**BAHG call 7: Humpback Chub, Nutrients and Water Quality, Foodbase, and Sediment**

Roll Call:

* Craig Ellsworth, WAPA
* Craig McGinnis
* Lee Traynham, BOR
* Peggy Roefer, CRC NV
* Sinjin Eberle, American Rivers
* Emily Omana Smite, GRCA
* Ryan Mann, AZGFD
* Erik Skeie, CWCB
* Peter Bungart
* Laura Tennant
* Seth Shanahan
* Randy Van Haverbeke, USFWS
* Jim Strogen
* Kathy Callister, BOR
* Kevin Dahl, NPCA
* Michael Moran, GCMRC
* Shane Capron, WAPA
* Kirk Young, USFWS
* Melissa Trammell
* Helen Fairley, GCMRC
* David Topping
* Rob Billerbeck, NPS
* Ted Kennedy, GCMRC
* David Ward, GCMRC
* Cliff Barrett
* Charles Yackulic
* Ken Hyde, NPS
* Scott VanderKooi, USGS-GCMRC
* Paul Grams, GCMRC
* Lesie James, CREDA
* Jeff Muehlbauer
* Kim Dibble
* Michelle Garrison
* Ben Reeder
* **Humpback Chub**
	+ Lead researcher: Charles Yackulic, Kirk Young, Mike Yard
		- How is work being done helping us meet:
			* Resource goals as described in LTEMP
				+ *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.*
			* Guidance from DOI in the 2019 Petty memo
				+ Future research should be tied directly to LTEMP resource goals and objectives
				+ Activities associated with the Endangered Species Act
			* BO Conservation Measures or PA requirements
				+ 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 experimentation
				+ 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
		- Describe how this data might be 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 inform management decisions, are populations increasing or decreasing?
		- How long will these studies last?
			* 1-3 years
			* 4-10 years
			* 11-20 years
		- Do we need to monitor every year?
		- Prioritization
			* 1) high priority (important and essential) to implement and/or maintain;
			* 2) medium priority (important but not essential) to implement and/or maintain;
	+ **Project Element descriptions (2021-23 TWP Proposal)**
		- Project Element G.1. Humpback Chub Population Monitoring
		- Project Element G.2. Annual Spring/Fall Abundance Estimates of Humpback Chub in the Lower 13.6 km of the LCR
		- Project Element G.3. Juvenile Chub Monitoring near the LCR Confluence (JCM-east)
		- Project Element G.4. Remote PIT Tag Array Monitoring in the LCR
		- Project Element G.5. Monitoring Humpback Chub Aggregation Relative Abundance and Distribution
		- Project Element G.6. Juvenile Humpback Chub Monitoring in Western Grand Canyon (JCM-West)
		- Project Element G.7. Chute Falls Translocations
		- Project Element G.8. Backwater Seining
		- *Project Element G.9. Assessing Yearly Variability in Humpback Chub Hatch Dates* <new>
	+ **Stakeholder discussion**
		- Do we have to monitor at the LCR every year to remain in compliance with the BiOp? What if we wanted to spend this TWP focused on WGC and come back to the LCR for the next TWP?
		- Peggy- text says juvenile production has been insufficient to maintain a spawning population at LCR: are we concerned about this?
			* Charles- Personally concerned, the degree to which we can do things relates to *why* juvenile production is down. IF it’s related to things like mainstem food base, things like Bug Flows; if more due to increase in competitor population (i.e. catfish), hoping Ward’s work could quantify leads towards action. Need to know more before we move. If related to flooding, etc. then it’s harder to operate: “*no HFE option on LCR, manage where and how we can manage*”
				+ Cliff- Where was this? (*pg. 30, beginning paragraph two*)
			* David Topping- The last time a flood happened on the LCR was in 2012, originating in Big Canyon. The last flood from farther upstream occurred in 2002. All other events since 1993 could be described as minor floods with negligible geomorphic disturbance. Only know 2012 flood origination because we had gaging at both Cameron and above mouth.
				+ Near Cameron gage used for sediment and mostly paid for with funds outside GCDAMP. Above mouth gage paid for with 50% GCDAMP funds, 50% USGS toxic funds for uranium monitoring.
		- Melissa- on Chute Falls translocation w/ potential to add chub: what period of time would that be over? would that offset decline in production?
			* *Translocation would lessen possibility to do removal: would soften decline, with the caveat of years with low amounts of juveniles (1/10)*
			* Kirk- Unsure of scalability; assuming effects would be scaled and we could take large ‘19 class and move up, see survival rates, etc.
		- Shane- Has any serious thinking this year gone into our ability to sequence these surveys? “We’re going to lose precision, modeling capability”. Population estimate error bounds are quite large: curious of thoughts on that.
			* Charles- *Always thinking of efficiency in a general sense, but formal analyses haven’t seen a whole lot of progress. These are budgeted as if they’re temporally concrete, but in practice are more fluid*. Not much excess capacity to look at others; kept wheels on the bus to collect data, but strategic, longer-term analyses would highlight efficiency.
			* Shane- Think there’s room for that thinking in these projects. Makes data interpretation more challenging, but there’s more possibilities here. “what could we give up to save a bit of money?” Citing opportunity for sequencing.
			* Charles- Integration of data streams that produce similar data (antenna data, etc.). Still need PIT Tags.
			* Kirk- Looking at four or five concrete efficiency changes, these are best practices, saving ~$100k for Program through consolidation on river trips, etc.
		- Craig E- How do we remain nimble enough to address new and emerging situations while still getting our normal work done?
			* Charles- *In W.GC, which has become a sustained part of normal work, wouldn’t consider it something “right on top of us that we don’t see coming”. Haven’t grasped as a group that both bad and good years occur re: juvenile production.*
				+ On mobility, part is riding the fine line between planning all possible for efficiency, but also having some capacity to respond to what comes. Note tradeoff between efficiency and capacity.
			* Craig E- BO makes certain requests for actions on timescales: if something new comes up, how flexible is the Program to make adjustments to these new and emerging situations?
				+ *Like to think we have capacity and relationships to respond*.
		- Melissa- Wondering about W.JCM: how important is that population to recovery?
			* Looking at LCR population as epicenter, most historically dependable. In 1989, fish populations were ~11k, could be biased low. Thinking of net gains in Canyon population, we think that makes the WGC population all that more important. Highly significant, but must balance with population vulnerability and resilience. “*Won’t know until we know*”.
				+ Resilience would be important for redundancy, as well.
			* Jim- Likely to see WGC population in good shape as long as Mead’s low?
				+ *Think that’s one of the factors: population displacement would be a potential impact. Biggest risk seems to be the thermal suitability for nonnative predators.*
				+ *Agree. In macro sense, two factors are Pearce Ferry and “sweet spot” of thermal suitability. On a finer scale, not like every year of juvenile production is a “boom year”: still teasing out why that is, how management actions might affect*.
				+ Looks as if, even if Lake came up, that chub #s in old Separation Canyon seem to decline downriver. Bulk of population between Pumpkin Springs and above Separation Rapids.

