compass

Structured Decision Making in Fisheries Management Applications

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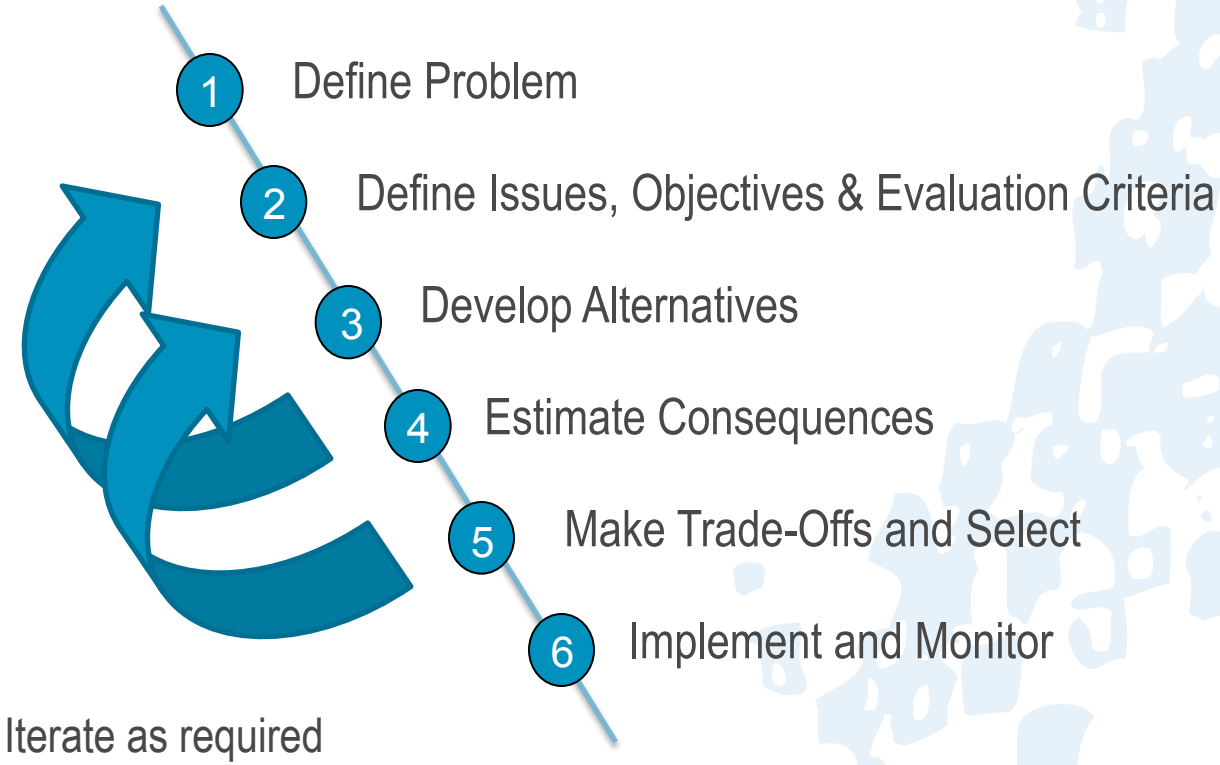
What is structured decision making?

"A formalization of common sense for decision problems which are too complex for informal use of common sense." ***(Ralph Keeney)***

- *A set of core steps*
- *A set of structuring tools from the decision sciences*
- *Informed by the behavioural sciences*
- *An integration of analysis and deliberation*
- *Flexible, scaleable and iterative*

