
Risk-informed Decision Making

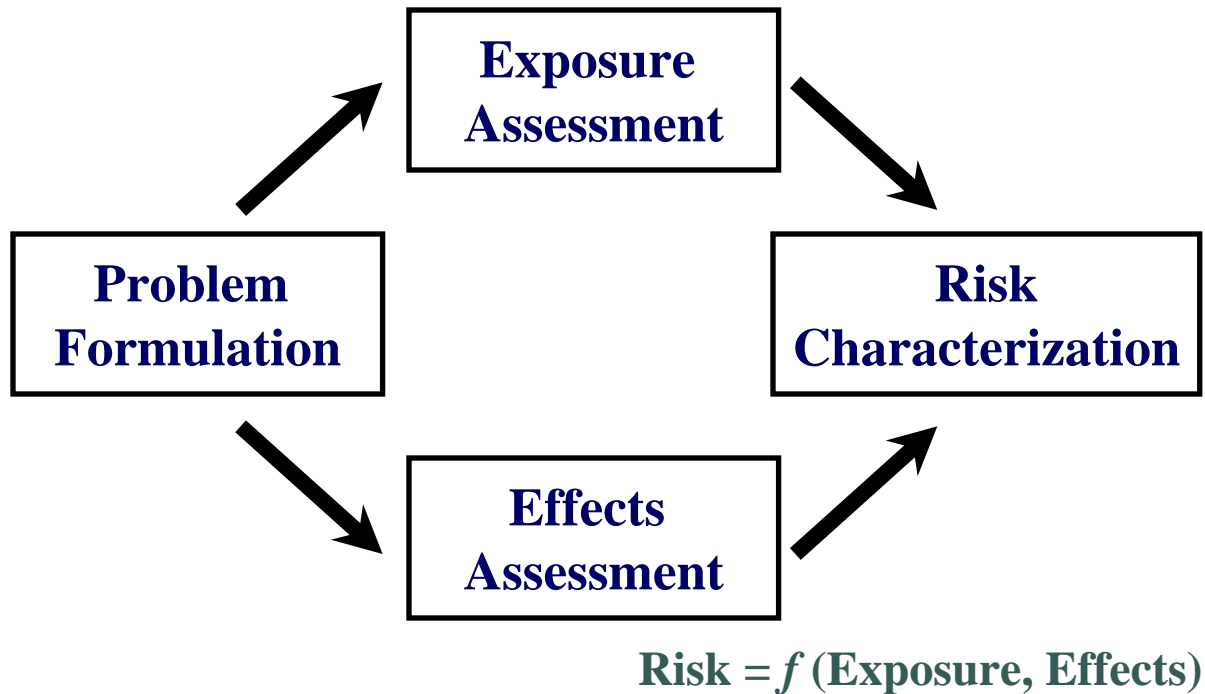
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and Todd Bridges**

