**Call 2: Humpback Chub, Nutrients, Water Quality, and Sediment. 2/20/20**

Attendees: Craig Ellsworth, Lee Traynham, Bill Davis, Craig McGinnis, Jakob Maase, Kirk Young, Mellissa Trammel, Ryan Mann, Peggy Roefer, Shane Capron, Peter Bungart, Rob Billerbeck, Paul Harms, Bill Persons, Seth Shanahan, Ken Hyde, Scott VanderKooi, Ted Kennedy, Helen Fairley, David Topping, David Ward, Charles Yackulic, Lucas Bair, Paul Grams, Mike Moran, Winkie Crook, Richard Begay, Jan Balsom,

BAHG Members MIA: Cliff Barrett, Charley Bulletts, Kurt Dongoske, Michelle Garrison, Brian Healy, Leslie James, John Jordan, Vineetha Kartha, Jessica Neuwerth, Theresa Pasqual, Ben Reeder, Larry Stevens, Jim Strogen, Steve Wolff, Clayton Palmer, Dave Rogowski,

* **Humpback chub**
  + Lead researchers: Charles Yackulic, Kirk Young, Mike Yard
  + Resource goal:
    - 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.
  + 2019 DOI guidance:
    - Future research should be tied directly to LTEMP resource goals and objectives
    - Activities associated with the Endangered Species Act
  + BO Conservation Measures:
    - Translocations above Chute Falls, Havasu Creek, and evaluate above Beaver Falls and other tributaries
    - Spring and fall population estimates
    - Control or removal of nonnative fish prior to translocations
    - Hatchery refugia
    - Aggregation monitoring
  + LTEMP experiment:
    - Low Summer Flows in the 2nd 10 years of LTEMP (2026-2036) to warm river temperatures (> 14°C) to benefit humpback chub
  + Status and Trends:
    - 2017: Moderate concern but unchanged with medium confidence
  + Knowledge Assessment recommendations:
    - 2017: none
  + Data collected in last TWP:
    - Project Element G.1. Humpback chub population modeling
      * Examine drivers of growth in the Colorado River and LCR
      * Develop mark-recapture models to jointly model the dynamics of rainbow trout and humpback chub populations
      * Use data from the LCR PIT-tag antenna array to quantify the flux of rainbow trout that move into the LCR every winter
      * Aid in analysis of age 0 and age 1 humpback chub abundances in the LCR over the last 15 years
      * Collaborate with GCMRC’s economist to develop decision support tools from humpback chub and rainbow trout population models (Project J)
      * Provide annual estimates of humpback chub abundances for BiOp triggers
    - Project Element G.2. Annual spring/fall humpback chub abundance estimates in the lower 13.6 km of the LCR
      * Mark-Recapture surveys 2x/year
    - Project Element G.3. Juvenile chub monitoring near the LCR confluence
      * Mark-Recapture surveys 3x/year
    - Project Element G.4. Remote PIT tag array monitoring in the LCR
      * Track the timing of the annual humpback chub spawn, test hypotheses about trap avoidance, and inform our population model
    - Project Element G.5. Monitoring humpback chub aggregation relative abundance and distribution
      * Hoop netting (CPUE) and portable PIT-tag antennas survey 1x/year
      * Natal origins via otolith microchemistry
    - Project Element G.6. Juvenile Chub Monitoring - West
      * Understand the drivers of, and developing rigorous population estimates for, aggregations outside the LCR
      * Mark-Recapture surveys 3x/year
    - Project Element G.7. Chute Falls translocations
      * Translocation and monitoring of humpback chub upstream of Chute Falls
      * Maintain a long term genetic refuge of humpback chub at Southwest Native Aquatic Resources and Recovery Center at Dexter, NM
      * Provide juvenile humpback chub for translocation activities into Shinumo Creek and Havasu Creek
    - Project Element G.8. Havasupai translocation feasibility
      * Coordinate with the Havasupai Nation about the concept of translocating humpback chub to upstream of Beaver Falls in Havasu Creek
  + Metrics used:
    - Mark-Recapture and CPUE: abundance estimates
    - Mark-Recapture: survival and growth rates
    - Condition
    - Distribution
    - Movement
    - Skip-spawning
    - Spawn timing
  + How is this being used to adaptively manage the CRE?
    - Informs BiOp
    - Decision support for nonnative removals at the LCR
    - Assess Translocations like Chute Falls and how it informs nonnative removal at the LCR
    - Vital rates informs management decisions, are populations increasing or decreasing?
  + Stakeholder discussion
    - How do we keep recovery going in Grand Canyon?
      * Forecasting a decline at the LCR
      * How do we keep things going in the WGC?
    - Adult mortality may be lower than thought with info from remote antennas.
    - Catfish in the LCR: Predation impacts? Dave is thinking about continuing tagging to get a population estimate.
    - Habitat quality in the LCR: Has been declining especially at Boulders for a couple of years. Floods, flushing, sand accumulation, calcium carbonate build up.
    - How many chub are in the WGC? Modeling and monitoring. Tweak aggregation trip to collect better data.
    - Otolith data: Determine if local production in the mainstem WGC or tribs in WGC? Otolith microchemistry have been collected, just need to evaluate the data.
    - Turbidity and predation: Will this continue? Lab vs field inconsistencies. Lab: as turbidity goes up predation goes down for sight feeding fish (rainbow trout). Field: when turbidity goes up predation by rainbow trout actually goes up. Because chub are moving more when turbidity is higher? Making them more susceptible to predation?
    - Western Grand Canyon: Is Pierce Ferry a barrier to nonnative fish? More monitoring should be down in the western Grand Canyon. What are the drivers for HBC in the WGC? How have resource availability changed? Fewer nonnative fish making more resources available for native fish? Need a trophic study. Develop a predictive model. Need to look at HBC spawning habitat and early life stages in the WGC. Will take more work to get into the WGC. What do we reduce at the LCR? Larval HBC don’t respond to light traps.
    - Pierce Ferry is outside the GCDAMP research area. AZ and FWS is funding monitoring below the rapid outside the AMP. Fall trip, PIT tagging.
* **Water quality and Nutrients**
  + Lead researchers: Charles Yackulic, Bridget Deemer
  + Resource goal:

No resource goal was identified for water quality. It was deemed more as "a means to an end" with regard to meeting goals for humpback chub, other native fish, and the rainbow trout fishery. The DFC for water quality was to maintain dissolved oxygen, nutrient concentrations and cycling, turbidity, temperature, etc., sufficient to support natural ecosystem functions, visitor safety and visitor experience to the extent feasible and consistent with the life history requirements of focal aquatic species.

* 2019 DOI guidance:
  + Future research should be tied directly to LTEMP resource goals and objectives
* BO Conservation Measures: none
* LTEMP experiment: none
  + Status and Trends:
    - 2017: Moderate concern and unchanged with medium confidence
  + Knowledge Assessment recommendations:
    - none
* Data collected in the last workplan:
  + Project Element E.1. Temperature and nutrients in the CRe – patterns, drivers, and improved predictions
    - Characterize spatial and temporal patterns in Colorado River temperatures and nutrient availability downstream of GCD as well as to explore several processes that can influence the rate at which bioavailable nutrients are cycled and re-supplied to food webs.
  + Project Element E.2. Linking temperature and nutrients to metabolism and higher trophic levels
  + Project Element A.2. Water quality
    - Water temperature, specific conductance, turbidity, and dissolved oxygen at eight stream gages.
  + Lake Powell water quality program
* Metrics used:
  + Release temperature
  + Release DO
  + Nutrients (phosphorus concentration)
  + Condition of the aquatic foodbase and the trout and chub populations
* How is this being used to adaptively manage the CRE?
  + Variation in P in the water column in Lake Powell
  + What are flow vs nutrient vs turbidity impacts on fish, RBT and HBC, and bugs
* Stakeholder discussion
  + Foodbase augmentation: Add leaves, sticks, or bark? Bugflows: can it increase foodbase production? Consider additional studies of looking how nutrient limitation affects production. Small pulsed nutrient addition: how is it taken up? Where does it go? Does it increase production? Small enough to look for response without changing the foodweb. NPS might have concerns with increasing foodbase for a sport fishery. Fluctuating flows make it difficult to measure. Would be much more affective to do something like this during steady flows.
  + Any other samples of other nutrients: some sampling at tributaries (BAC, DC) has been limited mostly to Lees Ferry. Bridget has taken samples on a couple of trips. Sediment bound nutrients might be more important in WGC. Might be cycling quickly. Might be limited downstream by pH or turbidity. Nutrients appears to be driving GPP. Temperature had a moderate impact of GPP, may shift the species of diatoms.
  + Future work: considering additional sampling downstream, extending samples collected by the Water Science Center,
  + SRP model: going to improve on modeling GPP and fish condition. Make ecosystem level predictions.

