Using Structured Decision Making Approaches to Clarify Environmental Management Choices

Robin Gregory, Decision Research & Value Scope Research
IRES, University of British Columbia

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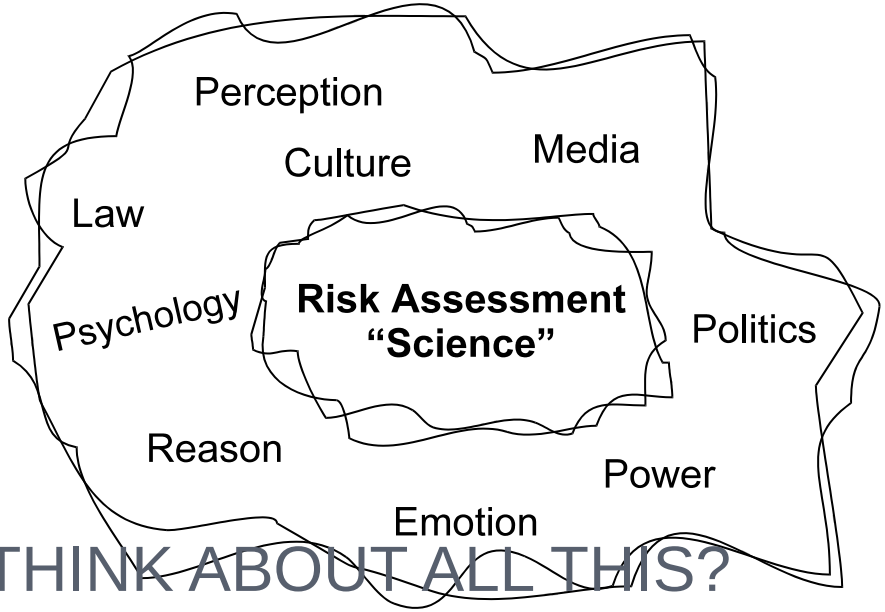
Lake Champlain Basin Program

SDM Overview: Environmental management as applied decision making

1. EM efforts are typically complex:
   - Multiple objectives: health risks, economics, social, environment, culture, process/governance
   - Multiple actions or sets of actions
   - Multiple metrics
   - Multiple participants (stakeholders)
2. Implementation takes place in a a constrained world (location, money, time, resources, knowledge)
3. Context shaped by both ecosystem & social considerations
4. It is hard to make predictions or to account for all factors, thus
5. Strategies need to be adaptive and responsive to uncertainty, but
6. Institutions and people may not always be sufficiently flexible.



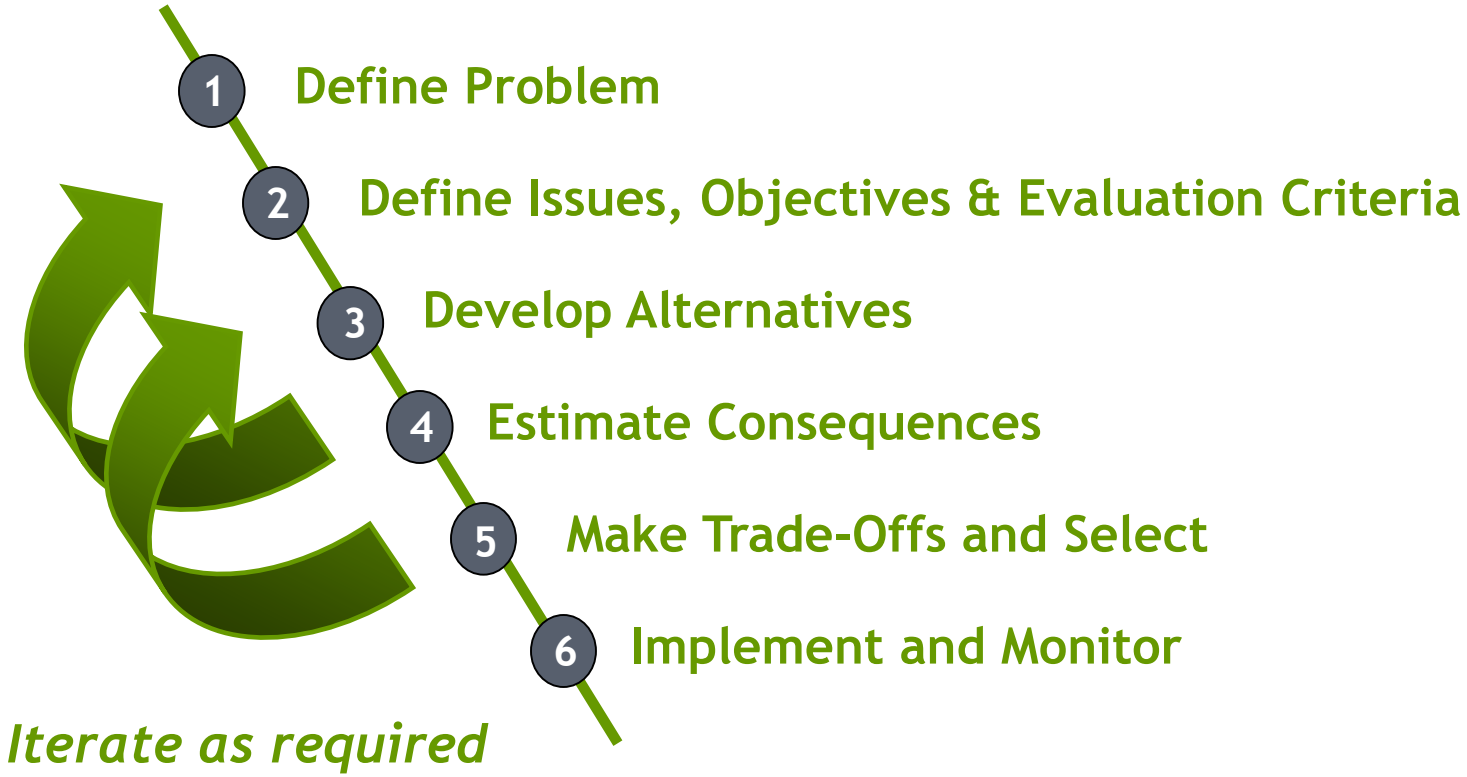
HOW TO THINK ABOUT ALL THIS?

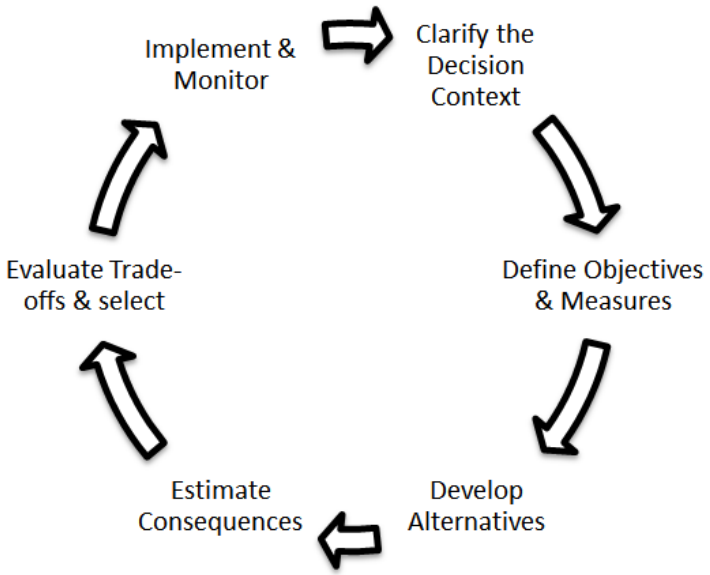
ENVIRONMENTAL DECISIONS THAT INVOLVE RISK AND UNCERTAINTY ARE COMPLEX, AND INVOLVE INTUITION AND EMOTIONS AS WELL AS "SCIENCE" -- MANY INTERESTS, MANY STAKEHOLDERS, TOUGH CHOICES.

PROBLEMS WITH CONVENTIONAL ENVIRONMENTAL MANAGEMENT FRAMEWORK

- Conventional thinking: If people have good information, they will make good choices. Assumes:
  - Information is relevant and people can understand it
  - Good information leads to good decisions
- Good information has a role to play. But:
  - Information only relevant if it's understandable and connects to the values / concerns of participants
  - People often find it difficult to make good decisions: too much information, probability neglect, judgment biases
- Search for "consensus" often leads to acceptance of "lowest common denominator" so key issues ignored
  - Dialogue alone no fix: groups also make poor choices
  - "Engagement" means more than long lists of concerns

Solution? At the start, treat each problem as a new decision opportunity and establish a structured decision process

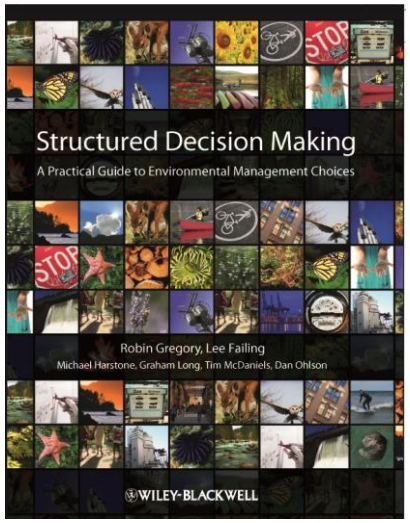




Structured Decision Making

A step-by-step approach to generating and evaluating policy strategies marked by

- Multiple interests
- Multiple participants
- Conflicting information
- Uncertainty



Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D. (2012). *Structured decision making: A practical guide to environmental management choices.* Chichester, West Sussex, UK: Wiley-Blackwell.

