US Federal Wind Turbine Guidelines Advisory Committee: Risk Management and Decision Support April 23-24, 2008 meeting

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FAC Risk management and decision support

Organization of presentation

Objective: to provide assistance on the use of structured decision making (SDM) and risk management (RM) approaches to aid committee discussions on ways to avoid or minimize impacts to birds, bats, and other wildlife and their habitats from land-based wind energy facilities.

Today's presentation will emphasize:

- Risk is a multidimensional construct. Risk management reflects both facts and values: information about the likely consequences of actions, and values based on the feelings /responses of individuals, agencies, and groups to these impacts.
- There are different attitudes toward risk. These reflect facts, values, and feelings about uncertainty. These are based on values and judgments, which are prone to systematic biases.
- Being "an expert" does not preclude provision of biased assessments of risks.
- Structured decision making approaches help identify mgt options for risk problems that involve diverse stakeholders, uncertain science, & tough tradeoffs.
- Defining and implementing an acceptable level of risks requires balancing across multiple objectives. Because decisions reflect uncertainty, it is important to learn over time and be flexible. A little humility helps as well.

Tomorrow`s presentation will focus more on specific approaches to risk management and use of SDM methods for moving ahead with recommendations & guidelines.

Basic Concepts and Terminology

Introduction to Risk

- Risk Definitions
  - Risk is often referred to as the product of probability of an event and the (usually negative) consequences of that event
    - Risk = Probability * Consequences
  - This definition is used in many engineering designs and safety analyses
  - It also underlies the logic of risk assessments used in other contexts
  - This approach was developed for cases where events can be discretely identified (e.g.. failure of an engineering component) and when consequences are discrete (e.g.. a dam breech)
  - It becomes more complex when applied to
    - Risk management rather than risk classification or analysis
    - Situations where probability and consequences are not discrete events but rather are distributions. E.g.., the probability of a loss of habitat or the predicted consequences of an action on migratory birds
    - Situations where there is disagreement among “experts” about how to define a risk or how to measure impacts

Basic Concepts and Terminology

Introduction to Risk

- The word “risk” is used in many different ways, even among experts. Consider:
  - Risk as uncertainty: What is the “risk” in your estimate?
  - Risk as hazard: What are the “risks” to migratory birds?
  - Risk as probability: What is the “risk” of a population impact?
  - Risk as consequences: What are the health “risks” from disinfection by-products?
  - Risk as trade-offs: Is that company a good investment risk?
- This is not trivial – fundamental misunderstandings and logical errors can result
  - For example, a wind turbine operation might be considered ‘high risk’ with respect to migratory birds because:
    - There is a high probability of killing at least one bird
    - There is the small probability to have a population level effect
    - There is a high probability of having a population-level effect
    - The likely benefits are low relative to the expected harm to birds
  - We therefore need to try to be precise in our understanding and use of language around the concept of ‘risk’

Basic Concepts and Terminology

Introduction to Risk

- Two paradigms for characterizing 'risk': ' Objective Risk' and 'Subjective Risk'
- Objective Risk' paradigm: risk is objective, measureable
  - Endpoints of importance (e.g.. human health, env'tal values) are self-evident
  - Indicators or criteria (e..g, probability of death per year) are self-evident
- Implications of the 'Objective Risk' Paradigm
  - qualified experts should design risk analyses and risk mgt frameworks
  - risk frameworks should reflect scientific judgments. Example: *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (Exec. Summary, 2007): "… provides a science-based approach for assessing the potential impacts that a wind energy project may have …"
  - learning thru precautionary or adaptive approaches is downgraded
  - public "irrationality" is thought to arise from difficulties people have in comprehending the very small probabilities often associated with hazards
  - the prime role of "risk communication" is to educate the public about expert's judgments on risk in terms they can understand.
  - uncertainty and differences in opinion among scientists are hidden.

