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# ***Risk-informed Decision Making***

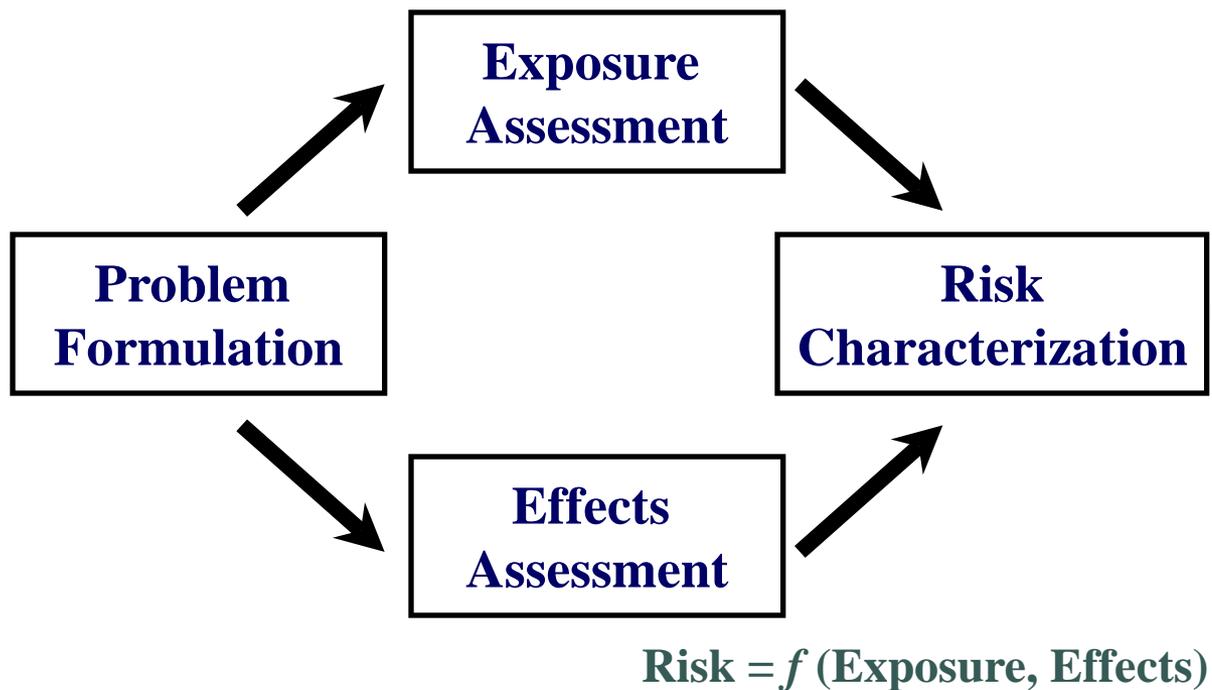
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Schroeder**