Origins of SDM

Based on principles of Decision Analysis and Multi-attribute Utility Theory (MAUT)

- Well developed axiomatic structure for how decisions should be made
- "The formal use of common sense for decision problems that are too complex for informal use of common sense" (Ralph Keeney, 1982)

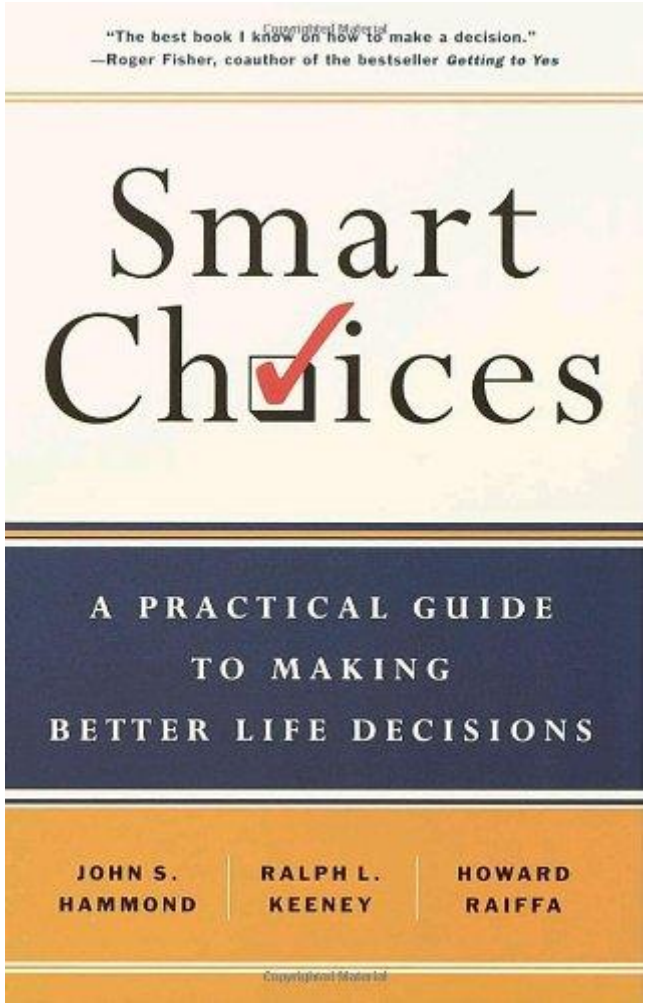
Incorporates insights from Behavioral Decision Theory, Psychology, and Economics

- How we process information and evaluate options
- What aspects of decision making we do poorly or well

Incorporates both rational / cognitive and affective / emotional aspects of decision making

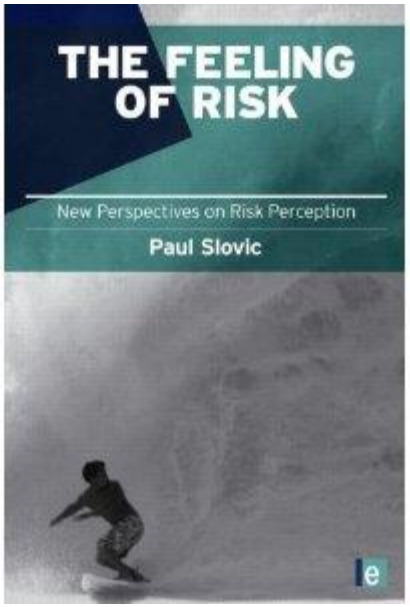
ADOPTING A DEFENSIBLE DECISION-MAKING PROCESS

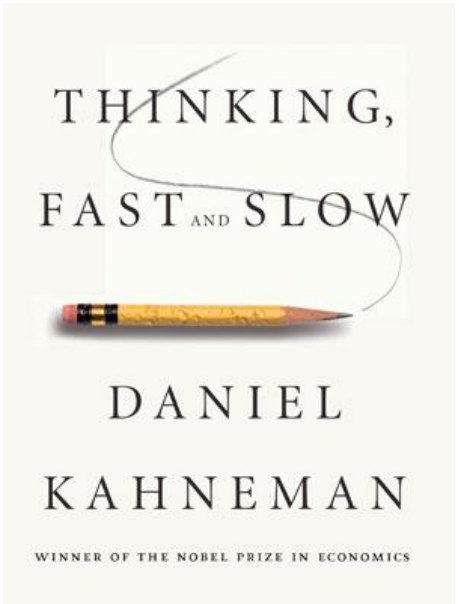
Hammond, J. S., Keeney, R. L., & Raiffa, H. (1999). *Smart choices: A practical guide to making better decisions. Cambridge, MA: Harvard Business School Press.*



UNDERSTANDING AND INTEGRATING INFORMATION – ABOUT VALUES AND PERCEPTIONS AS WELL AS FACTS -- AS PART OF A DECISION-MAKING PROCESS

- Slovic, P. (Ed.). (2010). *The feeling of risk: New perspectives on risk perception*. London, UK: Earthscan.
- Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.





SDM EXAMPLE: TRAVEL TICKET

- Imagine that you talk with a group of people and get their main ideas about what matters to them in terms of buying an air ticket from Vancouver to Montreal. They tell you:

- I don't want to spend much money
- I am concerned about all the airline crashes recently
- I want an aisle seat
- I want a direct flight
- I want decent leg room
- I don't want hidden fees and I don't want to pay extra for one checked bag
- I want friendly service
- I am not comfortable flying with a new airline
- I want easy check-ins

The question is: What do you do with this information? You could always make a list, the longer the better, to prove that you listen well. Or ……

SDM EXAMPLE: TRAVEL TICKET

Issues	Objectives	Evaluation Criteria
• I don't want to spend much money • I don't want hidden fees • I don't want to pay extra for my checked bag	➔ Minimize Cost	$ Total
• I want a direct flight • I want easy check-ins	➔ Minimize Travel Time	Hours
• I want decent leg room • I want an aisle seat • I want friendly service	➔ Maximize Comfort	Scale (5 = best, 0 = Worst)
• I am concerned about all the airline crashes recently • I am not comfortable flying with a new airline	➔ Maximize Safety	# Accidents / 1 million take-offs (5 yr ave)

SDM EXAMPLE: Buying Air Ticket

Objective	**Indicator Units**	**Preferred Direction**	**A Air Canada**	**B Transat**	**C Vintage Air**
Minimize Cost	$	Lower is better	$600	$450	$200
Minimize Travel Time	Hours	Lower is better	5-6	6-10	10-24
Maximize Comfort	(5 = best, 0 = worst)	Higher is better	4	4	? 0-5
Maximize Safety	# Accidents / 1 million take-offs (5 yr ave)	Lower is Better	3.8	2.6	? 0 – 40(?)

SDM EXAMPLE

Objective	Indicator Units	Preferred Direction	A Air Canada	B Transat	C Vintage Air
Minimize Cost	$	Lower is better	$2,000	$1,500	$ 00
Minimize Travel Time	Hours	Lower is better	8-9	13-15	12 64
Maximize Comfort	(subjective; 0 = worst)	Higher is better			? -5
Maximize Safety	# incidents / million take-offs (5 yr ave)	Lower is Better			? – 4 (?)

SDM IN ACTION

Structured Decision Making methods are a set of flexible approaches to aid decision makers in addressing tough environmental choices

Key insights:

1) Separate facts and values
2) Measure objectives in terms that make sense
3) Create alternatives responsive to objectives
4) Simplify decision elements when possible
5) Don't ignore uncertainty or data gaps
6) Stay flexible and incorporate what is learned
7) Involve stakeholders in both analysis and dialogue
8) Don't lose track of common sense

WHAT ARE THE PRACTICAL IMPLICATIONS FOR DECISION MAKERS?

- Structured Decision Making methods spend more time at the start of a decision making process, working with stakeholders to bound the problem and to develop a comprehensive set of concerns
- Both “tangible” and “intangible” concerns are considered – a level playing field for analysis
- Engagement is measured by decision quality and its relation to the decisions at hand – not by the number of people who attend meetings or the amount of money spent
- Success is measured by the ability of management alternatives to meet peoples’ fundamental concerns and to be implemented in a timely manner

Step 1: DEFINE THE PROBLEM

What is the problem, or the set of problems, that should be addressed? Depends on how the problem is defined:

- Who is involved (stakeholders)?
- What concerns are included? -- social, economic, environmental & health -- benefits, costs, and risks
- What options are possible?
- What are goals of decision makers?

Environmental management efforts often fail – and waste time and money – because they fail to define the correct problem.

Often the solution will be obvious, and no more analysis needed, once the problem is correctly defined!

SDM IS A VALUES-FOCUSED APPROACH

Any Environmental Management Issue will have multiple perspectives –understand the multitude of perspectives that are important to consider when making management decisions.