Rogowski- disagree, chub numbers increase RM-250 downstream.

* + - * + Also size distribution question: more but smaller fish?

catch all sizes downstream from adult to YOY

* + - Craig E- How long will it take to parse out some of these questions?
			* *Checking demographics through time, but lack resources to continue setting up “reference reaches”. If still growing as appears, ultimately will need to see where we reach equilibrium. Brainstorming different ways to get to this point most economically*.
			* Lot of increases in the adult Flannelmouth production happened ‘08-12, since then it has been bouncing around at higher levels. Year-to-year variability still exists. Will expect a similar trajectory with HBC.
* **Water quality and Nutrients**
	+ Lead researcher: Charles Yackulic, Bridget Deemer
		- How is work being done helping us meet:
			* Resource goals as described in LTEMP
				+ *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*.
			* Guidance from DOI in the 2019 Petty memo
				+ Future research should be tied directly to LTEMP resource goals and objectives
			* BO Conservation Measures or PA requirements
				+ none
			* LTEMP experimentation
				+ none
			* Status and Trends
				+ 2017: Moderate concern and unchanged with medium confidence
			* Knowledge Assessment recommendations
				+ none
		- Describe how this data might be 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
		- How long will these studies last?
			* 1-3 years
			* 4-10 years
			* 11-20 years
		- Do we need to monitor every year?
		- Prioritization
			* 1) high priority (important and essential) to implement and/or maintain;
			* 2) medium priority (important but not essential) to implement and/or maintain;
	+ **Project Element descriptions (2021-23 TWP Proposal)**
		- *Project Element E.1. Phosphorus Budgeting in the Colorado River* <new>
			* Closer proximity means SRP is a primary lever. More nutrients coming in from other sources (i.e., Tributary flooding). What and how significant a biological role do these inputs play?
			* Understanding of the relationship between WQ and nutrient load: trying to understand the amount of Phosphorus from Dam compared to from tribs. What can we manage to have more of that be released?
		- *Project Element E.2. Rates and Composition of Primary Producers in the Colorado River* <new>
			* Lot of interesting insight from DO modeling, collected predominately through A.2. **Modeling -> GPP**.
			* Aspects that get at specific questions:
				+ Lees Ferry GPP availability to bugs & fish
				+ Changes in vegetative community
			* Every ~3yr documentation of aquatic veg to see dynamics over time.
		- *Project Element E.3. Productivity at Higher Trophic Levels*
			* Developing models on energy flux based on food competition, energetic constraints due to GPP. Could improve prediction capability.
			* Increase sampling during flood events, longitudinal work from samples further downriver.
	+ **Stakeholder discussion**
		- Develop a mitigation plan for a DO crash in the Lees Ferry reach
			* Makes sense, it’s tricky: a lot of things you might do would be changes in infrastructure around the dam. Other ideas out there?
		- “More of a rebrand than a shuffling”
		- Jim- on keeping track of phosphorus in Powell, is that funded through Program or outside?
			* Charles- *Until a few years ago, none of this was through the Program. More recently, they’ve better resolved depth of Phosphorus monitoring. Basis of historic dataset funded through Bureau*.
			* David Topping- *we will be doing the automatic ISCO sampling fieldwork on the Paria and LCR for the nutrients project within the scope of the submitted Project A budget.*
		- Craig E- What’s the timeframe for developing a phosphorus budget?
			* Deemer- w*ould be led by a masters student, already set up for sampling on Paria, to be supplemented by sampling on LCR. Would hopefully have a product within first few years of TWP. Another aspect of work involves better understanding of phosphorus cycling, which might be somewhat iterative with work complete in WP*.
			* Peggy- lot of information at Lake Mead inflow, might help you also
				+ discussed using Diamond as outflow gauge: should do some thinking on how data layers (Diamond and Inflow) overlap.
				+ David- *Problem with Inflow is that the reservoir is reflective of deltaic sediments. Colorado above Diamond Creek is a much better outflow station and we do have a continuous silt and clay record there from project A that can be used to estimate phosphorus.*
		- Jim- Predictability of phosphorus plumes through Lake Powell?