Basic Concepts and Terminology

Introduction to Risk

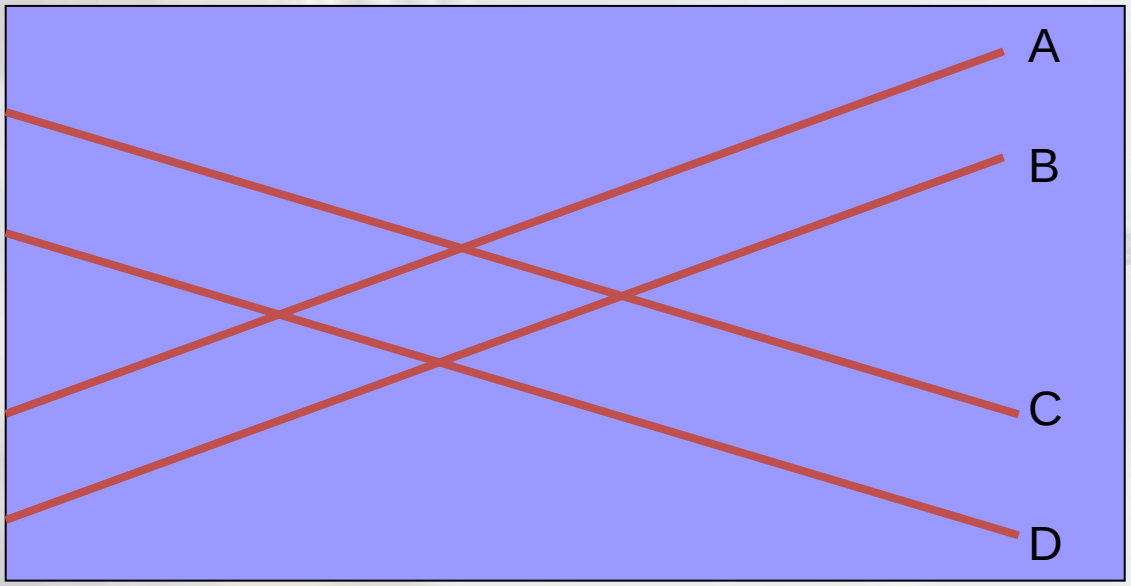
- 'Subjective Risk' paradigm: risk depends on societal perspectives and individuals' or groups' judgements, so risk management reflects value-baseddecisions
- Key implication: Indicator selection can profoundly affect the analysis of risks
  - Example (from P. Slovic & R. Gregory, 1999).
    - Question: Was U.S. coal mining getting safer, 1950-1997
    - Answer: Depends on how the risk is measured
  - If selected measure is: Accidental deaths per million tons of coal mined, the answer is: Yes
  - If selected measure is: Accidental deaths per thousand coal mine employees, the answer is: No

Both measures make good sense, but each embodies "hidden" judgments

As the subjective measure of risk changes, so do the conclusions about risk impacts and, in turn, choices about risk management actions

Take this same issue in the context of wind energy and impacts on birds …..

Introduction to Risk: Basic concepts
Is “bird fatalities due to wind energy” a reasonable measure of impact?



- A = Average number of bird fatalities per year due to wind turbines (as # sites increases)
- B = Median number of bird fatalities per site (as size of average site increases)
- C = Average number of bird fatalities per MW wind electricity (as mitigation improves)
- D = Average number of bird fatalities per MW total electricity (including reduced CC impacts)

What conclusion can be reached about effects of wind turbines on birds?

- Many other aspects of risk analysis and presentation also reflect judgements, so key questions are: How can these judgements be made defensibly, transparently, and consistently? Who has a say in how these judgements are made?
  - The selection of scope or problem bounds: What's "in" and what's "out"?
  - The choice of stakeholders and process: Who to involve, at what level, in what ways?
  - The definition of criteria or attributes
  - The role of distributional effects (across species or geographic areas)
  - The design of studies: Which technical assessment methods to use, which type of field studies, to what level of precision, over what length of time?
  - Key elements of analyses: What statistical analyses to use, at what levels of confidence?

- Numerous psychological factors also affect risk perception and acceptability
  - Research (by Slovic, Fischhoff, Lichtenstein, Kasperson, and others) has found that the concerns people have for certain types of risks are influenced by psychological or emotional responses to those risks.
  - Attributes of hazards that [decrease – increase] concern include:
    - Voluntary – Involuntary
    - Common – Dread
    - Individual – Catastrophic
    - Immediate – Delayed
    - Known to science – Not known to science
    - Controllable - Not controllable
    - Equitable – Not equitable

One of the reasons why many lay people do not trust scientific risk analyses is because they believe that important dimensions have not been included.

- These risk judgements are set against a background of uncertainty
  - Uncertainty about values (what matters, and how much):
    - What are the key concerns (these will be related impacts resulting from management actions – siting, mitigation, etc.)
    - Which of these is most important (in this specific context)
    - Are value differences across participants due to different belief systems or different priorities
  - Uncertainty about facts (what might happen, with what effects):
    - What are the key contributors to uncertainty
    - What level of data uncertainty is 'tolerable'
    - How should uncertainty be presented
    - Is enough known to go ahead now or is better information needed

One of the reasons why many risk-based decisions are later overturned or contested is that insufficient attention is given to dealing with uncertainty in the context of values or facts and reaching a shared definition of the problem.