STEP 2: IDENTIFY OBJECTIVES AND MEASURES

Objectives are the things that matter, in the context of the decision under consideration

- To define an objective: state what is valued along with an adjective to describe desired direction of change (more vs less) and an attribute / performance criteria to assess progress
- Why are objectives needed?
  - create the basis of transparent, consistent DM
  - create the basis for comparing alternatives, monitoring over time
  - create the basis for communicating the rationale for choices to those not directly involved
- Can be quantitative or qualitative, “hard” or “soft”

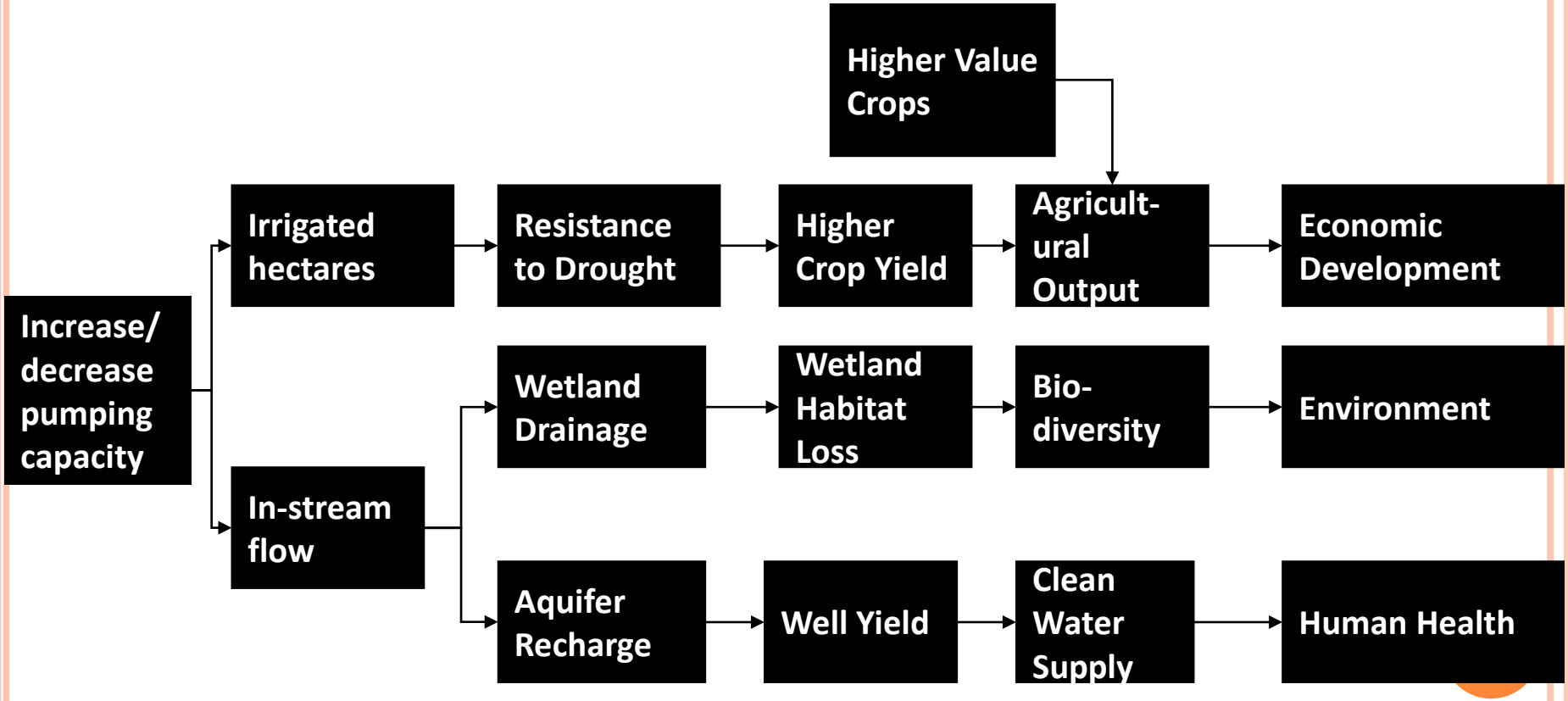
Objectives – A Primer

- **Fundamental (or Ends) Objectives**
  - A concise statement of the essential things that matter to decision makers
  - The ultimate outcomes that will be used to identify and compare alternatives, and ultimately to evaluate success
  - Include everything that really matters, whether you know how to quantify it or not
- **Means Objectives**
  - Not important in and of itself, but rather because it helps to achieve something else that is important (note: the choice among means objectives can matter greatly to a decision)
  - Means objectives usually are the basis for both measurement and alternatives in a structured decision approach.

Objectives – A Primer

Means…… Ends

"How could we do that?" *"Why is that important?"*



Objectives – A Primer

Characteristics of Good Objectives

- Complete
  - Nothing's missing
- Concise
  - Nothing's unnecessary, nothing's redundant
- Controllable
  - Within your scope of influence / affected by the alternatives under consideration
- Understandable
  - To decision makers and other stakeholders
- Preferentially Independent
  - You don't need to know what's happening on one objective in order to know how you feel about another (use the green vegetable test)

Example: BioSecurity Objectives Hierarchy (Australia)

- Environment
  - Ecosystems/Landscapes
    - Ecologically important
    - Culturally important
  - Species
    - Ecologically important
    - Culturally important
  - Biodiversity
  - Climate change
  - Ecosystem services
  - Cumulative effects?
- Human Health
  - Mortality
  - Morbidity
  - Perceptions/Fears
- Other??
- Economics
  - Total Business Losses
    - Forestry
    - Agricultural
    - Tourism
    - Other?
  - Local/Regional Impacts
    - Economic/Employment
    - Community Stability
- Amenity
  - Recreation
  - Aesthetics
  - Cultural practices or uses
  - Convenience/access/mobility
- Management Costs
  - Business
  - Government
  - Individual/Private

Implement objectives by defining Performance measures or Attributes

- Objectives establish what matters
- They need to be "operationalized" by identifying appropriate attributes or performance measures
- Permit comparisons across alternatives in terms of how well different actions achieve progress in satisfying attributes
- Without this step of setting measures or criterion or attributes, it's likely that there will be poor communication -- confusion, misunderstanding, frustration, and a lack of progress.

THREE COMMON TYPES OF MEASURES

1. Natural - direct measures of an objective
   - e.g., if an objective is to find the lowest cost option, then *dollars* is a natural measure

2. Proxy - indirect measures of an objective
   - e.g., if an objective is to improve highway safety, a proxy measure may be the *number of fatalities*

3. Constructed - developed specifically for an objective
   - e.g., if an objective is to improve city pride, a constructed measure may be *survey-based ratings of things that contribute to pride (e.g., unsightliness, etc.)*

A “good” measure fits the situation …

COMBINING OBJECTIVES & MEASURES: THE CONSEQUENCE TABLE

Objective	Attribute	Measures	Alternatives
Keep Costs Down	Cost		
Improve Environmental Health	Productivity of salmon		
Maintain Cultural Traditions	Self-ratings of activity		
Improve Human Health	Number of hospital visits		

OBJECTIVES & MEASURES

Objective	Attribute	Measures	Alternatives
Keep Costs Down	Cost	Dollars(Natural)	
Improve Environmental Health	Productivity of salmon	Number of Returning spawners^2(Proxy)	
Maintain Cultural Traditions	Self-ratings of activity	Survey(Constructed) 1=low, 10=high	
Improve Human Health	Number of hospital visits	Count number of visits(Proxy)	

Step 3: Create Alternatives

- Once objectives have been defined and measured, the next step is to identify alternatives and establish the consequences of each alternative with respect to its ability to meet the stated objectives.
- This effectively establishes a contract among stakeholders: what matters to decision makers and what alternative sets of actions are on the table
- Use consequence tables to visually summarize the decision framework

