
Risk-informed Decision Making

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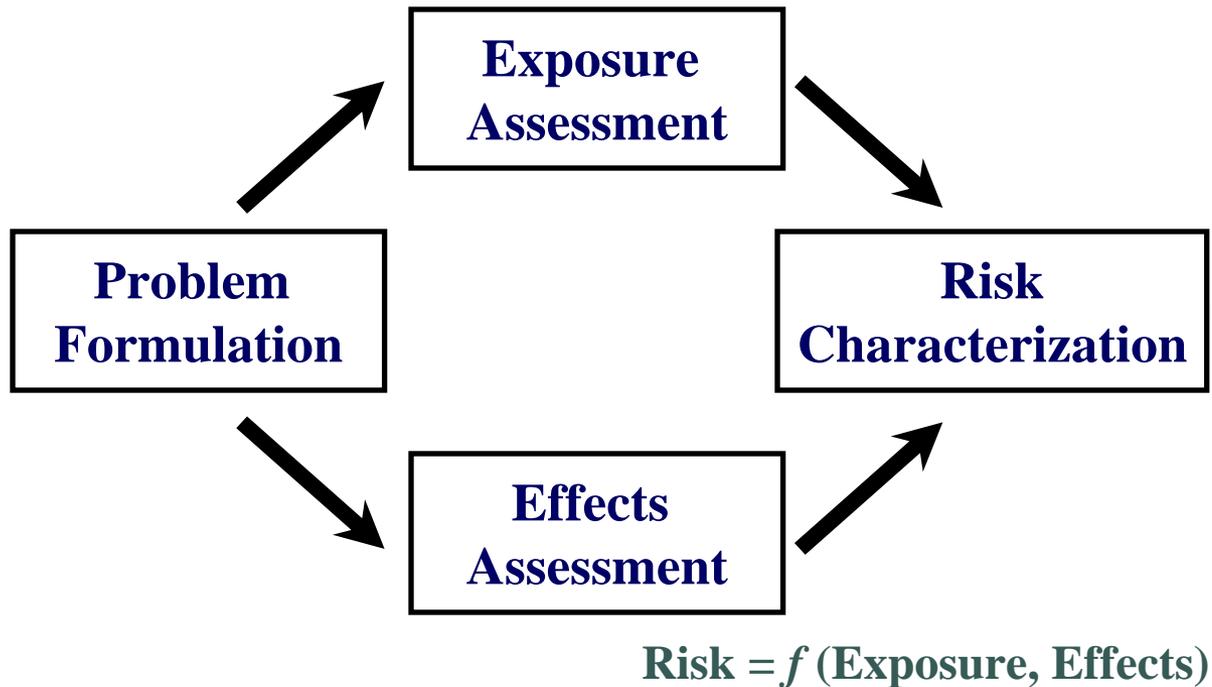