Introduction to Uncertainty

There are two main types of uncertainty: epistemic and linguistic.

- Epistemic Uncertainty: when incomplete knowledge results from:
  - Variability and incertitude
    - Variability is naturally occurring, predictable occurrence, e.g.. rainfall
    - Incertitude refers to parameter values or models e.g.. the temperature in location X, the relationship of X to Y
  - Measurement error
    - From imperfections in measuring equipment
  - Systematic error
    - Resulting from small sample sizes
  - Model uncertainty
    - The difference between the abstraction of a model and the reality the model is purported to represent
  - Subjective judgment
    - Due to the differences among scientists in their interpretations of data

Linguistic Uncertainty: results from the shortcomings of language or its use

- Vagueness
  - Due to how language treats thresholds: at what point does a population of algae become a 'bloom'? At what point is a population "at risk"?
- Context dependence
  - Results from failure to put a description into context: an oil spill that is big on my driveway would be considered small in the ocean
- Ambiguity
  - Arises when words can have more than one meaning and it is not clear which is intended: e.g.. natural environment
- Underspecificity
  - Arises when there is unwanted generality: e.g.. "it might rain tomorrow" vs. "there is a 70% probability of rain at location X tomorrow"

Basic concepts

Threshold Effects

Assumptions about threshold effects underlie the implementation of any approach to risk classification. Questions include:

- How is a threshold to be defined?
  - As a point (e.g.., a number: 60 individuals or less?)
  - As a range (e.g.., 30 – 85 individuals?)
  - As a distribution (e.g.., showing a mean estimate of 60 and a range of 30-85)
- Questions about thresholds
  - What if each of two of three thresholds are nearly but not quite met: what does this imply for regulation?
  - What about interactions between different components of risk?
  - How will the implementation of thresholds reflect tradeoffs?
  - Will coming "very close" to successfully meeting a threshold be considered OK if fully meeting the threshold were to entail substantial losses on some other concern (e.g.., a sharp increase in costs or a loss of stakeholder support)?

Basic concepts

Threshold Effects (continued)

What if stakeholders disagree about a threshold?

- What if the experts brought in by different groups disagree about the threshold definition (e.g.., one group says the loss of only 100 birds will make a difference to the population, another says 1000)?
- What if different groups have different risk tolerances (e.g.., one group says the loss of 100 birds matters to their members, another says it does not)?
- What if one group wants a clear threshold for one type of effect, whereas the same consequence is not considered to be important by another group?

- What types of concerns can be addressed through thresholds?
  - Do thresholds only address factual concerns related directly to risk. Or, for example, can thresholds be established for trust or cooperation of stakeholders?
- How might thresholds shift over time?
  - In response to cumulative effects, climate change, changing perceptions of key stakeholder groups, new information?

Where does this leave us?

Need a risk framework that will

- Address multiple sources of value
- Reflect uncertainty
- Incorporate multiple measures of risk
- Give attention to psychology as well as technical factors
- Be clear about the rationale for use of thresholds

And the focus of this framework should be on

- Risk management decisions rather than risk classification
- A broadly accepted basis for choices rather than solely scientific justification

One possible approach: A structured approach to making decisions about the risks and benefits that has been widely applied by governments and industry in North America, Europe, and Australia / New Zealand.

- What is Structured Decision Making?
  - a set of methods and a body of research that seeks to help risk managers and elected officials make better decisions
  - "a formalization of common sense for decision problems that are too complex for informal use of common sense." (Ralph Keeney, 1982)
  - Incorporates methods from decision analysis for structuring choices, for developing defensible attributes or indicators, and for addressing uncertainty (Keeney, Raiffa, Edwards, Clemen)
  - Incorporates methods from behavioral decision making for understanding cognitive and emotional perspectives on how people make decisions and form judgements (Kahneman, Tversky, Slovic)

- Structured Decision Making: the Decision Analysis roots
  - Decision analysis, based in multiattribute utility theory (Keeney & Raiffa), disaggregates complex problems so as to understand the definition, importance, and uncertainty of the key elements of a problem.
  - A set of methods is available:
    - Value hierarchies: visual depictions
    - Means-ends networks (distinguish fundamental from means objectives)
    - Different types of attributes (aka measures or criteria)
    - Influence diagrams (to show relationships among components)
    - Decision trees (to distinguish decisions from chance events)
    - Swing-weighting (to establish the relative importance of objectives)
  - Establishes a structure and order is provided for how decision processes should be conducted -- a standard for seeing whether consistency, comprehensiveness, and relevance to the problem have been achieved.