COMPARING AND GENERATING ALTERNATIVES

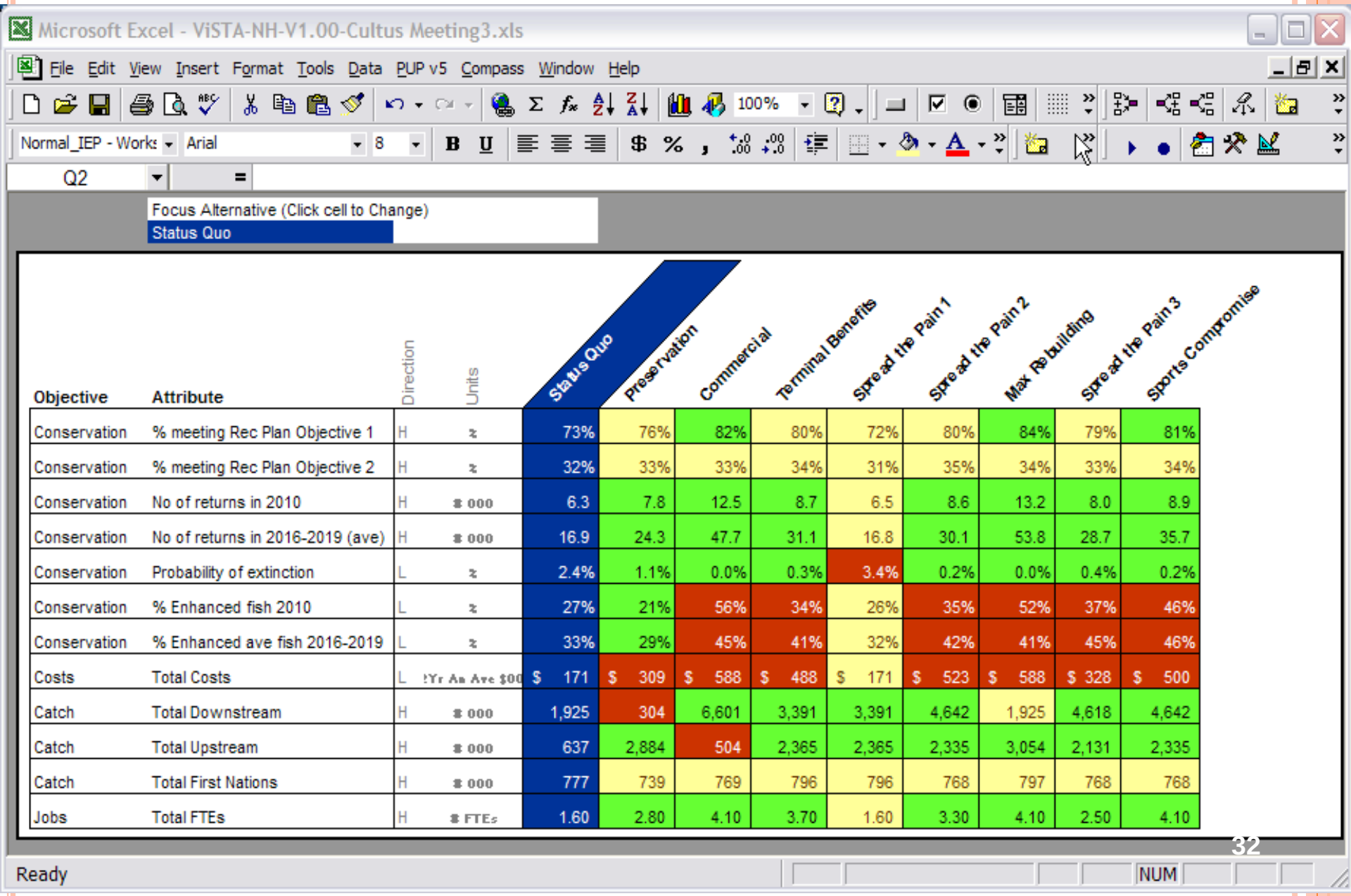
- One of the hardest tasks for risk/resource managers: knowing how to combine and sequence different actions to achieve stakeholders' diverse objectives.
- Too often, analyses focus on overly narrow set of presumably preferred alternatives, perhaps bracketed with +10% or -10% options or with unrealistic options. Need to think "outside the box" with reference to the decision situation under consideration.
- Developing and comparing portfolios of actions can be done with help from strategy tables & sensitivity analysis
- Generating the best alternative is what it's all about!

Step 4: Assess Consequences

- Once an initial set of alternatives has been defined and measured, the next step is to establish the consequences of each alternative with respect to its ability to meet the stated objectives.
- This effectively establishes a contract among stakeholders: what matters and what actions are on the table
- Use consequence tables to visually summarize the decision framework

Use multiple sources of information when collecting information about consequences

- Scientific knowledge
  generally given center stage; expert-driven, unique language and perspective. May use expert judgment techniques to clarify assumptions of different parties
- Local knowledge
  generally given insufficient attention. Refers to knowledge held by local resource users, local residents, community participants in various activities.
- Traditional ecological knowledge
  generally set off to the side. If ignored, can lose important objectives, observation-based insights, support from local participants.
- Emotions
  generally not considered helpful. If ignored, can lose important objectives (related to management, power issues), support, insights into new alternatives. And NB: Without emotions, how do you know what you "like" better in terms of certain (usually social) objectives; e.g., recreation.
- Trust (and other process concerns)
  generally not treated explicitly. Open to analysis :e.g., an explicit "trust" objective, using a constructed scale, or an explicit "community involvement" scale.



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 An Ave $00	$ 171	$ 309	$ 588	$ 488	$ 171	$ 523	$ 588	$ 328	$ 500
Catch	Total Downstream	H	# 000	1,925	304	6,601	3,391	3,391	4,642	1,925	4,618	4,642
Catch	Total Upstream	H	# 000	637	2,884	504	2,365	2,365	2,335	3,054	2,131	2,335
Catch	Total First Nations	H	# 000	777	739	769	796	796	768	797	768	768
Jobs	Total FTEs	H	# FTEs	1.60	2.80	4.10	3.70	1.60	3.30	4.10	2.50	4.10

But it is difficult to predict consequences

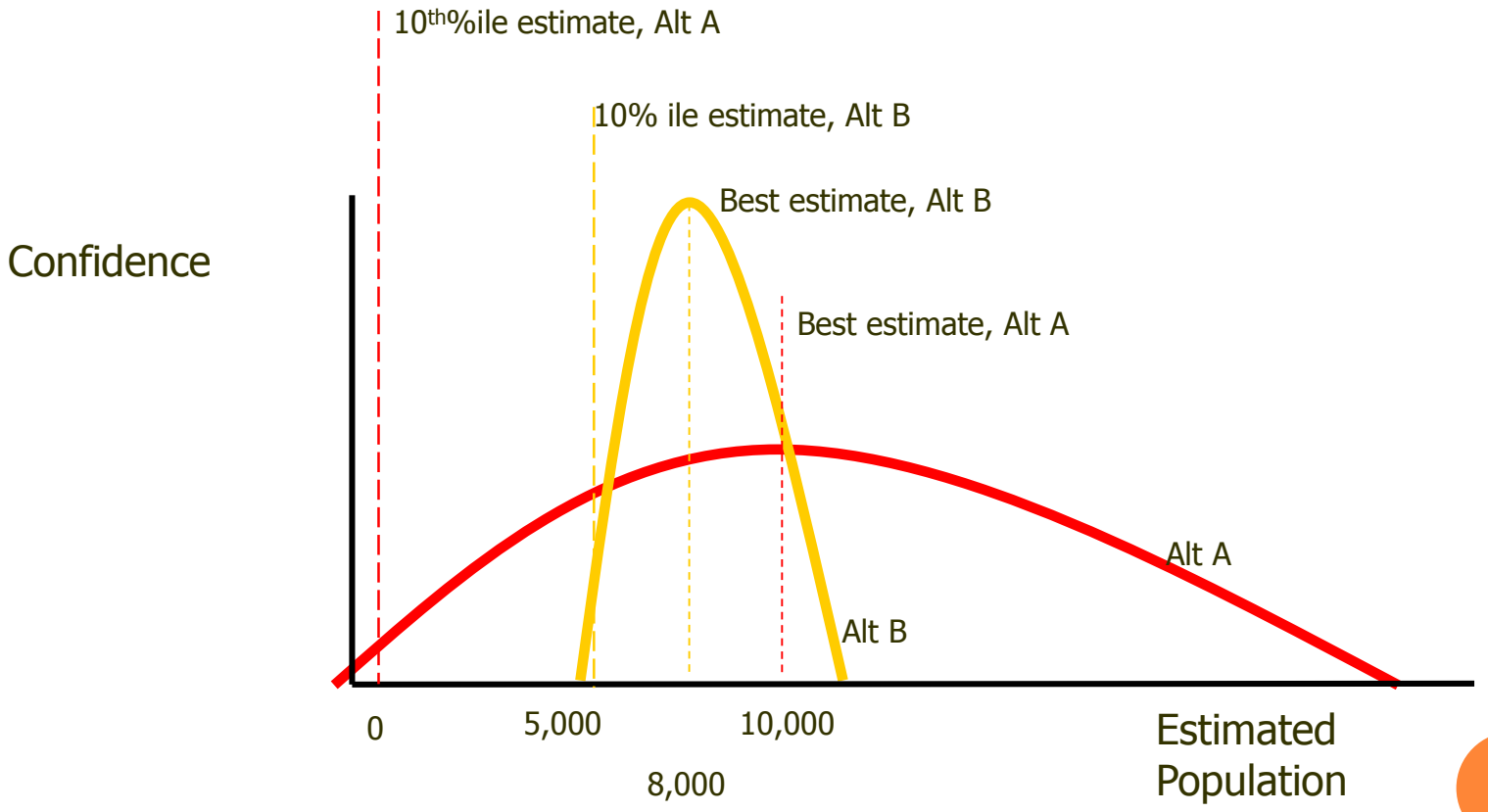
It is Important to Address Uncertainty in Consequences

Analyze and Communicate Uncertainty in Consequence Estimates

- Example: which alternative is best?

