?
- Can remedies mitigate these effects?
  - “Enhanced natural recovery”
  - Cap designs with habitat features

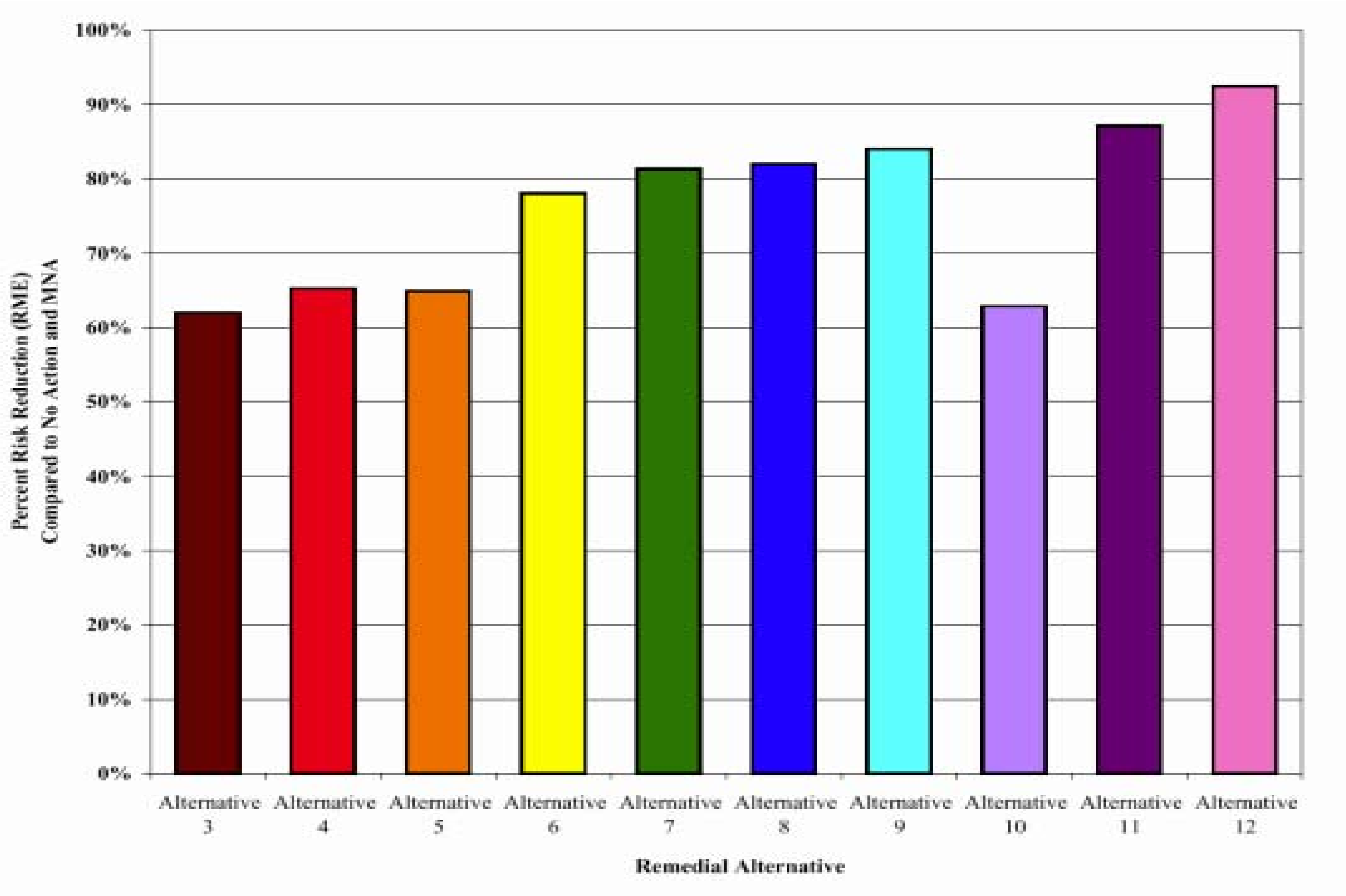
Long-term Risk Reduction

- All remedial options will have risk tradeoffs
  - Risks should be assessed against no action
  - Some options may transfer the risk
- Future risk scenarios are based on predictions
  - All predictions have uncertainties
  - Expected future risk depends on assumptions about remedy effectiveness
- EPA has not standardized an approach for assessing post-remedy future risks
- Role of permanence
  - Relates to the potential for long-term risk
  - Does not necessarily equate to mass removal