			* Best approach to predict what goes out is based on what comes in, citing year-to-year variability on what parts of the watershed are being activated. More potential for phosphorus lower in the water column.
			* Charles- loading modeling is a three-year window: that explains a decent amount of variation (40-50%) with only one covariant.
		- Dave Topping- **Make sure to go back through Webex Chat**\*\*\*
* **Aquatic Food Base**
	+ Lead researcher: Ted Kennedy
		- How is work being done helping us meet:
			* Resource goals as described in LTEMP
				+ A healthy food base is an indicator of Natural Processes and aligns with the LTEMP goal which states: "*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.*"
			* Guidance from DOI in the 2019 Petty memo
				+ Future research should be tied directly to LTEMP resource goals and objectives.
				+ 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 or PA requirements
				+ none
			* LTEMP experimentation
				+ Bug Flows 2018, 2019, ¿2020?
				+ Spring HFEs
			* Status and Trends
				+ 2017: Significant concern and declining with high confidence
			* Knowledge Assessment recommendations
		- Describe how this data might be used to adaptively manage the CRE
			* + Evaluate food web response to Bug Flows, HFEs, and other LTEMP flow experiments
		- How long will these studies last?
			* 1-3 years
			* 4-10 years
			* 11-20 years
		- Do we need to monitor every year?
		- Prioritization
			* 1) high priority (important and essential) to implement and/or maintain;
			* 2) medium priority (important but not essential) to implement and/or maintain;
	+ **Project Element descriptions (2021-23 TWP Proposal)**
		- *Project Element F.1. Aquatic Invertebrate Monitoring in Marble and Grand Canyons*
			* Big citizens science monitoring element: key data stream used to evaluate Bug Flows, efficacy on populations
		- *Project Element F.2. Aquatic Invertebrate Monitoring in Glen Canyon*
			* Monthly drift monitoring, collection through sticky and light traps.
			* Started sampling below Paria in the last few years. Compare/contrast invertebrate populations, effects of sediment. Looking at multiple types of insect data collection.
			* Working to streamline, collected drift with two different mesh nets, paired collection with greater collection per unit effort.
		- *Project Element F.3. Aquatic Invertebrate Monitoring of Grand Canyon Tributaries* <new>
			* Bright Angel monitoring: been working on invert sampling since ‘17, building on work prior to trout removals. Summer/fall/winter looks at the invertebrate community, to monitor over time.
			* Potential sunsetting halfway through work plan
			* processing and tributary samples from ‘14 as part of a past river trip. Dataset will help to compare with 90s sampling, how the river-wide community has changed, and what might be recolonized/repatriated.
			* Looking to repeat tributary sampling during last WP year (~10yrs since last sample), compare what communities look like over time.
		- *Project Element F.4. Fish Diet Studies* <new>
			* Lot of learning to be done about mainstem fish feeding habits
		- *Project Element F.5. Spring Powerplant Capacity Flow (Experimental Fund)* <new>
			* Experimental fund for opportunities borne out from infrastructure maintenance on the dam. Looking how springtime disturbance affects food base, downstream impacts.
	+ **Stakeholder discussion**
		- Add a project element to write a synthesis of the results of the Bug Flows experiment thus far (18-20).
		- Jim- Are there plans to look at various scales of tributary insects to recolonize up in Lees Ferry? Would experiments help parse out feasibility?
			* USGS doesn’t have a plan, perhaps talk to NPS. Doesn’t feel like they’re at that point yet.
			* Masters student looking at common tailwater taxa, characteristics found there. Another looking at regional genetic variability, showing species that aren’t going to make it to Ferry on their own.
			* David Topping- *Our gaging station on Bright Angel Creek includes water temperature and automatic sediment sampling. As part of the NPS trans canyon pipeline project, NPS is also measuring turbidity at this gage. Our gage data and the turbidity data provide valuable context for the food base project and the BA Creek translocation work. This gauge is one of our low-cost installations that costs <$2,000 per year*.
		- Peggy- Will you bring potential experiments through FLAHG?
			* Ted- *You bet, would be happy to engage FLAHG.*
			* “Hydrograph ball is in GCMRC court”: Opportunity to recognize biological effects of low flows.
		- Shane- F.5 includes potential experimentation re: *looking at substrate*, etc. How much work are we doing next 3yrs- what are your thoughts on anoxic substrate, etc., potential for experimenting at various substrates to potentially support invertebrates in the future?