	Alternative A	Alternative B
Best estimate of increase in species X population	10,000	8,000

SDM TECHNIQUES

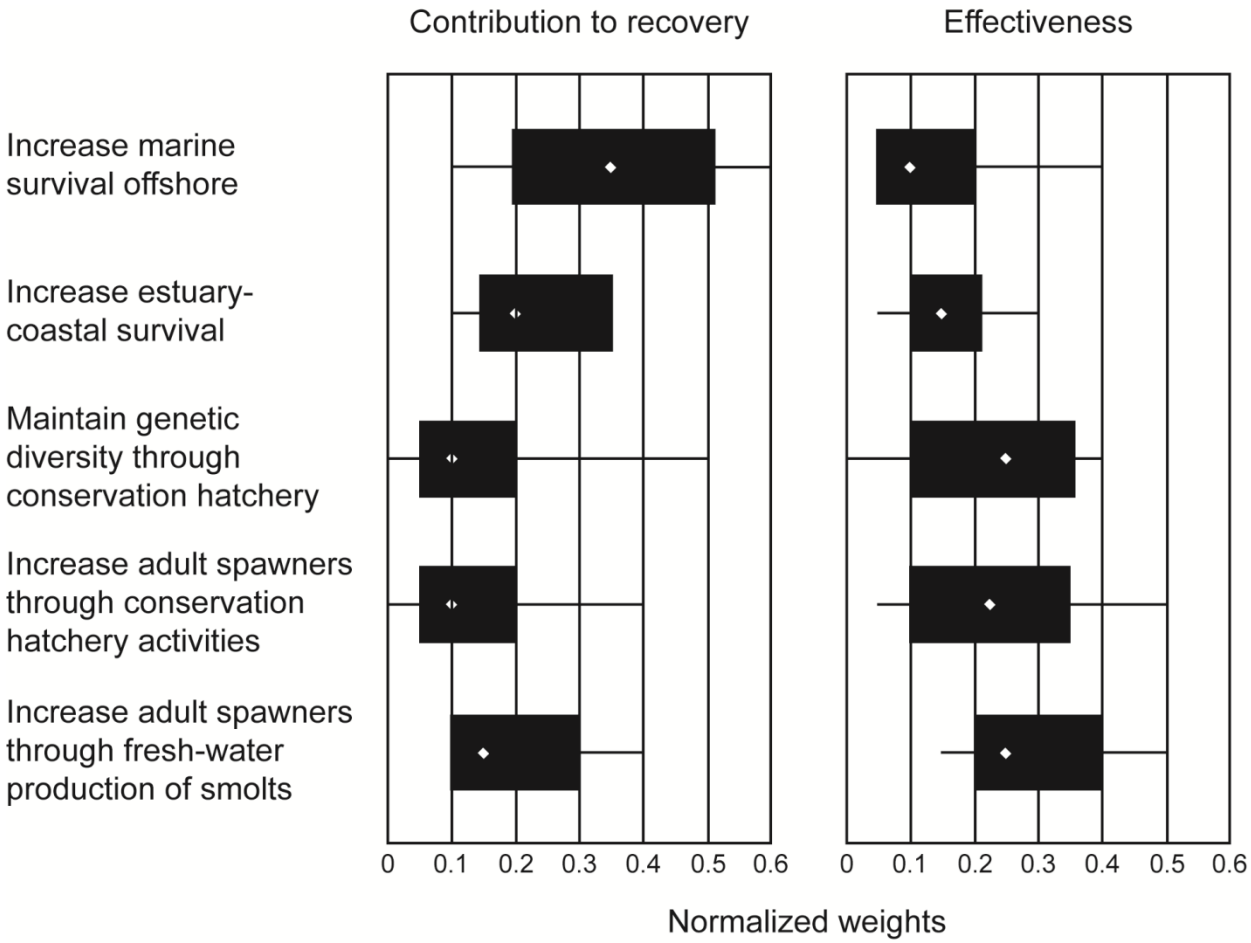


SDM TECHNIQUES

Now which alternative is best? It's a question of risk tolerances, perhaps informed by legislation (e.g., SARA or ESA) …

	Alternative A	Alternative B
Median (50th %ile) estimate of species X population	10,000	8,000
Low (10th %ile) estimate of species X population	0	5,000

CLARIFYING UNCERTAINTY INFORMS BUT DOESN'T MAKE TOUGH CHOICES: Atlantic Salmon Recovery Planning Example



Working to fill information gaps: Expert Interviews

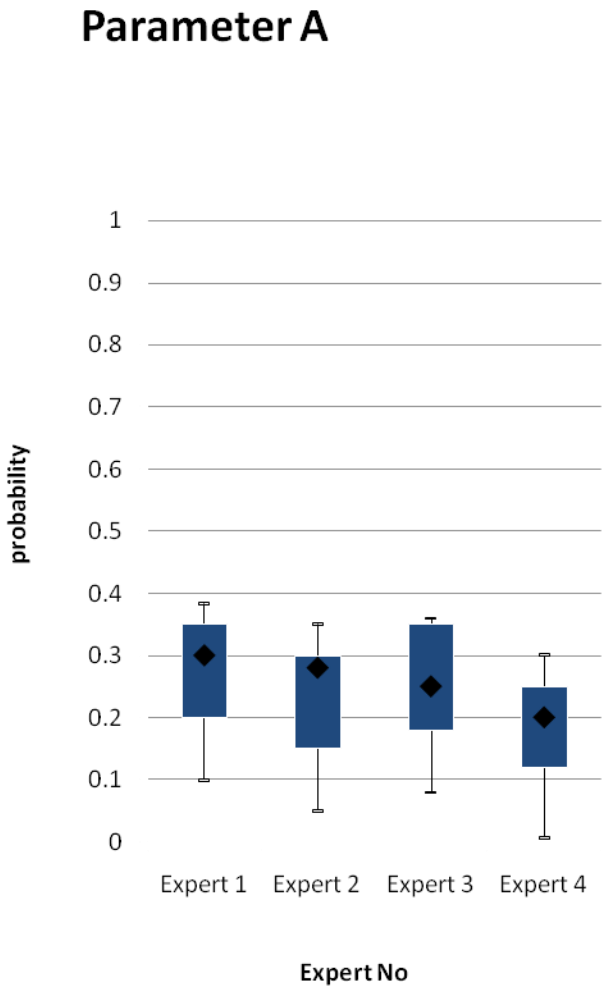
Information gaps often can be addressed through expert judgment elicitations, rather than new field studies or more expensive models.

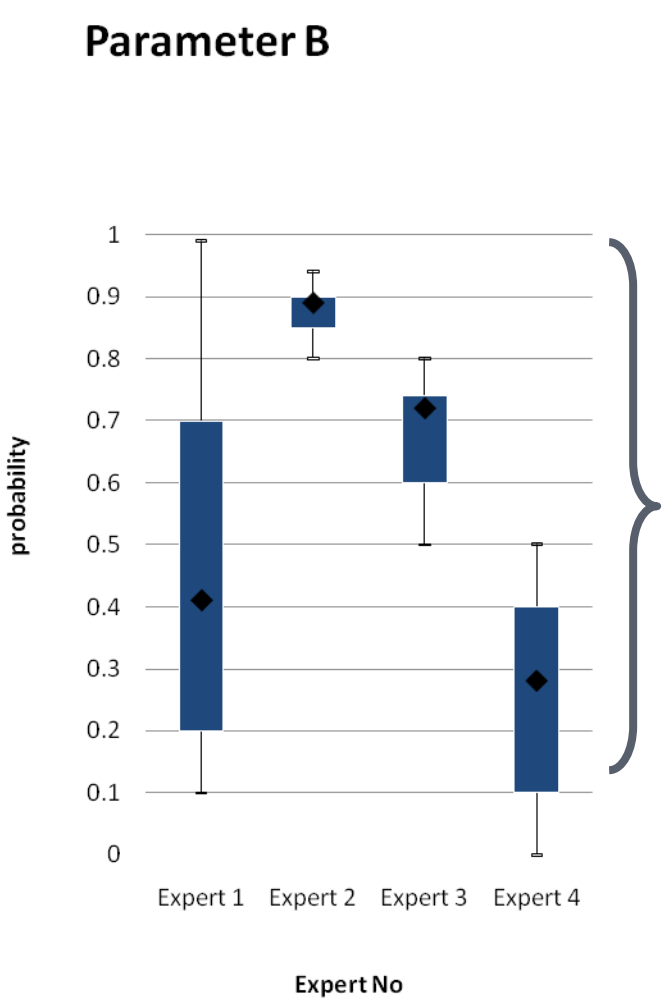
All "experts" – however selected -- tend to be overconfident in their assessments of consequences and, surprisingly, rarely engage in *structured* discussions with their peers about assumptions.

SDM techniques can help to encourage dialogue among experts, highlighting areas of agreement & exposing reasons for disagreements.

Result? More transparency, often more agreement.

SDM TECHNIQUES: EXPERT JUDGEMENTS TO ADDRESS INFORMATION GAPS





Wide range of judgements…

– priority for research?