US Army Engineer Research and Development



RISK FRAMEWORK

RISK ASSESSMENT PARADIGM

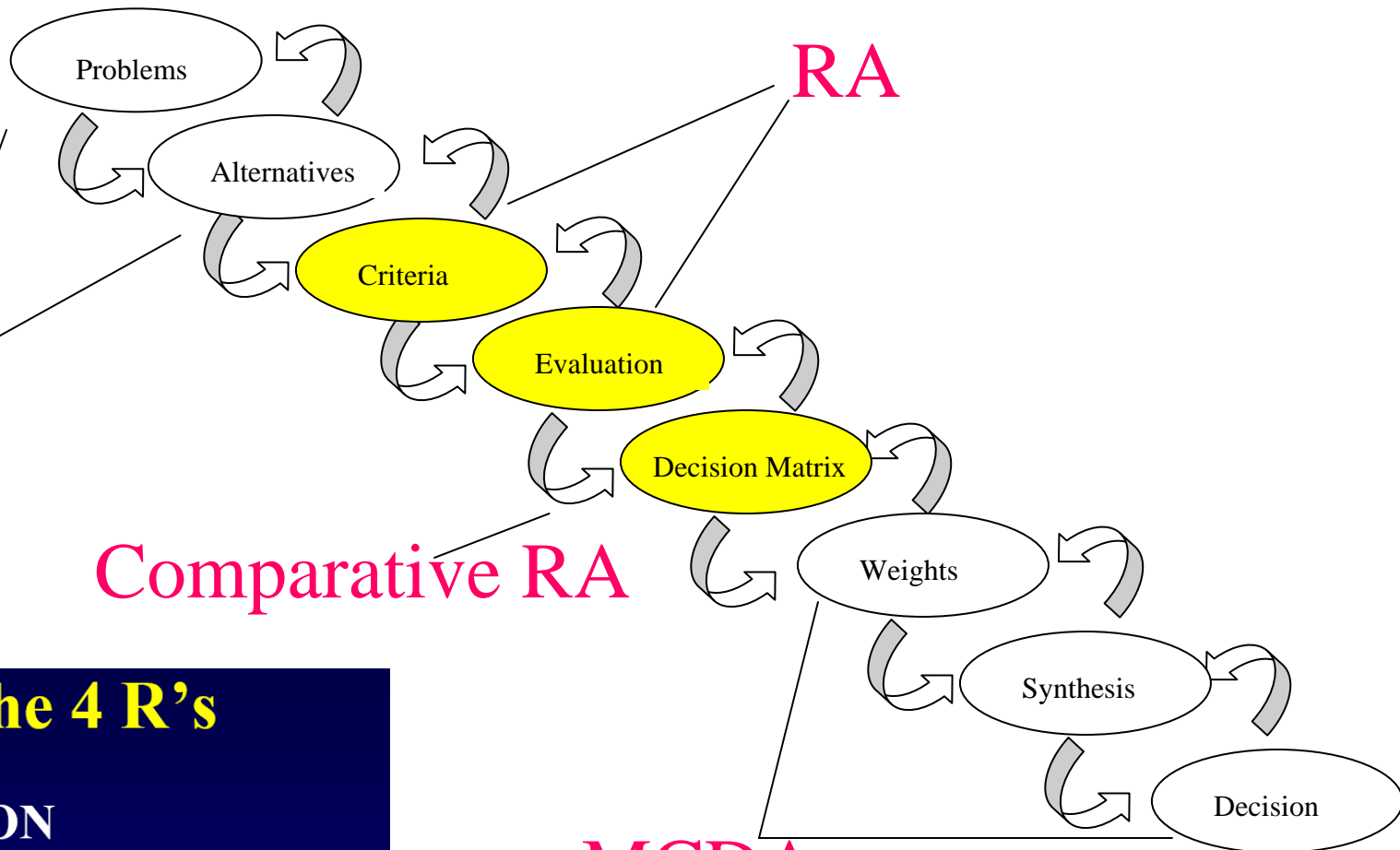


**Economic Analysis,
Socio-Political,
Engineering
Feasibility**

**Risk
Management**

MCDA





MCDA
Feeds
RA

The 4 R's

RESUSPENSION

RELEASE

RESIDUALS

RISK



Decision Framework

Presentation -- Overview

- **Using Risk Assessment in Decisions**
 - MCDA Approach
 - Application to Toddistan
- **Conclusions**

