Final Draft Performance Metrics for the Long-Term Experimental & Management Plan

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Acronyms Used in This Presentation

- AMWG: Adaptive Management Work Group
- BO: Biological Opinion
- CRE: Colorado River Ecosystem
- DOI: Department of Interior
- GCD: Glen Canyon Dam
- GCE: Grand Canyon Ecosystem
- GCMRC: Grand Canyon Monitoring and Research Center
- GCNRA: Glen Canyon National Recreation Area
- HBC: Humpback Chub
- HFE: High Flow Experiment
- LCR: Little Colorado River
- LTEMP: Long Term Experimental and Management Plan
- ROD : Record of Decision
- SRP: Soluble Reactive Phosphorous
- TWG: Technical Work Group

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Why does GCDAMP need metrics?

- LTEMP defines 11 Goals for 20-year plan
  - How do we know if the goals are being achieved?
  - Need to define performance metrics
- Section 6.1(c) of the LTEMP ROD*

  "The DOI, in consultation with the AMWG, will develop monitoring metrics for the goals and objectives using those in Appendix C as a starting point."

  (Note: Appendix C = performance metrics developed by Runge et al. (2016) to help select the preferred LTEMP alternative.)
- FY 21-23 TWP, Reclamation Project C.12

* Department of Interior, 2016, Record of Decision for the Glen Canyon Dam Long Term Experimental and Management Plan Final Environmental Impact Statement, December 2016. Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah and National Park Service, Intermountain Region, Lakewood, Colorado.

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Monitoring vs. Performance Metrics

Many types and reasons for monitoring:

- **Effectiveness (or Performance) Monitoring**
  1. Assess effectiveness of policy, plan, or legislation
  2. Evaluate progress towards achieving management objectives or regulatory standards
- **Surveillance Monitoring/Ecosystem Monitoring**
  3. Detect incipient trends (“early warnings”)
  4. Determine resource status in order to plan appropriate management actions
- **Validation Monitoring**
  5. Increase understanding of resource dynamics
  6. Develop and refine models or predictions

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Performance Metrics

A quantitative measure to assess performance, track progress, and monitor success or failure

- ***Are we on track to meet program goals?***
- ***Have we achieved program goals?***
- ***Where do we need to focus future attention, i.e., where is there need for improvement?***

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Some basic tenets of good performance metrics

- Prioritize quality of metrics over quantity
- Design metrics that are easy to understand
- Design metrics that are easy to compare over time
- Avoid redundant metrics

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LTEMP Performance Metrics: Criteria

- Quantifiable (metric = measurable): allows for objective assessment of change over time
- Goal-oriented: Focuses on measuring LTEMP goal outcomes, not the underlying "means objectives"
- Actionable: highlights where adjustments to processes or improvements are needed
- Technically & financially feasible to measure (e.g., sustainable to monitor over a long period of time)
- * Where possible. Not all desired goal outcomes are directly measurable.

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Example: Humpback Chub (*Gila cypha*)

- **Goal Statement:** ***Meet humpback chub recovery goals, including maintaining a self-sustaining population, spawning habitat, and aggregations in the Colorado River and its tributaries below the GCD***
- **Performance Metrics**
  - **3.1 Current BO tier of HBC in LCR aggregation**
  - **3.2 Grand Canyon-wide HBC abundance**
  - **3.3 Proportion of Grand Canyon ecosystem with evidence of all 3 life stages**
- **Surveillance metrics ("drivers" of outcome):**
  - **Water qualities (temperature, oxygen, turbidity, etc.)**
  - **Nutrients (e.g., SRP) and food base quality**
  - **Predator loads**
  - **LCR flood magnitude & frequency**

