



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

**Technical Work Group Meeting
Phoenix, Arizona
November 8, 2023**

Helen C. Fairley

**U.S. Geological Survey, Southwest Biological Science Center
Grand Canyon Monitoring and Research Center**

Acronyms Used in This Presentation

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

Why is this project important?

(Purpose and Need for Metrics)

- **LTEMP defines 11 Goals for 20-year plan**
 - **How do we know if 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.

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?*
- **Metrics require standardized monitoring protocols so as to be comparable over time**
- Some basic tenets of metrics design and selection include:
 - Prioritize quality of metrics over quantity
 - Design metrics that are easy to understand
 - Design metrics that are easy to compare

Monitoring not the same as Metrics

Principal types and reasons for monitoring include:

- **Effectiveness (or Performance) Monitoring**
 1. To assess effectiveness of policy, plan, or legislation
 2. To evaluate progress towards achieving management objectives or regulatory standards
- **Surveillance Monitoring**
 3. To detect incipient trends (“early warnings”)
 4. To determine resource status in order to plan appropriate management actions
- **Validation Monitoring**
 5. To increase understanding of resource dynamics
 6. To develop and refine models or predictions

This Project

- Focus on defining metrics to monitor effectiveness of LTEMP (i.e., Are we achieving LTEMP Goals?)
 - “To assess effectiveness of policy . . .” and
 - “ track progress towards achieving management objectives . . .”
- Specific focus is on defining metrics for assessing and tracking achievement of LTEMP Goal outcomes
 - These metrics are not tracking means to achieving goals
 - Metrics for other objectives & purposes can be defined later
- Performance metrics tell us “achieving/achieved” or “not achieved” -- *but not necessarily why*
- This will not be a comprehensive Monitoring Plan!

LTEMP Goals

■ LTEMP Goals (from 2016 LTEMP FEIS and ROD)

- 1. Archaeological and Cultural 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.**
- 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.**
- 3. Humpback Chub. **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.**
- 4. Hydropower and Energy. **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.**
- 5. Other Native Fish. **Maintain self-sustaining native fish species populations and their habitats in their natural ranges on the Colorado River and its tributaries.**
- 6. Recreational Experience. **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.**
- 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.**
- 8. Tribal Resources. **Maintain the diverse values and resources of traditionally associated Tribes along the Colorado River corridor through Glen, Marble, and Grand Canyons.**
- 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.**
- 10. Nonnative Invasive Species. **Minimize or reduce the presence and expansion of aquatic nonnative invasives.**
- 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.**