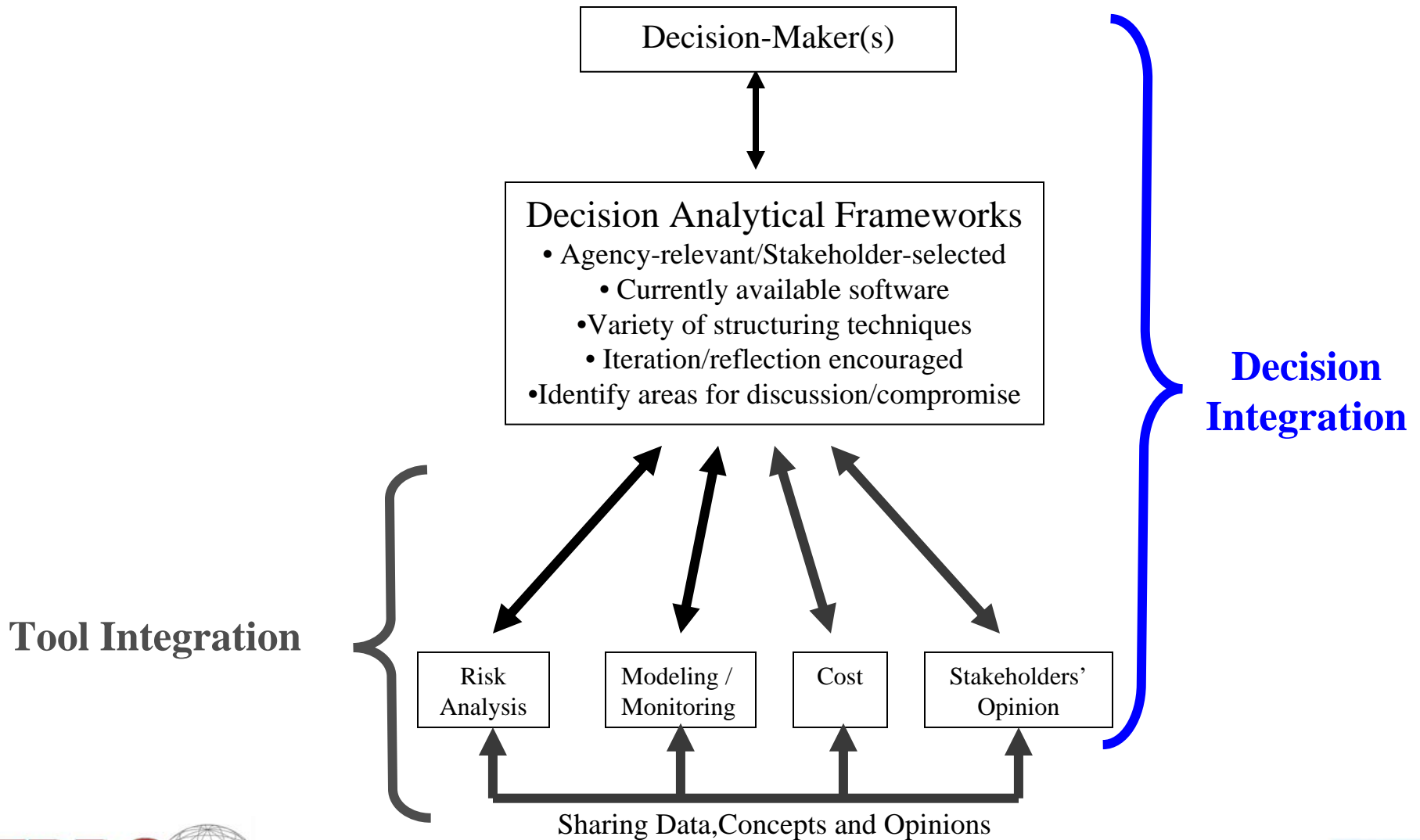


Main Points

- **Risks and benefits associated with alternative resuspension management strategies can be quantified using MCDA.**
- **Model, Parameters and Scenario uncertainty and variability associated with predicting efficiency of dredging alternatives as well as stakeholder value judgment are important to consider**
- **Challenges of risk assessment and planning require coupling traditional risk assessment and planning with MCDA to support dredging decisions**