- Structured Decision Making: the behavioral and psychology roots
  - Behavioral decision theory asks:
    - How do individuals think about risk decision problems?
    - How do individuals or groups make choices among alternatives (descriptive rather than prescriptive)?
    - How do people process uncertain information?
  - Key findings:
    - Use of information depends on context and frame
    - In many risk decision situations, clear views about problem structure or preferences do not exist prior to elicitation, so cues are significant
    - Cognitive biases are widespread and influence judgements:
      - Overconfidence (we know less than we think we do)
      - Anchoring (we tend to overweight initial assessments)
      - Availability (we tend to over-rely on easily recalled instances)
      - Incomplete specification (we ignore important aspects of problems)

Basic Concepts and Terminology

Introduction to Structured Decision Making

- Focus of SDM approach to risk management: clear judgements from all participants (typically: government, community, users, scientists, NGOs)
- Better judgements lead to better assessments. So SDM puts time and energy into improving judgements: understanding values and tradeoffs, understanding sources of uncertainty and implications for consequence estimates.
- One widespread problem: overconfidence. For FAC, overconfidence of scientists
  - What scientists believe to be true
  - How confident they are in that assessment
  - Baran (2000) result: ecologists asked to estimate 90% intervals for number of 0.1 H quadrants required to sample 95% of perennial, vascular plant spp: only 2 of 22 intervals captured correct answer.
- Typical task: assign X% confidence intervals (50%, 90%) to an estimate so that the correct answer falls within these limits X % (50%, 90%) of the time.
  - Common task: used all the time to elicit range for estimates
  - Common result: 90% intervals fail to contain true answer about 60% of the time (Cooke & Vose, 1996) -- more so for 90% confidence intervals than for 50%.

- Not surprisingly, this leads to disagreement among experts. Often, the level of disagreements is surprising to the scientists themselves – alarming???
- SDM response: need for "expert judgement elicitation": working with experts to improve judgments & predictions by
  - provide training in judgements under uncertainty (data collection .. prediction)
  - identify key sources of uncertainty (decomposing problem)
  - elicit probability distributions (or frequencies, or degrees of belief)
  - use this as a basis for dialogue and for moving ahead

  Example: Columbia river salmon restoration, 7 key sources of uncertainty.

Uncertainty elements	Expert A	Expert B	Expert C	Expert D
Length of Transition	.33 .67	.20 .80	.60 .40	.50 .50

- Typical Steps in a Structured Decision Making (SDM) Approach
  - Define the decision context
  - Identify objectives and indicators
  - Create alternative solutions to the problem
  - Evaluate the anticipated performance of each alternative solution with respect to each indicator
  - Evaluate the consequences of actions, and work with experts to improve their judgements of predicted effects (a novel judgmental task?)
  - Consider the trade-offs that exist among the alternatives; eliminate alternatives considered sub-optimal; create new, more optimal alternatives
  - Iterate until only a suite of optimal, distinct alternatives remain; select a preferred alterative
  - Implement the preferred plan(s) and monitor

Steps in structured decision aiding

Basic Concepts and Terminology

Treatment of Risk in an SDM approach

- Because of the choice of the 'decision' as the organizing focus the concept of "risk" is conditionalized by
  - the issues that matter to the identified stakeholders
  - the outcomes that matter because they can be influenced by management decisions
  - the uncertainty surrounding particular outcomes
  - the importance given to content and process concerns: how much emphasis is placed on being inclusive, on economic returns, on social implications, on being precautionary, on being adaptive
- For example, consider Alternatives A, B and C all of which are specific mitigation proposals put forward to reduce risk to a bird population from a wind power plant. Suppose:
  - Alternative A involves disabling the wind turbines for one month per year
  - Alternative B involves installing ground features nearby with the intent of guiding migrating birds away from the power plant
  - Alternative C involves doing both A and B in combination

  How can this information be presented in a way that facilitates good choices?