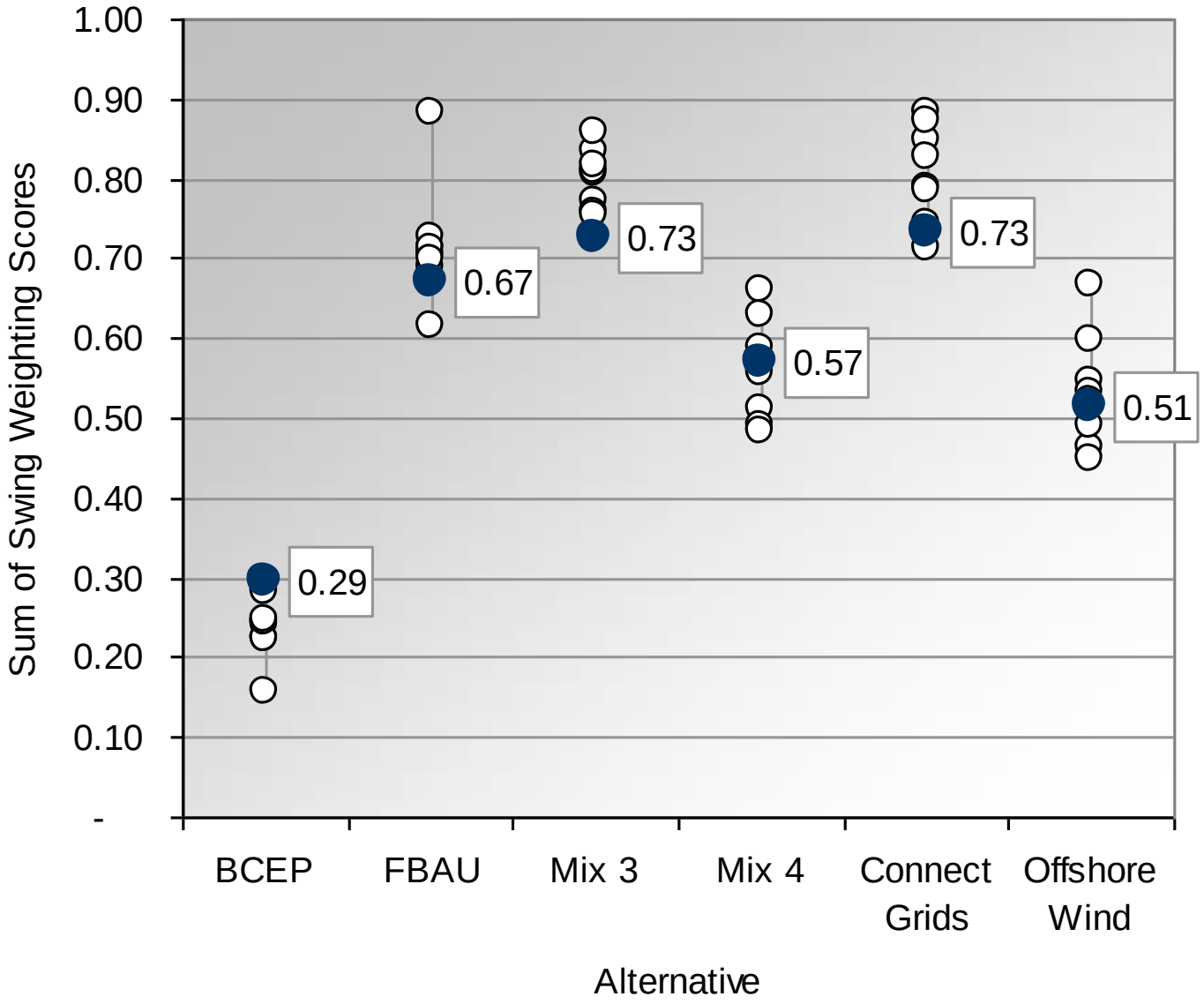
-result of
-strategic bias?

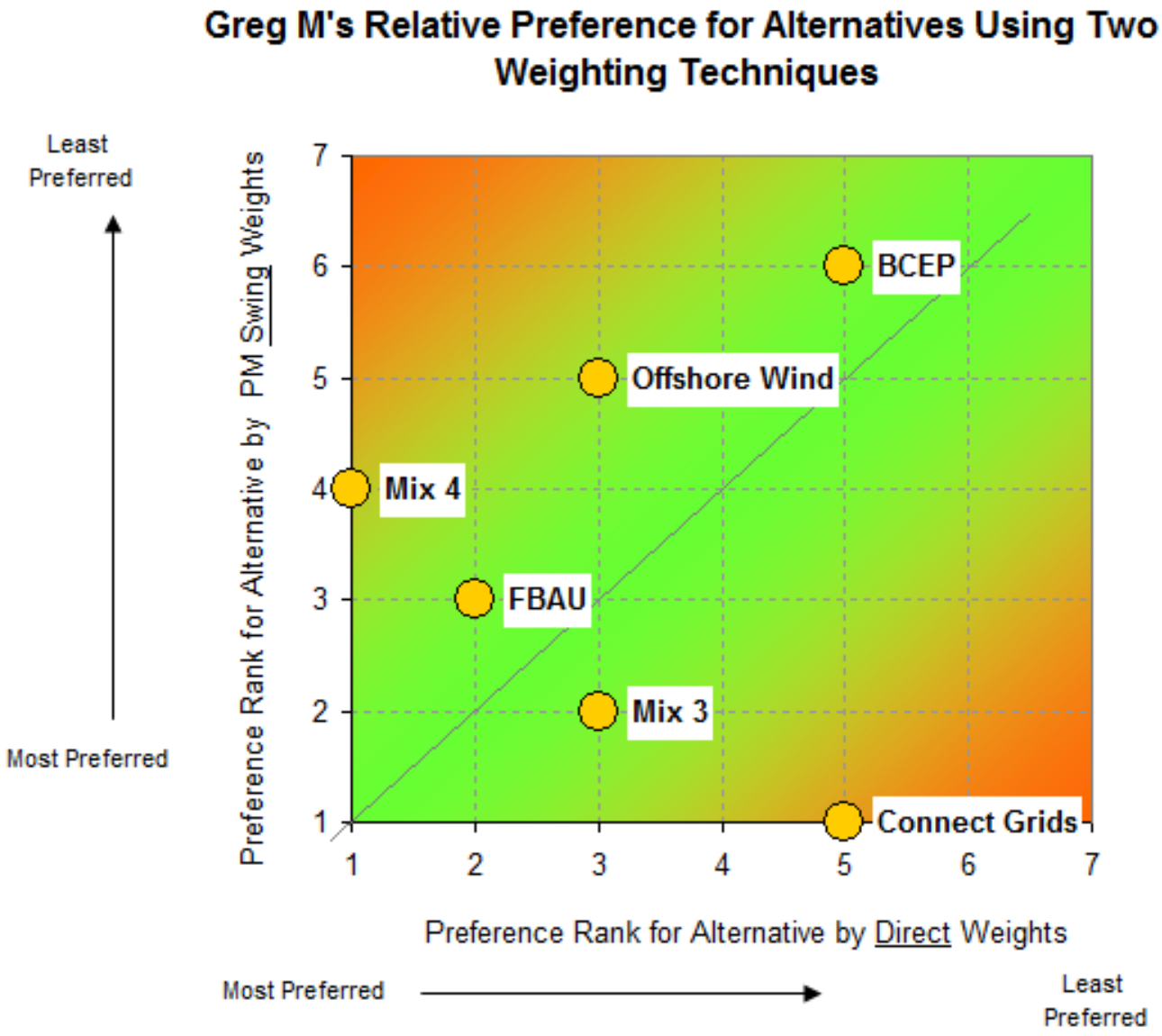
-evidence for poorly defined question?

Step 5: Address Values-Based Tradeoffs across Multiple Stakeholders

- Even if there is agreement on the problem structure, key objectives, and facts, reasonable people may disagree about what values are most important – and this leads to different preferences for management alternatives
- SDM approaches do not seek "consensus." Instead, the goal is to inform decision makers about the reasons for areas of agreement and areas of disagreement
- Trade-off tools used in SDM include both analytic and deliberative techniques to encourage useful dialogue and analysis.

Greg M's Swing Total Scores (Blue) Relative to Others' (White)




Greg M's Relative Preference for Alternatives Using Two Weighting Techniques
Least Preferred
Most Preferred
Preference Rank for Alternative by PM Swing Weights
7
6
5
4
3
2
1
BCEP
Offshore Wind
Mix 4
FBAU
Mix 3
Connect Grids
1
2
3
4
5
6
7
Preference Rank for Alternative by Direct Weights
Most Preferred
Least Preferred

Step 6: IMPLEMENT, MONITOR, LEARN

- Learn over time
  - New factual information – reduce uncertainties, incorporate new sources of information
  - New values information – informs dialogue as individual and societal values are constructed over time
  - New technological possibilities – effect what is possible, associated costs and risks
  - New political possibilities/partners
- Create and implement new options – but only if the management plan is flexible & adaptive!

CASE STUDIES

Example case studies to demonstrate Structured Decision Making methods and how to link analysis with deliberations about management options

Case Study 1: Cultus Lake Sockeye

- Cultus Lake Sockeye
  - Iconic endangered species, not listed for political reasons
  - Multi-million dollar commercial interests at stake
  - Legal aboriginal rights issues at play
  - Significant biological uncertainties
  - Keen interest from NGOs
  - Overlapping jurisdictions
- Client: Fisheries and Oceans Canada
- Worked with multi-stakeholder committee (approx. 20 people) over 1 month period
- Key risk tradeoff: protection of endangered stocks vs commercial fishing revenues

R. Gregory and G. Long. Using SDM to help implement a precautionary approach to endangered species management. Risk Analysis 9: 518-532.