Steps in a typical planning decision

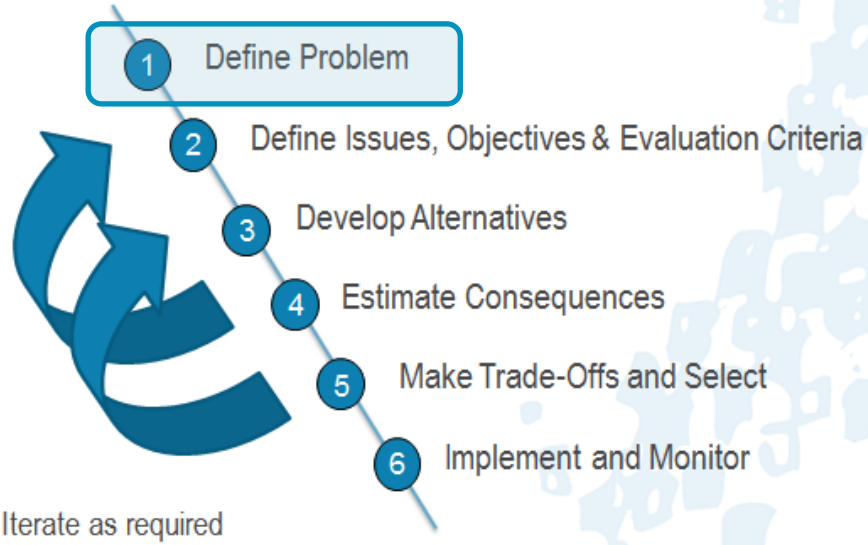


Structuring Tools

SDM

- Objectives hierarchies
- Means-ends diagrams
- Influence diagrams
- Decision trees
- Value-focused thinking
- Strategy tables and portfolio builders
- Consequence tables
- Structured expert judgment
- Risk profiles and risk tolerance
- Multi-attribute trade-off analysis (MATA)
- Adaptive management

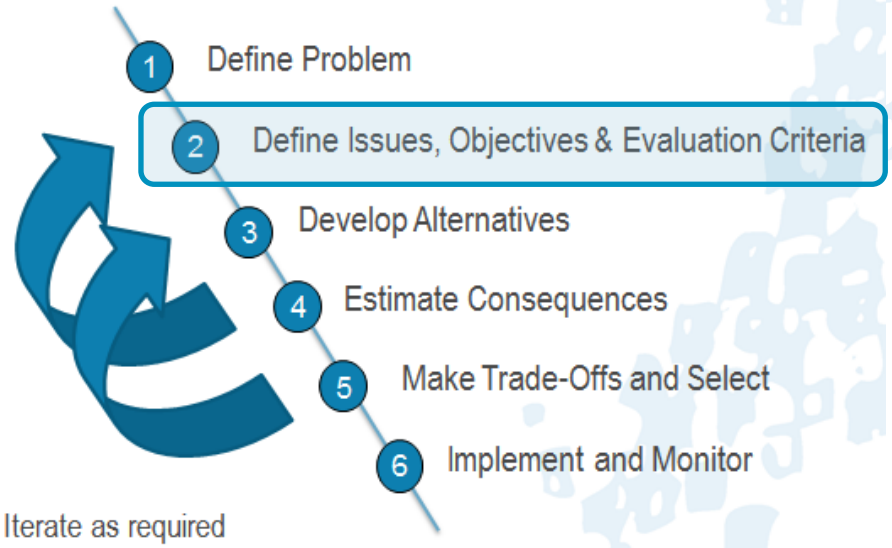
Kim's Truck



- **Kim's thinking of buying a truck as part of her job**
- **She needs it primarily for hauling workshop materials around over the next five years, but also has to use it to ferry visitors…**
- **No strict budget, but has to demonstrate diligence and value**

Kim's Truck

- **She starts by making a long list of all the issues she could consider important when choosing…**
  - Cost, payload, condition, mileage, cupholders, cd player, sunroof, tire condition, # passengers, comfort, looks, etc etc