Comparing Future Risks

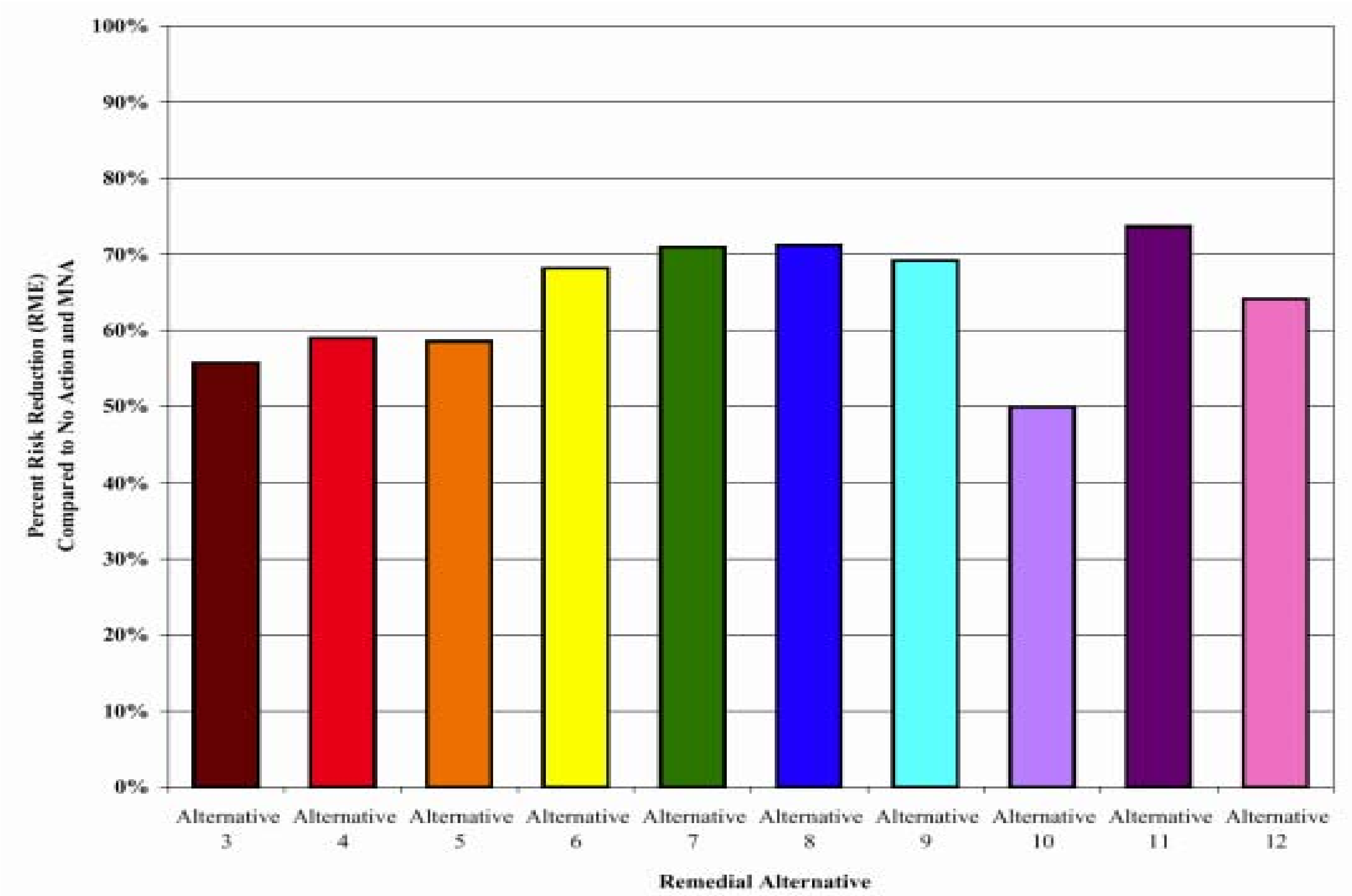
- At some sites EPA has compared future risks to the no action alternative
  - Reported as the percent of risk reduced
- Example: The next two charts illustrate the differences in comparative risk when “short-term” effects are included in the analysis
  - First figure looks at an RME fish ingestion scenario starting when the remedy is complete
  - Second figure looks at an RME scenario including the time period during construction
  - Including the “short-term” effects changes the comparative risk
    - Especially when the construction period is long
      - Focus on Alt 12
    - Different remedy effectiveness assumptions change the comparative risk profile as well

Predicted Long Term Risk Reduction for Fish Ingestion Compared to No Action



Calculations start after remedy is complete – include 30 yr exposure period

Predicted Combined Short and Long Term Risk Reduction for Fish Ingestion Compared to No Action



Calculations start at remedy construction – include 30 yr exposure period

Comparative Net Risk Evaluation (CNRE)