US Army Engineer Research and Development



# RISK FRAMEWORK

## RISK ASSESSMENT PARADIGM

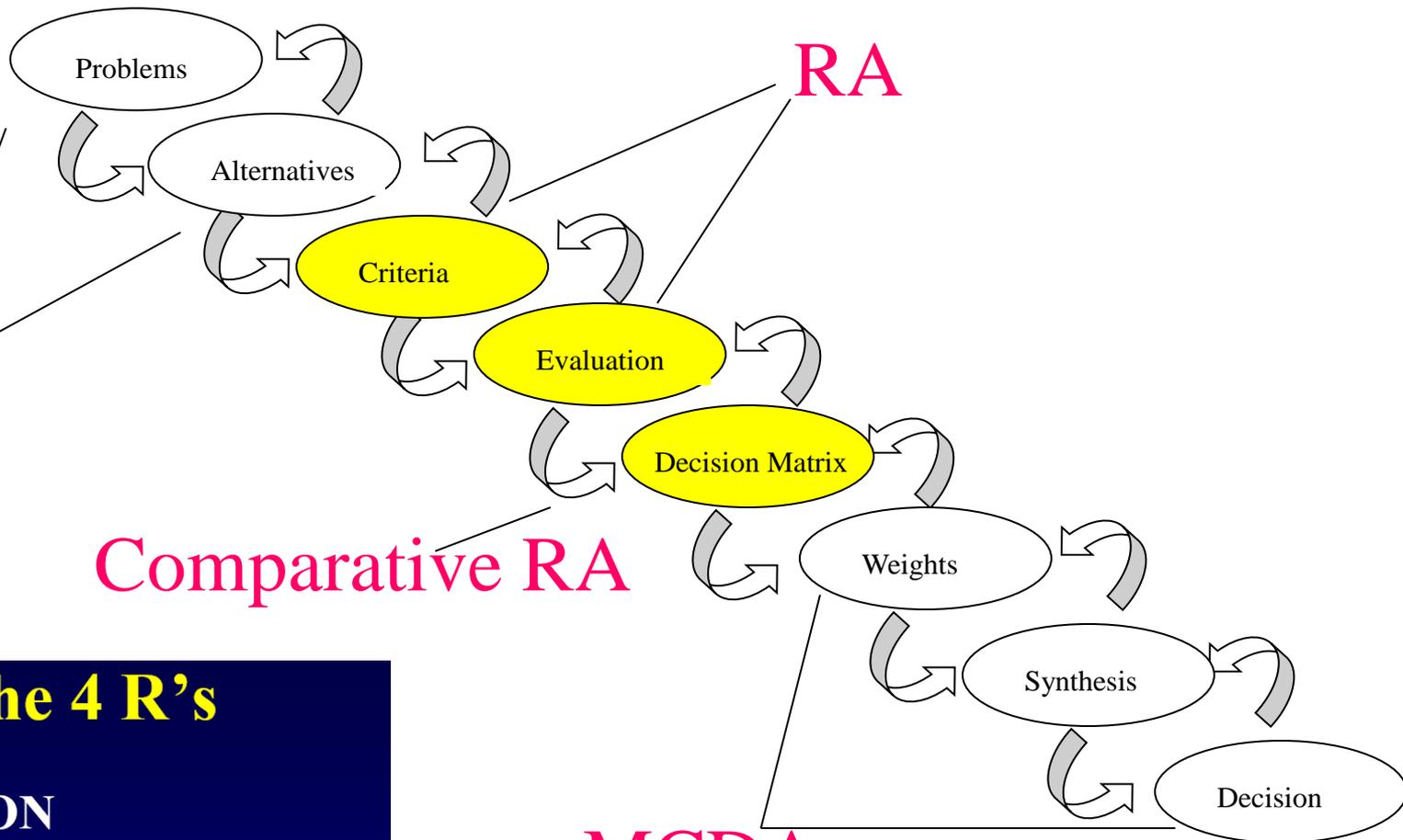


Economic Analysis,  
Socio-Political,  
Engineering  
Feasibility

Risk  
Management

MCDA





MCDA  
Feeds  
RA

**The 4 R's**

**RESUSPENSION**

**RELEASE**

**RESIDUALS**

**RISK**

**Decision Framework**