* **Sediment**
  + Lead researchers: David Topping, Paul Grams
  + Resource goal:
    - 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.
* 2019 DOI guidance:
  + Future research should be tied directly to LTEMP resource goals and objectives
  + TWP and budget should focus on compliance priorities including
    - Actions necessary for compliance with the National Historic Preservation Act
    - Research and monitoring as required by the Grand Canyon Protection Act
  + Explore vegetation management to benefit high value recreational beaches and protect vulnerable archaeological sites
  + Explore the feasibility of conducting a spring HFE, along with modeling for improvements and efficiencies that benefit natural, cultural, recreational, and hydropower resources
* BO Conservation Measures: none
* LTEMP experiments:
  + Spring and Fall HFEs (2012, 2013, 2014, 2016, 2018) - sediment triggered
  + Proactive Spring HFEs – discharge triggered
  + Extended duration Fall HFEs - sediment triggered
  + TMFs – evaluate effects to sediment
  + Status and Trends:
    - 2017: Moderate concern and unchanged with medium confidence
    - 2020: Sandbars currently being maintained by HFEs; HFEs result in deposition; erosion occurs between HFEs
    - Success of HFE Protocol has occurred during average or above sand inputs and average or below annual dam release volumes
    - Analysis of sand-transport data and sand budgets for 2003-2019 indicate that net sand accumulation occurs in Marble and Grand Canyons only during years when tributary sand inputs are well above the 1998-2017 average and dam releases are below the long-term 1964-2017 average.
    - Paria River sand inputs have been well above average and dam releases have below the long-term average during the post-2012 period of the HFE protocol; therefore, sandbar responses observed during the 2012-present period are not necessarily a good predictor of likely sandbar response for the future.
* Knowledge Assessment recommendations:
  + - Sand management in the CRE may be made more sustainable by timing higher dam-release years with higher tributary sand-supply years.
    - Identify the minimum duration or amount of bypass needed to rebuild sandbars that meet the LTEMP goals for sediment-related resources (this recommendation comes from the hydropower KA; need better defined/quantifiable goals to pursue this)
    - Develop study plan to evaluate effectiveness of proactive and extended duration HFEs
    - Develop study plan for trout management flows to evaluate the effect of increased daily fluctuations and increased downramp rates on sandbar stability.
* Data collected in the last workplan:
  + Project Element A.1. Stream gaging
    - Discharge data at 21 gaging stations on the Colorado River and on key tributaries.
  + Project Element A.3. Sediment transport and budgeting
    - Continuous 15- minute measurements and also episodic measurements of suspended and bed sediment at 13 stream gages.
  + Project Element B.1. Sandbar monitoring using topographic surveys and remote cameras
    - Track the individual and cumulative effects of HFEs and intervening dam operations on sandbars and campsites in the CRe.
  + Project Element B.2. Bathymetric and topographic mapping for monitoring long-term trends in sediment storage
    - Track the effects of dam operations (including HFEs) on sandbar conditions and sand storage over the time scale of the HFE protocol and the LTEMP and thereby provide a robust measure of whether or not that supply of sand (the sum of recent tributary inputs and background storage) necessary for building sandbars is increasing, decreasing, or stable.
  + Project Element B.5. Control network and survey support
    - Provide a framework to enable high-accuracy change detection and to ensure that geospatial data collected in support of Project B and other projects are accurately referenced, precisely defined, and can be reliably compared with past and future datasets within Geographical Information Systems (GIS).
  + Project Element B.6. Sandbar response to differences in HFE magnitude and duration
    - Collect and analyze field data on the effects of flow experiments (HFEs and TMFs) on sediment resources when these experimental dam operations occur.
    - Project L. Remote Sensing Overflight in Support of Longterm Monitoring and LTEMP (May 2021)
      * Multispectral Imagery
      * Digital Topography
    - Website content and virtual online maps
    - Cartographic products
      * River map books
      * Publication maps
    - Colorado River centerline and river mile system
    - Flowlines
      * Extracted from low-flow water's edge (~8,000 CFS) in overflight imagery
      * Modelled from overflight topography and water surface elevation data
    - Land cover and landform mapping and change detection
      * Water, sand, vegetation
      * Geomorphic basemap
    - Campsite delineation
      * Campsite atlas
    - Topography data
      * Topographic change detection
      * Hydrologic flow modeling
* Metrics used:
  + Change in sand volume at sandbar campsites (correlates with campsite area, but is a more objective and repeatable metric)
  + Change in sandbar campsite area
  + Change in sand storage in the channel and in eddies
  + Change in sediment mass balance (for each segment between gages)
* How is this being used to adaptively manage the CRE?
  + Stage, discharge, water-temperature, dissolved-oxygen, turbidity, and specific conductance (salinity) (A.1 and A.2) data used to address almost all LTEMP goals
  + Discharge (A.1) and sediment-transport and sand-budgeting (A.3) data are used to plan and design HFEs
  + Sandbar monitoring (B.1) results are used to determine whether HFEs have intended response and are included in resource assessments that are required before each HFE
  + Sandbar monitoring (B.1) results will be used to assess effect of LTEMP operations on sediment resources at 10- and 20-year LTEMP milestones
  + Sand-storage monitoring (B.2) results will be used to assess the effect of LTEMP operations on sediment resources at 10- and 20-year LTEMP milestones
* Stakeholder discussion
  + Would collecting gaging data at less than 15 min intervals cost less? Not really, would be harder to quality control so might require more work. Topping feels that it is very cost effective and efficient. Reduce tributary gaging stations?
  + Stagger channel mapping with sandbar monitoring? Sandbar monitoring is simple to do every year. Channel mapping has already been scaled back to one or two trips for every TWP. Need to maintain some level of staff capacity.
  + Considerations: gaging is directly tied to measuring the effects of dam operations and releases.
  + Requests for monitoring sandbars below Diamond Creek from Hualapai. Paul will present at the next TWG in April. Concern: boating through the old Lake Mead delta, lots of in channel sandbars creating navigation issues. Do HFEs erode terraces and create bigger in channel sandbars?
  + Brown trout and Fall HFEs: make for better spawning condition in the Lees Ferry reach. Flushing gravels? Any way to evaluate? Will discuss with Charles or Yard. Most of the transport comes from midchannel. Could look at the section below Waterholes, measure what is coming in vs what is going out? Look at pre and post HFE spawning habitat condition?