Multi-Attribute Evaluation of Key Resources in GCDAMP

Technical Working Group

Feb 26, 2003

Background

- Need to establish quantitative targets to guide management and assess progress over time, but setting targets is complicated by:
  - **Uncertainty** about cause and effect relationships, and
  - **Trade-offs** among key resources
- Focus has been on uncertainties; need to also start exploring trade-offs

Trade-offs

- Low steady flows will conserve tributary **sediment** inputs but reduce **power** values from GCD (certain)

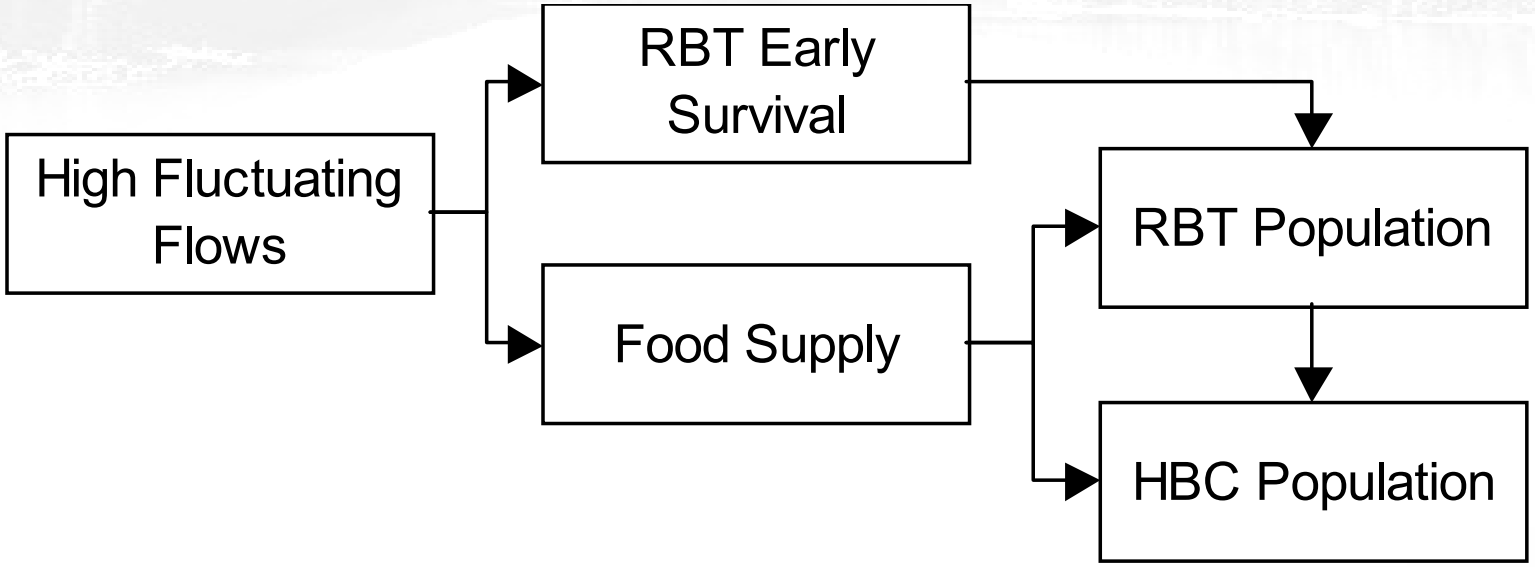
- Short duration - high flows with sufficient sediment in main channel and lower eddies will benefit sand bars and **camping beaches**, but will reduce **riparian vegetation** and terrestrial habitat (certain)

Trade-offs

- Increases in unsteady flows potentially have negative effects on **rainbow trout** and beneficial effects for **native fish.** Two major uncertainties:
  - Reducing rainbow trout abundance in Glen Canyon will increase fish size and benefit the recreational fishery
  - Reducing rainbow trout abundance in Grand Canyon may increase native fish recruitment rates
- If both hypotheses are correct there is no trade-off. Instead it is a win-win situation.