**Dredged Material Assessment and Management Seminar
15-17 September 2009, Detroit, MI**



RISK FRAMEWORK

RISK ASSESSMENT PARADIGM

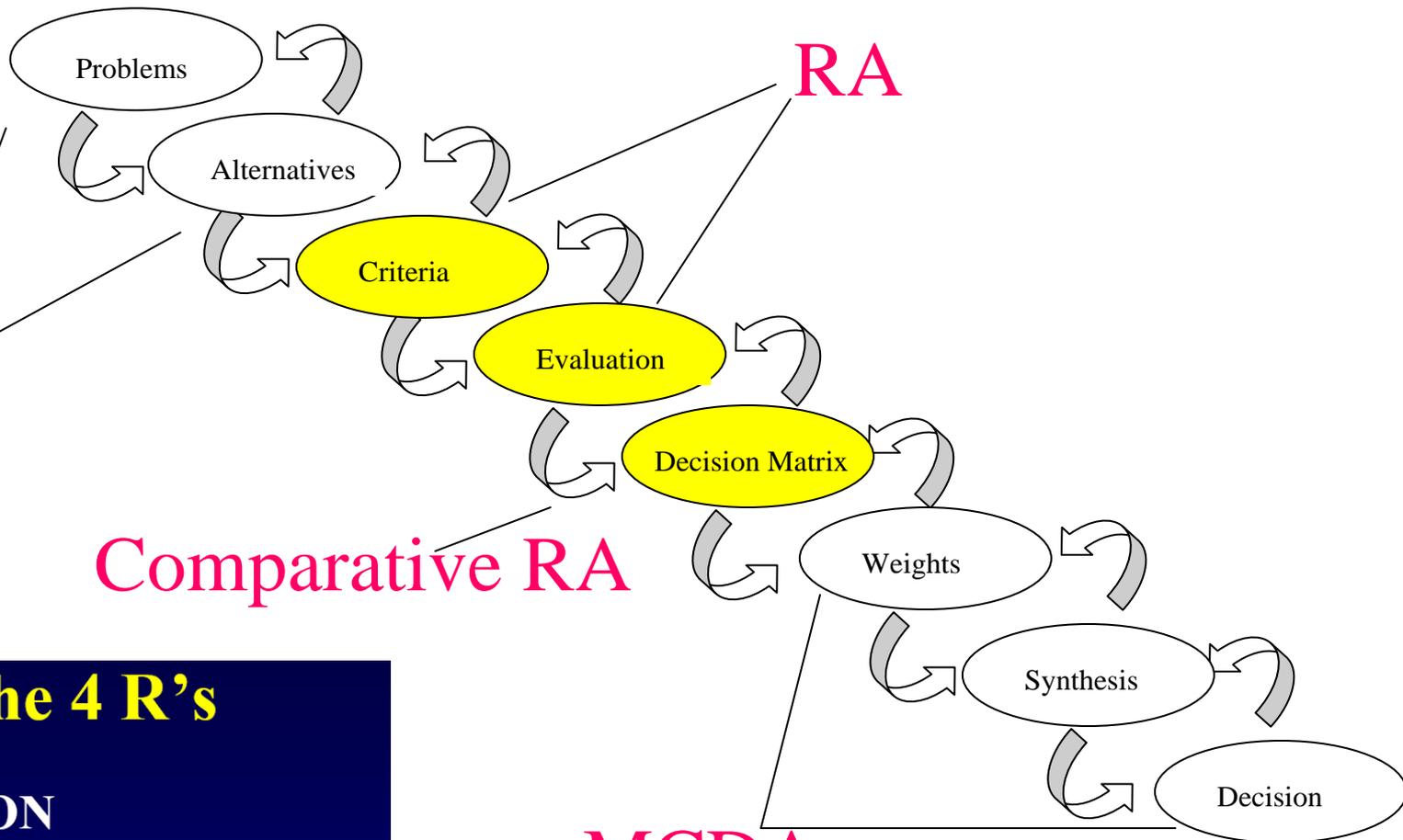


Economic Analysis,
Socio-Political,
Engineering
Feasibility

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 Toddaho
- **Conclusions**

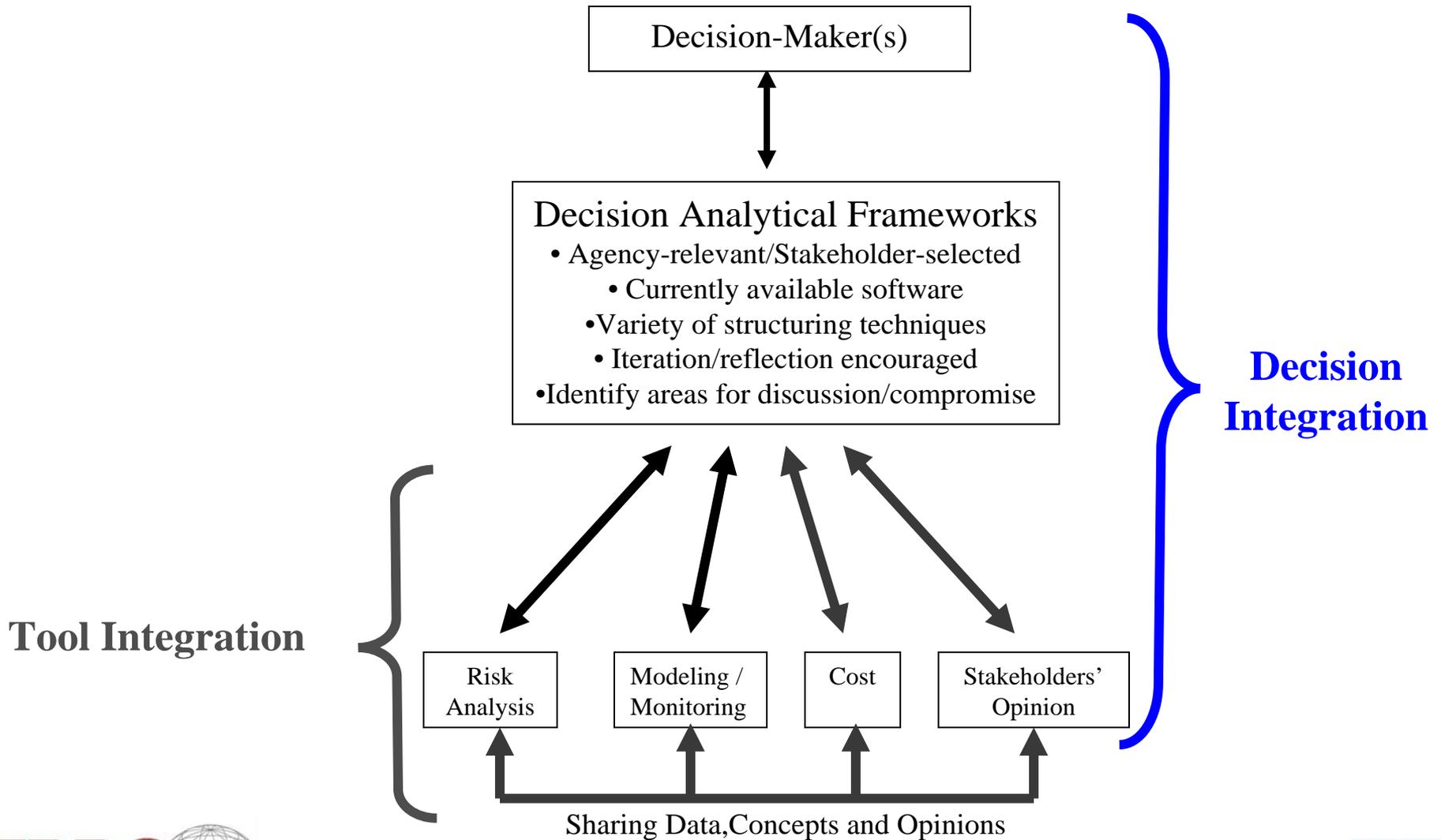


Main Points

- **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



Toddaho Environmental Window

SPRING

SUMMER

FALL

WINTER



WINDOW



Environmental Window

- Provides protection for juvenile salmon by eliminating TSS during migration
- Provides protection for fish spawning by eliminating TSS during spawning season
- Provides protection for fish spawning by eliminating deposition during spawning season



Toddaho Scenario Info

Dredging Scenario	Production (cy/day)	Dredging Duration (days)*	Dredging Costs**
Hopper w/ OWP	12,000	4	\$280,000
Clamshell w/ OWP	3,000	16	\$350,000
Clamshell w/ CDF	3,000	16	\$540,000
Restricted Clamshell w/ OWP	2,000	24	\$450,000
Clamshell with Silt Curtain & OWP	2,400	20	\$510,000
Clamshell with Silt Curtain & CDF	2,400	20	\$700,000

* Days without downtime

** Environmental window would add \$100,000 to cost due to scheduling, and greater equipment capitalization



Risk Criteria

Alternative	Relative Costs	Survivability, %		
		Salmonids	Fish Eggs	Mussels
Hopper w/ OWP	No EW: 35	95	40	100
	w/ EW: 48	100	100	100
Clamshell w/ OWP	No EW: 44	60	90	100
	w/ EW: 56	100	100	100
Clamshell w/ CDF	No EW: 67	60	96	99
	w/ EW: 80	100	100	99
Restricted Clamshell w/ OWP	No EW: 56	85	93	100
	w/ EW: 69	100	100	100
Clamshell with Silt Curtain & OWP	No EW: 64	95	94	100
	w/ EW: 76	100	100	100
Clamshell with Silt Curtain & CDF	No EW: 88	95	99	99
	w/ EW: 100	100	100	99