Basic Concepts and Terminology: consequence tables

- In this example, our objectives might be linked to the alternatives in a table:
  - Minimize bird deaths
    - Possible indicator(?): expected number of bird deaths per year
  - Minimize cost
    - Possible indicator(?): Levelized $ per year
  - Minimize visual impacts
    - Possible indicator(?): scale, where 1= Worst and 0= Best

Objective	Indicator	Alt A	Alt B	Alt C
Minimize Bird Deaths	Expected number of bird deaths per year (50^{th} %ile estimate)	5,000	200	200
	Expected number of bird deaths per year (10^{th} %ile estimate)	2,000	10,000	2,000
Minimize Costs	Levelized $ per year	$ 1million	$ 2 million	$ 3 million
Minimize Visual Impacts	Scale (1= Worst and 0= Best)	0	1	1

Basic Concepts and Terminology

Introduction to SDM

- Treatment of Risk in an SDM Approach
  - Alternatives are shown via expected performance on several indicators
  - Uncertainty about the expected number of birds killed is represented by two points on a probability distribution curve (50^{th} and 10^{th} percentile)
  - ALL the objectives are deemed important by the decision makers
  - This example uses 'number of bird deaths per year' as an indicator. An alternative indicator would imply a different analysis.
- Thus a decision-focus when evaluating wildlife risks
  - Compares choices across multiple objectives
  - Defines measures of performance for each objective
  - Includes multiple alternatives: focusing on mgt initiatives (e.g. mitigation)
  - Uses science to estimate consequences, with explicit estimates of uncertainty
  - Links expected consequences to objectives (what matters)
  - Examines tradeoffs explicitly, to find "acceptable" balance, and is
  - Especially helpful for comparing several alternative regulation possibilities

Alternative Regulatory frameworks for managing risk

Introduction to SDM: Risk Frameworks

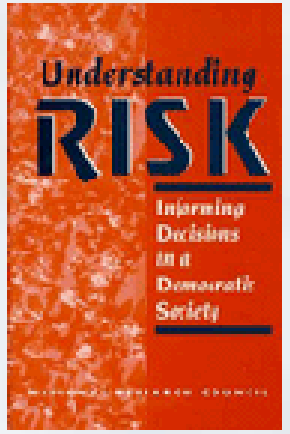
For discussion purposed, organize risk frameworks into three different types:

1. Principles and concepts:
   - US National Research Council "Understanding Risk: Informing Decisions in a Democratic Society"
2. Influential Generics
   - AS/NZS 4360-1995 Risk Management
   - CSA Guideline CAN/CSA-Q850 Risk Management: Guideline for Decision Makers
   - US Department of Interior Adaptive Management Technical Guide (Natural Resource Management)
3. Sector-Specifics
   - California Wind Energy Development (Reduce risks to birds and bats)
   - DFO Risk Management Framework (Risks to Fish Habitats)

Regulatory Frameworks for Managing Risk

US NRC "Understanding Risk: Informing Decisions in a Democratic Society"

- Context
  - In this framework, the US NRC attempted to integrate the findings of social and behavioural research into a broad, policy-level framework for informing decision making concerning social risks.
  - The book is premised on the importance of analysis and deliberation:
    - "Analysis uses rigorous, replicable methods, evaluated under the agreed protocols of an expert community – such as those disciplines in the natural, social, or decision sciences…to arrive at answers to factual questions
    - "Deliberation is any formal or informal process for communication and collective consideration of issues.



Regulatory Frameworks for Managing Risk

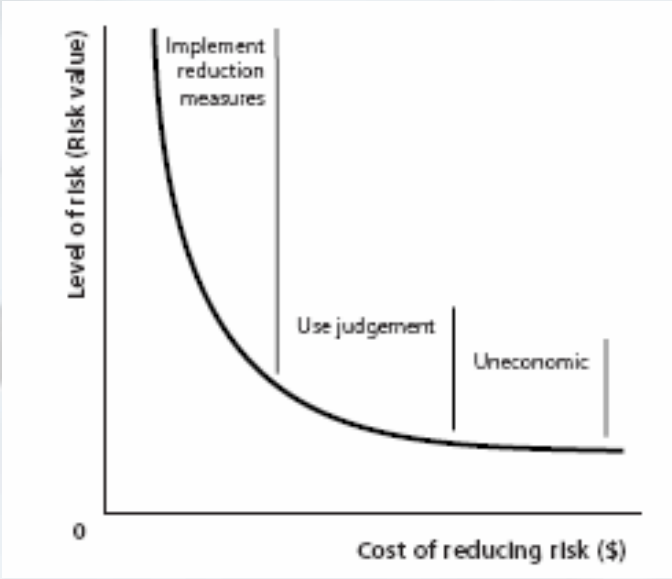
AS/NZS 4360-1995 , Australian and New Zealand Risk Management

- Context
  - This framework, often referred to simply as “ANZ”, was originally published in 1995 (updated in 1999 and 2004)
  - The Standard “provides a generic guide for the establishment and implementation of the risk management process involving establishing the context and the identification, analysis, evaluation, treatment, communication and ongoing monitoring of risks”.
  - In its preface, the Standard lays out its view of risk management:
    - “Risk management is an iterative process consisting of well-defined steps which, taken in sequence, support better decision-making by contributing a greater insight into risks and their impacts.
  - The framework is sensitive to the multi-dimensional nature of risk. It recognizes that risk identification, endpoint selection and indicator definition reflect judgements, and thus asks: ‘Who should participate in the process?’