Targets and Trade-offs

- Some endpoints (e.g. some RBT abundances) may be incompatible with others (e.g., viable HBC population)
- Cannot set achievable targets for these endpoints without understanding trade-offs between the two



Setting Targets

- How to set targets in multi-attribute management setting:
  - Identify endpoints
  - Identify specific management alternatives
  - Estimate (or measure) impacts on endpoints
  - Determine acceptable trade-offs among endpoints
  - Select a management alternative(s)
  - Set targets - for endpoints (long term) and interim indicators (short term)
  - Monitor and adjust
- First task is getting the multi-attribute framework set up

Project Approach/Steps

1. Define endpoints and attributes
   - Endpoints from GCDAMP Management Objectives
   - Attributes are from MOs, GCM, and interviews
2. Identify management alternatives
   - From TWG
3. Estimate impact of alternatives on endpoints
   - Using GCM and professional judgment
4. Explore trade-offs and uncertainties
   - Using GCM and trade-off analysis

Endpoints

- **Endpoints** are the fundamental ends the plan is trying to address, the resources for which targets are to be set.
- The project will select endpoints from the GCDAMP management objectives
  - 57 management objectives in 12 categories
  - Mix of "means" and "ends"….
  - Means are not less important than ends, just different. The project uses a subset of endpoints from the MO's

Endpoints

Proposed project endpoints:

(2) **Native Fish - HBC**

(4) **Rainbow Trout – above Paria**

(6) **Vegetation – Spring and marsh**

(9) **Recreation – Camping beaches**

(10) **Power - Revenue**

(11) **Cultural Resources**

Endpoints

Other MOs not addressed for now:

- **1 (Food Base), 7 (Water Quality)** and **8 (Sediment)**
  - Are means of influencing the endpoints. They are modeled in GCM, and can be reported as interim indicators.
- **12 (Science)**
  - Is also a means, but is a process oriented objective. It is not modeled.
- **3 (Extirpated)**
  - Is not directly addressed, but 2 (Native/HBC) serves as a proxy for it.
- **5 (Kanab Ambersnail)**
  - Is not addressed. It can be added in the future.

Attributes

- Attributes are the measurable metrics used to report how a management alternative affects an endpoint. They should be:
  - Clearly related to the endpoints
  - Measurable or predictable
  - Meaningful to scientists
  - Meaningful to (non-technical) decision makers
  - Sensitive to the alternatives under consideration
- Examples:
  - Power: Annual Revenues ($/year)
  - Recreation: Area of Sandy Beaches (hectares per year, or % of 199x beach area)

Attributes and Impacts

- Use the attributes to compare the alternatives

MO	Endpoint	Attributes	A	B	C
2	Native Fish - HBC	abundance			
4	Rainbow Trout	abundance			
6	Vegetation	ha of desired veg communities			
9	Recreation	ha of sandy beaches			
10	Power	annual revenues			
11	Cultural Resources	frequency of flooding/erosion			

Explore Trade-offs

- Hypothetical decision at end of current treatments

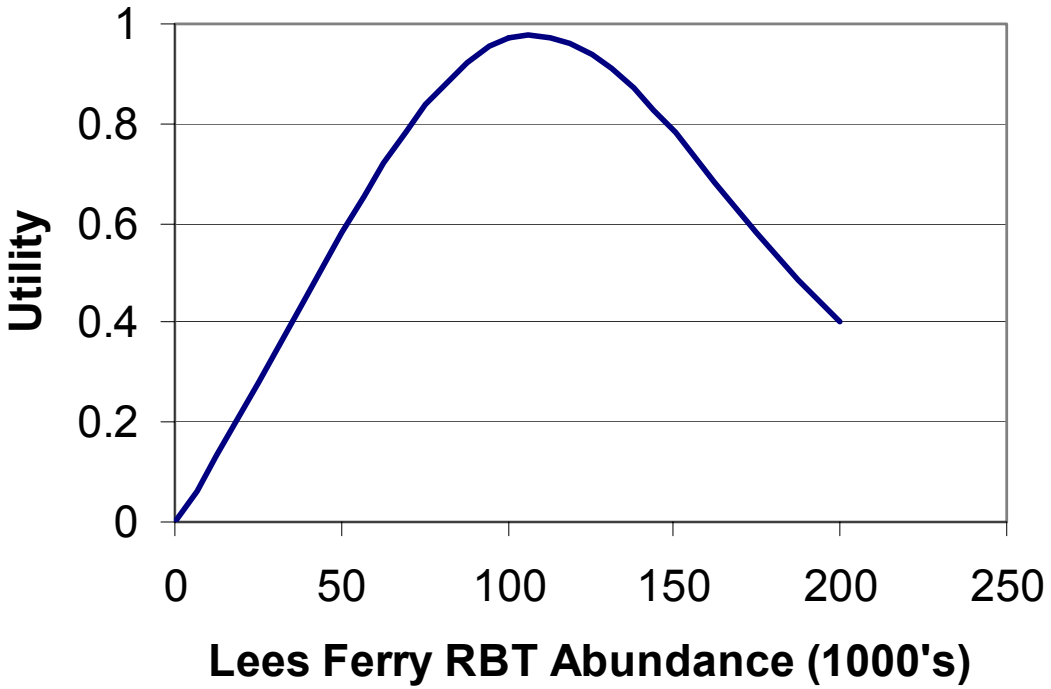
MO	Endpoint	Attribute	Continue Current	Modified Flow Treatment	Non-Flow Treatment
2	Native Fish - HBC	abundance	2-3	2-5	0-20
4	Rainbow Trout	abundance	100	80	60
6	Vegetation	ha of desired veg communities	--	--	--
9	Recreation	ha of sandy beaches	--	--	--
10	Power/Financial	annual revenues	100	95	50
11	Cultural Resources	frequency of flooding/erosion	--	--	--