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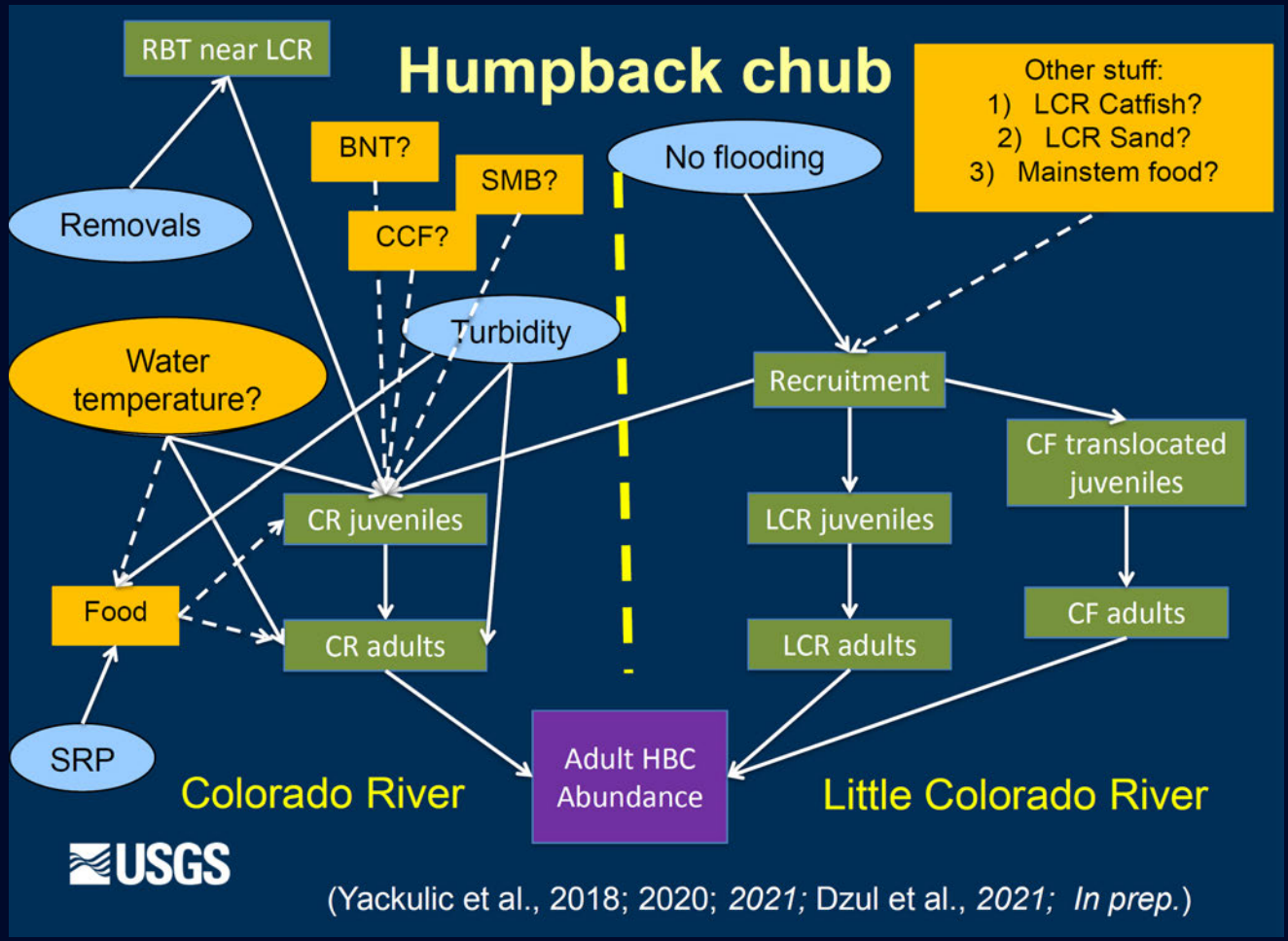
Conceptual diagrams capture underlying “drivers” of goal outcome



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Examples of Surveillance Metrics

"Drivers" of goal outcomes are not performance metrics; But are important to monitor for other reasons

