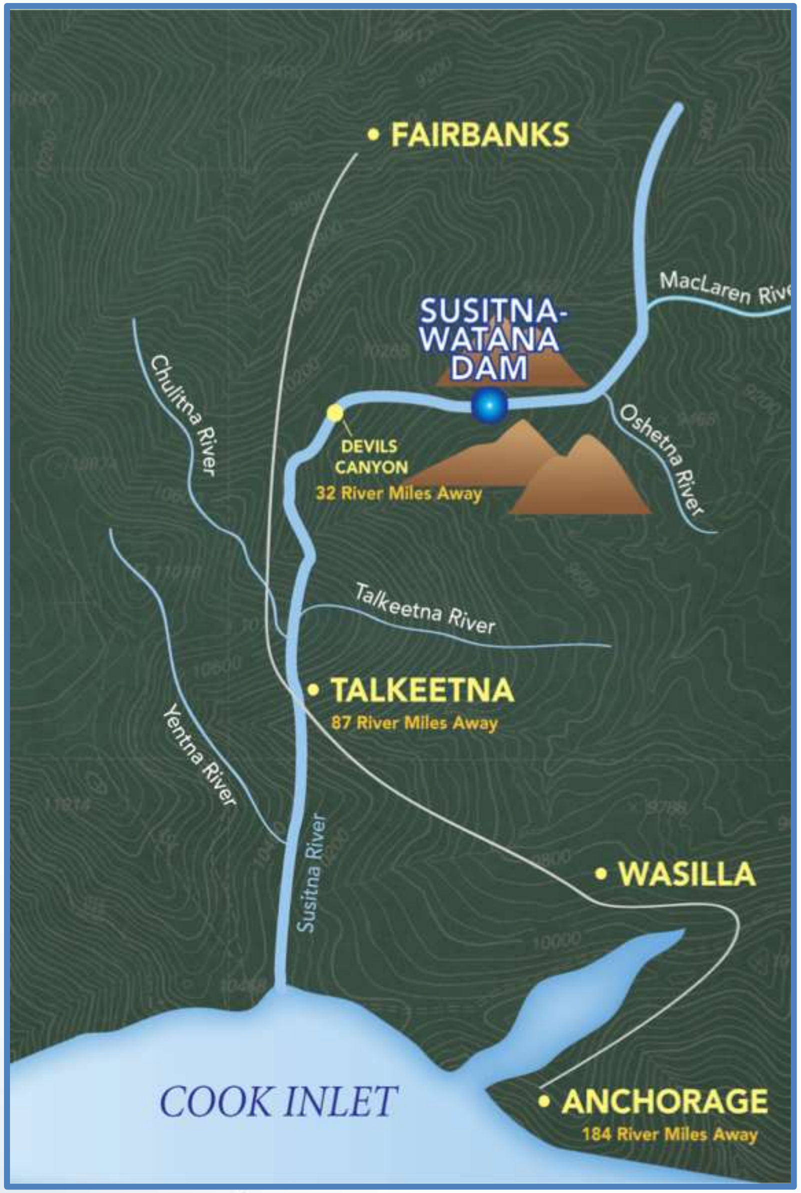


Instream Flow Technical Team Meeting - *Riverine Modeling*

November 13-15, 2013

Decision Support System Options

Prepared by R2 Resource Consultants

SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

Decision Support System - Define

- Decision: Choice among options on dam operations (Existing Conditions, Optimum Energy Output, OptA, OptB,....,)
- Support System: *Framework* for evaluating options based on "EVALUATION METRICS"

Decision Support System - Goal

- "The goal of a decision support system is not to make a decision, but rather to *reduce the complexity* of information and *focus attention on tradeoffs* involved in the decision." (USGS: Auble, et al 2009, DSS for Gunnison River)

Decision Support System - RSP

- Primary tool for “Instream Flow Study Integration” (RSP Section 8.5.4.8)
- “Evaluate the benefit and potential impacts of alternative operational scenarios”
- Focus attention on attributes of highest priority for evaluation of operational scenarios

DSS: Important Considerations

- Integration
- Focus
- Simplify
- Transparency
- Complexity of System/Time/Budget