# *Presentation -- Overview*

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



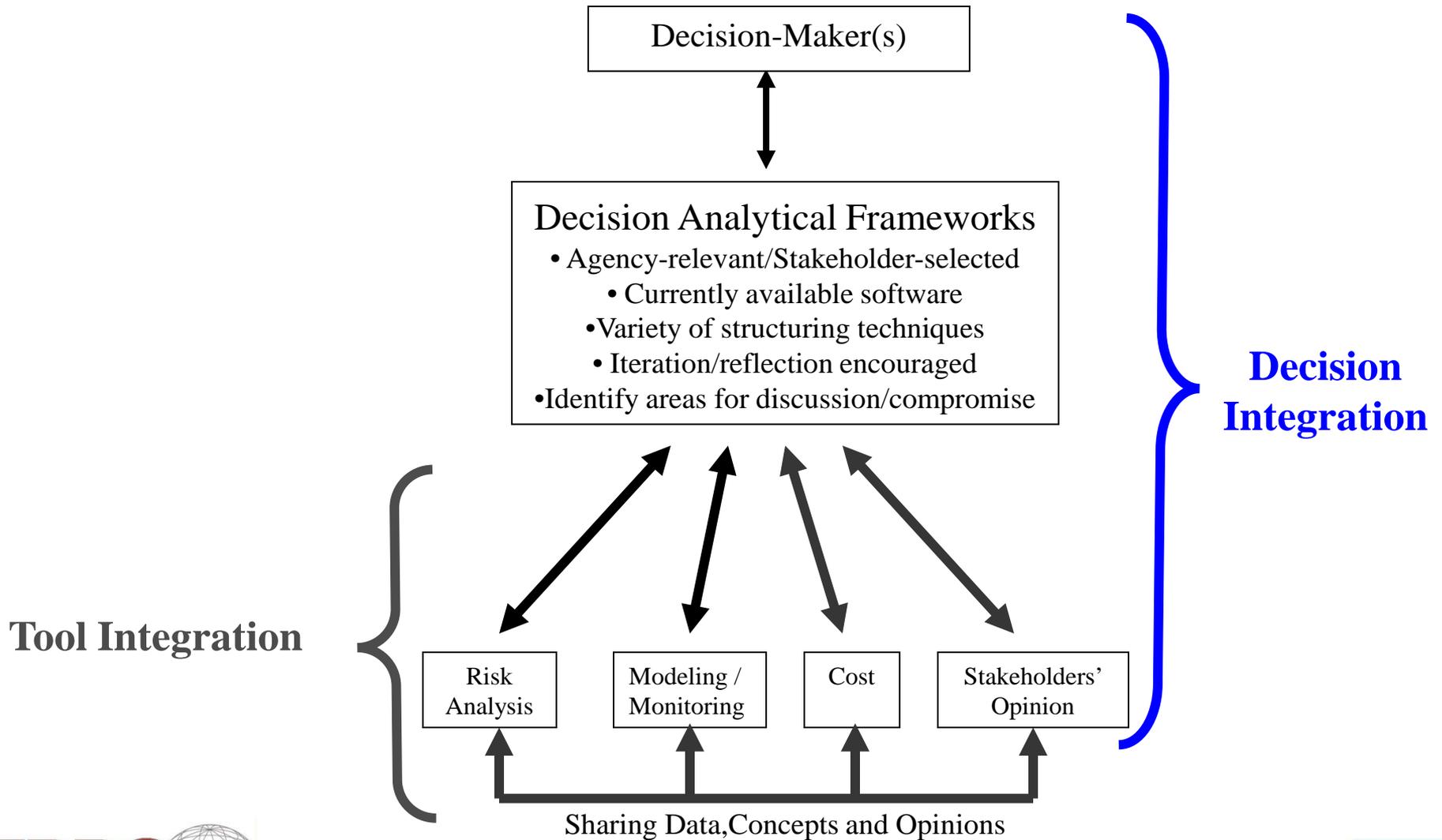
# Main Points

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- **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

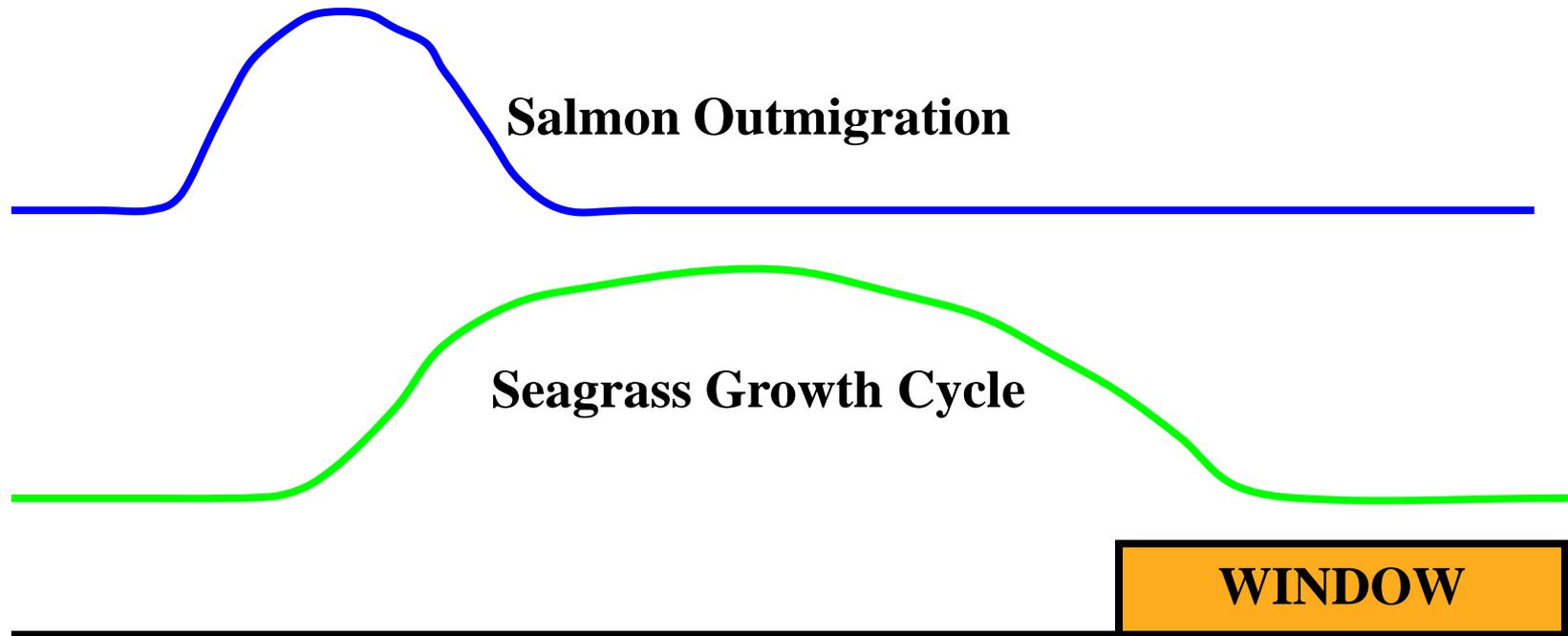
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**SPRING**