Refining Attributes

- Need to be specific in defining what the key attributes of performance are:
  - Rainbow
    - Abundance only? Or does size/condition matter?
  - Vegetation
    - What types of communities are preferred?
  - Recreation
    - Hectares of beach? Or % of 199x area?
  - Humpback chub
    - Abundance? Or "probability of achieving a viable population"? Or two attributes – for LCR and Other?
- Interaction between model capability / professional judgment and stakeholder preferences

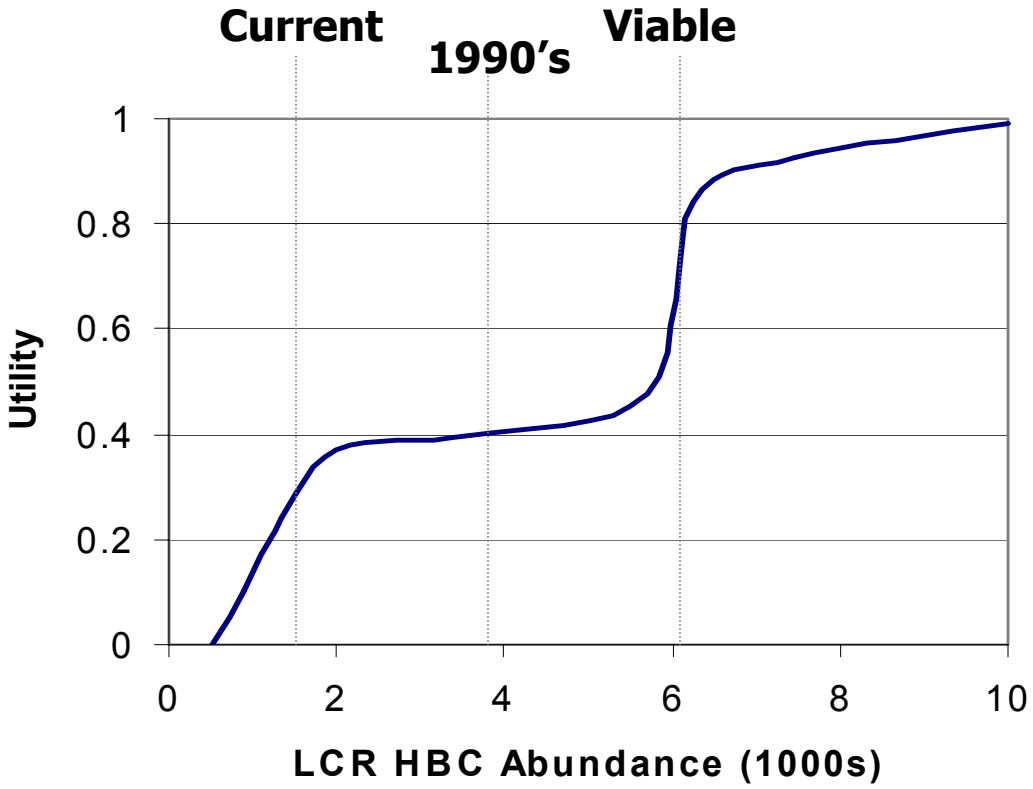
Why defining attributes ≠ setting targets

- Might assume that target should be at peak – 100k
- But what if peak RBT causes declines in HBC? Or what if you can get 80% of the peak at 20% of the cost?