Evolving Decision-Making Processes



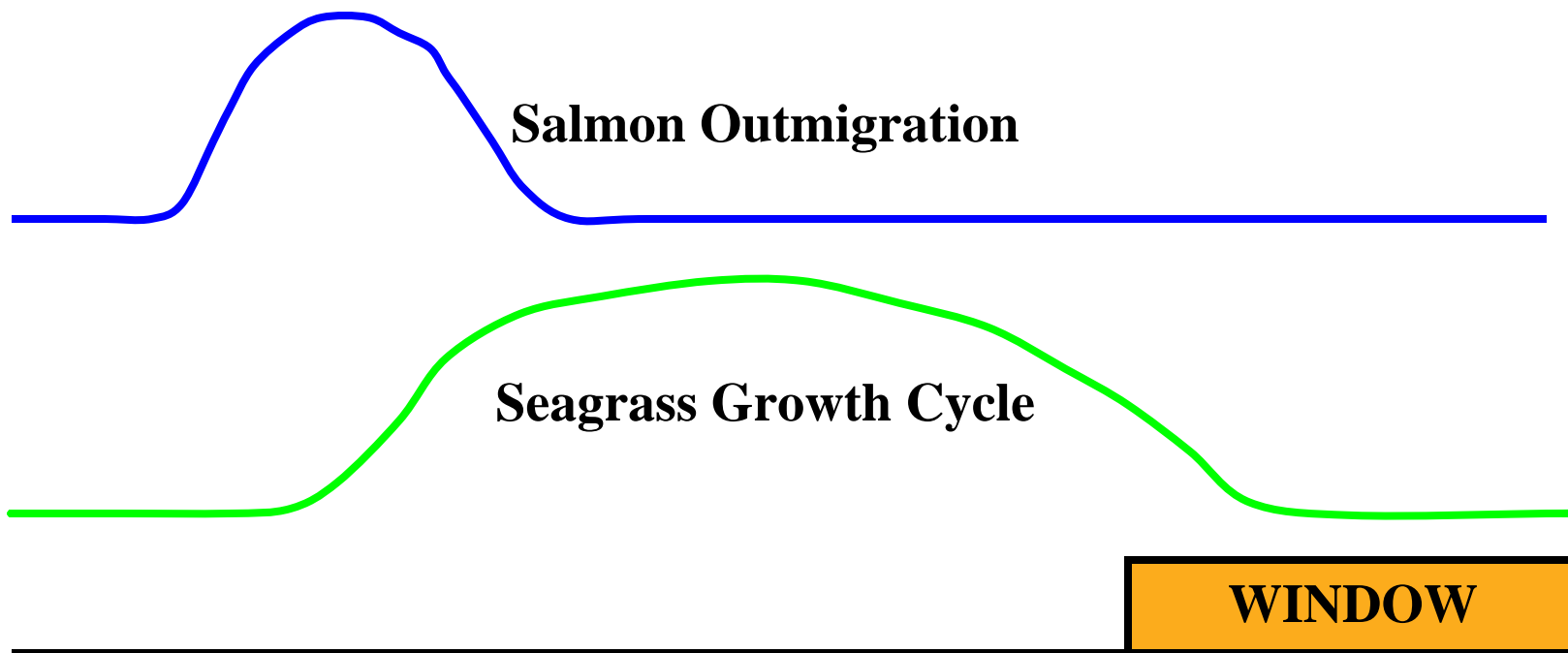
Toddistan Environmental Window

SPRING

SUMMER

FALL

WINTER



Environmental Window

- Provides protection for juvenile salmon by eliminating TSS during migration
- Provides protection from light attenuation by eliminating TSS during SAV growing season
- Provides protection from rate of deposition by eliminating TSS during SAV growing season
- Does not provide protection from burial by anoxic deposition; therefore, overflow is restricted to 15 minutes to provide this protection



Toddistan Scenario Info

| Dredging Scenario | Production (m ³ /day) | Dredging Duration (days)* | Dredging Costs** |
|---|----------------------------------|-------------------------------|------------------|
| No Overflow | 32,000 | 219 | \$13,100,000 |
| 15 Minutes Overflow | 48,000 | 146 | \$8,800,000 |
| 30 Minutes Overflow | 58,000 | 122 | \$7,300,000 |
| Environmental Window w/ 15 Minutes Overflow | 48,000 | 146 over two dredging seasons | \$9,900,000*** |