**SUMMER**

**FALL**

**WINTER**



# Environmental Window

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- 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 <sup>3</sup> /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



# Risk Criteria

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



# 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 alternatives and their scores:

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(x)

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

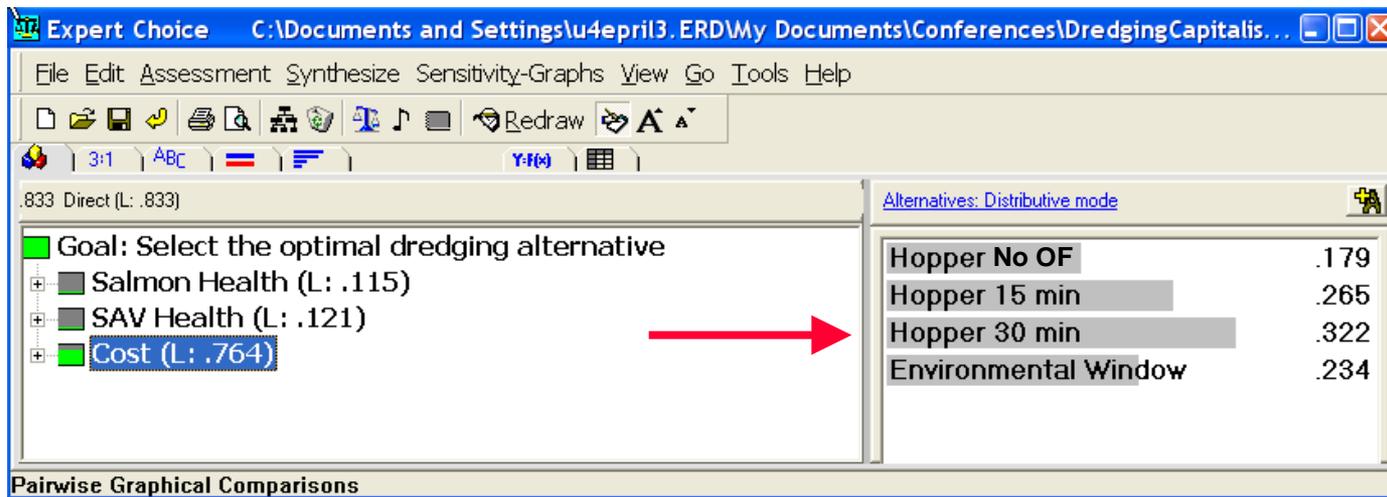
	Hopper	Hopper 15	Hopper 30	Environme
Hopper		1.5	1.8	1.3
Hopper 15 min			1.2	1.1
Hopper 30 min				1.4
Environmental Window	Incon: 0.00			