DSS: Structured Decision Making

- Requirements:
  1. Explicit management alternatives
     - Actions: Operational scenarios
  2. Explicit, quantifiable objectives
     - Values: Maximize energy output, Maximize chum spawning habitat, etc.
  3. Models that predict #2 from #1
     - Beliefs: Assumptions, Data

DSS: Evaluation Metrics

- A set of joint values
- Must be *quantifiable* and *spatially* and *temporally explicit*
- Could be combined using “multicriteria methods”

DSS: Potential Approaches

- Manual Matrix Method
- USGS DSS for water management
  - Gunnison, Upper Yakima, Delaware Rivers
- Decision Analysis/Bayesian Belief Networks

Matrix Methods

- Operational and Flow Scenarios

  → Evaluation Metrics
- Some spatial and/or temporal variability included
  - Future 50 years is weighted average of dry, average, wet years responses
  - Averaged over Focus Areas in MR
- Uncertainties/assumptions are dealt with ahead of time
  - Choice of "average" flow year; choice of models; HSC methods
- Result = decision matrix comparing all operational scenarios for all EMs

EXAMPLE SUBSET of a Matrix

Resource Area	Temporal Scale	Spatial Scale	Evaluation Metrics (EXAMPLE)	Existing Conditions	OS1	OS2	OS3
Power	Nov-March average over expected 50 year flow	n/a	Power Generation (MWh)				
Hydrologic	Nov-March minimum over expected 50 year flow	n/a	2Day Low Flow (cfs)				
Riparian	Years 10-20	Geomorphic Reach	Floodplain Plant Community Colonization Area (acres)				
Resident Fish	Averaged over expected 50 year flow	Geomorphic Reach	Grayling weighted usable spawning habitat (ft2)				
Ice processes	Median date at year 50	n/a	Timing of ice breakup				
Anadromous Fish	Averaged over expected 50 year flow	Focus Area	Coho effective spawning/incubation habitat area in FA-104 (Whiskers Slough), averaged over expected 50 year flow.				
Anadromous Fish	Averaged over expected 50 year flow	Focus Area	Chinook effective spawning/incubation habitat area in FA-104 (Whiskers Slough), averaged over expected 50 year flow.				
Anadromous Fish	Averaged over expected 50 year flow	Focus Area	Chinook juvenile rearing habitat area in FA-104 (Whiskers Slough), averaged over expected 50 year flow.				
Anadromous Fish	Averaged over expected 50 year flow	Focus Area	Coho juvenile outmigration habitat area in FA-104 (Whiskers Slough), averaged over expected 50 year flow.				
Anadromous Fish	Averaged over expected 50 year flow	Focus Area	Chinook adult migration habitat area in FA-104 (Whiskers Slough), averaged over expected 50 year flow.				

Making a Decision From a Matrix

- Potentially hundreds of metrics in multiple resource categories
- No single optimal choice
- Three options:
  - Multiple Criteria Decision Analysis
  - Focus on KEY metrics
  - Leave a huge matrix

Multiple Criteria Decision Analysis

- Provide weighting of metrics (could be all equal).
  - Example 1: Number of metrics representing significant decline over existing conditions
  - Example 2: Weighted average of change from existing conditions, with anadromous fish habitat parameters double weighted.
- Decision rule – based methods
  - Example: Maximize power generation such that flow never drops below a minimum cfs criteria during juvenile rearing season.

Making a Decision From a Matrix

- Three options:
  - Multiple Criteria Decision Analysis
  - Focus on KEY metrics
  - Leave a huge matrix

USGS DSS Approach

- USGS uses VBA macros in MSExcel to compute similar decision matrix and show graphics automatically
- User inputs flow scenarios and can change some model parameters
- Outputs many tables and graphs, as well as decision matrix (red, yellow, green)
- Can accommodate multiple criteria analysis

Summary of Matrix/DSS Methods

- Has been successfully used for FERC licensing
- All decision metrics in one matrix
- Uncertainty is not explicit
  - Assumptions are vetted ahead of time or through *re*-running models under changes to assumptions (after the fact).

