WHAT CAN DECISION ANALYSIS DO FOR YOU?
What do they have in common?
HARD DECISIONS

Complex Science
Uncertainty
Tough Trade-offs
High Stakes
Intense Public Scrutiny
Jurisdictional Overlap
Multiple Stakeholders
Entrenched Positions
Polarized Values
The Idea

When you frame your problem as a decision – a choice with multiple objectives and alternative courses of action – it changes your point of entry into the problem and, consequently…
… it changes everything you do

• The make up of your project team
• The allocation of resources
• The collection of information
• The focus of uncertainty analyses
• The timing and methods for engaging stakeholders
A Species Recovery Plan
Scientific studies
Decision relevant studies
Sketch the Decision
## Pre-Sketch Framing

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Baseline Studies</th>
</tr>
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<tbody>
<tr>
<td>abundance</td>
<td>✓</td>
</tr>
<tr>
<td>probability of persistence</td>
<td>✓</td>
</tr>
<tr>
<td>habitat</td>
<td>✓</td>
</tr>
<tr>
<td>food</td>
<td>✓</td>
</tr>
<tr>
<td>mortality</td>
<td>✓</td>
</tr>
</tbody>
</table>
Influence Diagram

Predator Control

Management actions

Road Closure

Habitat

Predation

Corridors

Predator Control

Predation Closure

Predation

Corridors

Predator Control

Predation Closure

Predation

Corridors

Predator Control

Predation Closure

Predation

Corridors
### Post Sketch Framing: A Consequences Table

<table>
<thead>
<tr>
<th></th>
<th>Habitat Protection</th>
<th>Predator Control</th>
<th>Road Closures</th>
</tr>
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<tbody>
<tr>
<td>Caribou</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wolves</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Recreation</td>
<td></td>
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<td></td>
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<tr>
<td>Local Business</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to Government</td>
<td></td>
<td></td>
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</tbody>
</table>
Or…Kai’s example…
A Consequences Table

<table>
<thead>
<tr>
<th>Stock sustainability</th>
<th>ITQ</th>
<th>Derby</th>
<th>Other?</th>
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</thead>
<tbody>
<tr>
<td>Total economic value</td>
<td></td>
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<tr>
<td>Coastal employment</td>
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<td></td>
<td></td>
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<tr>
<td>Business ownership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsistence catch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Key Message: Sketch the Decision
But there’s little guidance on decision making....
Today

• Decision Traps
  – Barriers to using good science in decision making

• Structured Decision Making
  – An approach from the decision sciences

• Key Messages
Some traps that prevent the uptake of science in decision making

DECISION TRAPS

CAN YOU NAME THEM?
Common Decision Traps

- Working in Silos
- Lack of Level Playing Field
- The Power Play
- Ambiguity
- Gut Feel
- Anchoring & Positioning
- Groupthink
- Hostage-taking
- The Goldilocks
- The Stall and Study
- The End Run
Structured Decision Making

INTRODUCTION

Public sector, private sector and non-governmental organizations are increasingly adopting sustainability or triple bottom line (TBL) policies, and working to embed them into everything they do, including organizational decision-making.

For more than a decade, BC Hydro has been developing a more structured approach to decision-making, which was recently formalized as Structured Decision Making (SDM). The goal is to help staff and the organization overall make better decisions by generating options based on multiple (and sometimes competing) objectives and by carrying tradeoffs, while remaining focused on the triple-bottom-line.

TBL AT BC HYDRO

BC Hydro is the third largest electric utility in North America. 95% of the population of British Columbia are served by the Ministry of Energy, Mines and Petroleum Resources.
What is SDM?

An organized framework for helping people, especially **groups**, identify creative options and make informed, **defensible** and **transparent** choices
SDM is…

Based in the decision sciences
• A set of core steps
• A set of structuring tools

Adapted for the real world
• Practical, scalable and iterative
• Helps avoid “decision traps”

Recognized best practices
• Analysis and deliberation
• Facts and values
“Decision analysis is formal use of common sense for problems that are too complicated for informal use”

Ralph Keeney

Steps of SDM

1. Clarify the Decision Context
2. Define Objectives and Measures
3. Develop Alternatives
4. Estimate Consequences
5. Evaluate Trade-Offs and Select
6. Implement, Monitor and Review

Iterate
SDM integrates…

- Technical analysis with engagement process
- Small group engagement with broader public engagement
What Decision Analysis Can Do for You

SDM LESSONS
Sketch the Decision

- What decision is being made? By whom?
- What’s in and out of scope?
- What kind of technical analysis is needed? What are the key gaps?
- What kind of engagement is needed?