ModelView

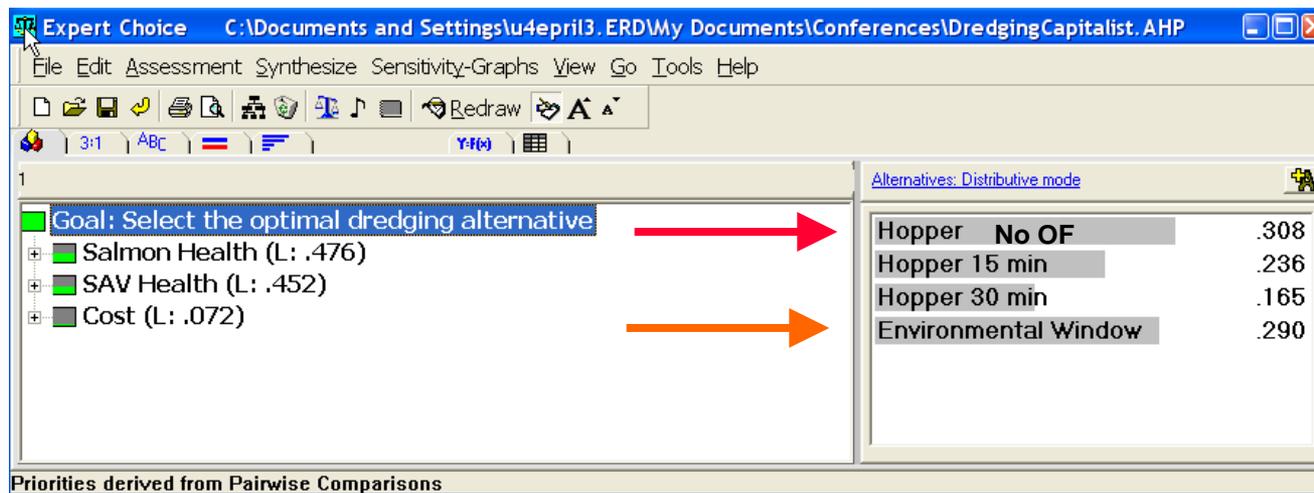


# Results for Different Stakeholders

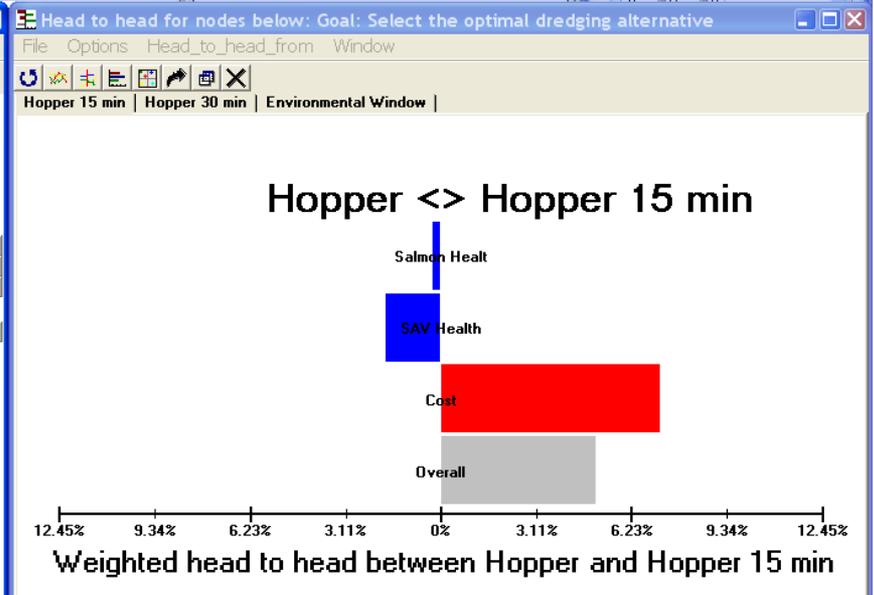
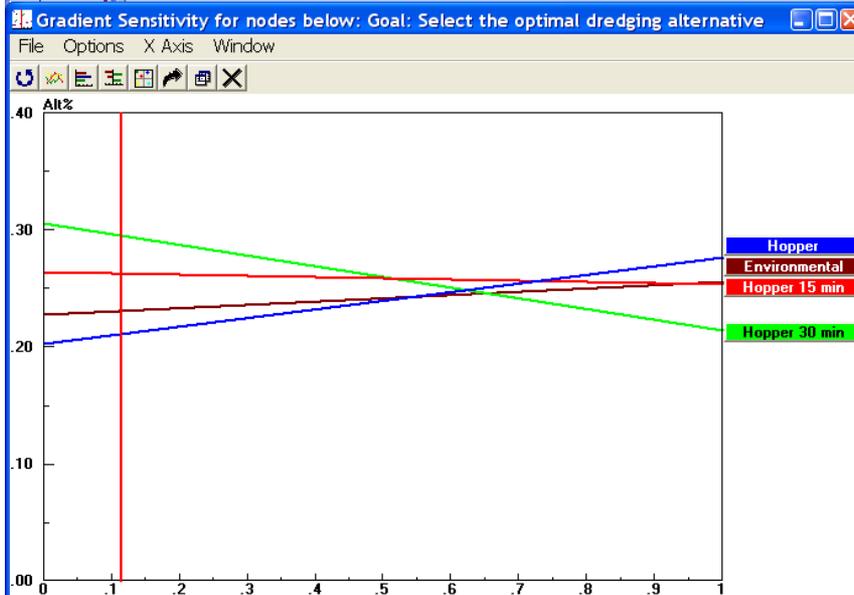
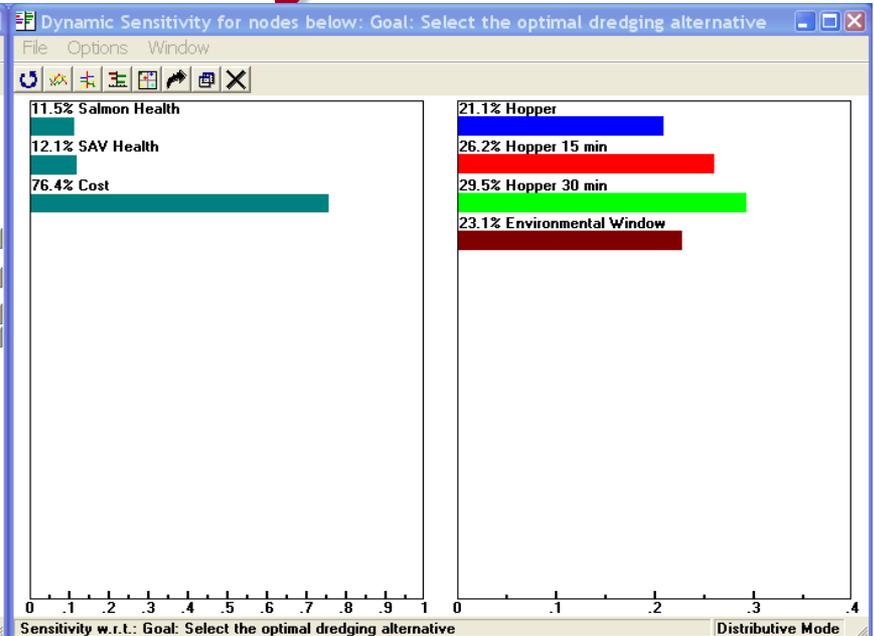
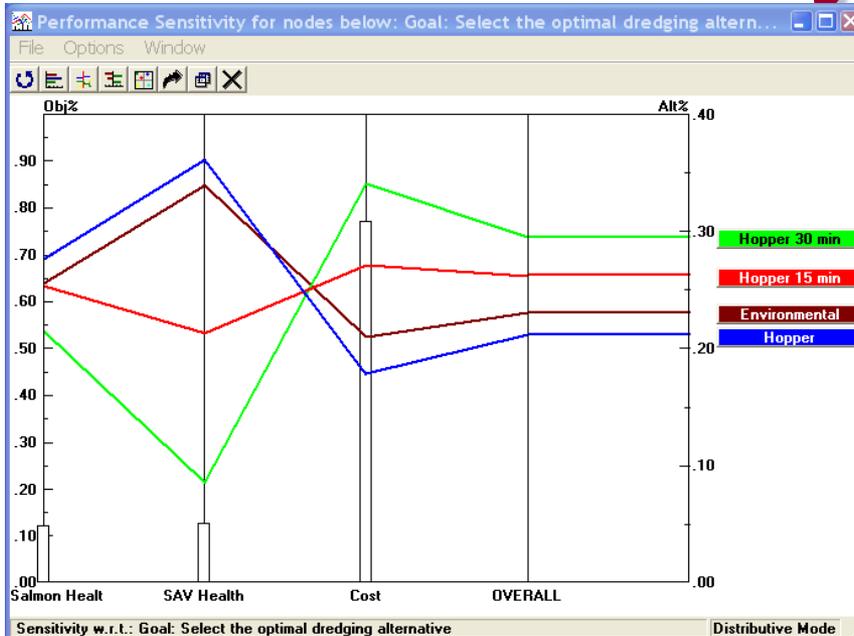
**Toddistan  
Officials**



**World  
Bank**



# Sensitivity Analysis



# Results

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- **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

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- **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**



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# Questions?