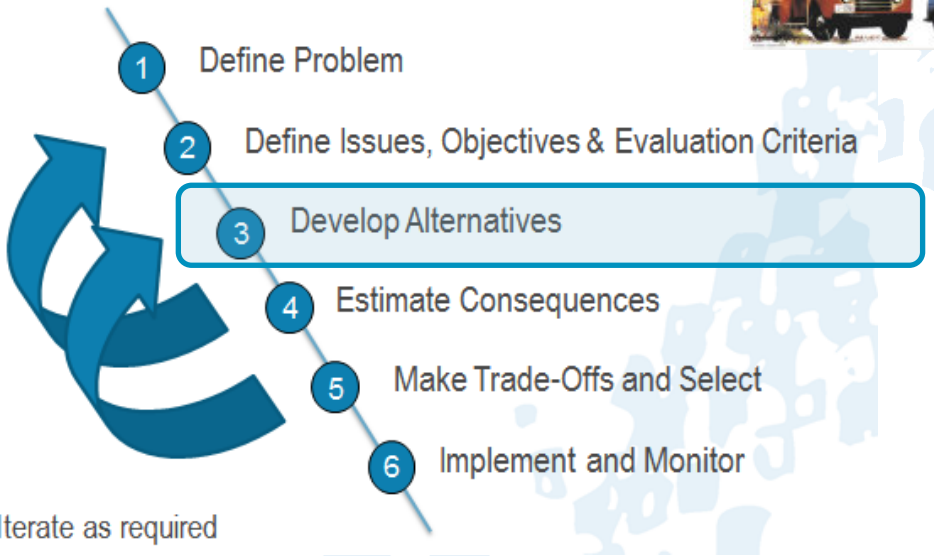
Kim's Truck

- **She trims them to the ones that *really matter to her and her employers, and develops evaluation criteria*:**

Objective	Sub Objective	Evaluation Criteria	Direction
Price	Cost	$	less
	Fuel Economy	L / 100 km	less
Durability	Mileage	kilometres	less
Functionality	Bed Size	feet	more
	Payload	pounds	more
	Passengers	#	more