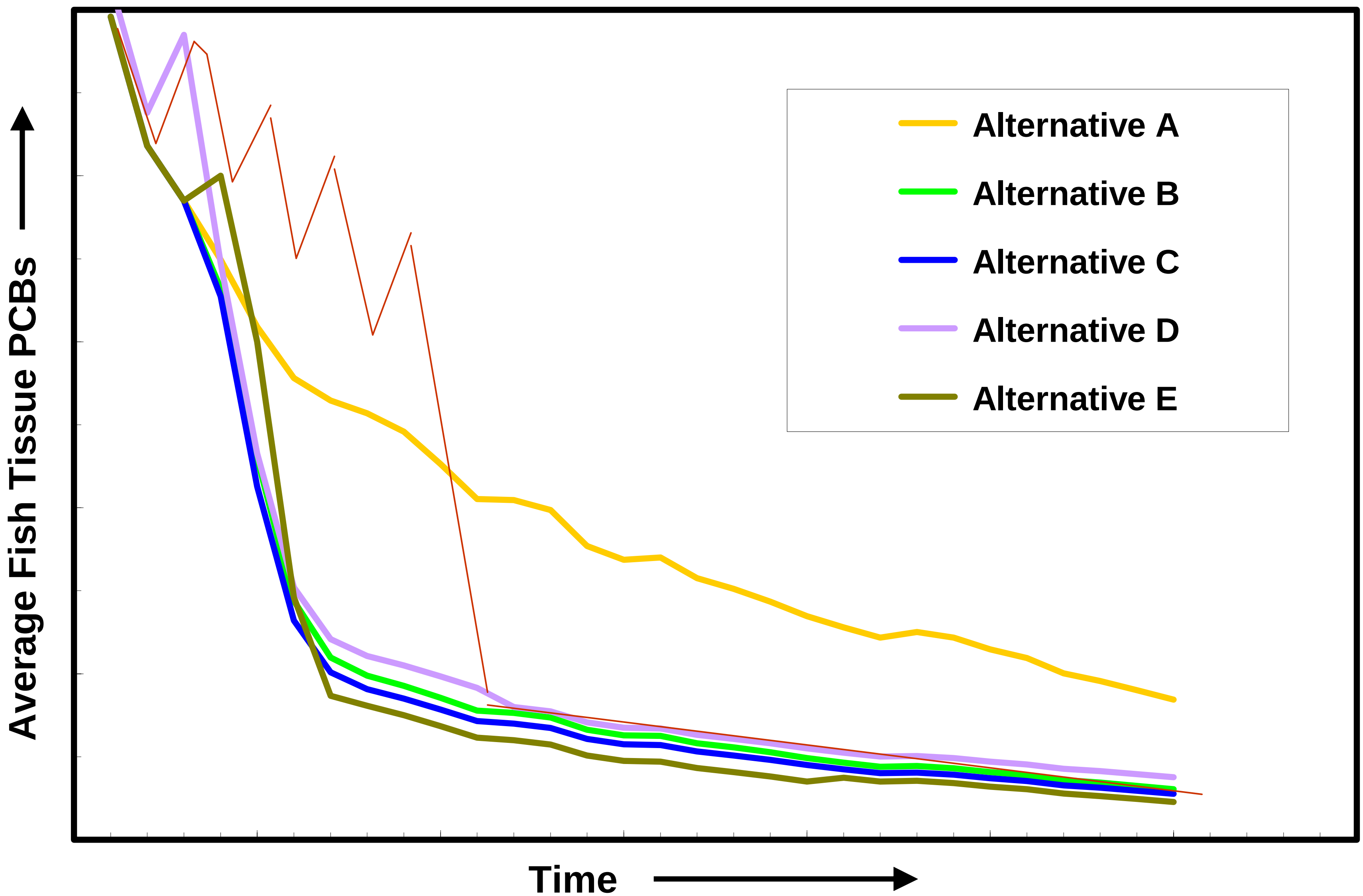
- Remedy effectiveness can be evaluated based on net risk reduction
- CNRE tries to measure the net effects of the remedial action, offset by the competing risk created
  - Considers potential for each alternative to meet remedial goals
  - Considers potential down-sides of each alternative (e.g., risk of the remedy)
- CNRE includes an evaluation of a broader array of risk than the long-term risk of sediments (or residuals)
  - Considers factors not included in EPA's baseline risk assessment
    - Releases during remedy implementation
    - Transportation or traffic accidents/spill
    - Worker injuries/fatalities

UNIT 3 - Short-term Impacts vs. Long-term Risk Reduction

- Examples of less effective balance of tradeoffs
  - Remedial response that causes harm
  - Failure to account for short term impacts can skew remedy evaluation
  - Failure to recognize that “short-term” effects may continue for years at large sites
- Examples of effective balance of tradeoffs
  - Use a “worst first” phased approach
  - Manageable short-term effects and real long-term risk reduction
  - Use of reasonable construction corrective action triggers to help control short-term effects

UNIT 3 – Hypothetical Problem

- Same case as Unit 2, except:
- Based on stakeholder feedback an additional alternative has been developed
  - Dredge > 1 ppm
  - An endangered fish spawns in the site thus causing the dredge work to require multiple seasons
    - The ecological risk assessment indicates that the endangered species is not currently at risk from the PCBs


Alternative A
Alternative B
Alternative C
Alternative D
Alternative E
Average Fish Tissue PCBs
Time

UNIT 3 - Questions for the Groups

- What collateral effects could be expected from each remedy?
- What are "acceptable" short-term impacts?
- How should we evaluate long-term risk reduction?
  - Timeframe for performance?
  - How to consider catastrophic events?
  - For dredging alternatives, how should we consider risk transfer?
- How do we include the endangered species in our evaluation?
  - Would the answer be different if the species only migrated through the area?