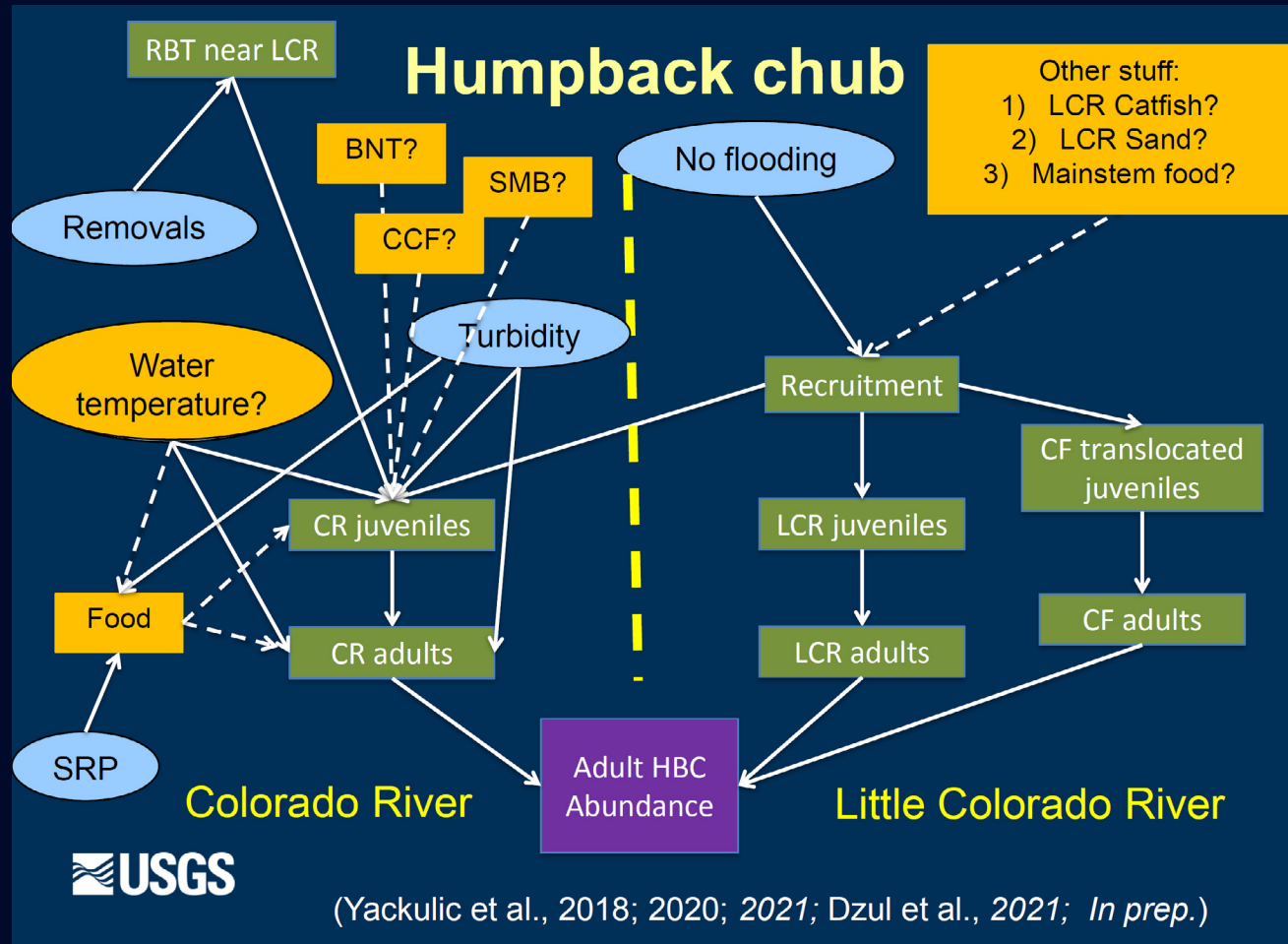
LTEMP Performance Metrics: Criteria

- Reflects the expected performance outcome of each LTEMP goal, not underlying “means objectives”
- **Quantifiable (metric = measurable)**
- Technically & financially feasible to measure (e.g., sustainable to monitor over a long period of time)
- **Relevant to the metrics used to select LTEMP preferred alternative**

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 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

Conceptual diagrams capture underlying “drivers” of goal outcome



Examples of Surveillance Metrics

These are “drivers” of goal outcomes; important to monitor for many reasons & resources

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, NO ₂ , NH ₄ , TDN)	mg/L	GCD, LF	monthly	grab sample	2,3,5,9,10,11
Available Sunlight (Canyon shading)	PPFD $\mu\text{mol m}^{-2}$ 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

Update on Draft Metrics Report

- **FY '21:** Start project. Settle on project scope, initiate internal discussions, draft metrics for review
- **February '22:** Multiple meetings with DOI agency partners and other cooperators to review draft metrics
- **June 9, '22:** Draft report sent to TWG; discussed at June TWG meeting. Revised base on initial TWG comments
- **Oct. '22:** TWG Presentation; more comments received
- **November '22-Feb '23:** Additional revisions made
- **March '23:** Revised draft shared with DOI agencies
- **May '23:** Meeting with DOI agencies to discuss draft
- **June-Sept '23:** GCMRC made requested DOI revisions to Goals 1 and 2; ongoing discussion re: sediment metrics



Now: Need to loop back with DOI again

Draft metrics, Goal 1

■ 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

Draft Metrics, Goal 2

■ 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

(We also discuss “sub-metrics” for 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

Draft Metrics, Goal 3

- **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 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**

Draft Metrics, continued

■ 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 the 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)

■ 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

Draft Metrics, continued

■ 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 – Economic Value of Hydropower

■ 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

Draft Metrics, continued

■ 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
 - 10.4, 10.8 = very high

Draft Metrics, continued

■ 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

Goals/Metrics still under discussion

- **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.
- **Status: Internal agreement on 2 metrics; discussion ongoing re: 3 other metrics**
- **8. Tribal Resources.** Maintain the diverse values and resources of traditionally associated Tribes along the Colorado River corridor through Glen, Marble, and Grand Canyons.
- **Status: No agreement on metrics; no change since April 2023.**

Goal 7: Sediment

- **Goal 7 Statement:** *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 Metrics (agreed on):**
 - Normalized Sand Bar Volume
 - Normalized Sand Bar Volume by Type
- **Other Metrics (not agreed on):**
 - Sand supply by river segment (mass balance)
 - Turbidity
 - Mean sandbar response to HFES

Goal 8: Tribal Values & Resources

- **Goal 8 Statement:** *Maintain the diverse values and resources of traditionally associated Tribes along the Colorado River corridor through Glen, Marble, and Grand Canyons.*
- **Can we define metrics around some shared values?**
 - **Respect**
 - **Responsibility (Stewardship)**
 - **Relationships**
 - **Reciprocity**

Next Steps

- **November-December 2023:** GCMRC will meet with DOI agencies; revise and finalize draft report
- **January 2024:** Final Draft of metrics sent to TWG and AMWG; GCMRC reports on draft metrics at Annual Reporting Meeting
- **February 2024:** Consult with AMWG
- **March 2023:** Finalize metrics report

Questions?



Confluence of the Colorado and Little Colorado Rivers

Top: E. C. La Rue. August 13, 1923; Bottom: A.H. Fairley, May 2, 2018

Metric Description Format

Goal X Statement

Background (sets stage and rationale for selecting specific metrics)

Conceptual diagram (shows “means variables” & “ecological drivers”)

Metric X.1 (Metric Name)

- **Metric Type:** direct observation/measurement, estimate based on model, etc.
- **Relevant Criteria:** Describe how it relates to the established criteria for metrics
- **Data required:** Data required to produce the metric
- **Metric calculation:** How metric will be calculated
- **Frequency:** How often will the metric be measured?
- **Presentation:** How will the metric be presented (graphically; example provided)
- **Interpretation:** How will metric be interpreted (historic range, trend, thresholds?)
- **Limitations and uncertainties of the metric**
- **NEW Addition:** Current status of metric