1. Clarify the Decision Context
2. Define Objectives and Measures
3. Develop Alternatives
4. Estimate Consequences
5. Evaluate Trade-Offs and Select
6. Implement, Monitor and Review

Context  Objectives  Alternatives  Consequences  Trade-offs  Monitoring
From the sketch:

- A road map
- Integrated process
- Insight into likely trade-offs and uncertainties
- Terms of reference

<table>
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<td></td>
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<tr>
<td>Local Business</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cost to Govt</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Define a concise set of Objectives

Objectives and performance measures define what matters in the decision and become the criteria for evaluating alternatives.
Assess “what matters”

….not what you have data on

“spiritual quality”

Voice of the River
• Sound
• Smell
• Movement
• Interaction of people and water
### Assess “what matters”

<table>
<thead>
<tr>
<th>Objective</th>
<th>Sub-objective</th>
<th>Measure (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon</td>
<td>All species</td>
<td>Biomass (kg)</td>
</tr>
<tr>
<td></td>
<td>Chinook</td>
<td>Biomass (kg)</td>
</tr>
<tr>
<td>Species at Risk</td>
<td>Harlequin ducks</td>
<td>Abundance (#)</td>
</tr>
<tr>
<td>Riparian Health</td>
<td>Adult cottonwood</td>
<td>Growth Mm/year</td>
</tr>
<tr>
<td></td>
<td>Juvenile cottonwood</td>
<td>Growth Mm/year</td>
</tr>
<tr>
<td>River Health</td>
<td>Benthic community abundance</td>
<td>Millions of individuals</td>
</tr>
<tr>
<td></td>
<td>Benthic community diversity</td>
<td>% EPT</td>
</tr>
<tr>
<td>Spiritual Quality</td>
<td>Voice of the river</td>
<td>Scale (1-5)</td>
</tr>
<tr>
<td>Finances</td>
<td>Power revenues</td>
<td>$ million per year</td>
</tr>
</tbody>
</table>
Use Performance Measures to level the playing field…

• Across objectives
  – They operationalize hard-to-quantify objectives

• Across alternatives
  – Every alternative is evaluated on the same basis

• Across participants
  – Synthesize technical concerns for non-technical participants
Use Performance Measures to identify and prioritize studies…

Does the uncertainty affect a PM?

Does it vary across alternatives?

Can it be meaningfully resolved in a reasonable time?

Y  N

Consider a study

Consider:
Implement and Monitor
Adaptive Management
Scenario Analysis
Look for robust alternatives
Alternatives

What’s the right number of alternatives?
Generate a Range of Alternatives

• Develop a range of real, distinct and creative alternatives
• Iterate
• Don’t panic!

People won’t make tough trade-offs unless they’re sure they have to… and that only happens if they believe the best alternatives are on the table
Alternatives can take many forms…

- Packages
- Sequenced alternatives

**Strategy 1: Do nothing now, maybe something later**

- **Scen 1**: Do nothing
- **Scen 2**: Build partial barrier
- **Scen 3**: Build full barrier

**Strategy 2: Partial now, then let’s see**

- **Scen 1**: Do nothing further
- **Scen 2**: Build full barrier
- **Scen 3**: Do nothing further

**Strategy 3: Big bet now**

- **Scen 1**: Build full barrier
- **Scen 2**: Build full barrier
- **Scen 3**: Build full barrier
Make a Consequence Table

- Focus studies on populating the table
- Do analysis that is “good enough” to inform the decision
- Use models and expert judgment
- Iterate

### Objective Attribute

<table>
<thead>
<tr>
<th>Alternative</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper Campbell</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion risk days per year</td>
<td>37</td>
<td>13</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Recreation rec days per year</td>
<td>43</td>
<td>40</td>
<td>106</td>
<td>158</td>
<td>158</td>
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<tr>
<td>Fish - Cutthroat % Available Habitat</td>
<td>40</td>
<td>60</td>
<td>50</td>
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<td>35</td>
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<tr>
<td><strong>Lower Campbell</strong></td>
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<td></td>
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<tr>
<td>Erosion risk days per year</td>
<td>3</td>
<td>27</td>
<td>13</td>
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<td>Recreation rec days per year</td>
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<tr>
<td>Fish - Cutthroat % Available Habitat</td>
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<td>18</td>
<td>95</td>
<td>79</td>
<td>79</td>
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<tr>
<td>Fish - Rainbow % Available Habitat</td>
<td>26</td>
<td>3</td>
<td>49</td>
<td>49</td>
<td>47</td>
</tr>
<tr>
<td><strong>Campbell River</strong></td>
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<td></td>
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<tr>
<td>Flooding flood days per year</td>
<td>34</td>
<td>48</td>
<td>24</td>
<td>59</td>
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</tr>
<tr>
<td>Recreation rec days per year</td>
<td>66</td>
<td>83</td>
<td>51</td>
<td>81</td>
<td>79</td>
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<tr>
<td>Fish - Spill Risk spill days per year</td>
<td>118</td>
<td>214</td>
<td>102</td>
<td>176</td>
<td>177</td>
</tr>
<tr>
<td>Fish - Spawning % success</td>
<td>55</td>
<td>89</td>
<td>78</td>
<td>59</td>
<td>59</td>
</tr>
<tr>
<td>Fish - Rearing risk index</td>
<td>0.53</td>
<td>0.48</td>
<td>0.53</td>
<td>0.50</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Salmon River</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Canoe Route canoe days</td>
<td>162</td>
<td>167</td>
<td>153</td>
<td>204</td>
<td>183</td>
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<tr>
<td>Fish and Wildlife Habitat habitat risk index</td>
<td>0.54</td>
<td>0.47</td>
<td>0.44</td>
<td>0.48</td>
<td>0.53</td>
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<td><strong>System-Wide</strong></td>
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<td></td>
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<tr>
<td>Power Annual Revenue $ / Year</td>
<td>68.5</td>
<td>64.6</td>
<td>68.6</td>
<td>65.1</td>
<td>65.3</td>
</tr>
</tbody>
</table>
Get good at expert judgment

