GILA RIVER BASIN
NATIVE FISHES
CONSERVATION PROGRAM

Monitoring Workshop #2: Expert Panel
December 12, 2019

WORKSHOP NOTES

Workshop Objectives:

- Discuss example of other long-term fish monitoring programs
- Review Reclamation's existing protocols
- Discuss recommendations for designing a new sampling plan

Invited expert panel to inform:

Michael Colvin	(Mississippi State University)
Scott Bonar	(U. S. Geological Survey)
Keith Gido	(Kansas State University)
James Peterson	(Oregon State University)
David Stewart	(U. S. Fish and Wildlife Service)
Charles Yackulic	(U. S. Geological Survey)

Participants – see last page

Presentation: History of Gila River Native Fishes Conservation Program and monitoring – *Kent Mosher*

- Central Arizona Project (CAP) canal opened up Phoenix for development
- Also opened up mechanisms for non-native introduction
- Much of the decline of all key species is due to non-native introductions and decreased suitable habitat, most flowing water is in canals and not in streams.
- Monitoring began as a conservation measure (started in 1995) and will extend through 100-year life of the canal
- Changes in 2011 monitoring contract
  - First 5 years - AGFD
  - 2016- Marsh and Associates
- Goal: Desired (and revised) monitoring protocol outcome: ideally develop protocol April 2020 and implement early 2021

Current monitoring questions and discussion from the panel

Decision-making

- *What kind of decisions are made using the data?*
  - Data is not currently integrated into decision making.
    - Monitoring is used to assess what is going on, but no real synthesis to date of the information.
    - There is overlap across agencies which is problematic as well
- *Where does BOR monitoring fit in with AGFD and NMGFD?*
  - There is decision making outside of the program for the agencies on how to proceed

Key comment from panel: Decision-making is important in anticipating how to build a monitoring protocol – the panel can best help by knowing what types of decisions need to be made from the data.

Status and trend monitoring follows Recovery Plans

- Bureau of Reclamation (BOR) currently monitoring status and trends of fish and non-natives in the streams
  - Status = abundance - *Defining status in a more accurate way would be helpful*
  - Presence = yes/no
- USFWS defines status is defined as resiliency
- Positive or stable trends for each population
- Trend is dependent on the species and life history – monitoring should depend on the species
- Using the data quantitatively to start a management action
  - Different for each species, recovery plan age and methods differ across species.
  - Recovery plans have some definition of viability
- Reclamation protocol and other agency protocol are different, and the results differ especially in presence and absence
- Abundance is important and challenging to determine – sampling for each species is different because of life history

Incidental Take

- Determined by monitoring?
  - Indirect measures for fish – not evaluated each year and kept in mind for Biological Opinion
  - There are numbers for each species for monitoring by AZ Game and Fish Department
  - BOR only has to report if a population disappears and if it was CAP mediated non-native species was the cause

Species overview presentation and discussion

Discussion Gila Topminnow

- Gila topminnow – reintroductions: most in locations where there were no non-natives and there is a barrier in place.
  - There are no records for a lot of the sites and why there are limited populations.
- Recruitment - multiple generations in a year. Younger of year is generally detected in late spring (reproduce all year in thermal ponds)
- Adequate representation of age classes
- Population varies: Fossil Creek is 15 miles stretch vs a population that is the size of this room.
- Populations can fluctuate greatly throughout the year
  - Some wax and wane (not addressed in the Recovery plan),
  - Could meet or not meet the criteria year to year.
- Very few meta populations.
- Measurable criteria for each of the species for delisting - same a 1999, look at the # of populations, how long they have to exist, natural population have to be secure.
- Boundaries on the population (ex: Santa Cruz that is dry and wet) –
  - Dry season tends to have interrupted pools.
  - Ad hoc system of determining if a system is a population.
  - Assumption: if sources are different then they are different populations.
- No legal definition of population - often defined in a Recovery Plan but for topminnow there is not
- Determining population is an important point – the Gila Basin with all tributaries or separate streams?
  - Sampling early in the year will get you a better answer on overwintering.
- Question: How is that addressed if there are10 populations, of which 5 that meet criteria, but those 5 are different every year?
  - Some populations are augmented in the early years and sometimes for genetics. Most is assessed at a point in time, and all factors taken into consideration
- No numeric criteria on the natural populations – maintain all of them
- Persist – 500 individuals every year? Taken at a point in time