* Days without downtime

** Without mob-demob cost of about \$700,000

*** Plus an additional mob-demob cost of \$700,000



Metrics

| Alternative | Direct and Indirect Costs | Survivability of Juvenile Salmonids, % | Survivability of SAV % |
|----------------------------------|----------------------------------|---|-------------------------------|
| Hopper - No Overflow | 100 | 95 | 95 |
| Hopper – 15 Min. Overflow | 70 | 80 | 70 |
| Hopper – 30 Min. Overflow | 60 | 70 | 30 |
| Env. Window w/ 15 Min. OF | 80 | 100 | 80 |



Risk Concerns / Recovery

| Eco-Risk | Recovery Time | | Weight of Concern |
|------------------|-------------------------|----------------------|--------------------------|
| | Sublethal Effect | Lethal Effect | |
| Salmonids | Rapid, weeks to months | Rapid, 1 year | Low |
| SAVs | Moderate, 1 year | Slow, decade | High |
| Corals | Very Slow, decade | Very Slow, decades | Very High |



Assessment Criteria

The screenshot shows the Expert Choice software interface. The title bar reads "Expert Choice C:\Documents and Settings\lu4epri3.ERD\My Documents\Conferences\DredgingCapitalist.AHP". The menu bar includes File, Edit, Assessment, Synthesize, Sensitivity-Graphs, View, Go, Tools, and Help. The toolbar contains icons for file operations, assessment, and visualization. The main window is divided into two panes. The left pane shows a hierarchical tree of assessment criteria:

- Goal: Select the optimal dredging alternative
 - Salmon Health (L: .115)
 - TSS (L: 1.000)
 - SAV Health (L: .121)
 - Irradiance reduction (L: .750)
 - Burial (L: .250)
 - Cost (L: .764)
 - Direct (L: .833)
 - Indirect (L: .167)

The right pane, titled "Alternatives: Distributive mode", displays a table of scores for four alternatives:

| | |
|----------------------|------|
| Hopper | .211 |
| Hopper 15 min | .262 |
| Hopper 30 min | .295 |
| Environmental Window | .231 |

Below the table is an "Information Document" section, which is currently empty.



Criteria Weights

Expert Choice C:\Documents and Settings\u4epril3.ERD\My Documents\Conferences\DredgingCapitalist.AHP

File Edit Assessment Inconsistency Go Tools Help

Reorder Structural adjust Freeze Judgments

3:1 ABC Y-F(*)

Salmon Health

Compare the relative importance with respect to: Goal: Select the optimal dredging alternative

SAV Health

- Extreme
- Very Strong
- Strong
- Moderate
- **Equal**
- Moderate
- Strong
- Very Strong
- Extreme

| | Salmon He | SAV Health | Cost |
|---------------|-------------|------------|------|
| Salmon Health | | 1.0 | 7.0 |
| SAV Health | | | 6.0 |
| Cost | Incon: 0.00 | | |

Pairwise Numerical Comparisons



Metric Assessment by Criteria

Expert Choice C:\Documents and Settings\lu4epril3.ERD\My Documents\Conferences\DredgingCapitali...

File Edit Assessment Inconsistency Go Tools Help

Reorder Structural adjust Freeze Judgments

3:1 ABC Y-F(*)