Regulatory Frameworks for Managing Risk

AS/NZS 4360-1995 , Australian and New Zealand Risk Management

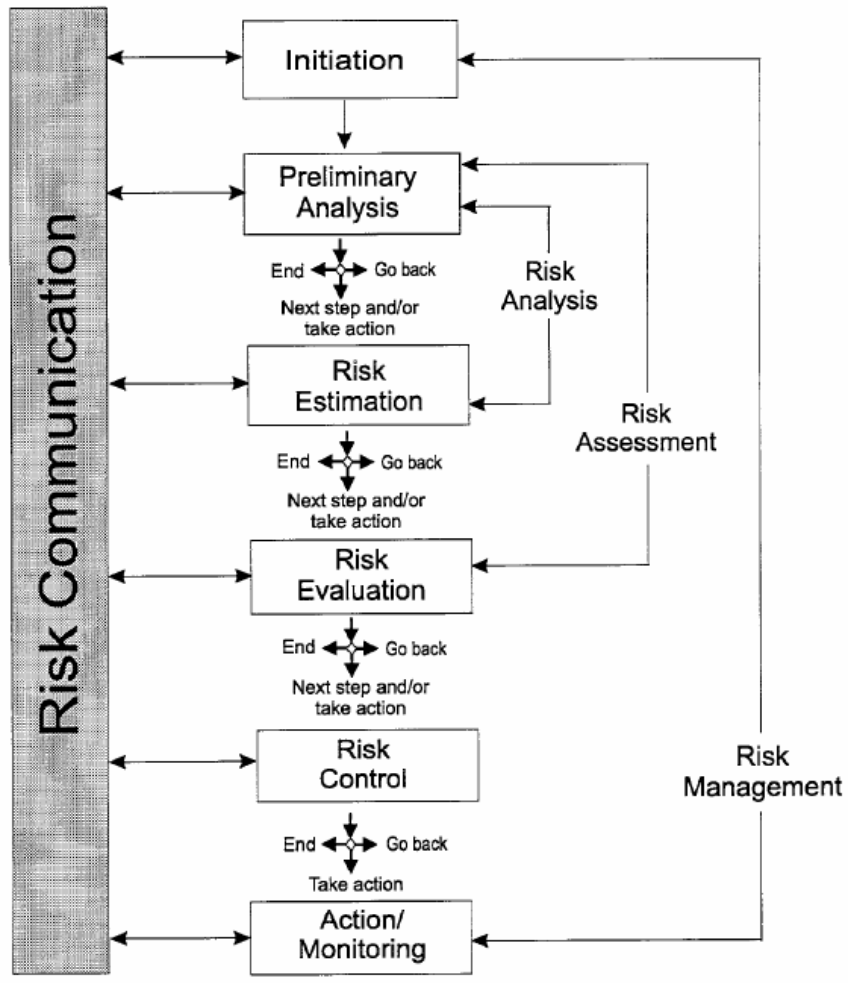
- Discussion
  - The ANZ framework is unusual in that it specifically addresses the question of risk mitigation cost-benefit issues
  - It offers this advice on trade-offs
    - "Selection of the most appropriate option involves balancing the cost of implementing each option against the benefits derived from it.
    - The cost of managing risks needs to be commensurate with the benefits obtained."
    - "Where large reductions in risk may be obtained with relatively low expenditure, such options should be implemented. Further options for improvement may be uneconomic and judgment needs to be exercised as to whether they are justifiable"



Regulatory Frameworks for Managing Risk

CSA Guideline CAN/CSA-Q850 Risk Management: Guideline for Decision Makers

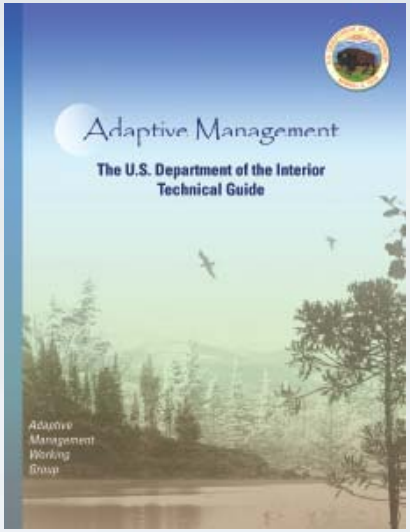
- CSA Q-850 Flowchart
  - In this chart, the Standard emphasizes the iterative nature of the risk management process; at each step, the process may end, go back, take the next step or take action.
  - Risk communication is indicated as a two-way arrow at every stage
  - Risk Analysis, Assessment and Management are shown as nested components