Assessment Criteria

The screenshot displays the Expert Choice software interface. The title bar reads "Expert Choice D:\Work\ERDC\DREDGING\dredging_example.ahp". The menu bar includes "File", "Edit", "Assessment", "Synthesize", "Sensitivity-Graphs", "View", "Go", "Tools", and "Help". The toolbar contains icons for file operations, a "Redraw" button, and font settings. The main window is divided into two panes. The left pane shows a hierarchical tree of assessment criteria:

- Goal: Select the optimal dredging alternative
 - Cost (L: .857)
 - Survivability (L: .143)
 - Salmonids (L: .333)
 - Fish Eggs (L: .333)
 - Mussels (L: .333)

The right pane, titled "Alternatives: Distributive mode", lists 13 dredging alternatives with their corresponding scores:

Hopper w/ OWP - No EW	.143
Hopper w/ OWP - w/ EW	.120
Clamshell w/ OWP - No EW	.126
Clamshell w/ OWP - w/ EW	.103
Clamshell w/ CDF - No EW	.079
Clamshell w/ CDF - w/ EW	.054
Restricted Clamshell w/ OWP	.102
Restricted Clamshell w/ OWP	.076
Clamshell with Silt Curtain	.086
Clamshell with Silt Curtain	.062
Clamshell with Silt Curtain	.037
Clamshell with Silt Curtain	.013

At the bottom of the right pane, there is a section labeled "Information Document" with an empty text area below it.



Criteria Weights

The screenshot shows the Expert Choice software interface. The title bar reads "Expert Choice D:\Work\ERDC\DREDGING\dredging_example.ahp". The menu bar includes "File", "Edit", "Assessment", "Inconsistency", "Go", "Tools", and "Help". The toolbar contains icons for file operations and specific functions like "Reorder", "Structural adjust", and "Freeze Judgments". Below the toolbar, there are buttons for "3:1", "ABC", and "Y-F(x)".

The main interface features two boxes labeled "Cost" and "Survivability" with a slider between them. The slider is positioned at the 6.0 mark on a scale from 1 to 9. Below this, a text box says "Compare the relative importance with respect to: Goal: Select the optimal dredging alternative".

At the bottom, a table displays the results of the comparison:

	Cost	Survivability
Cost		6.0
Survivability	Incon: 0.00	



Metric Assessment by Criteria

Expert Choice D:\Work\ERDC\DREDGING\dredging_example.ahp

File Edit Assessment View Go Plot Tools Formula Type Help

Freeze Judgments Redraw

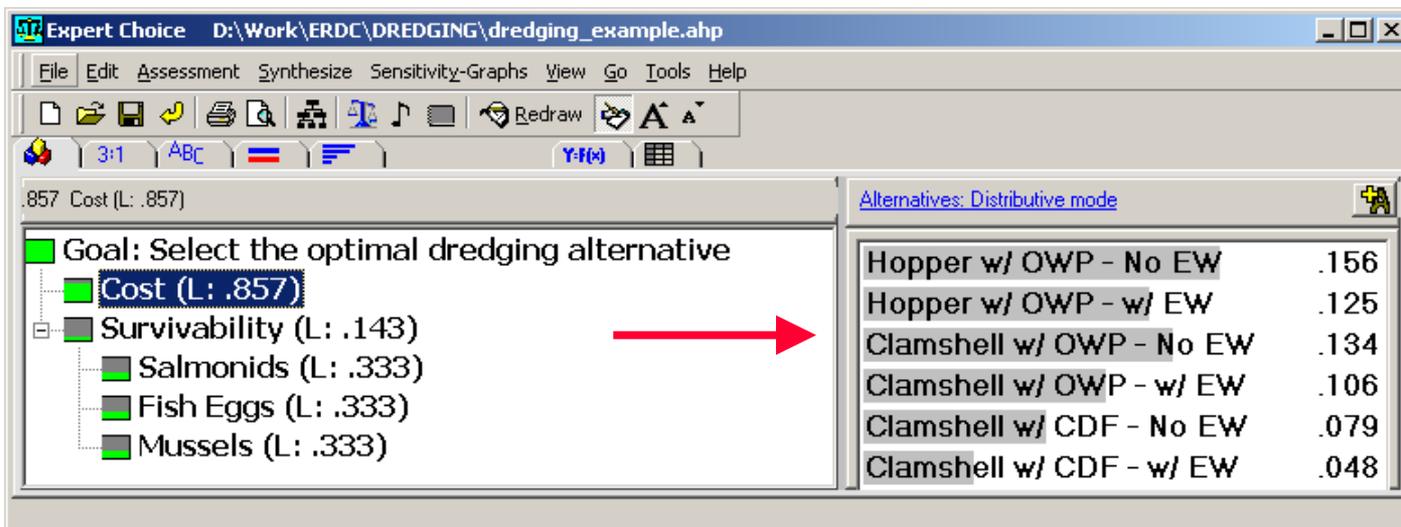
Y-F(x)