Hopper

Compare the relative preference with respect to: Cost \ Direct

Hopper 15 min

Extreme
Very Strong
Strong
Moderate
Equal
Moderate
Strong
Very Strong
Extreme

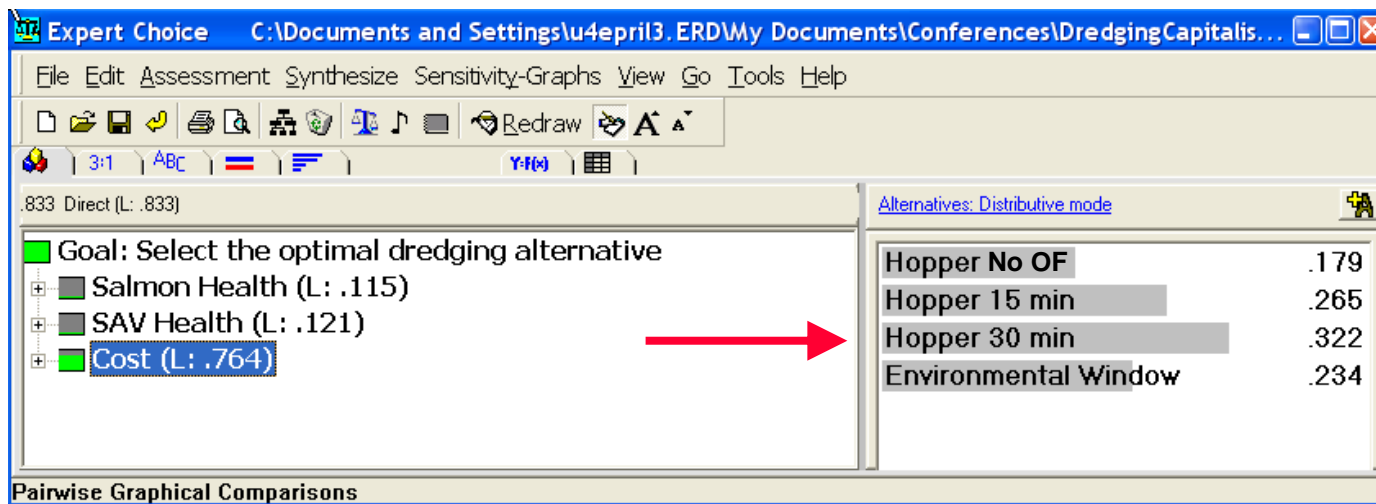
| | Hopper | Hopper 15 | Hopper 30 | Environme |
|----------------------|-------------|-----------|-----------|-----------|
| Hopper | | 1.5 | 1.8 | 1.3 |
| Hopper 15 min | | | 1.2 | 1.1 |
| Hopper 30 min | | | | 1.4 |
| Environmental Window | Incon: 0.00 | | | |