Discussion Spikedace

- Remnant population is Aravaipa in AZ, and all in NM

- Similar to topminnow in the variety of numbers of species
  - Not as extreme, but similar that they could have high numbers one year and low the next
  - Most limiting factor is the type of habitat
- No definition of population, not to mention remnant and replication population
- Stable means not negative: no power associated with it
  - With so much variability it would be helpful to use power
  - Stable at what level? At the population level?
- Management actions
  - Non-native co-exist with some native species?
    - Different in different species and locations
    - Non-native abundance may have a lot to do with it
- Decision analysis – what is the model that existed to put this together
- Needed/helpful: conceptual model of these populations?
  - Current SSAs for these species have them, but not the old ones

<u>Discussion Loach Minnow</u>

- Scale at which a population exists – separate populations of the east, west fork etc.
- Blue River is a meta population in the drainage – assumption: if there is no physical barrier then they are one population
- Genetic information helps determine the separation of populations
- How the FWS has defined it determines how each agency defines a population
- In a system like the Blue, you need to measure the redundancy (getting at the 3Rs), there would need to be distribution across the system, not just in one spot and call it good
  - Topminnow gets at the minimum number of replicates of the genetic lineages and they have to be in 4 separate locations

<u>Discussion Gila Chub</u>

- Stable or positive trends for Catch Per Unit Effort (CPUE) – expected value or absolute value? This is not defined
- How is the population defined? - The population and the number for that stream – site and population are used interchangeably in this species
- Variable population sizes vary year to year and their habitat can vary greatly through dry and wet portions of the year
- Defining the boundaries of the populations – what divides the 2 populations (barriers, etc.)
- Consider – CPUE is data from a site, expanding habitats mean fish generally disperse and when the habitat is smaller the population will contract and CPUE will be skewed based on those variables
- None of these species have Species Status Assessments (SSA's), they haven't been put through the lens of the FWS to determine status
- Interpret the CPUE (for spreading out vs really fecund years, lots of young of year)
  - Can design the answer the specific questions based on the disagreements
- Sample at the hydrograph (when water is low)?
  - Standardize the time of year for sampling

<u>Overall question</u>

- How well are these systems gauged?
  - Not well covered – varies by area
  - Areas of ungauged flow can be estimated by descriptive (stream stats), using regression equations for the AZ streams for in between gauges – National Hydrography Dataset (NHD)

Discussion Questions – Species and cross-jurisdictional monitoring:

1. Have you worked with these species or species similar life histories?
   a. *Charles Yackulic*:
      i. Humpback chub –mark recapture,
      ii. Rio Grande silver minnow.

    iii. Multi state occupancy modeling: present and meeting minimal viable, present and enough abundance

b. *Keith Gido:*
    i. Loach minnow spikedace, habitat associations, trophic studies

c. *Scott Bonar:*
    i. Multiple species, habitat work, monitoring programs
    ii. Comparisons across state boundaries.
    iii. Large role in the new AFS guidelines about –less problems with litigation if methods are standardized; can compare data across states, positive benefits.
    iv. Using the advantages of statistics. Have grad student that AGFD is supporting, comparing the AFS methods and AGFD methods and correlations

d. *Jim Peterson:*
    i. chub, desert fishes in OR, focus on speckledace, other chubs – Umpqua chub to evaluate a couple of different designs, multi state occupancy, mark recapture followed by snorkel surveys (double surveys) to look at power – moved to multi species occupancy modeling.
    ii. Brook Petaluma – eDNA on top of the existing sampling with occupancy design to see if eDNA can be used for occupancy. The biggest variable (using eDNA) is the distance from the source

e. *Michael Colvin*:
    i. Sturgeon on the Missouri (Army Corps) to re-work the monitoring systems to determine recovery, has been using CPUE and that wasn't working – now a combination of occupancy, mark recapture - moves into the AM&M and now integrating incidental take in the monitoring

f. *Dave Stewart:*
    i. Rio grande area – multi-stage surveys to determine occupancy over time.
    ii. Yaqui fishes, depletion threat survey for abundance.
    iii. In-mixture design to draw inference to true abundance on species that are small, hard to sample

2. What approach have you taken to monitor these species over the long-term?
    - **Take Habitat measurements**: can help determine what is driving the variables, ultimately helpful in understanding trends.
        - Smokey mtn national park, riparian habitat survey for birds: trends show some spp going up and some going down - no riparian habitat data. Model to track is only as good as the data that is collected –
        - Getting the important habitat metrics is important.
    - **Have standards of recording:** Some folks don't want to measure all the fish, not just species of interest. Standard way of recording: fish per second, fish per 100m, habitat on the Xm of the river.
        - Standards give much more power to trend analysis
    - **Determine what it is that you actually need to know before you design the protocol,**
        - Is it important that all data that collected is helpful for the model and determining trends
    - **Consider putting your dollars in areas where there is less status certainty**