Metric Name	Measurement	Location(s)	Frequency	Method	Relevant Goals
Daily/monthly/annual releases	m3/sec (cfs)	GCD, LF, Phantom, DC	15 min increments	auto sample	All
Daily range (magnitude of fluctuations)	m3/sec (cfs)	GCD, LF, Phantom, DC	15 min increments	auto sample	All
Water Temperature	Degrees C (F)	GCD, -8 mi, LF, 5 sed gages	15 min increments	auto sample	2,3,5,6,9,10
Turbidity	fnu	6 mainstem sed gages	15 min increments	auto sample	2,3,5,6,7,9,10
Dissolved Oxygen	mg/L	GCD, -8 mile, LF	15 min increments	auto sample	2,3,5,9,10
Ph	unitless	GCD, LF	monthly	grab sample	2,3,5,9,10,11
Phosphorus (SRP, TDP, TP)	mg/L	GCD, LF, Paria	monthly	grab sample	2,3,5,9,10,11
Nitrogen (TN, NO23, NH4, TDN)	mg/L	GCD, LF	monthly	grab sample	2,3,5,9,10,11
Available Sunlight (Canyon shading)	PPFD µmol m-2 s-1	Entire Cre- Yard et al. 2005	instantaneous	modeled	2,3,5,9,10,11
Sediment mass balance (inputs/export)	metric tons	6 mainstem gages	15 min increments	auto sample/modeled	1,2,6,7,11
Weather/climate parameter: Air Temperature	Degrees C (F)	LF, 11mi, 24.5, 70, 125, 223mi	4 min increments	auto sample	2,6,11
Weather/climate parameter: Wind intensity	km/hr	6 weather stations	4 min increments	auto sample	1,6,7,11
Weather/ climate parameter: Wind direction	degrees	6 weather stations	4 min increments	auto sample	1,6,7,11
Weather/climate parameter: precip.intensity	mm/hr	6 weather stations	4 min increments	auto sample	1,6,7,11
Weather/climate parameter: precip.amount	mm/hr	6 weather stations	4 min increments	auto sample	1,6,7,11
weather/climate parameter: humidity		6 weather stations	4 min increments	auto sample	6,11

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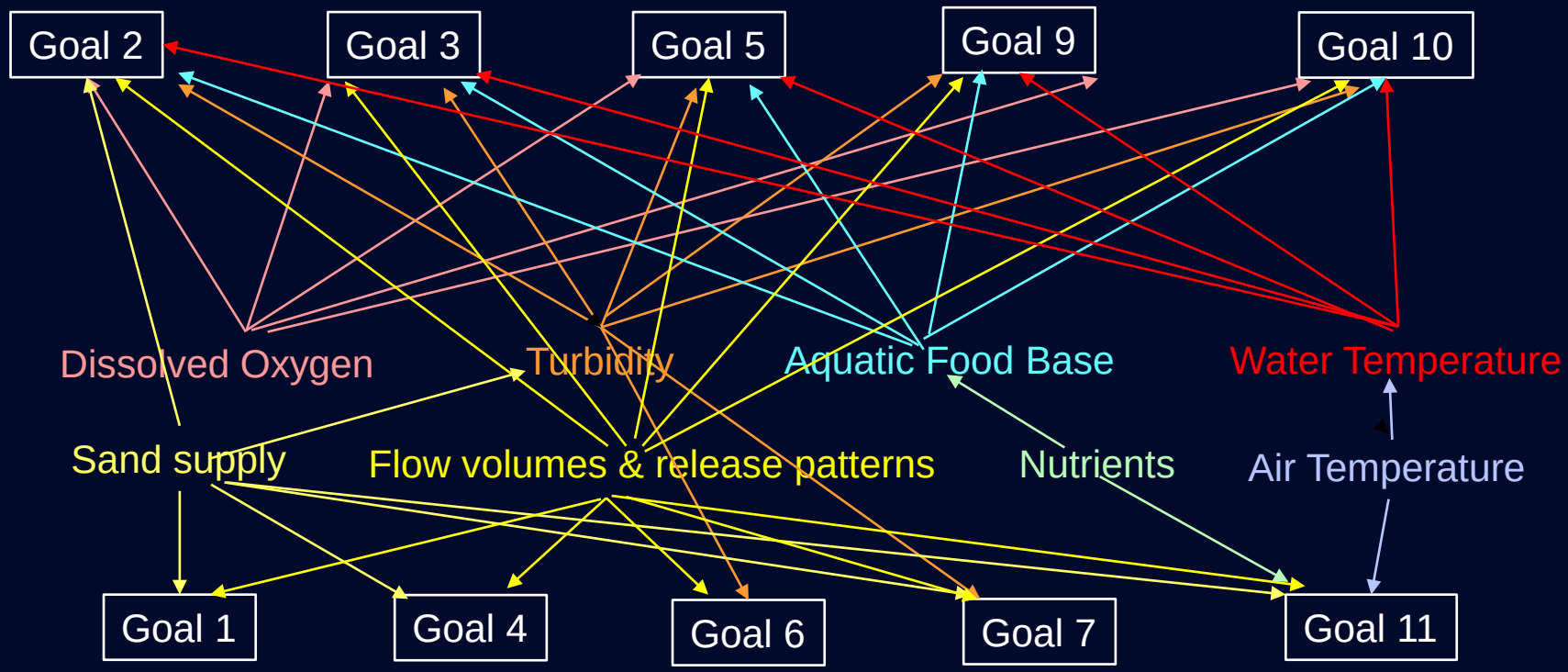
Preliminary data. Subject to Review. Please do not cite