Refining Attributes

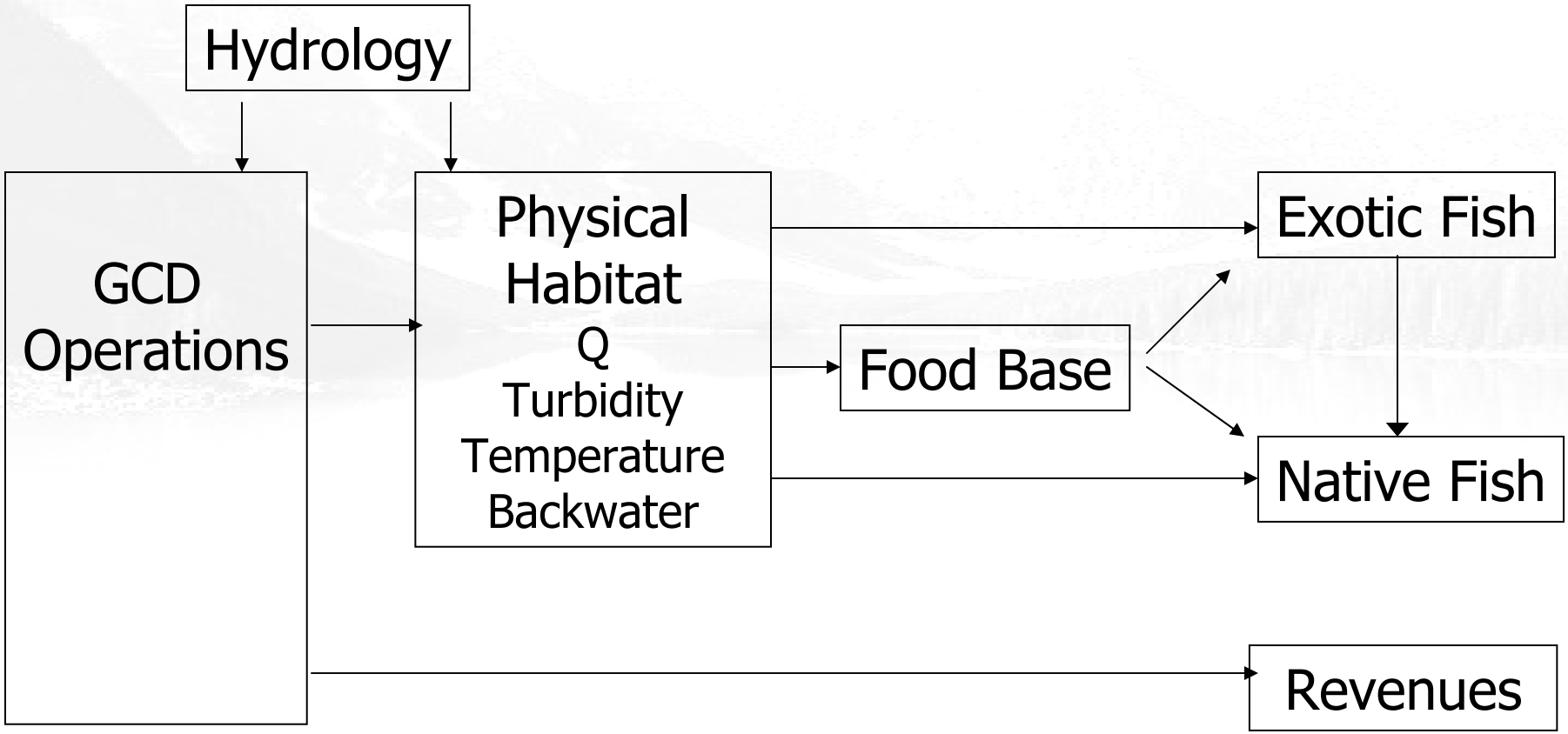
- Should establish important thresholds when defining attributes
- They help you identify alternatives and assess performance, but they aren't *necessarily* fixed targets