CULTUS LAKE SOCKEYE

- Multiple interests:
  - High visibility species, high importance to Conservation, commercial fishers, and First Nations
- Data quality variable (and underlying science often controversial)
- Data inputs from agency scientists/consultants as well as other stakeholders (e.g., resource users)
- Multiple management options (exploitation rate, captive breeding, predator removal) but uncertainty about consequences of actions

CULTUS LAKE SOCKEYE: Objectives

- 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
  - Total First Nations FSC
- Jobs
  - Employment opportunities directly related to enhancement and freshwater projects

CULTUS LAKE SOCKEYE

- Alternatives created by assembling 'blocks' of options:
  - Cultus Exploitation Rate %
  - Enhancement options
  - Freshwater projects options

- Make use of strategy tables to encourage creative thinking. An example:

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"

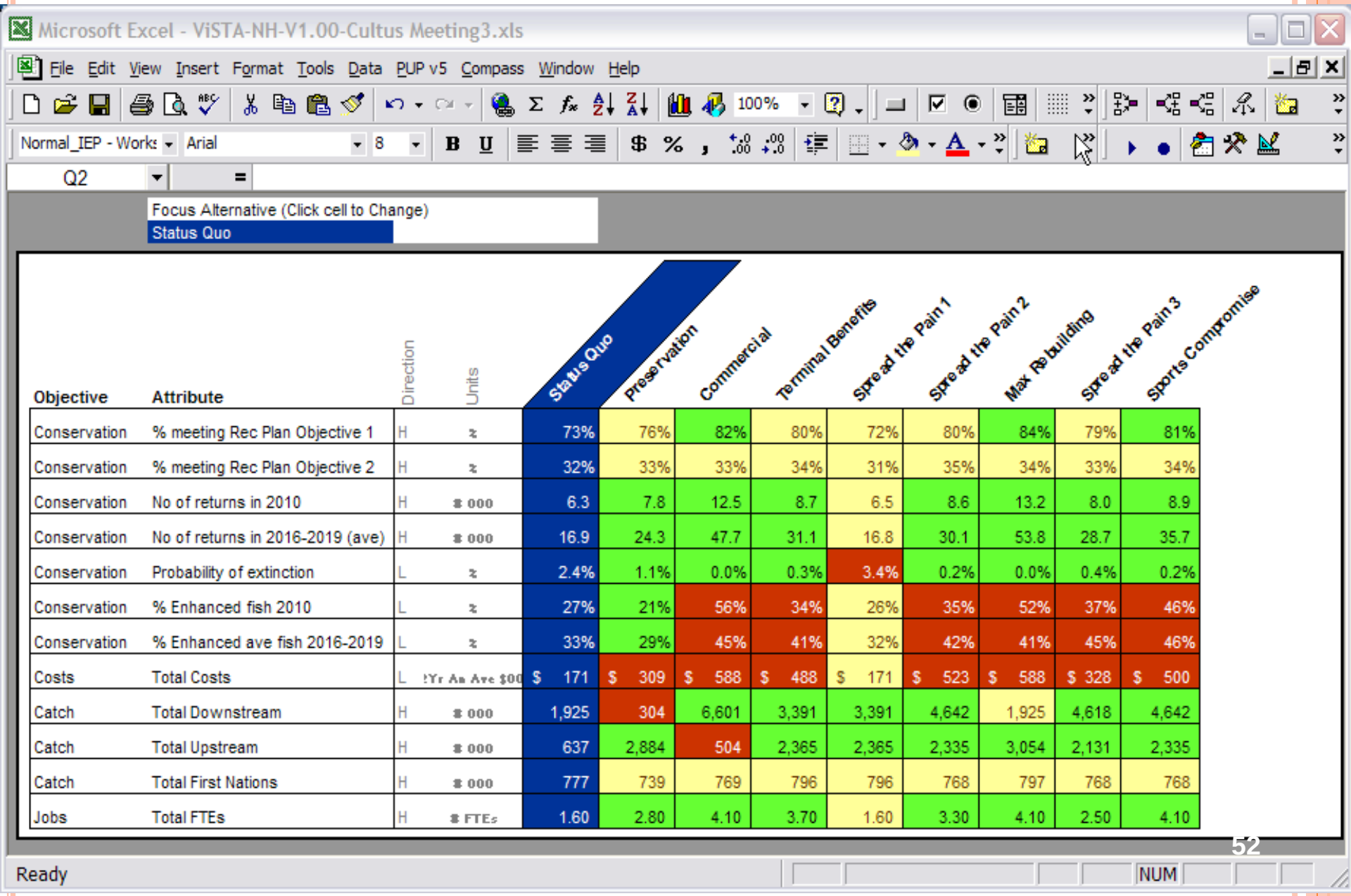
CULTUS LAKE SOCKEYE

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”

CULTUS LAKE SOCKEYE

- Recognition of need to simplify the decision problem through elimination of less relevant objectives and alternatives.
- Do this via exploration of
  - Redundancy: where performance measures do not vary across alternatives
  - Dominance: where one alternative is better than or equal to all (or, by collective agreement, nearly all) aspects of another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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 An Ave $00 $ 171 $ 309 $ 588 $ 488 $ 171 $ 523 $ 588 $ 328 $ 500
Catch Total Downstream H $ 000 1,925 304 6,601 3,391 3,391 4,642 1,925 4,618 4,642
Catch Total Upstream H $ 000 637 2,884 504 2,365 2,365 2,335 3,054 2,131 2,335
Catch Total First Nations H $ 000 777 739 769 796 796 768 797 768 768
Jobs Total FTEs H $ FTEs 1.60 2.80 4.10 3.70 1.60 3.30 4.10 2.50 4.10
Ready
NUM

CULTUS LAKE SOCKEYE

- Three alternatives remained at the end of this process

Objective	Attribute	Direction	Units	Commercial	Spread the Pain 1	Spread the Pain 3
Conservation	% meeting Rec Plan Objective 1	H	%	82%	72%	79%
Conservation	No of returns in 2016-2019 (ave)	H	# 000	47.7	16.8	28.7
Conservation	Probability of extinction	L	%	0.0%	3.4%	0.4%
Conservation	% Enhanced fish 2010	L	%	56%	26%	37%
Conservation	% Enhanced ave fish 2016-2019	L	%	45%	32%	45%
Costs	Total Costs	L	1Yr As Ave $00	$ 588	$ 171	$ 328
Catch	Traditional Commercial	H	# 000	5,877	3,088	3,878
Catch	Available Comm TAC Above Vedder	H	# 000	131	2,920	2,130
Jobs	Total FTEs	H	# FTEs	4.10	1.60	2.50

CULTUS LAKE SOCKEYE

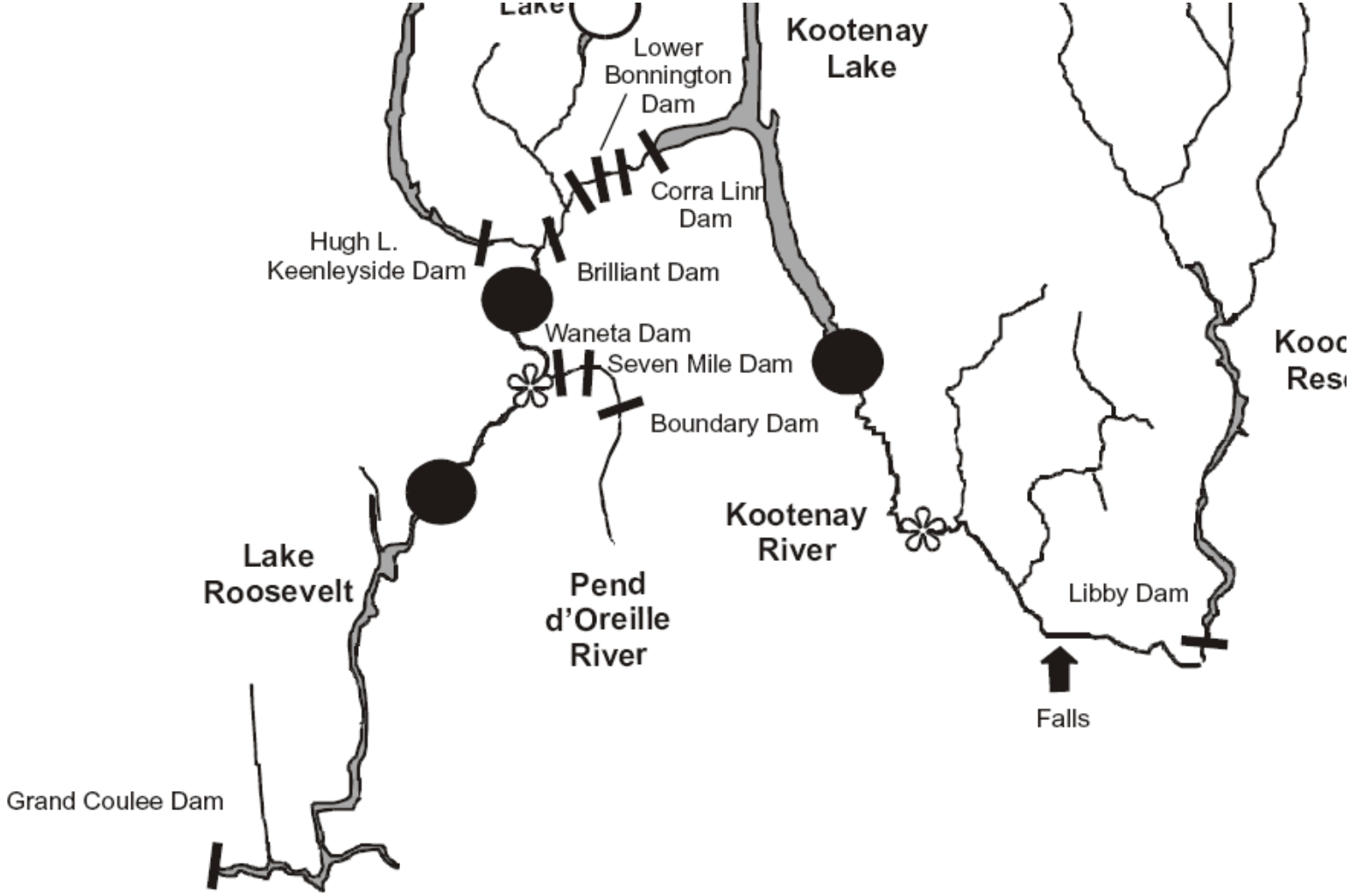
- After three meetings, key elements of one alternative favoured by all participating stakeholders, including
  - Agreement on structure of problem (as basis for discussions in future years)
  - Agreement on many common features:
    - Freshwater projects
    - Habitat treatment (invasive species)
    - Predator treatment
    - Enhancement options
- Remaining issues (e.g., exploitation rates) settled through additional talks that also included other parties who had not participated in initial SDM