There are best practices… use them!

- Use multiple experts
- Separate facts and values
- Avoid common biases
- Avoid ambiguity
- Use an appropriate elicitation protocol
- Compare across experts
- Create a traceable account (peer reviewable!)
Be explicit about uncertainty
Address Risk Tolerance

Upper Campbell / Buttle Lake: Spawning Habitat - Cutthroat

Alternative

% Available Habitat

- Best Impact
- Median
- Worst Impact

Alternative

% Available Habitat

0 10 20 30 40 50 60 70 80

E F G H I J
Put the most relevant info in the CT

• Important but routine/repeated decisions
  – Expected value may be most relevant?

• Low probability high consequence events matter
  – Report both expected and extreme events?

• Low probability high consequence events can be ignored
  – 90% confidence interval?

You can’t put all the uncertainty ranges in for all the performance measures
Focus on Trade-offs

(That’s another talk!)
Focus on Trade-offs

Simplify by eliminating dominated alternatives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Attribute</th>
<th>E</th>
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<td>Flooding</td>
<td>flood days per year</td>
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**Alternatives**

- **E**
- **F**
- **G**
- **H**
- **I**
Focus on Trade-offs

- But suppose there are irreducible and complicated trade-offs?
- Use structured methods to facilitate useful dialogue and summarize differing views.

### Table 1

<table>
<thead>
<tr>
<th>Location</th>
<th>Performance Measure</th>
<th>Units</th>
<th>Worst Case</th>
<th>Best Case</th>
<th>Rank</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Campbell Lake</td>
<td>Recreation - Days / Year</td>
<td>weighted days (217.5, 218.5, 200m by season)</td>
<td>40</td>
<td>158</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Erosion</td>
<td>weighted days (220 and 221 m)</td>
<td>37</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Effective Littoral Zone</td>
<td>hectares</td>
<td>91</td>
<td>220</td>
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</table>

### Table 3

<table>
<thead>
<tr>
<th>Location</th>
<th>Performance Measure</th>
<th>Units</th>
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<th>Best Case</th>
<th>Rank</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>Campbell River</td>
<td>Flooding - Total Days</td>
<td>weighted days (300, 453, 530 cms)</td>
<td>59</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recreation - Days / Year</td>
<td>weighted days (28 cms - 80 cms)</td>
<td>51</td>
<td>83</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spawning Habitat - All %</td>
<td>successful redds (Chum as indicator)</td>
<td>55</td>
<td>89</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rearing Habitat - All Sp &quot;Average&quot;</td>
<td>risk index (scale 0 - 1)</td>
<td>0.53</td>
<td>0.48</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### INSTRUCTIONS

For each table:

- A. Rank the measures in terms of their relative importance, with a rank = 1 being your most important measure. Ties are okay.
- B. Assign 100 points to the #1 ranked measure.
- C. Assign points to the other measures to reflect their importance relative to the #1 ranked measure. Remember to assign points based on how important it is to swing the measure from its worst to its best. If the range from worst to best is very small or very large, that should affect the importance you give it.
Monitoring and Adaptive Management

Final Operating Alternatives

Monitoring Programs

Context | Objectives | Alternatives | Consequences | Trade-offs | Monitoring
Key Messages

• Sketch the decision before you start – it will change the focus of analysis
• Level the playing field – using performance measures let’s non-technical people participate on equal footing
• Generate alternatives – solutions are only as good as the alternatives explored, and science has a role to play
• Focus your analysis on the evaluation of alternatives
• Compare the risk profiles of alternatives – let decision makers express their risk tolerance
• All choices involve tough trade-offs; there are ways to help groups address them productively
• Agreement in the presence of uncertainty is likely to require a firm commitment to monitoring and adaptive management
THANKS!

Lee Failing, P. Eng. MRM
www.compassrm.com
www.StructuredDecisionMaking.com