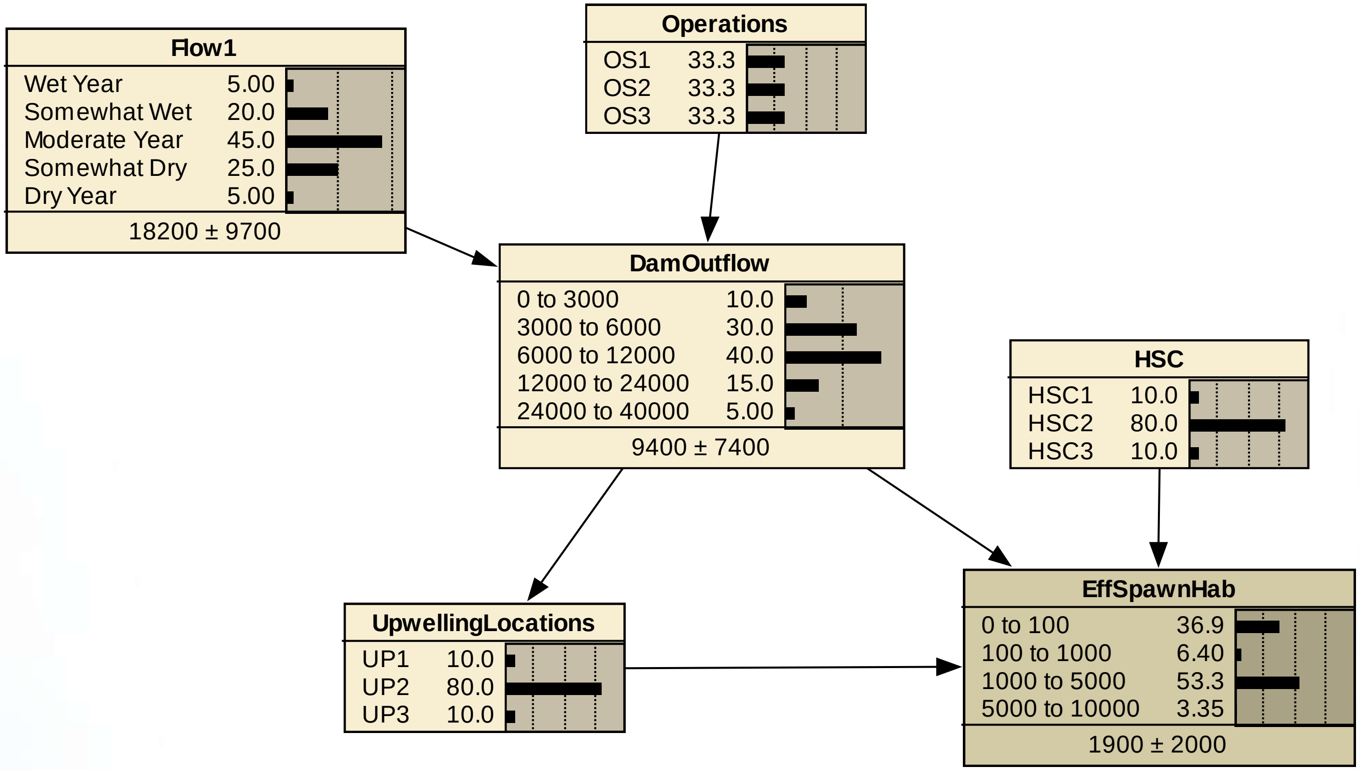
DSS: Other Options

- Decision analysis methods for including uncertainty
- Bayesian Belief Networks (BBNs)

Decision Analysis/Inclusion of Uncertainty

Resource Area	Temporal Scale	Spatial Scale	Evaluation Metrics (EXAMPLE)	Assumptions	Probability	Existing Conditions	OS1	OS2
Anadromous Fish	Averaged over expected 50 year flow	Focus Area	Coho effective spawning/incubation habitat area in FA-104 (Whiskers Slough), averaged over expected 50 year flow.	HSC1	0.2			
				HSC2	0.8			
				HSC3	0.2			
				Weighted Average				

Example BBN for Spawning Habitat



DSS: conclusions

- Matrix method will be done
- Amount of automation/software not yet determined
- May include some explicit uncertainties if possible
- BBN interesting, but not planned due to complexities/timing