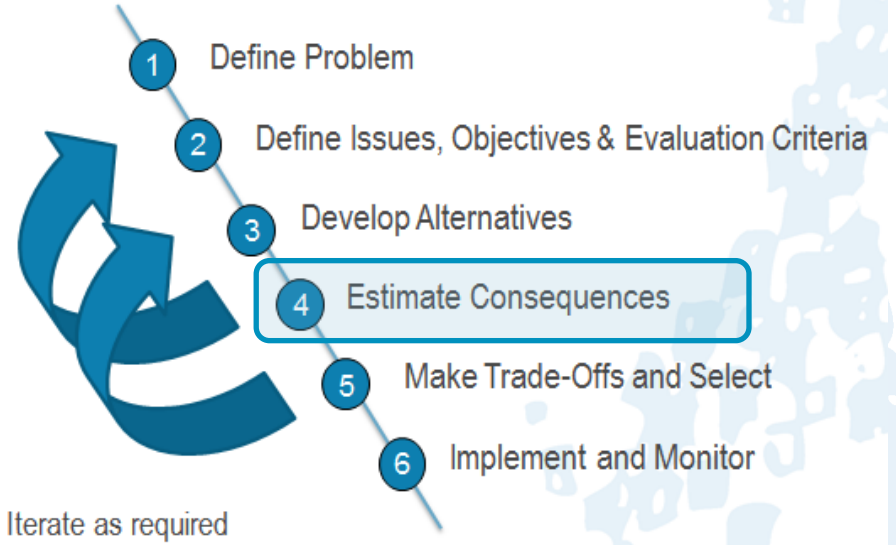
Kim's Truck

- **Then she's off shopping…**



Kim's Truck

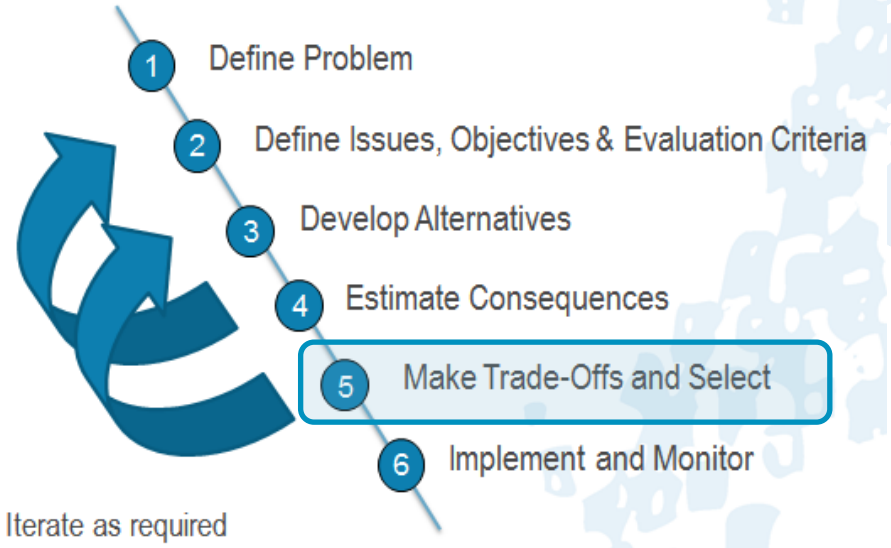
- She picks a few likely trucks and does some homework on six of them:



Obj.	Sub Objective	Criteria / Units	Dir	Truck A	Truck B	Truck C	Truck D	Truck E	Truck F
Cost									
	Price	$	L						
	Fuel Economy	L / 100 km	H						
Durability									
	Mileage	km on clock	L						
Functionality									
	Bed Size	feet	H						
	Payload	pounds	H						
	Passengers	#	H						

Kim's Truck

- But how can she decide which one is the best?
- And how can she demonstrate her diligence to her employers?



