Risk-informed Decision Making

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RISK FRAMEWORK

RISK ASSESSMENT PARADIGM

Problem Formulation ➔ Exposure Assessment ➔ Risk Characterization ➔ Effects Assessment ➔ Risk Management

Risk = f(Exposure, Effects)

Economic Analysis, Socio-Political, Engineering Feasibility

MCDA
MCDA
Feeds
RA

Comparative RA

Decision Framework

The 4 R’s

RESUSPENSION

RELEASE

RESIDUALS

RISK
Presentation -- Overview

• Using Risk Assessment in Decisions
  ➢ MCDA Approach
  ➢ Application to Toddahoe

• 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

Tool Integration

- Risk Analysis
- Modeling / Monitoring
- Cost
- Stakeholders’ Opinion

Decision-Maker(s)

Decision Analytical Frameworks
- Agency-relevant/Stakeholder-selected
- Currently available software
- Variety of structuring techniques
- Iteration/reflection encouraged
- Identify areas for discussion/compromise

Decision Integration

Sharing Data, Concepts and Opinions
Toddaho Environmental Window

SPRING  SUMMER  FALL  WINTER

Salmon Outmigration

Fish Spawning

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

<table>
<thead>
<tr>
<th>Dredging Scenario</th>
<th>Production (cy/day)</th>
<th>Dredging Duration (days)*</th>
<th>Dredging Costs**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hopper w/ OWP</td>
<td>12,000</td>
<td>4</td>
<td>$280,000</td>
</tr>
<tr>
<td>Clamshell w/ OWP</td>
<td>3,000</td>
<td>16</td>
<td>$350,000</td>
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<tr>
<td>Clamshell w/ CDF</td>
<td>3,000</td>
<td>16</td>
<td>$540,000</td>
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<tr>
<td>Restricted Clamshell w/ OWP</td>
<td>2,000</td>
<td>24</td>
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<tr>
<td>Clamshell with Silt Curtain &amp; OWP</td>
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<tr>
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<td>20</td>
<td>$700,000</td>
</tr>
</tbody>
</table>

* Days without downtime  
** Environmental window would add $100,000 to cost due to scheduling, and greater equipment capitalization
# Risk Criteria

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Relative Costs</th>
<th>Salmonids</th>
<th>Fish Eggs</th>
<th>Mussels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hopper w/ OWP</td>
<td>No EW: 35</td>
<td>95</td>
<td>40</td>
<td>100</td>
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<tr>
<td></td>
<td>w/ EW: 48</td>
<td>100</td>
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<td>100</td>
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<tr>
<td>Clamshell w/ OWP</td>
<td>No EW: 44</td>
<td>60</td>
<td>90</td>
<td>100</td>
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<tr>
<td></td>
<td>w/ EW: 56</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Clamshell w/ CDF</td>
<td>No EW: 67</td>
<td>60</td>
<td>96</td>
<td>99</td>
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<tr>
<td></td>
<td>w/ EW: 80</td>
<td>100</td>
<td>100</td>
<td>99</td>
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<tr>
<td>Restricted Clamshell w/ OWP</td>
<td>No EW: 56</td>
<td>85</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>w/ EW: 69</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Clamshell with Silt Curtain &amp; OWP</td>
<td>No EW: 64</td>
<td>95</td>
<td>94</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>w/ EW: 76</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Clamshell with Silt Curtain &amp; CDF</td>
<td>No EW: 88</td>
<td>95</td>
<td>99</td>
<td>99</td>
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<tr>
<td></td>
<td>w/ EW: 100</td>
<td>100</td>
<td>100</td>
<td>99</td>
</tr>
</tbody>
</table>
Assessment Criteria

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

Alternatives: Distributive mode
- 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
Criteria Weights

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

<table>
<thead>
<tr>
<th>Cost</th>
<th>Survivability</th>
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<tr>
<td>6.00</td>
<td>0.00</td>
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</table>

Cost: 6.0
Survivability: 0.00

Incon: 0.00

Expert Choice D:\Work\ERDC\DREDGING\dredging_example.ahp
Metric Assessment by Criteria

<table>
<thead>
<tr>
<th>Alternative</th>
<th>DECR Cost (L. .857)</th>
<th>Survivability Salmonids (L. .333)</th>
<th>Survivability Fish Eggs (L. .333)</th>
<th>Survivability Mussels (L. .333)</th>
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<td>100</td>
<td>100</td>
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<tr>
<td>Clamshell with Silt Curtain &amp; CDF - No EW</td>
<td>88</td>
<td>95</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>Clamshell with Silt Curtain &amp; CDF - w/ EW</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>99</td>
</tr>
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</table>
Results for Different Stakeholders

Regulatory

Community

Public
Sensitivity Analysis

- 85.7% Cost
- 14.3% Survivability

Hopper w/ OWP - No EW vs. Hopper w/ OWP - w/ EW

Weighted head to head between Hopper w/ OWP - No EW and Hopper w/ OWP - w/ EW

- 13.36%
- 10.02%
- 6.68%
- 3.34%
- 3.34%
- 6.68%
- 10.02%
- 13.36%
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 an adaptive management framework will be used to ensure ecological risks are acceptable.
Questions?