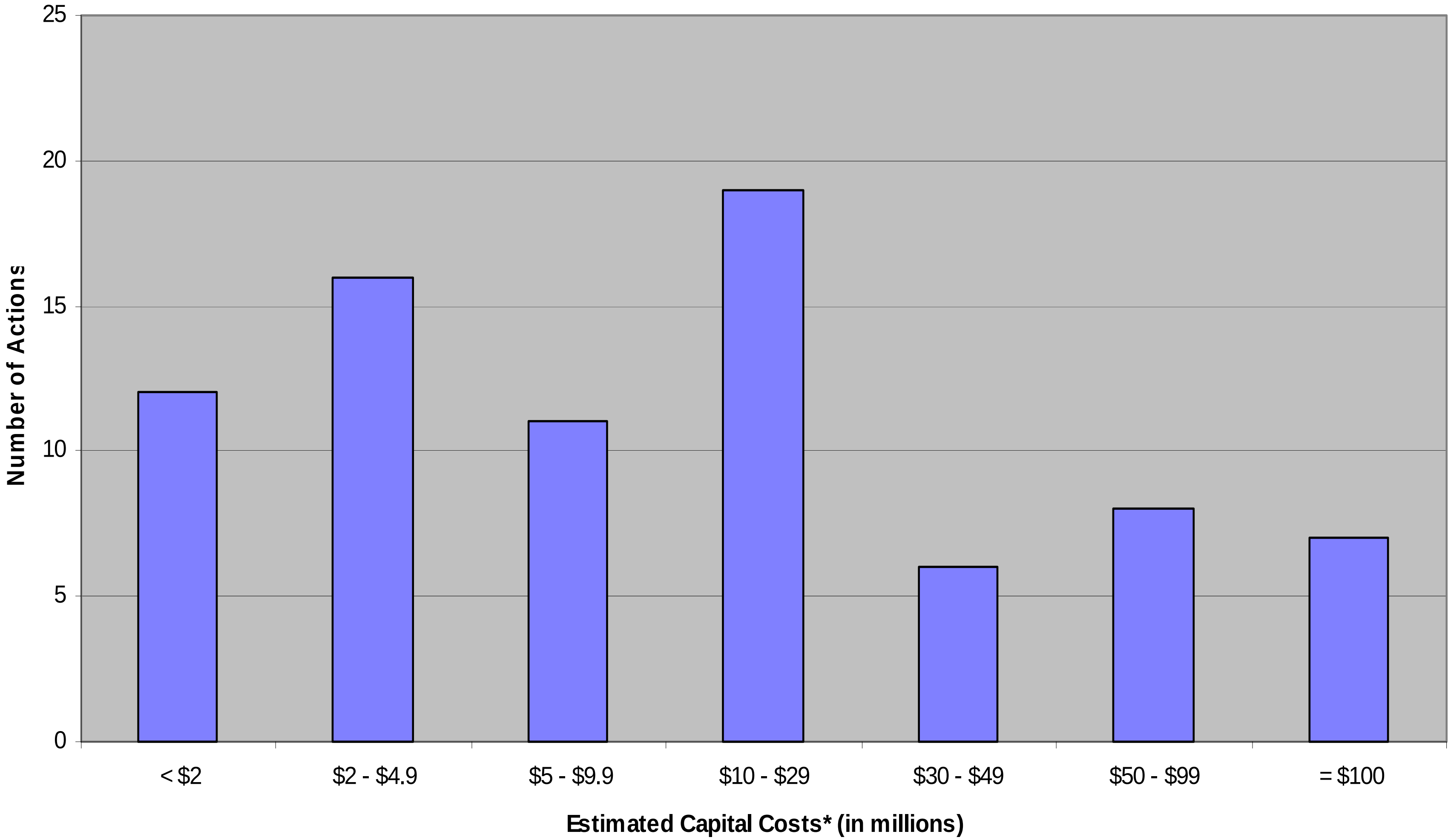
Cost vs. Degree of Protection

UNIT 4

Sediment Site Costs

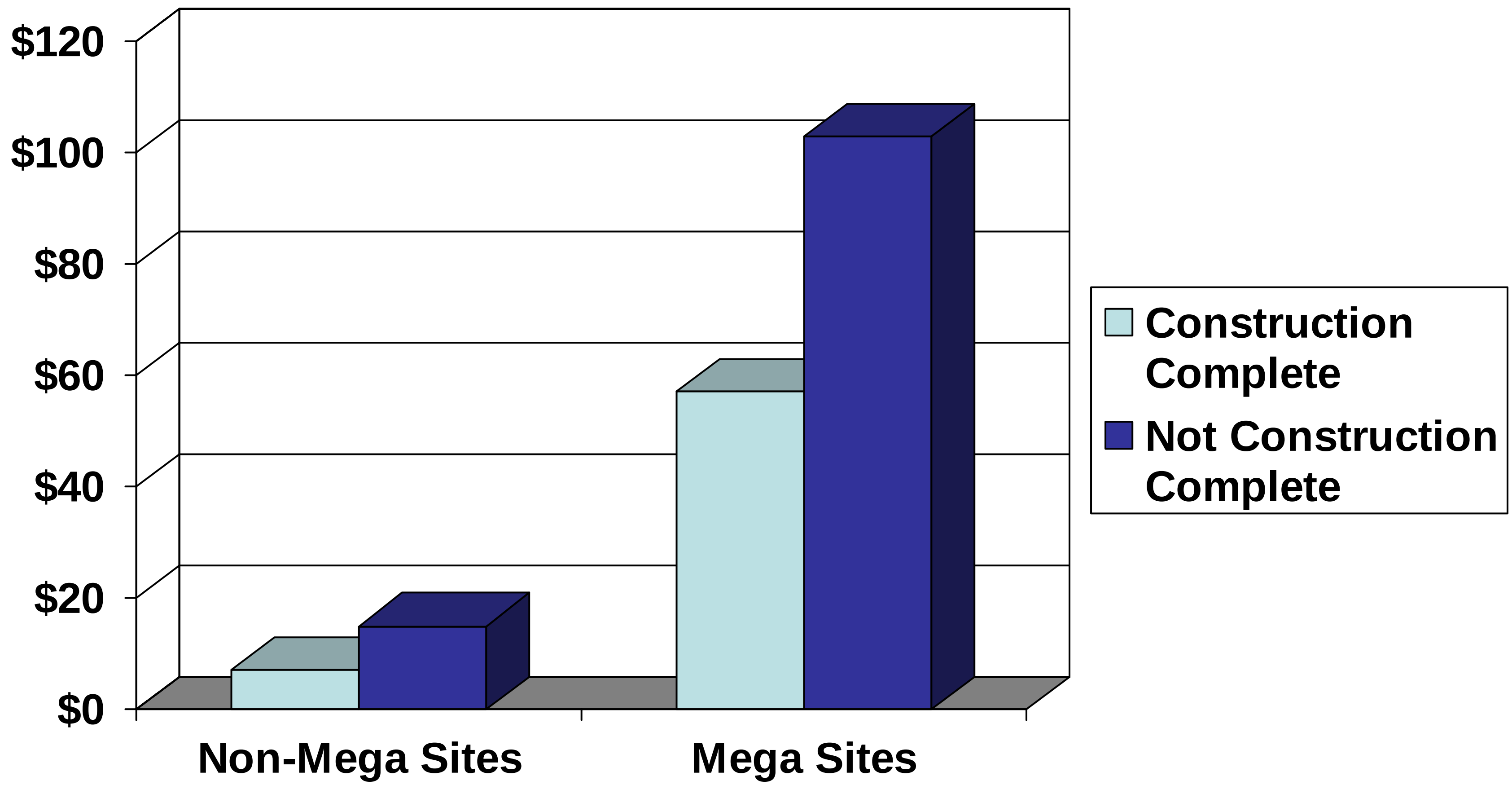
- Sediment site investigations can be costly
- Sediment remediation costs can be significant
  - Driven by the size of the project and technology chosen
    - Dredging is often the most costly option
  - Need to consider realistic costs:
    - Schedule – work season, ecological event restrictions
    - Materials and water management – volumes, production rates, processing rates, disposal and/or discharge
    - Monitoring costs – construction and post-construction
    - Transportation costs
    - New infrastructure costs – capital, siting, restoration costs of disturbed non-Superfund site properties

Estimated Capital Costs of Sediment Site Cleanup Actions*



*** When estimated capital costs were not available, present worth costs were used instead.**

Cost Of Fund-Lead NPL Sites



Modified from EPA’s 120-Day Study

Sediment Remedy Costs

- Sediment site cost evaluations should include the common cost elements
  - Capital
  - O&M
  - Net present value
- When costs are very uncertain, this should be evaluated and reflected
  - e.g., disposal costs for large volumes
- Superfund vs. natural resource costs
  - Should not include potential natural resource damage claims or restoration credits
  - May include costs for mitigation of habitat lost or impaired by the remedial action

Role of Cost in Decision Making

- CERCLA requires that a determination be made that a remedy is cost-effective
  - Remedy provides effectiveness proportional to its cost
- EPA position → cost only considered when selecting among protective alternatives
  - If all remedies are equally protective, EPA will select the least expensive
  - When all factors are not equal, EPA will use the balancing criteria including cost
  - EPA will not always select the most protective option, regardless of cost
  - In comparing alternatives, examine incremental cost differences in relation to incremental differences in effectiveness
    - Does the option have a reasonable value for the money?