Low	High	Curvature
0.	100.	Linear

Alternative	DECR Cost (L: .857)	INCR Survivability Salmonids (L: .333)	INCR Survivability Fish Eggs (L: .333)	INCR Survivability Mussels (L: .333)
<input checked="" type="checkbox"/> Hopper w/ OWP - No EW	35	95	40	100
<input checked="" type="checkbox"/> Hopper w/ OWP - w/ EW	48	100	100	100
<input checked="" type="checkbox"/> Clamshell w/ OWP - No EW	44	60	90	100
<input checked="" type="checkbox"/> Clamshell w/ OWP - w/ EW	56	100	100	100
<input checked="" type="checkbox"/> Clamshell w/ CDF - No EW	67	60	96	99
<input checked="" type="checkbox"/> Clamshell w/ CDF - w/ EW	80	100	100	99
<input checked="" type="checkbox"/> Restricted Clamshell w/ OWP - No EW	56	85	93	100
<input checked="" type="checkbox"/> Restricted Clamshell w/ OWP - w/ EW	69	100	100	100
<input checked="" type="checkbox"/> Clamshell with Silt Curtain & OWP - No EW	64	95	94	100
<input checked="" type="checkbox"/> Clamshell with Silt Curtain & OWP - w/ EW	76	100	100	100
<input checked="" type="checkbox"/> Clamshell with Silt Curtain & CDF - No EW	88	95	99	99
<input checked="" type="checkbox"/> Clamshell with Silt Curtain & CDF - w/ EW	100	100	100	99