			* Ted- *lot to be learned of the role of springtime disturbance and ecological response*. How might we translate something to a potential management action?
			* Jeff- Part of low-flow allure is the “new frontiers” of doing something new experimentally that hasn’t been presented in a very long time. Significant opportunity for learning due to this low flow that hasn’t been there in past.
		- Shane- thoughts about importance of emergent substrates? Is that something that could be important when looking at other drivers?
			* Ted- *They matter: literature out to support*.
			* Craig- would love to hear ideas to enhance experimental fund study next year, if we can reorganize group to examine what we’ve talked of before
		- Larry- Surprised by zooplankton, other life in side channels and pools. Examination could be quite interesting
			* Ted- *the more we can experiment, the more we can learn. limits of learning on observation alone*.
		- Scott- Assuming this is for up in Glen Canyon? (*yes*) The nature of the canyon changes as you go downstream. Nature of access would make downstream work more difficult.
		- Line item in food base budget for 18-20 Bug Flow data synthesis?
			* *In Glen Canyon Monitoring (.2) - can’t see specifics in this versioning.*
			* Leslie- How long would that work take?
				+ *Under this proposal, finish processing differences in drift, guts on weekends vs. weekdays in Bug Flow experiments. Depends if we keep collecting data, in part dependent on COVID-19 response. Expecting to finish up in next fiscal year, with per review and other to follow*.
			* Craig E- Not just weekend-weekday aspect, but also annually: what has the data synthesis been for Bug Flows over the TWP term?
			* Scott- given 2020 uncertainties with potential work, may put caveat: “clearly we want to be responsive, but for a bigger view it may take longer, depending on monitoring that takes place in 2020. Looking for a longer-term, systemwide response that may delay things a little bit.”
				+ Jeff- *we will be able to report on everything we know in current time during FY. Will continue to learn over time, anticipate synthesizing best of knowledge from first three years*.
* **Sediment**
	+ Lead researcher: David Topping, Paul Grams
		- How is work being done helping us meet:
			* Resource goals as described in LTEMP
				+ *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.*
			* Guidance from DOI in the 2019 Petty memo
				+ 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 or PA requirements
				+ none
			* LTEMP experimentation
				+ *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
			* 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 down-ramp rates on sandbar stability.
				+ Describe how this data might be used to adaptively manage the CRE
		- How long will these studies last?
			* 1-3 years
			* 4-10 years
			* 11-20 years
		- Do we need to monitor every year?
		- Prioritization
			* 1) high priority (important and essential) to implement and/or maintain;
			* 2) medium priority (important but not essential) to implement and/or maintain;
	+ **Project Element descriptions (2021-23 TWP Proposal)**
		- Project Element A.1. Stream Gaging and Hydrologic Analyses
		- Project Element A.2. Continuous Water-quality Parameters
		- Project Element A.3. Sediment Transport and Budgeting
		- Project Element A.4. HFE Experimental Fund
		- Project Element B.1. Sandbar and Campsite Monitoring with Topographic Surveys and Remote Cameras
		- Project Element B.2. Bathymetric and Topographic Mapping for Monitoring Long-term Trends in Sediment Storage
		- Project Element B.3. Control Network and Survey Support
		- Project Element B.4. Bank Erosion, Bed Sedimentation, and Channel Change in the Colorado River Arm of the Lake Mead Delta in Grand Canyon <new>
		- Project Element B.5. Streamflow Modeling <new>
		- Project Elements B.6-B.9. Sandbar and Riverbed Response to Experimental Actions (to be funded only when experiments occur)
	+ **Stakeholder discussion**
		- Ben- Is project he proposed re: HFE down-ramping rates in the TWP? Could we have that in there, given the opportunity to take a look (various HFEs, etc.)? Lot to gain, very little to lose from doing this; would benefit a lot of the resources. Less spill = longer lasting positive impacts to beaches.
			* *Not currently. Could easily be added without a budget item due to the experimental component. Would have to be connected with an ongoing experiment.*
			* Paul Grams- Re: TWP/Budget, wouldn’t change much. Actually, doing it might be something to pursue in FLAHG.
				+ Craig E- This would be a tech team thing, wouldn’t it?