Kim's Truck

- **[SWITCH TO SPREADSHEET DEMONSTRATING TRADE-OFF ANALYSIS]**

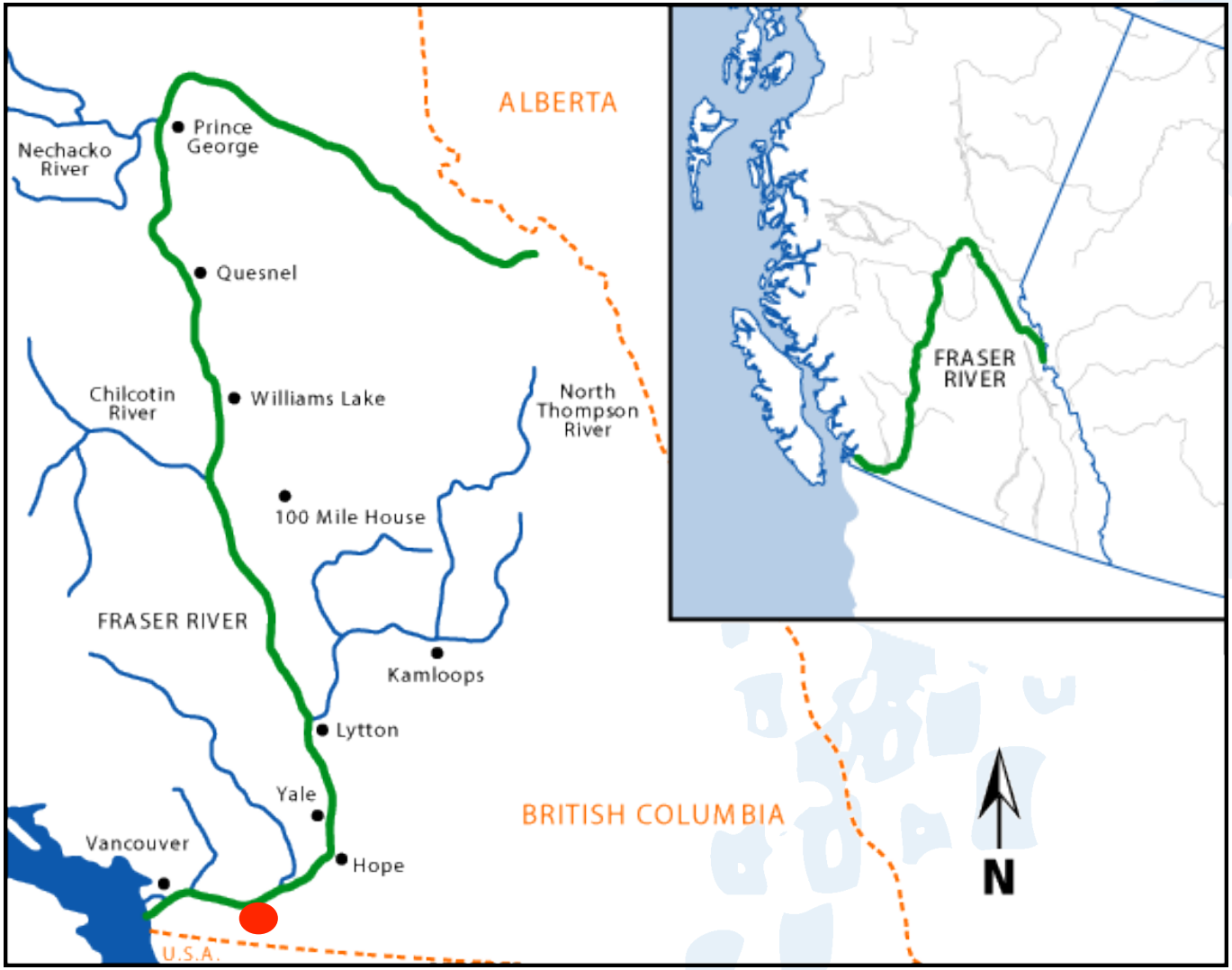
Simple Example: Key Points

- **Decided first on decision scope, structure**
- **Decided on objectives and criteria**
  - Did not set thresholds…
- **Looked out for alternatives**
- **Filled the table with data**
- **Selected a preferred alternative using explicit value judgments**
- **Reasonable people may disagree on the value judgments, but hopefully could agree on the data**

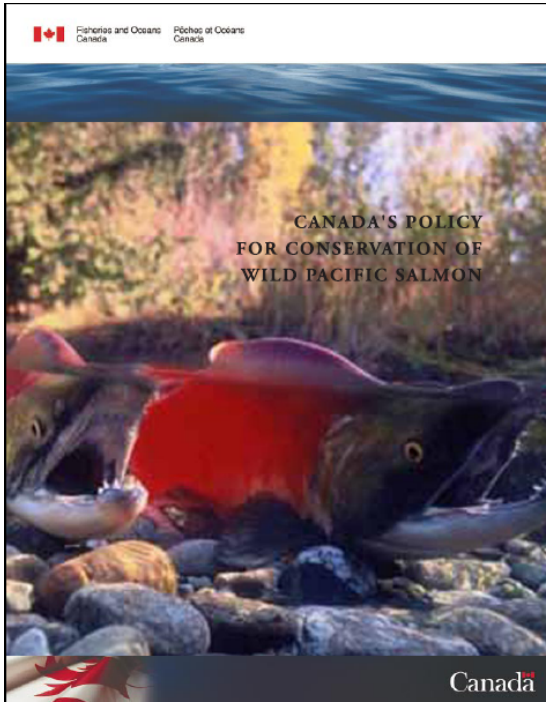
(Work undertaken win partnership with Robin Gregory, Value Scope Research)

EXAMPLE: CULTUS LAKE SOCKEYE

Cultus Lake Sockeye



SDM Cultus Sub-committee



- **Canada's Wild Salmon Policy**
- **Proposes a multi-stakeholder, five step planning process under certain circumstances:**
  - Step 1 - Identify planning priorities
  - Step 2 - Identify resource management options and alternative management strategies
  - Step 3 - Establish biological, social, and economic performance indicators
  - Step 4 - Assess the likely impacts of management alternatives
  - Step 5 - Select the preferred management alternative