3. If multiple agencies were involved in the long-term monitoring, did they all use the same sampling protocol? If not, how did you deal with sampling differences across agencies?
    - **Consistent monitoring guidelines/protocols**: OR – monitoring a subset of the sites vs. CA – data collected by 2 states agencies, USFWS and contractors; Result, the data was all over the place and using the data in the model was useless.
        - Now (coming out soon, Jan 2021), specific monitoring guidelines (AFS), are available
        - For contracts and proposals there are the standards for how many times, when to deliver the data
    - **Shared database**: it has been used in OR. BOR could provide funding for database
        - Caveat: it doesn't work if people aren't putting the same kind of data in – the core standards (what are these?: gear, effort, timing, etc.)
    - **Standard Operating Procedures**: If everyone is held to the same monitoring protocols, then results are non-biased and changes/errors in data are only due to fish biotic factors (as opposed to sampling error)
    - **Combine intensive studies with annual monitoring** (short lived species), there are some things you can't control for (water temp. and flow) – control what you can and understand the things you can't control.

Key question from the Panel: What is preventing the agencies from coming together and using the same protocol?

- Limitation: 30 yrs of data with a certain protocol in each state,
- Differences in state data –
    - NM: sample by habitat with different gear (electroshocking and seining), fish per meter squared, in AZ set up a reach with electrofishing. Different protocols by species, net hours, efforts.
    - AGFD – some approaches are species specific (apache trout on reservation and forest service) – protocol developed with an outside agency for that species. Would be great to do that for the different species across state lines.
    - NMGFD – long term dataset that has been valuable, not sure how to approach an altered methodology/protocol and maintain the existing data that can be used. NM has the same approach within the state (USFWS, NMGF, USFS, BLM).

Recommendations to address issue

- Objectives meeting – state level was crosswalk the legacy data to the new methodology. Mark recapture where the first day is the legacy data to crosswalk the efforts – paired datasets. Consider a method that considers how the data has been collected over the decades.
- Utilize AFS for how to compare old data sets with new data sets – a lot of this exists, look into the AFS
- Understand how modifications be paired so that existing datasets are still informative.

4. How did you deal with jurisdictional boundaries?
    - Objective is independent monitoring and collaboratively lead –get more buy-in with all jurisdictions and tribes early
    - For Apache trout it is a point of pride for the reservation, but there might not be the same buy in for loach minnow
    - Different agencies have different limitations and each system is different. Need comparable estimates, not necessarily the exact same data. Examples include;
        - Estimator – occupancy, efficiency – mark recapture (NM, AZ and Aravaipa) to get an estimate; depends on the state: the species is not there, the species is there but under the desired levels, or the state is there and above.
        - Efficiencies across reaches
        - Paired situation of electrofishing and seining, and then just elctrofishing
    - More broadly
        - Define trend to make it measurable and determine the protocol goals.
        - Ensure that your data isn't confounded by the things that affect your ability to catch fish (flow, water temperature, crews getting better over time)
        - Develop a protocol that does not require annual monitoring because of the impact to fish – e.g., NM monitors annually for the first 5 yrs and then every 3 yrs after that

Reclamation Long-Term Native Fish Monitoring Protocol

Sampling Design Discussion

5. Does Reclamation's current monitoring protocol provide the necessary data to best inform the recovery criteria for each focus species?
    - Issues and assumptions with current protocol
        - Reach defined by person doing the monitoring and length of the stream is not identified/outlined in the original protocols
            - This is problematic and a quantitative definition of the sampling frame is needed, then stratified in some way (random, etc.), the variability in catch is not highlighted in the
        - Issue with the "rare" (what does that mean, needs defining)
        - Reach = division of the river/stream, but the number of sites per reach/miles is unclear
        - Protocol reads that 25 CPUE would indicate the species is doing ok but no one knows where 25 comes from, but how can you measure CPUE if it is less than or more than 25
        - Reports are differentiated by reach, effort is not reported.

            - Some of these sites were developed in 2012 and now, there is preferred habitat in different areas of the stream.
        - No clear alignment with USFWS goals – is it trends or detection, is increase or decrease?