David T- *Tech team would make sense, working with them in hydrograph design and sand transport. Can look at deposition rates, sand supply data*.

* + - * + Scott- *FLAHG doesn’t seem like place, tech team makes sense.*
			* Seth- absolutely something the tech team *would* consider and contemplate by default, but doesn’t forego ask for additional contemplation by TWG. Role for TWG, whether or not in FLAHG or not.
			* Ben- Glad to see different avenues for continuing the conversation. Don’t need to necessarily be included in TWP for this conversation to potentially continue in the next TWP.
				+ Craig E- *no, but needs to be captured somehow: not all TWG members on tech team calls when developing HFE hydrographs. Unsure of what the best way to do so would be.*

Leslie- agree re Seth’s point that not all stakeholders are on the Tech Team.

* + - * + Paul- to be in the position of learning from it, need to be able to study in detail. Worth it and fits in line with other projects.

David T- *It makes the most sense to me for maximum learning to do the slower down ramp test during the next opportunity when we can have a 45,000 cfs HFE.*

* + - * + Leslie-

To David- would it then make sense to do a 45kcfs HFE with comparatively faster down ramps?

David- *we have already done those three times (1996, 2004, 2008) and to some degree in 2012 when we dropped in quickly after reaching power plant capacity. But yes, it always makes sense to repeat things*.

to Ben: do you agree that slower down ramps need to be analyzed in terms of hydropower impacts?

* + - * + Seth- If it is being contemplated and is something recommended for action, we should have legwork already done prior to potential implementation.

Might be worth FLAHG conversation. If it could be shared w/ tech team, it’s a conversation that we’d like to continue.

* + - * Peter- Will there be causal relationships between sedimentation of HFEs and increase in endangered native species in W.GC? Would that be worthwhile to tie some of this research together? (Local turbidity and food base)
				+ David- delta turbidity increases downstream as a function of delta. Related issue to nutrient problem, where inflow is more complicated than in Diamond.

Leslie- then maybe that data could be drawn from to compare resource benefits/costs?

* + - * + Brian- We have been collecting turbidity data with the small bodied/larval sampling, and you can see some of the data in the BIOWEST reports. There's a pretty strong relationship between temperature and discharge and # of larval suckers and chub. Thinks the turbidity/fish relationships are weaker but can check.

Leslie- Then maybe that data could be drawn from to compare resource benefits/costs?

David T- how continuous are the turbidity data farther down in the delta and for what time periods?

*Spot measurements during sampling, from Bright Angel to Pearce 8 trips/yr at 55 sites.*

* + - * + Larry- Seems like biological hotspots are around tributary mouths. Unsure of sampling amount, fair amount to be learned on interaction of big, complicated degree fan complexes. Because we go by Spencer Creek, we support work at the non-GCDAMP funded gage on the creek during the last day of our two river trips. So, we know when large flows on the creek occur and change the fan.
			* Craig E- Anything else GCMRC is looking for from stakeholders on what we’ve heard today?
				+ Scott- suggest that people provide written comments; calls are important and helpful, but written comments are particularly useful.
				+ Cliff- Will chats become notes? (*not writ-large, but if of critical importance they can be added for the record*)

Put Leslie’s chats in\*

* + - * + David- **four or five LCR chats in HBC context would like to be recorded**
				+ Cliff- What are the next steps?