



Review of TWG Feedback on Draft Performance Metrics for the Long-Term Experimental and Management Plan

**Technical Work Group Meeting
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Presentation Outline

- **Project Overview**
- **Stakeholder Review and General Comments**
 - **Discussion re: general comments/issues**
- **Specific Metrics by Goal**
 - **Discussion re: specific metrics**
- **Next Steps**

Acronyms Used in This Presentation

- **AMWG: Adaptive Management Working Group**
- **CRE: Colorado River Ecosystem**
- **CREDA: Colorado River Energy Distributors Association**
- **DOI: Department of Interior**
- **GCD: Glen Canyon Dam**
- **GCMRC: Grand Canyon Monitoring and Research Center**
- **GRCA: abbreviation for Grand Canyon National Park**
- **GLCA: abbreviation for Glen Canyon National Recreation Area**
- **HBC: Humpback Chub**
- **LCR: Little Colorado River**
- **LTEMP: Long Term Experimental and Management Plan**
- **ROD : Record of Decision**
- **TWG: Technical Work Group**
- **TWP: Triennial Work Plan**
- **WAPA: Western Area Power Administration**

Project Overview (Purpose and Need)

- **LTEMP defines 11 Goals**
 - **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.

Monitoring & Metrics

Monitoring & metrics serve a variety of purposes. 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 decide appropriate management actions

- **Validation Monitoring**

5. To increase our 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 the 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
 - *metrics for other objectives & purposes to 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 Performance Metrics: Criteria

- Reflects the expected performance outcome of each LTEMP goal, not the 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**

Metrics design & selection

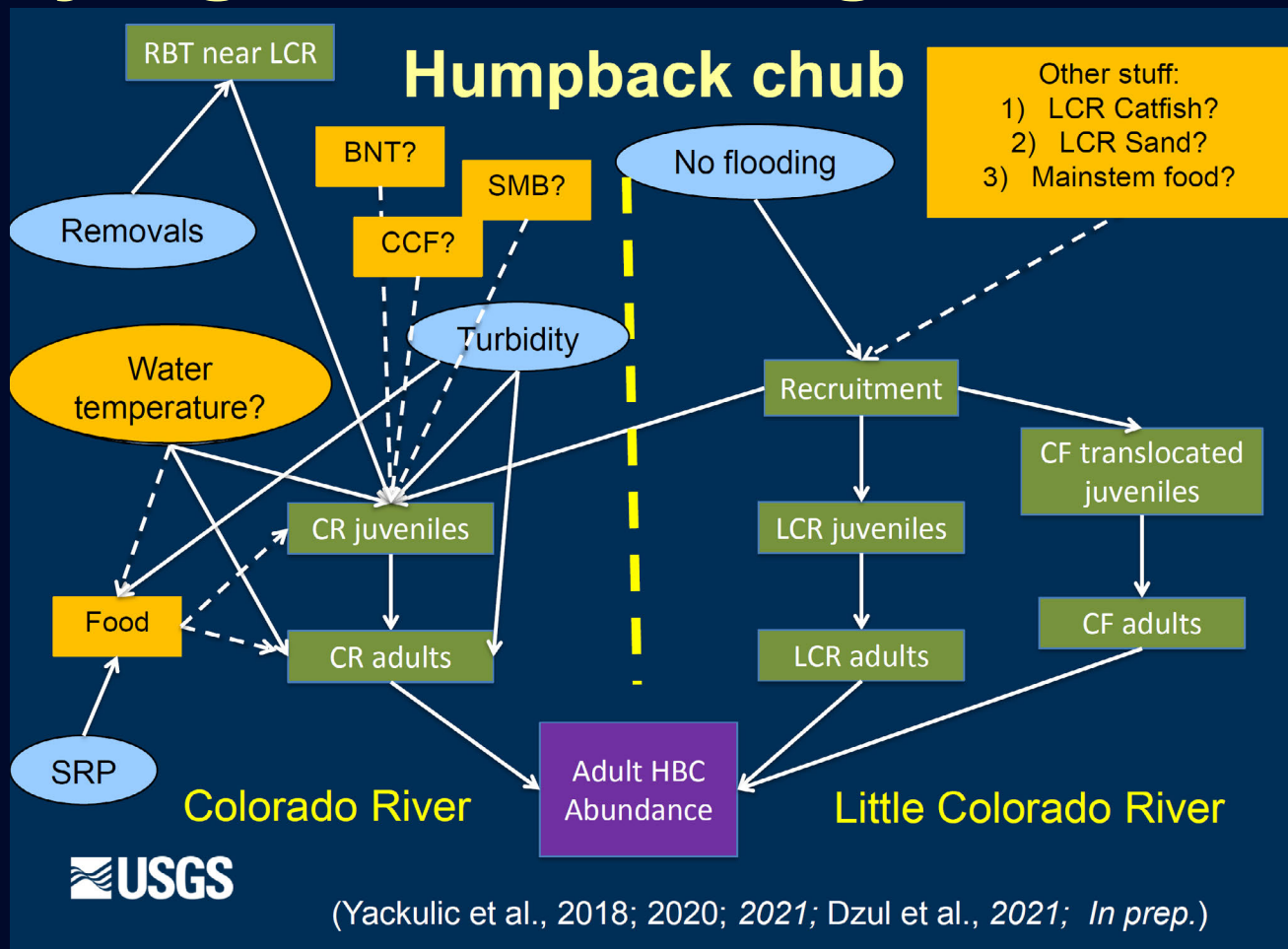
Some basic tenets of metrics design and selection include:

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

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, turbidity, etc.)
 - Nutrients (e.g., SRP) and food base quality
 - Predator loads
 - LCR flood magnitude & frequency

Conceptual diagrams capture underlying “drivers” of goal outcome



Draft Metrics Report & TWG Review

- Draft report sent to TWG June 9, 2022; discussed at June TWG meeting
- Reviews received from AZ, NM, CO, CA, TWG chair, and WAPA/CREDA (*Thanks to all who provided comments!!!*)
- Comments consolidated into two documents; GMRC Pls reviewed all & responded to most
- **Some TWG comments are in conflict; some will require substantial work to address**
- Some changes have not been made to the draft, pending further discussion with TWG

General TWG Comments & Issues

- **Uncertainty about the role/function of metrics and how they will be used in decision-making**
- **Some stakeholders would like more metrics (e.g., WAPA would like to include ALL variables from previous Knowledge Assessments)**
- **Some stakeholders suggest combining individual metrics, while others propose opposite approach**
- **Frequency that metrics will be reported (annually vs. less frequently in some cases)**

Examples of Surveillance Metrics (Physical “drivers” of goal outcomes; important to monitor but NOT = performance metrics)

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 ₃ , NH ₄ , TDN)	mg/L	GCD, LF	monthly	grab sample	2,3,5,9,10,11
Available Sunlight (Canyon shading)	PPFD μ 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

Knowledge Assessment Metrics vs. Performance Metrics

	2017 KA	2019 KA	2022 GCMRC Metrics
	<ul style="list-style-type: none"> not assessed in 2017 	not assessed in the 2019 Knowledge Assessment	<ul style="list-style-type: none"> Deviation from the natural annual hydrograph Deviation from the natural daily hydrograph Springtime Gross Primary Productivity in Marble and Grand Canyon Percent EPT
AQUATIC FOOD BASE (This is not an LTEMP goal)	<ul style="list-style-type: none"> Food base diversity Secondary production 	<ul style="list-style-type: none"> Food base diversity Secondary production 	not assessed in the 2022 GCMRC Metrics (but see 3 rd and 4 th metrics above)
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.	<ul style="list-style-type: none"> Adult population in western Grand Canyon Adult population that spawns in LCR Juvenile chub population in CR near LCR Juvenile chub population in western Grand Canyon 	not assessed in the 2019 Knowledge Assessment	<ul style="list-style-type: none"> Current tier of humpback chub in the LCR aggregation Grand Canyon-wide abundance of adult humpback chub Proportion of the Grand Canyon ecosystem with evidence of all 3 life stages of humpback chub
WATER QUALITY (This is not an LTEMP goal)	<ul style="list-style-type: none"> GCD outflow concentrations of dissolved oxygen GCD outflow concentrations of metals (e.g., selenium, mercury, uranium, etc.) GCD outflow concentrations of nutrients (e.g., phosphorous, nitrogen) GCD outflow concentrations of phytoplankton, zooplankton, chlorophyll a GCD outflow salinity, TDS, specific conductance GCD outflow temperature GCD outflow turbidity/sediment load 	<ul style="list-style-type: none"> GCD outflow temperature and dissolved oxygen in support of condition for trout GCD outflow temperature in support of condition for chub GCD outflow phosphorus concentrations in support of ecosystem productivity 	not assessed in the 2022 GCMRC Metrics

KA Metrics vs. Performance Metrics

	2017 KA	2019 KA	Metrics Draft
<p>Recreational Experience <i>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.</i></p>	<ul style="list-style-type: none"> • Backpacking/day-use shore access • Backpacking/day-use shore availability • Backpacking/day-use usable campsite area • Flatwater floating in Glen Canyon NRA • GLCA walk-in angling access and safety • GLCA walk-in angling trout abundance • GLCA walk-in angling trout condition • GLCA watercraft angling access and safety • GLCA watercraft angling trout abundance • GLCA watercraft angling trout condition • Whitewater (WW) boat mooring • WW navigational risk • WW navigational risk Diamond down • WW river crowding (i.e., rapids, beaches) • WW river running experience (i.e., rapids) • WW time on river 	<ul style="list-style-type: none"> • Glen Canyon river corridor access and safety (includes angling, boating, hunting, etc.) • GLCA rainbow trout condition • GLCA rainbow trout abundance • WW experience - rapids and time on river • WW experience - reduced beaching risk • WW experience - crowding and navigational risk • WW usable campsite area 	<p>Economic Value of Recreational Experience (WTP)</p>

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

Goals/Metrics still under discussion

- 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. **Status: Agreement on 3 metrics; still discussing need for 4th**
- 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: Agreement on 2 metrics; discussion on hold pending resolution of TWG issues**
- 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: discussion in progress, no agreement on specific metrics yet**

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 Seasonal Timing of River Flow
- 2.2 Sub-daily fluctuation in River Flow
- 2.3 Springtime Gross Primary Productivity
- 2.4 Percent EPT

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 HBC abundance**
- **3.3 Proportion of Grand Canyon ecosystem with evidence of all 3 life stages**

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

Next Steps

- **Today:** Provide additional input on draft metrics (purpose/need/focus of this project; need for more or fewer individual metrics; frequency that metrics will be reported, etc.)
- **October-December 2022:** GCMRC will continue to revise draft report with latest input from TWG
- **January 2023:** GCMRC will pilot example metrics at Annual Reporting Meeting
- **January-March 2023:** Finalize metrics report

Questions?

July 1973 →



May 2022 →

River Mile 122.3, left bank. Top photo:
July 1973, photographer unknown.
Bottom photo: May 9, 2022 by A.H. Fairley