ModelView

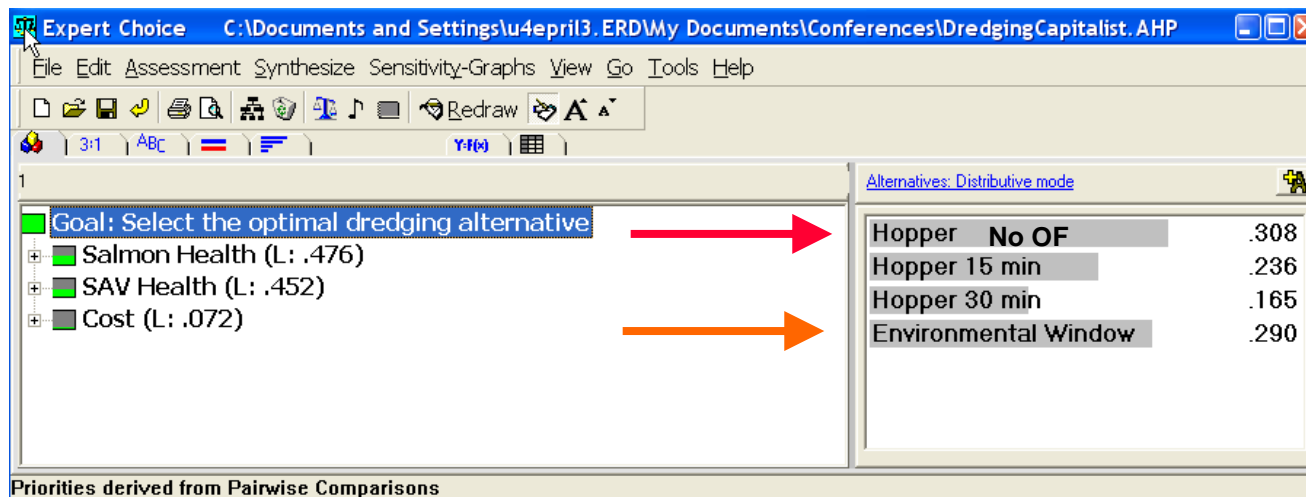


Results for Different Stakeholders

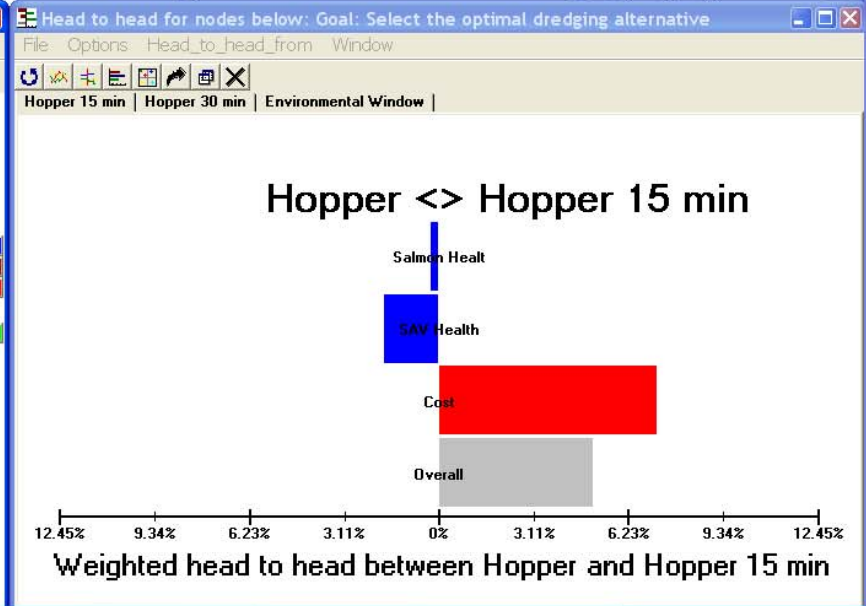
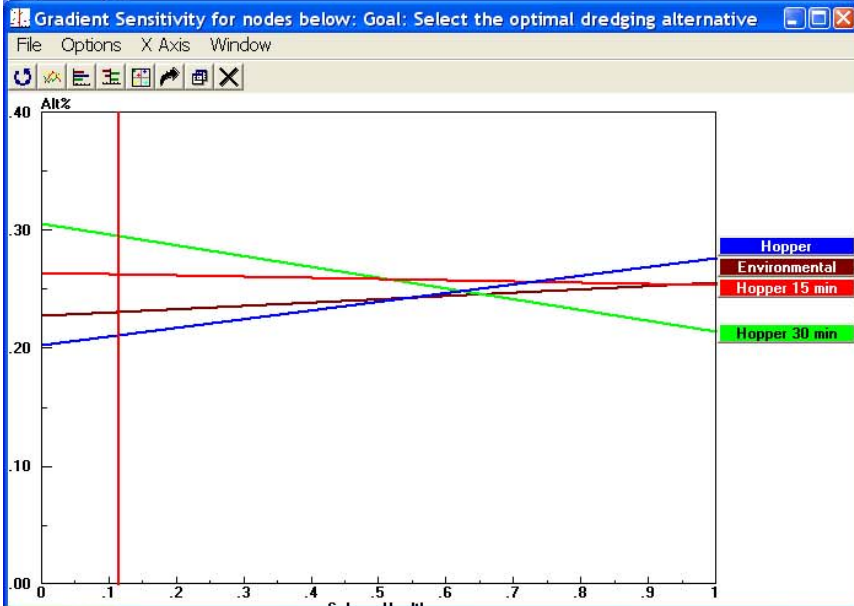
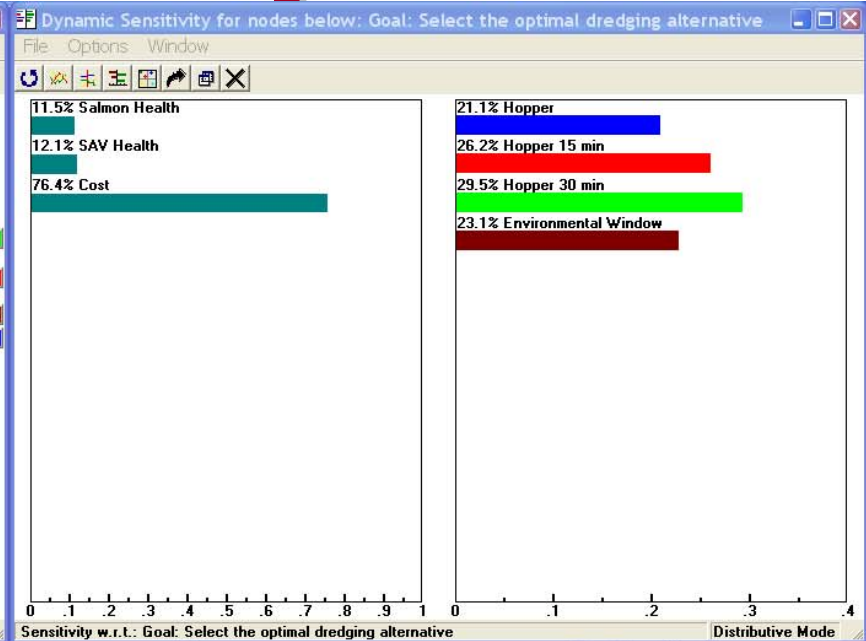
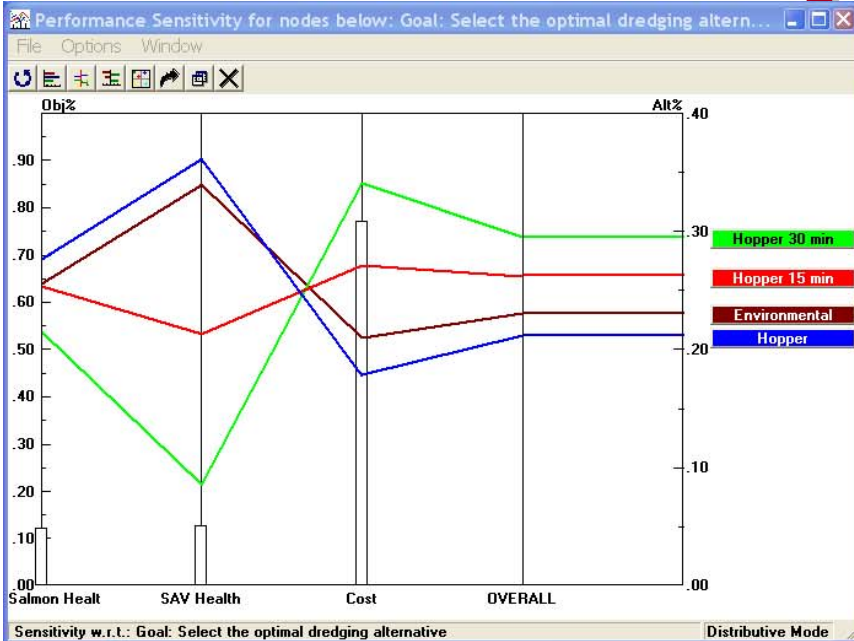
**Toddistan
Officials**



**World
Bank**



Sensitivity Analysis



Results

- **Balanced weighting** would yield selection of **15 minutes of overflow** as the optimal alternative
- **High weighting of cost and indirect costs/ schedule** yields selection of **30 minutes of overflow** as the optimal alternative
- **High weighting of environmental resource protection** yields selection of **no overflow or possibly environmental windows** as the optimal alternative



Summary

- **15 minutes of overflow was selected as the optimal alternative**
- **Adaptive management will be used to address uncertainties concerns**
- **Monitoring within a adaptive management framework will be used to ensure ecological risks are acceptable**



Questions?