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- **Met three times over April 2006**
- **Present were:**
    - *Fisheries and Oceans Canada (DFO)*
    - *BC Ministry of Environment*
    - *A First Nations' NGO*
    - *Commercial Fisheries*

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- **Purpose was to:**
  - *Apply the SDM process to the question of Cultus Lake Sockeye management decisions for 2006*
    - in a highly curtailed timeline…
  - *Bring findings back to an existing multi-stakeholder planning committee*
  - *Explore the use of the process for improved management decisions in future*

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Meeting	Activity
Meeting 1 April 3	• Scope & Bound Problem • Objectives and Performance Measures • Build Alternatives • Confirm Consequence Table Sketch
Meeting 2 April 21	• Present populated Consequence Table • ID key uncertainties • Group critique of data • Mock trade-off exercise • Ideas for improved alternatives
Meeting 3 April 27	• Present revised Consequence Table • Trade-off exercise • Set context and schedule for future work • Document areas of Agreement and Disagreement

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Objectives & Evaluation Criteria

- **Sockeye conservation**
  - *Probability of meeting Recovery Plan objectives 1 and 2*
  - *Returns in years 2010 and average of 2016-19*
  - *Probability of extirpation by 2036*
  - *% Enhanced in 2010 and average of 2016-19*
- **Costs**
  - *Total costs over 12 years, levelized*
  - *No cost allocation attempted*
- **Catch**
  - *Traditional commercial catch*
  - *Commercial TAC available upstream of Vedder River*
  - *Total First Nations Food, Social and Ceremonial (FSC)*
- **Jobs**
  - *Employment opportunities directly related to enhancement and freshwater projects*

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Alternatives

- **Created by assembling 'blocks' of options:**
  - Cultus Exploitation Rate %
  - Enhancement options
  - Freshwater projects options

  - Initially, "Location" was included as a defining factor, later removed because doubts about implementation in 2006

- **Two examples:**

Cultus Lake Sockeye

Cultus Exploitation Rate %	Enhancement	Freshwater projects options
5	None	None
10	Current Captive Brood	Current Milfoil Removal
20	Double Current Capacity	Current Pikeminnow
30	Maximum Enhancement	Large Milfoil Removal
40		Large Pikeminnow Removal

Alternative 1: “Status Quo”

Cultus Lake Sockeye

Cultus Exploitation Rate %	Enhancement	Freshwater projects options
5	None	None
10	Current Captive Brood	Current Milfoil Removal
20	Double Current Capacity	Current Pikeminnow
30	Maximum Enhancement	Large Milfoil Removal
40		Large Pikeminnow Removal

Alternative 2: “Spread the Pain 2”

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Alternatives

- **Three iterations of alternatives**
  - Meeting 1
    - *created 6*
  - Meeting 2
    - *reviewed 6 and created 3 more*
  - Meeting 3
    - *reviewed 9, eliminated 6*
    - *agreed on several key components*
    - *created 6 new simpler variations of one alternative, sketched out performance and compared*
  - Post-Meeting 3
    - *Modelled 6 variations*

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Consequences of Alternatives

- **To fill the matrix with data, we:**
  - Employed and modified a freshwater model and the Fraser Panel's fishery model
  - Obtained input on enhancement issues and costs from DFO enhancement
  - Obtained input on freshwater project issues and costs from DFO

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Consequences of Alternatives

- **In the time available, we were unable to meaningfully address many key issues relating to data uncertainty**
- **Ideally, we would have undertaken a sensitivity analysis of key assumptions in models used to**
    - Identity key uncertainties
    - Flag those that can be reduced by research
    - Undertake formal expert judgment elicitations for those that cannot
    - Better understand and represent uncertainty in the decision

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Consequences of Alternatives

- **In meeting 3, examined consequence table for key trade-offs across objectives**