Cost vs. Degree of Protection

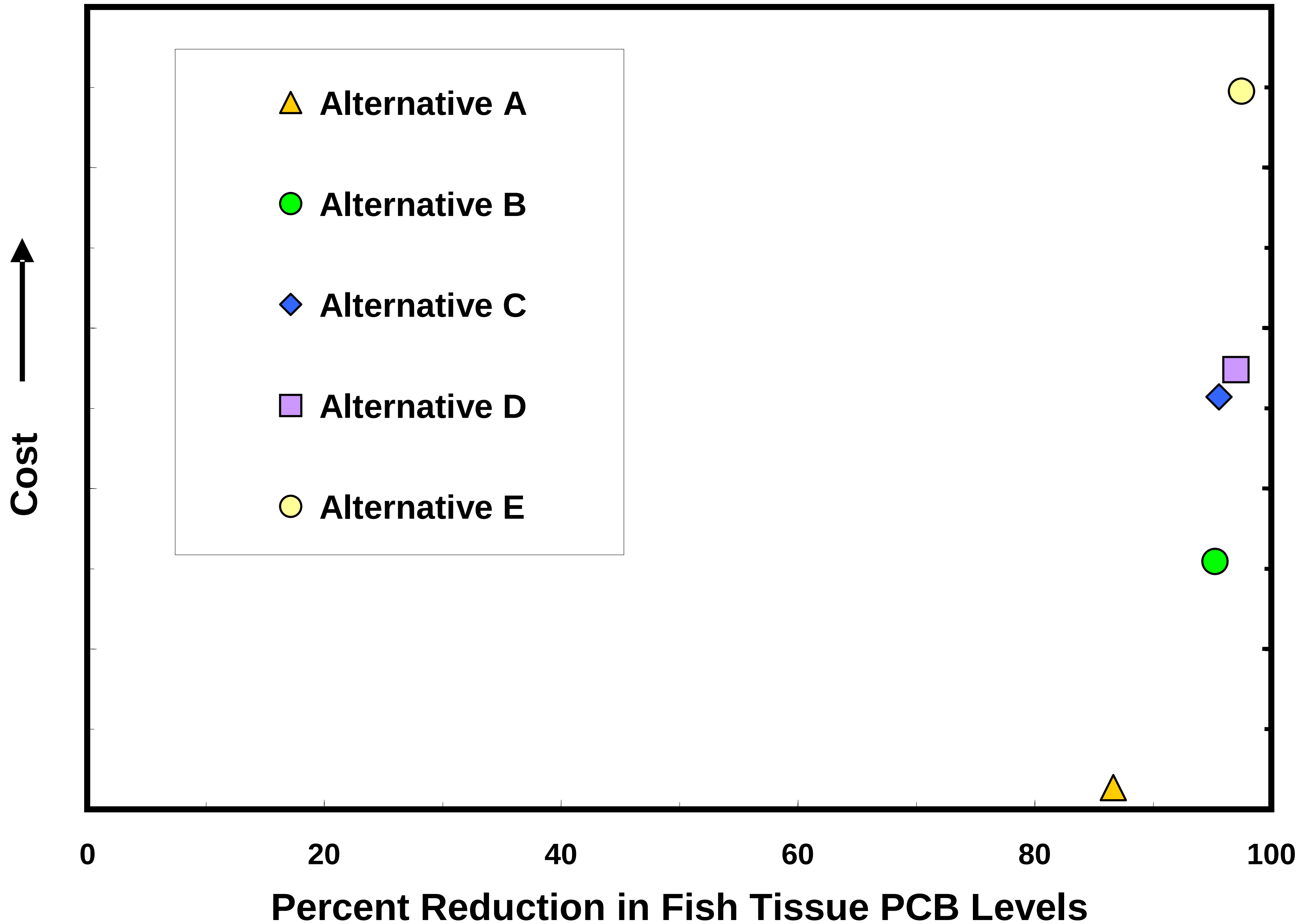
- Because sediment sites can be very costly, it is important to consider “What is reasonable to pay for cleanup relative to the magnitude of the actual risk?”
  - In view of the degree of uncertainty with remedial outcomes
  - In view of the degree of uncertainty in assessing current and expected future risks
- There may be very large cost differences between remedies for apparently similar expected outcomes
  - Need to consider incremental differences

UNIT 4 - Cost vs. Degree of Protection

- Examples of less effective balance of tradeoffs
  - Spend money, time, resources on remediation with limited or no risk reduction
  - Decisions that fail to prioritize resources expenditures
  - Decision that fail to consider significant cost differences for similar expected outcomes
- Examples of effective balance of tradeoffs
  - Conduct early, discreet actions that are expected to be beneficial and prioritize resources
    - Source control is fundamental
    - “Worst first”
  - Expend resources to get best bang for the buck

UNIT 4 – Hypothetical Problem

- 100 acre lake
- PCBs are the contaminant of concern
  - Fish bioaccumulation the risk driver
- Five remedial alternatives developed
  - Alternative A - MNR
  - Alternative B - Cap 40 acres
  - Alternative C - Dredge and cap 40 acres
  - Alternative D - Cap 80 acres
  - Alternative E - Dredge and cap 80 acres
- Percent reduction compares projected fish tissue levels in 20 years to levels now


Alternative A
Alternative B
Alternative C
Alternative D
Alternative E
Cost
0
20
40
60
80
100
Percent Reduction in Fish Tissue PCB Levels

UNIT 4 - Questions for the Groups

- Is it fair to expect PRPs to sign on for very costly remedies that are expected to occur in a short construction period?
  - Considering the uncertainties around:
    - What can be achieved from a risk reduction standpoint
    - Cost and consequences of various approaches
  - Considering that at some Fund-lead sites, EPA has made the decision to incrementally fund the work. This results in managed costs and work stretched out over many years.
- For the hypothetical case:
  - Since reductions in fish levels seem to be driven by the cap component, could we justify the dredging cost? (Compare B to C and D to E)
  - Could we justify the larger scale projects? (Compare B and C against D and E)

Finality vs. Long-term Management

UNIT 5

Finality vs. Long-term Management

- All parties want closure
- Characteristics of complex sediment sites can make this difficult
  - Limits of technology
  - Risk based goals
  - Costs
- Site decisions need to consider ability to meet long term management needs
  - Commitment to monitor outcomes
  - Commitment and ability to conduct additional work if needed to achieve the long-term goals