Surveillance metrics inform on multiple goals, not just one goal



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History of Draft Metrics Report

- **FY 2021:** DOI settles on project scope; GCMRC initiates internal discussions, drafts metrics for initial review
- **FY 2022:**
  - Multiple meetings with DOI agency partners and other cooperators to review and discuss draft metrics
  - First draft report sent to TWG; discussed at June TWG meeting. Revised based on initial TWG comments
  - Oct. TWG Presentation; more comments received
- **FY2023:**
  - Additional revisions made; Revised draft shared with DOI agencies
  - Meeting with DOI agencies; requested revisions made to Goals 1 and 2; ongoing discussion re: sediment

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History of Metrics, continued

- **February 2024:** Presentation at AMWG; Secretary's Designee requests resolution of remaining issues re: Sediment, Tribal Metrics, Hydropower by Feb. 2025.
- **Sept-Oct 2024:** DOI agencies meet to discuss Sediment metrics. Multiple additional metrics added.
- **November 2024:** Tribes, BOR and USGS meet to discuss Goal 8 metrics. Pilot solution proposed.
- **April 2025:** BOR, USGS, WAPA meet to discuss hydropower metrics; 2 additional metrics proposed
- **June-August 2025:** Metric descriptions for Goals 7 & 8 completed; Hydropower metrics nearly final.

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Goal 1 Metrics

- **Goal 1 – Archaeological Resources**

Maintain the integrity of potentially affected NRHP-eligible or listed historic properties in place, where possible, with preservation methods employed on a site-specific basis.

- **1.1 Integrity**
- **1.2 Topographic Change at a Sample of Sites**
- **1.3 Change in Vulnerability to Loss of Integrity**

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Goal 2 Metrics

- **Goal 2 – Natural Processes**

Restore, to the extent practicable, ecological patterns and processes within their range of natural variability, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems

- **2.1 Deviation from Natural Flow Metric**
  (with “sub-metrics”: spring-early summer, late summer-fall, and winter deviation from natural flows)
- **2.2 Sub-daily Flow Fluctuation Metric**
- **2.3 Springtime Gross Primary Productivity**
- **2.4 Percent EPT Metric**

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Goal 3 Metrics

- **Goal 3- Humpback Chub (*Gila cypha*)**

Meet humpback chub recovery goals, including maintaining a self-sustaining population, spawning habitat, and aggregations in the Colorado River and its tributaries below the Glen Canyon Dam

- **3.1 Current B.O. Tier of HBC in LCR Aggregation**
- **3.2 Grand Canyon-wide Abundance of Adult HBC**
- **3.3 Proportion of Grand Canyon Ecosystem with Evidence of All 3 Life Stages of HBC**

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Goal 4 Metrics

- **Goal 4- Hydropower**

Maintain or increase Glen Canyon Dam electric energy generation, load following capability, and ramp rate capability, and minimize emissions and costs to the greatest extent practicable, consistent with improvement and long-term sustainability of downstream resources