Objective	Attribute	Direction	Units	Status Quo	Preservation	Commercial	Terminal Benefits	Spread the Pain 1	Spread the Pain 2	Max Rebuilding	Spread the Pain 3	Sports Compromise
Conservation	% meeting Rec Plan Objective 1	H	%	73%	76%	82%	80%	72%	80%	84%	79%	81%
Conservation	% meeting Rec Plan Objective 2	H	%	32%	33%	33%	34%	31%	35%	34%	33%	34%
Conservation	No of returns in 2010	H	# 000	6.3	7.8	12.5	8.7	6.5	8.6	13.2	8.0	8.9
Conservation	No of returns in 2016-2019 (ave)	H	# 000	16.9	24.3	47.7	31.1	16.8	30.1	53.8	28.7	35.7
Conservation	Probability of extinction	L	%	2.4%	1.1%	0.0%	0.3%	3.4%	0.2%	0.0%	0.4%	0.2%
Conservation	% Enhanced fish 2010	L	%	27%	21%	56%	34%	26%	35%	52%	37%	46%
Conservation	% Enhanced ave fish 2016-2019	L	%	33%	29%	45%	41%	32%	42%	41%	45%	46%
Costs	Total Costs	L	!Yr Av Ave $00	$ 171	$ 309	$ 588	$ 488	$ 171	$ 523	$ 588	$ 328	$ 440
Catch	Traditional Commercial	H	# 000	1,298	72	5,877	3,088	3,088	4,588	1,298	3,878	4,588
Catch	Available Comm TAC Above Vedder	H	# 000	4,710	5,936	131	2,920	2,920	1,420	4,710	2,130	1,420
Catch	Total First Nations FSC	H	# 000	1,048	842	1,030	1,150	1,150	1,073	1,048	1,115	1,073
Jobs	Total FTEs	H	# FTEs	1.60	2.80	4.10	3.70	1.60	3.30	4.10	2.50	4.10

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Trade-Off Analysis

- **Participants examined the 'trade-offs' between alternatives**
- **Participants eliminated alternatives through exploring areas of**

    - Insensitivity – where performance measures do not vary across alternatives

    - Dominance – where one alternative is better than or equal to all (or, by collective agreement, most) aspects of another

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Trade-Off Analysis

- **[SWITCH TO SPREADSHEET DEMONSTRATING TRADE-OFF ANALYSIS]**

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Conclusions

- **We applied SDM in a highly curtailed timeline**
- **This was a data rich example – data poor might look different but with the same underlying structure**
- **Different regulatory standpoint**
  - Focus in this case was not on defining thresholds – don't need them as long as the consequences of actions are properly represented

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Conclusions

- **Focus on ‘process’ as a means of defining optimality**
  - If the process is defensible, then the claim that the final choice is socially ‘optimal’ is defensible
- **Structuring helps:**
  - gain an understanding of what matters to whom
  - understand what some coherent, distinct options might look like
  - explore how different options might affect different people’s interests
  - ground discussions about trade-offs in reality
  - find a path through that everyone can feel good about
  - create a documentable process that others can understand

SDM works best when…

- **People are realistically looking to find a solution that all can live with**
  - Respectful, non-positional atmosphere
- **People agree that an analytical approach to understanding trade-offs is necessary**
- **People are willing to make decisions while building a framework for reducing uncertainty over time**
- **The process is given time and resources commensurate to the stakes and complexity of the problem**

More…

Risk Analysis, Vol. 29, No. 4, 2009

DOI: 10.1111/j.1539-6924.2008.01182.x

Using Structured Decision Making to Help Implement a Precautionary Approach to Endangered Species Management

Robin Gregory[1]* and Graham Long[2]

Endangered species protection is a significant risk management concern throughout North America. An extensive conceptual literature emphasizes the role to be played by precautionary approaches. Risk managers, typically working in concert with concerned stakeholders, frequently cite the concept as key to their efforts to prevent extinctions. Little has been done,

Thanks

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