Superfund Program Expectations

- Site completion occurs when:
  - No further response required (except O&M)
  - All cleanup goals met
  - Site is deemed protective of human health and the environment
- Construction completions occur when:
  - Any necessary physical construction is complete, whether or not final cleanup levels have been achieved; or
  - The response action will be limited to measures that do not involve construction; or
  - The site qualifies for deletion from the NPL
- Five-year reviews
  - Required when hazardous substances remain on site above levels that permit unrestricted use or unlimited exposure
  - They evaluate implementation and performance of the remedy to determine if it remains protective

Role of Institutional Controls

- There are fundamental differences of opinion on the appropriateness of ICs to control risk
  - Reliability and effectiveness are concerns
- EPA recognizes that ICs may be necessary at many sediment sites for some time period
  - To supplement other response actions
  - Even when the remedy attains sediment goals
- Most common ICs include:
  - Fish consumption advisories and fish bans
  - Waterway use restrictions
  - Land use restrictions or structure maintenance agreements

Post-construction Monitoring

- Monitoring should occur to:
  - Assess compliance with design and performance standards
  - Assess short-term remedy performance and effectiveness in meeting sediment goals
  - Assess long-term remedy effectiveness in meeting RAOs and reducing risk
- Plan should conform with the ROD objectives
- Monitoring techniques
  - Physical
  - Chemical
  - Biologiocal
    - Generally the most difficult to interpret

Measuring Remediation Success

- Goal of Superfund remedies → provide cost-effective, long-term protection of human health and the environment
- Fully successful remedy:
  - Selected sediment cleanup levels were met and maintained over time
  - Risks were reduced to acceptable levels
    - Based on the anticipated future uses of the water-body and the goals and objectives in the ROD.

Measuring Remediation Success (cont.)

- Four measures to consider:
  - Short-term remedy effectiveness; i.e., have the sediment cleanup levels been achieved at the completion of dredging or capping?
  - Long-term remedy effectiveness; i.e., have the sediment cleanup levels been reached and maintained for at least five years?
  - Short-term risk reduction; e.g., have trends been observed demonstrating reductions in fish tissue levels, decreases in benthic toxicity, or increases in species diversity or other community indices after five years?
  - Long-term risk reduction; e.g, have the remediation goals in fish tissue been reached or has ecological recovery been accomplished within the predicted time frame?

UNIT 5 - Finality vs. Long-term Management

- Examples of less effective balance of tradeoffs
  - Desire for “final” decisions may influence remedy scope without adequate understanding of outcome
  - Decisions that focus on mass removal which may not attain risk-based goals
  - Lack of follow-up due to desire for finality
- Examples of effective balance of tradeoffs
  - Realistic assessment of relationship between remedial options and long term management needs
  - Realistic assessments of the management time-frame
  - Flexible phased approaches that provide for modifications based on performance

UNIT 5 – Hypothetical Problem

- 15 mile long freshwater river system
  - First 5 miles (headwaters and downstream) are contaminated
  - Flow in this stretch is highly variable
    - River is a series of runs with fast moving flow and little sediment, and wide, slow-moving depositional areas
    - In drought periods the flow is negligible in places
  - Source has been controlled
- Mercury is the contaminant of concern
  - Fish bioaccumulation is the risk driver
  - Risk is controlled by methyl-mercury (meHg), not total mercury
    - EPA meHg studies occurred during a wet period

UNIT 5 – Hypothetical Problem (cont.)

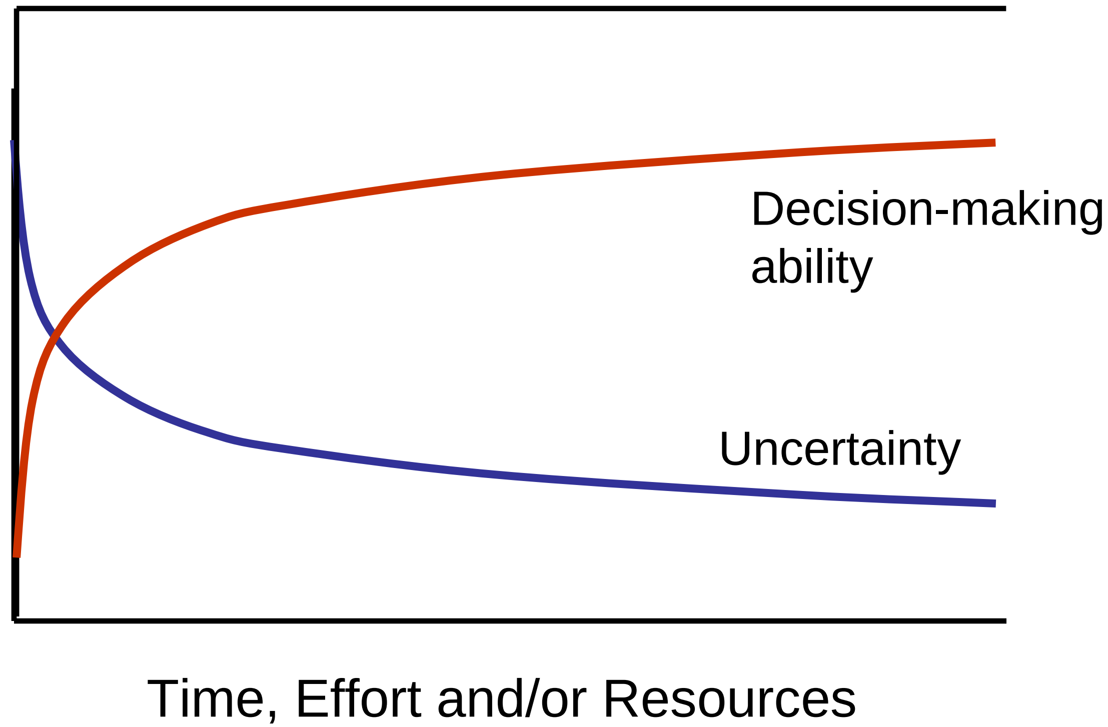
- EPA ROD requires:
  - Excavation in the dry of specific areas
  - Post-construction SWAC of 1 ppm total mercury
    - Goal based on site specific data correlating total and meHg; pilot study indicating the ability to attain low residuals; and literature based bioaccumulation values for meHg
- There is a state-wide fish advisory on all freshwater rivers to eat no more than one meal per week because of air deposition of mercury
- Some stakeholders have expressed concerns that under different future conditions the remaining mercury could pose a risk
  - Concern that during drought periods the residuals would methylate