Regulatory Frameworks for Managing Risk

US Department of Interior Adaptive Management Technical Guide

- Context
  - Although not strictly a risk management framework, this guide is important in that it addresses a widely-used aspect of risk management, adaptive management
  - Adaptive management is framed within the context of structured decision making, with an emphasis on uncertainty about resource responses to management actions and the value of reducing that uncertainty to improve management.



Regulatory Frameworks for Managing Risk

US Department of Interior Adaptive Management Technical Guide

- Discussion
  - Role of Structured Decision Making is fundamental: “Adaptive management is framed within the context of structured decision making, with an emphasis on uncertainty about resource responses to management actions and the value of reducing that uncertainty to improve management” (Executive Summary)
  - Views adaptive management as a means to making better decisions, about the design of management experiments and monitoring initiatives
  - However, the framework is not sufficiently comprehensive:
    - Neglects the important linkages between objectives and consequences
    - Fails to consider many important non-environmental values (social, cultural, economic, …)
    - Fails to compare the pros and cons of an AM approach to those of other approaches to resource management under uncertainty, such as precautionary or robust approaches
    - Fails to provide a solid basis for comparing different AM approaches in terms of their relative costs, benefits, risks, or likelihood of success

Regulatory Frameworks

Managing Adaptively

- There are advantages to adaptive management approaches
  - AM permits one-time decisions to be modified into sequenced decisions
  - AM refines the rationale for monitoring and links learning to flexibility in management plans
  - AM helps to identify cross-linkages among what might otherwise be seen as one-off actions
- There are also disadvantages
  - AM costs money and requires ongoing commitments of personnel and funds
  - AM requires that effects of the experimental design be distinguished from external influences (those outside the control of the mgt actions)
  - AM is not effective or appropriate for many cases (e.g.., where inter-site comparisons cannot be made or where time scales for learning are long)
- There are also alternatives to AM as a way to learn under uncertainty, including physical modelling, expert judgements, or importing learning. And there are other concepts, such as precautionary strategies.
- Bottom line: Adaptive management can be helpful in appropriate situations, but it is no panacea. Suggestions to incorporate AM should be rigorously evaluated.

Regulatory Frameworks for Managing Risk

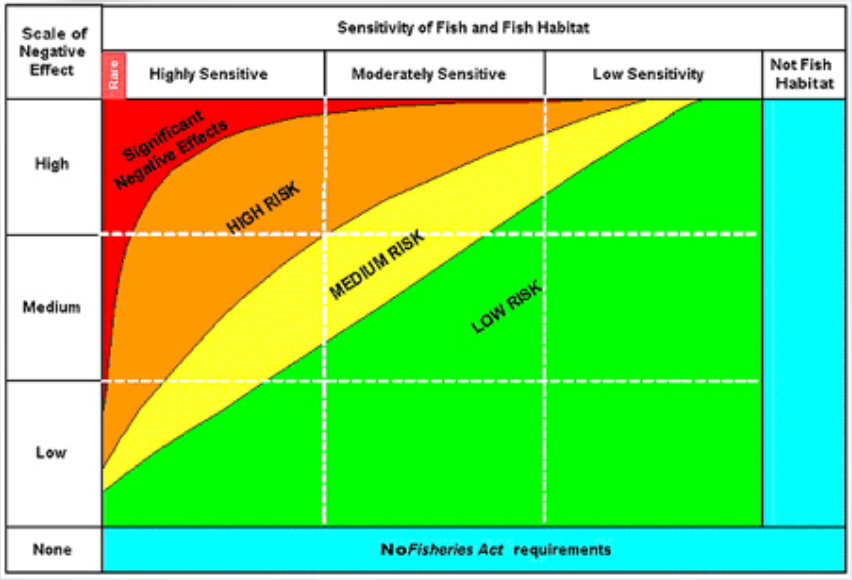
DFO Risk Management Framework

- Context
  - This document provides broad guidance to the Habitat Management Program of DFO on applying a risk management approach to decision-making under the *Fisheries Act.*
  - Historically, DFO focused its efforts on reviewing development proposals forwarded to the department ('referrals') on a case-by-case basis.
  - The intent of this new approach is to provide a transparent process screening potential activities according to the potential for harm to fish values.
  - The Framework is intended to "provide a structured approach to decision-making that takes into account the concepts of risk, uncertainty and precaution." Practitioners can:
    - analyze development proposals and apply mitigation to minimize residual effects;
    - assess residual effects and characterize the risks to fish and fish habitat;
    - use risk characterization process to support management decisions; and
    - communicate the rationale for their decisions".