CASE STUDY 2: Recovery planning for Endangered Upper Columbia River White Sturgeon

- Used DA / EJ methods to clarify uncertainty among experts, dialogue thru "science court"
  - Expose differences across technical experts
  - Explore reasons for these differences
  - Consensus position or agreement to disagree?
  - Use influence diagrams to clarify "hypothesis pathways"
  - Explore degree of confidence that experts hold in their assessments

Source: Gregory, Failing, Harstone, Long, McDaneils & Ohlson (2012). Structured Decision Making: A Practical Guide to Environmental Management Choices. Wiley-Blackwell.

UPPER COLUMBIA WHITE STURGEON



Upper Columbia River White Sturgeon Recruitment Failure – TECHNICAL EXPERTS

- Upper Columbia River White Sturgeon
  - Features
    - Iconic endangered species (listed)
      - No recruitment in last 40 years
      - Functional extinction within 25 years
    - Overlapping jurisdictions
      - Canadian Federal, Provincial, USFWS, State of Washington
    - Major industrial interests
      - Mining corporation, hydroelectric utility corporation
    - Serious scientific uncertainties
    - Recovery plan with too many 'priority actions' produced in 2002
    - Little activity for several years on Action Plan – why?

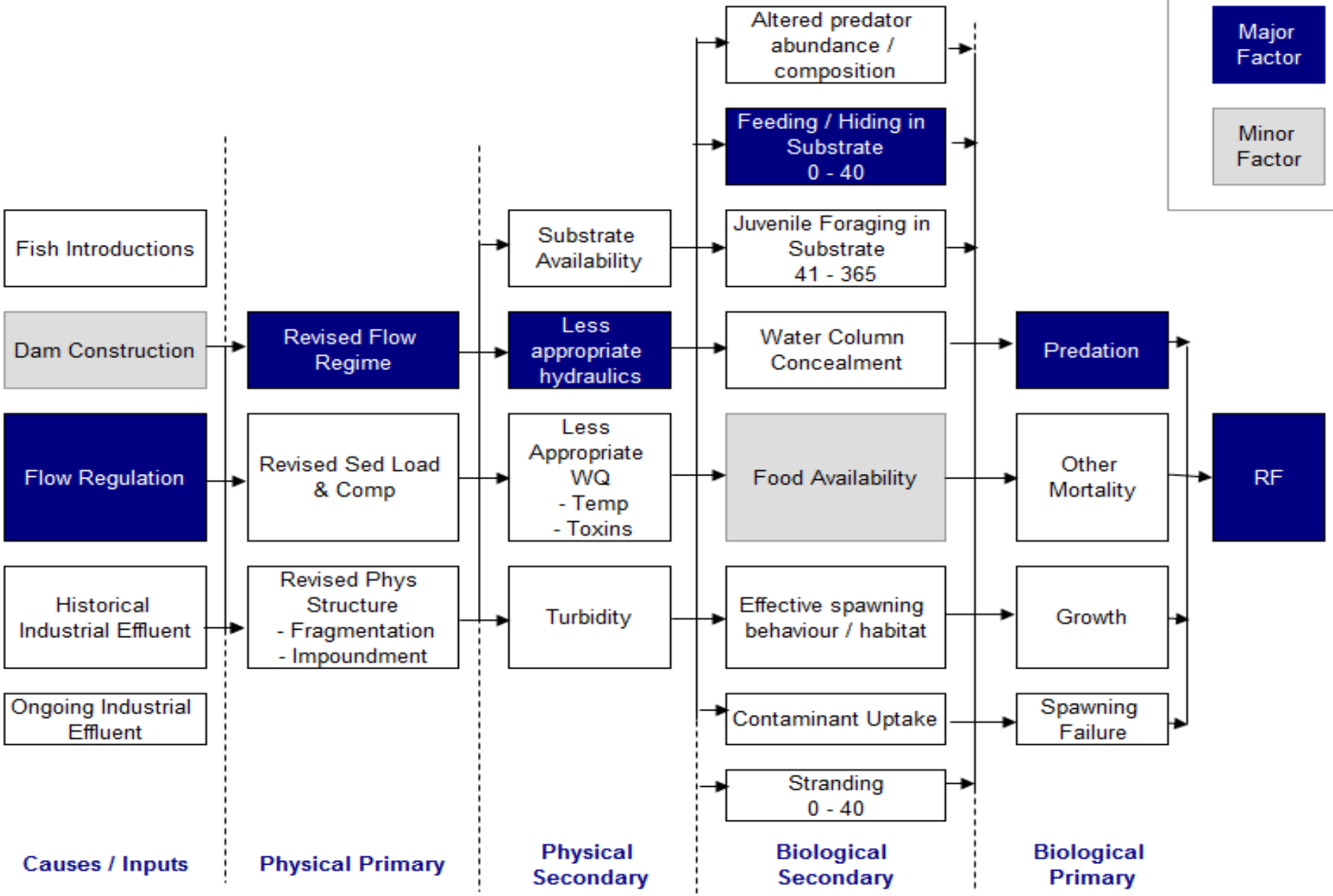
UPPER COLUMBIA WHITE STURGEON

- Problem: Apparent failure of White Sturgeon to recruit in Upper Columbia River following construction of hydroelectric dams in 1960s and 1970s
- How to aid recruitment through
  - altering flows (volume, temperature, turbidity, timing);
  - restoring habitat (food availability, substrate for spawning, rearing, feeding);
  - removing predators
  - other means?

UPPER COLUMBIA WHITE STURGEON

- Our work, using SDM:
  - Organize and group ("bin") competing hypotheses
  - Develop precise meaning for each hypothesis
  - Help experts reach a common understanding of relative importance of hypotheses via "science court" arguments, for and against (presentation plus discussion)
  - Clarify ties between hypotheses and management actions
  - Link management actions to existing and proposed research
  - Prioritize and sequence management and research actions (in progress)
  - Clarify extent to which new work would reduce uncertainty

LC1: Movement to habitat, Age: 0-15



UPPER COLUMBIA WHITE STURGEON

Q1	Q2	Q3
What % of ongoing RF is attributed to this H, based on current knowledge?	**How certain are you in your assessment for Q1?**	**How likely is it that further research could 'confirm' that this H accounts for <u>at least</u> 20% of ongoing RF?**
Distribute 100% points	5 = I expect I could be wrong by up to ±10% points 4 = I expect I could be wrong by up to ±20% points 3 = I expect I could be wrong by up to ±30% points 2 = I expect I could be wrong by up to ±40% points 1 = I expect I could be wrong by more than ±40% points	1 = Very unlikely (<20% chance) 2= Unlikely (20-40% chance) 3= As likely as not (40-60% chance) 4 = Likely (60-80% chance) 5 = Very likely (>80% probability)

SUMMARY: HOW CAN AN SDM APPROACH HELP TO GENERATE & EVALUATE ACTIONS?

- Aids defensibility of decisions
- Provides consistent framework for analysis
- Creates structure to incorporate multiple views
- Facilitates transparent use of information (links facts/science and emotional/intuitive sources)
- Incorporates learning
- Sets context / foundation for communication
- Provides basis for info transfer & comparison
- Restores management capability to managers
- Links *what* decisions are made with *how* decisions are made

REMEMBER: Each "problem" is a decision opportunity

SDM approaches are now widely used by resource managers. Examples include:

- US Dept of Interior: adaptive management programs
- BC Hydro: all business decisions over $1 million
- DFO: hatchery risks to wild stocks, allocation issues
- DAFF, Australia: biosecurity plan for invasive pests
- B.C. Ministry of Environment: conservation planning for grizzly bear, caribou, cumulative effects
- Alberta Env't: water allocations from Athabasca River, cumulative effects assessment
- New York, Vermont & Quebec: adaptive management to reduce Lake Champlain phosphorus loading
- US/Canada task force: recovery planning for endangered Upper Columbia River White Sturgeon
- NOAA/FWS: Recovery planning for Atlantic salmon
- BC Water Comptroller: WUPs at all major hydro sites

THANK YOU.

Robin Gregory
Galiano Island, B.C.
robin.gregory@ires.ubc.ca
250-539-5701