UNIT 5 - Questions for the Groups

- What would we need to say that a sediment site is “done”?
- In general, what are the long-term management concerns for post-construction sites with remaining sediment contamination?
  - Does our view differ if the contaminants are in a small volume of dredge residual vs. sediments left either capped or for MNR?
- For the hypothetical case, what is required after remedy construction?

Conclusions

Using tradeoffs can reduce uncertainty and support decision-making



RPMs need to make decisions!

Sound Science is Needed to Assess Tradeoffs

- Sound science can help compare tradeoffs
  - Fundamental to good decision making
  - Needs to be employed to support realistic assessments
- Science needs to be advanced in fundamental areas to help future decision making
  - System processes that affect risk and remedial outcomes
  - Effectiveness and limitations of technologies
- RPMs would benefit from a comprehensive assessment of what happened and why at past cleanups
  - Could provide information on:
    - Technology effectiveness
    - Risk reduction outcomes (short-term and long-term)
    - Cost (predicted vs. actual)

Before Selecting a Remedy

- Questions to ask:
  - Has a sound conceptual site model been developed that is consistent with the data?
  - Has a weight of evidence approach been used to consider data and evaluate uncertainty?
  - Is it probable that additional data collection and/or modeling can reduce the uncertainty to a significant degree?
  - Has the degree of stability of the contaminants in the sediment been evaluated?
  - Have significant on-going sources to the system been characterized and controlled?
  - Have all remedial options been assessed fairly?
    - Have realistic predictions of effectiveness been used?
    - Have realistic costs estimates been developed?
  - Have the long-term cumulative risks and risk reductions been evaluated using realistic expectations?
  - Has a phased approach been considered?

Project Management Ideas that Help Lead to Success

- Communication between regulators, regulated and other government parties
  - Frequent exchange of information and opinions
    - Team approach
  - Willingness to listen to other viewpoints
    - Not always pleasant, critically important
- Public involvement
  - Public concerns can drive tradeoffs
- Quality science
  - Sound conceptual site model
  - Ongoing collection of data linked to a clear objective
  - Appropriate technical expertise

Project Management Ideas (cont.)

- Phased approach
  - Source control is critical
  - Implementation in steps can help
    - Start to reduce risks
    - Provide quality information to assess future decisions
    - Allows refinement of the conceptual site model
  - Reduce uncertainty
    - Scientifically compare approaches without the bias of a pre-conceived idea of what is “right” or “wrong”
    - Learn from implementation of actions
    - Evaluate effectiveness of remedial approaches

Project Management Ideas (cont.)

- Uncertainty management → part of all actions
  - Provisions in early phases to revisit the actions as part of subsequent decisions
  - Requirements to measure during and post-construction conditions
    - To evaluate effectiveness
    - To establish expectations for next phases
  - Corrective action triggers established for work
    - To mitigate short-term effects
- Decision makers need to understand that there may not be one "best" answer for these sites

Tradeoffs are Inevitable

- There are no perfect solutions to complex sediment sites
- Project managers must evaluate and balance tradeoffs to allow site progress
  - Key issues must be faced:
    - Bang for the buck for continued study
    - Means by which uncertainty is handled in decision making
    - Consequences of a “wrong” approach
  - A phased approach may start to reduce risks while providing quality information to assess future decisions
  - Considering and balancing tradeoffs does not compromise EPA’s authorities or mission
- Try to find common ground and build from there

Remember Your Goals

- Need to maintain focus on risk reduction as the goal for sediment cleanups
- Build cooperation and commitment among the affected parties
  - May help prevent stalled or unnecessary action
  - Remember that appropriate use of tradeoffs may allow progress and improve future decisions
- Have a commitment to monitor outcomes and conduct additional work if needed to achieve the agreed upon long-term goals