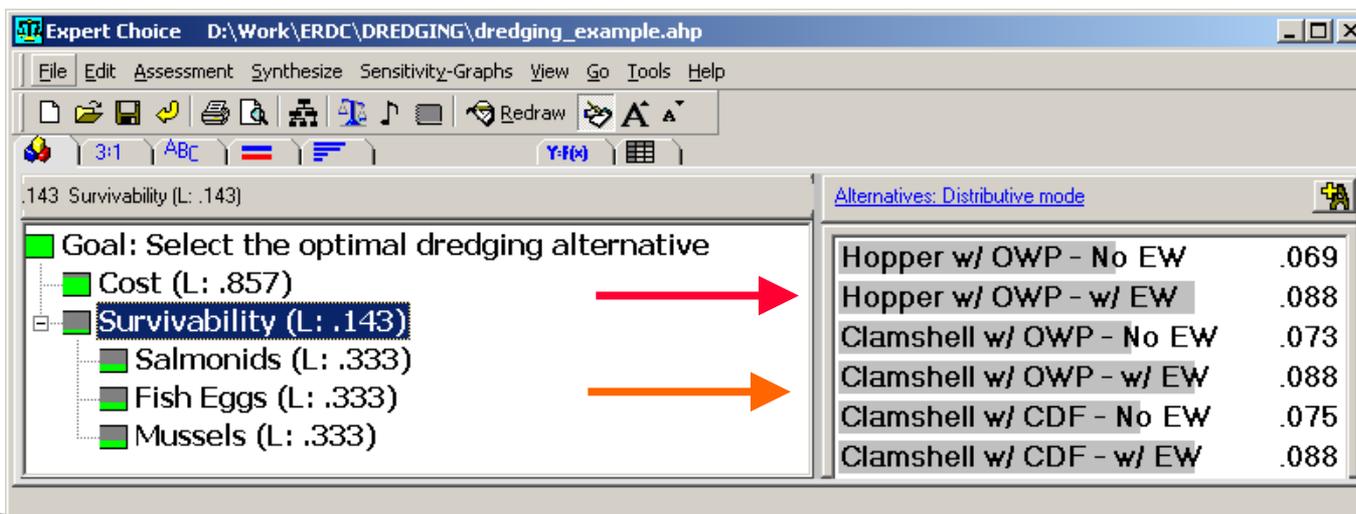


Results for Different Stakeholders

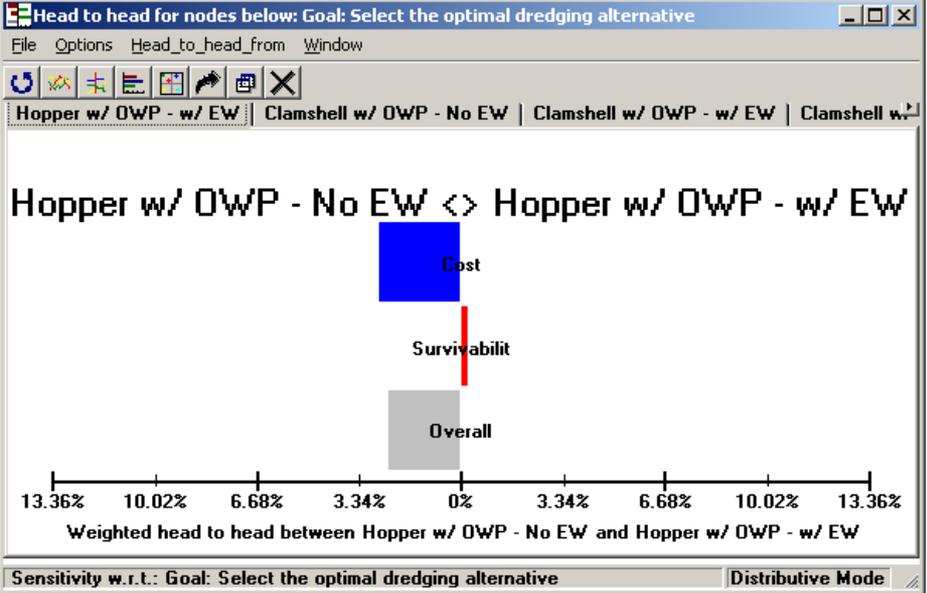
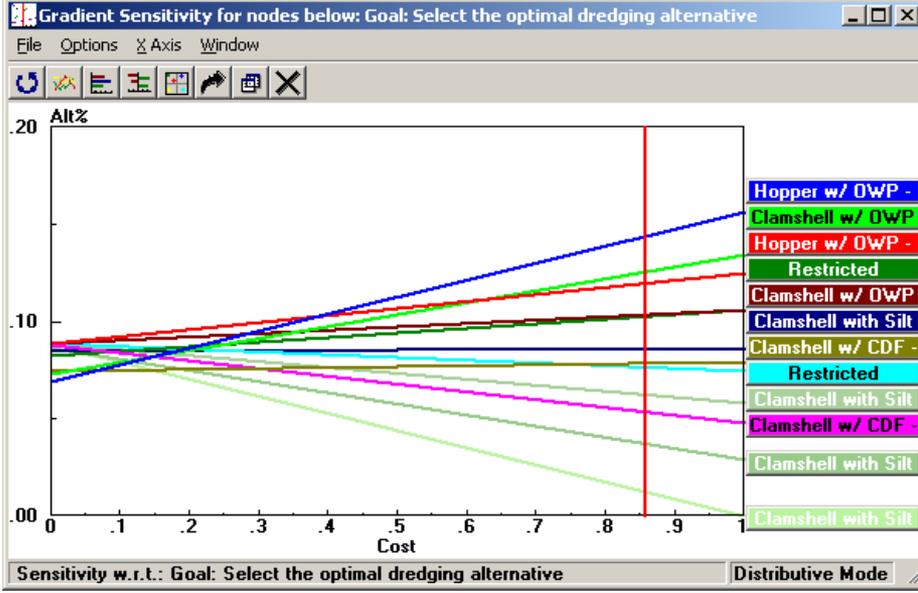
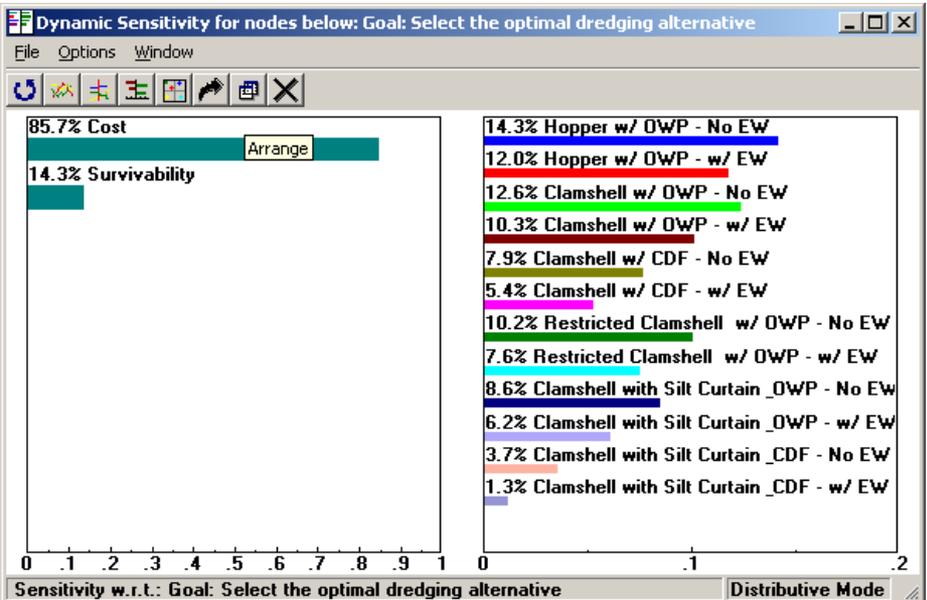
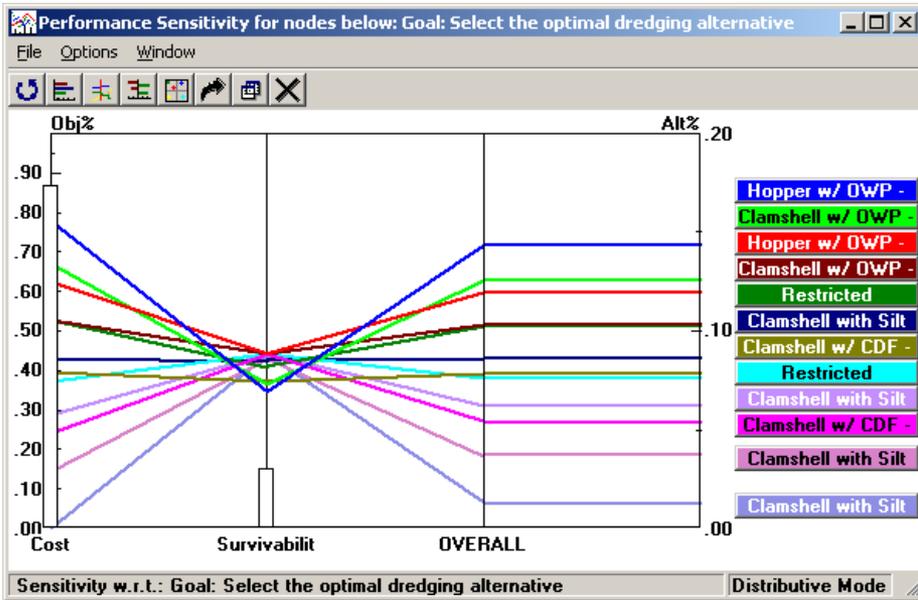


Regulatory
Community

Public



Sensitivity Analysis



Results

- **Balanced weighting** would yield selection of **Clamshell Dredging with OWP** as the optimal alternative
- **High weighting of cost and indirect costs/ schedule** yields selection of **Hopper Dredging** as the optimal alternative
- **High weighting of environmental resource protection** yields selection of **Hopper Dredging with OWP during an Environmental Windows** as the optimal alternative



Summary

- **Clamshell dredging with open water placement without controls 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?