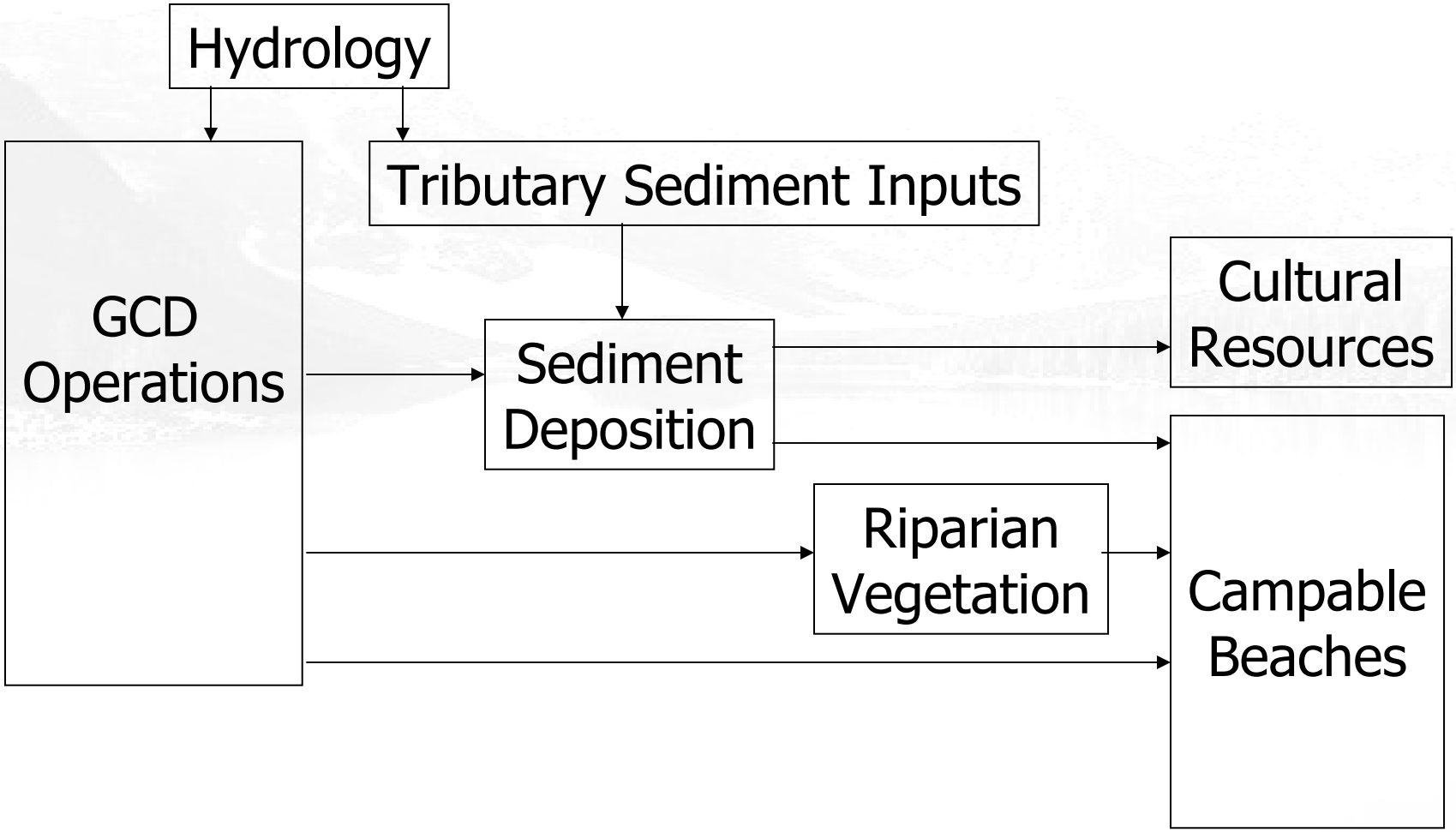
Estimating Impacts

- The project will use GCM and professional judgment to estimate impacts of management alternatives on the endpoints
- Predicted values for the attributes will be used to compare alternatives and expose trade-offs

Estimating Impacts – GCM Structure



Estimating Impacts – GCM Structure



Making Trade-offs

- Which is preferred?
  - Answer depends on values
- Set targets based on alternative selected

MO	Endpoint	Attributes	A	B
2	Native Fish - HBC	abundance	10	10
4	Rainbow Trout	abundance	100	80
6	Vegetation	ha of desired veg communities	2000	3000
9	Recreation	ha of sandy beaches	1000	1500
10	Power	annual revenues	100	200
11	Cultural Resources	frequency of flooding/erosion	9	11

Next Steps

Confirm the endpoints (working group followup)

Confirm attributes, threshold values (working group, modeling)

Summarize proposed endpoints, attributes and alternatives to be modeled (briefing note to TWG)

Model alternatives

Workshop to explore uncertainties and trade-offs

- Game with GCM to test sensitivity of results to uncertain parameter values and alternative hypotheses
- Provide value judgments about preferences for various outcomes