Regulatory Frameworks for Managing Risk

DFO Risk Management Framework

- The Risk Assessment Matrix
  - The core of this framework is a binning (triage) matrix designed to determine which evaluation process a particular proposal should follow
  - A proposal's score on two axes determines its location and therefore its 'risk' rating.
  - Attributes used to describe the scale of negative effects (Y-Axis)
    - Extent
    - Duration
    - Intensity
  - Sensitivity of Fish and Fish Habitat (X-Axis)
    - Species Sensitivity
    - Species' Dependence on Habitat
    - Rarity
    - Habitat Resilience



Regulatory Frameworks for Managing Risk

DFO Risk Management Framework

- Discussion
  - Relatively little attention is given to the role of stakeholders in problem definition and framing.
  - Uncertainty in assessments (data, analysis) is not carefully addressed
  - Risk "communication" is notionally an aspect of all parts of this matrix, yet is intended primarily for 'information-out' reasons; the process places a heavy emphasis on value judgements made by technical experts
  - Implementation experience is uncovering several challenges, including:
    - Difficulties from treating each axis (sensitivity, scale of negative effect) as independent (doesn't fit users' mental models)
    - Defining threshold effects: what (exactly) should define the difference between the low, medium, high and significant risk ratings?
    - To what degree should any given risk rating that emerges from the exercise direct specific management actions?
    - Not clear how consideration of other objectives (e.g.., cost, reducing uncertainty) enters into the management process

Regulatory Frameworks for Managing Risk

California Guidelines for Reducing Impacts to Birds/Bats from Wind Energy

Context (for 2007 draft report)

- Provides a "science-based approach" for assessing potential impacts of a wind energy project on bird and bat species
  - suggests measures to avoid, minimize, and mitigate impacts.
  - discusses site screening, permitting requirements, per-permitting assessment methods, mitigation, and monitoring
- Does not discuss
  - objectives: to the extent that wind energy is encouraged so as to minimize climate change contributions, how does this affect the assessment of projects? How are direct vs. indirect impacts on birds to be evaluated?
  - tradeoffs: how might a developer or regulator seek to balance conflicting goals in siting a wind facility? Who decides on value weights?
  - the role of stakeholders: who is to be involved in siting decisions? How will disputes be handled? What information should be shared among participants?
  - the treatment of uncertainty: How will uncertain data be presented/debated?

Regulatory Frameworks

California Guidelines and Trade-Offs

Why is explicit attention to tradeoffs important? Consider the following examples:

Should a risk framework distinguish between the following pairs of proposed actions?

Action A: Negligible impact on birds, high cultural impact on local First Nations

Action B: Negligible impact on birds, no cultural impact on First Nations

Action C: Negligible impact on birds, no stakeholder opposition

Action D: Negligible impact on birds, but key stakeholders (local residents, NGOs) very upset and threatening to protest

Action E: Negligible impact on birds, but mitigation to cost $100 million

Action F: Slightly higher than negligible impact, with mitigation to cost $10,000

Action G: Negligible impact on birds, so long as inexpensive but untried monitoring scheme succeeds

Action H: Negligible impact on birds, so long as expensive but widely used monitoring scheme succeeds

If any answer is Yes, then risk classification (along the lines of California's Guidelines or DFO's habitat approach) is insufficient and a multi-objective risk management framework is required.

Key Considerations for Next Steps

CONCLUSION: Risk Frameworks presentation (Day 1)

- There is likely no perfect framework in existence that the FAC can use as a model for the development of a wind energy / wildlife risk management framework .
- That said, there is a strong developing trend in the field of risk management toward the use of decision-focussed frameworks that:
  - Formally recognize multiple management objectives and trade-offs
  - Engage stakeholders early and meaningfully in the development and implementation process
  - Explicitly acknowledge and address uncertainty
  - Build in accommodations for adaptive management or learning over time
- Development of an effective, robust, defensible risk management framework that addresses these key considerations will require a substantial commitment of time, intellectual and emotional resources, and goodwill.
- In tomorrow's presentation, I plan to focus on
  - methods for clarifying objectives and uncertainty
  - lessons learned from one or more case-study examples