  - **4.1 GCD Energy Production**
  - **4.2 Economic Value of GCD Energy Production**
  - **4.3 Marketable Capacity of GCD Energy**

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Goal 5 Metrics

- **Goal 5 – Other Native Fishes**

Maintain self-sustaining native fish species populations and their habitats in their natural ranges on the Co. River and its tributaries

- **5.1 - 5.3: Proportion of Grand Canyon Ecosystem (GCE) with evidence of all 3 life stages of Bluehead Sucker *(Catostomus discobolus)* (5.1), Flannelmouth Sucker (*Catostomus latipinnis*) (5.2), Razorback Sucker (*Xyrauchen texanus*) (5.3)**
- **5.4 Proportion of GCE with Speckled Dace (*Rhinichthys osculus*) (any life stage)**
- **5.5 Proportion of GCE with extirpated species (any life stage)**

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Goal 6 Metric

- **Goal 6 – Recreation**

Maintain and improve the quality of recreational experiences for the users of the Colorado River Ecosystem. Recreation includes, but is not limited to, flatwater and whitewater boating, river corridor camping, and angling in Glen Canyon

6.1 – Economic Value of Recreation Experience

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Goal 7 Metrics

- **Goal 7 – Sediment**

Increase and retain fine sediment volume, area, and distribution in the Glen, Marble, and Grand Canyon reaches above the elevation of the average base flow for ecological, cultural, and recreational purposes.

Performance Metric:

- **7.2 Sand Bar Volume**
  (includes multiple “sub-metrics”, e.g., normalized sandbar volume by type, mean sand bar response to HFEs)

Surveillance Metrics:

- **7.1 Sand Supply By River Segment (Sand Mass Balance)**
- **7.3 Silt & Clay Retention by River Segment (Turbidity)**

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Goal 8 Metrics

- **Goal 8 – Tribal Resources**

Maintain the diverse values and resources of traditionally associated Tribes along the Colorado River corridor through Glen, Marble, and Grand Canyons.

1. **Is the Colorado River ecosystem healthy? Please explain why or why not.**
2. **How well is LTEMP doing at meeting its goals? Please explain the basis for your assessment.**
3. **Overall, is the Grand Canyon doing better, worse, or about the same as last year? Please explain the basis for your assessment.**

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Goal 9 Metrics

- **Goal 9 – Rainbow Trout Fishery**

Achieve a healthy high-quality recreational rainbow trout fishery in GCNRA and reduce or eliminate downstream trout migration consistent with NPS fish management and ESA compliance

  - **9.1 Trout Angler Catch Rate**
  - **9.2 Rainbow Trout (*Oncorhynchus mykiss*) Abundance**

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Goal 10 Metrics

- **Goal 10 – Non-native aquatic species**

Minimize or reduce the presence and expansion of aquatic nonnative invasives.

- **10.1 - 10.4: Average number of "risky species" per Habitat Segment in Grand Canyon Ecosystem**
- **10.5 - 10.8: Average number of "risky species" with evidence of recent recruitment per Habitat Segment in Grand Canyon Ecosystem**
  - **10.1, 10.5 = Low risk species**
  - **10.2, 10.6 = Medium risk species**
  - **10.3, 10.7 = High risk species**
  - **10.4, 10.8 = Very high risk species**

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Goal 11 Metrics

- **Goal 11 – Riparian vegetation**

Maintain native vegetation and wildlife habitat, in various stages of maturity, such that they are diverse, healthy, productive, self-sustaining, and ecologically appropriate

- **11.1 Total Plant Cover**
- **11.2 Native Plant Richness**
- **11.3 Native to Non-native Plant Species Cover Ratio**

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Conclusions

- 38+ metrics identified for 11 goals; number of metrics per goal ranges from 1 to 8
- Current metrics status presented April 2025 at Annual Reporting Meeting
- Report on FY2024 metrics status under review by USGS; will be available shortly
- Report describing the metrics to follow

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Questions?

Confluence of the Colorado and Little Colorado Rivers

Top: E. C. La Rue. August 13, 1923; Bottom: A.H. Fairley, May 8, 2019

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