Presentation and Discussion: Current sampling efforts in AZ and NM -

- Current sampling efforts for AZ
    - **Blue River**:
        - Barrier in place, 200m reach with pool run riffle sequence.
        - Total catch, # sites sampled, CPUE mean and standard error,
        - Length frequency for target species, other spp are categorized in to size class
        - Flow varies throughout the year -survey timing, non-natives in June and May and natives in the Fall (October)
        - Monitoring in 200m sites broken down by mesohabitat
        - Annual Native Fish monitoring
            - Reporting: CPUE for every 200m site and then a mean for the reach
            - Recommended to not do the 3-pass depletion
            - BOR picking up this site with the agreement that the protocol that has been used.
        - Reclamation portion – is that all one population? Yes, on loach minnow as they are all above the barrier
        - Includes one location on the Campbell Blue
        - Standardized the electrofishing – it is zig zag method, try to minimize the injury to the fish per AFS. Standardize the sampling method, the back and forth across the stream/river/etc. Reduce the variability in sampling – there are recommendations for accounting for length variability (pool to riffle length ration)
    - **Fossil Creek:**
        - Travertine system, non-natives were detected, treated with Rotenone and now is monitored more for non-natives and not spikedace and loach minnow.
        - Recorded/reported fish per hour observed. CAMP monitoring using hoop nets.
        - Antimycin treatment in 2000/2004, chub monitoring after this.
        - Reaches delineated by some sort of natural fall/drop. 15 sites within 3 reaches.
        - Effectiveness of stocking and repatriation – is that an objective? It is of AGFD when they do a stocking.
        - Reporting efforts so they are comparable (seconds and in length), don't make changes to the sampling frame if you want to be able changes over time.
        - Measured response of sucker after treatment through snorkeling
        - Targeted topminnow trapping may be more effective in addition to snorkeling
- Current Sampling efforts in NM:
    - One area, once a year (due to wilderness and access issues), sample by habitat type (with different methods), sites vary between 100-200m shoal habitat, numbers by habitat type, fixed sites (some started in 1988). 7 sites every year in October.
        - Could you revisit 2 of those same 7 sites – estimate detection
        - Yes, Keith has done this after Bryan has monitored
        - Measured in fish/area by habitat type
        - If not detected, they may be there, but in low abundance
    - Also using eDNA to identify areas where spikedace are that have never been recorded in standard monitoring
    - There is merit in keeping those long term sites - can keep trends within habitat type
    - Variation from pool to pool in same time, versus same pool at different times. (spatial variation vs temporal variation)
        - Sample design – compare variation over time and in different places
        - Temporal (year to year) variation is greatest in NM, not so much spatially
    - eDNA sampling
        - This could help by filling in gaps, as well as a specific project (w/in BOR) that samples more densely

Occupancy Modeling Discussion

- Guidance: Determine what you want to make inferences to; what level of heterogeneity; what kind of population dynamics exist (help you diagnose a problem) and how these might translate to abundance
    - Minnow traps, snorkeling, mark recapture – sites; how many can be random and how many can be fixed to determine population growth rate –
        - Fixed sites, and then determine high priority areas for random sites moving forward
    - Efficiency Emphasis on planning sites to be revisited for snorkeling were on the way to other sites that needed to be sampled.
    - Question: What do you sacrifice eliminating one site to add a visit to another site – do you lose precision, or not that much?
        - Current capacity seems good (panel opinion) 15 weeks with a 3- person crew has the possibility to have large spatial coverage – range wide coverage for the USFWS
    - Would be good to know if populations are increasing/decreasing and contracting/expanding
    - Determine if it is rare, common or abundant – consider spatial scale…physical methods are great, but there is still uncertainty in eDNA detections because decent flow particles can be transported quite far and the discharge determines particle flow.

What are the objectives of monitoring?

Objectives/Goals of the monitoring (2-3 yr life span for Spikedace and loach minnow, longer for chub)

- Link recovery and precision goals
- Presence, are they increasing or decreasing, trend – important but may be expensive
    - Trends and distribution as goals from USFWS – differs by species
        - Loach minnow – doesn't even look at trend
        - Topminnow – varies greatly
        - Gila Chub – trend is more important
- Evidence of recruitment (getting at status recovery)
    - Consider – certain measurement smaller and bigger, length frequency
- Geographic distribution pattern
    - is that fish presence in a lot of different areas?
    - trying to get to a number is difficult, but saying that you saw the fish in a lot of different places is highly correlated to abundance.
    - Broader spatial coverage and less effort at a site, that may give you more indication of how well a fish is doing.
- Detect and assess age/size structure of focus species (spikedace, loach minnow and chub)
- Estimate population and assess cause (mechanism: water temperature at mid-day, non-native presence, habitat description, interactions between species)
- Formally link monitoring to decision-making – if there are declines there needs to be an action

Frequency of sampling

- Consider the flow data that is cyclical when determining frequency of sampling
- High risk areas (more urban, FC, etc.) get visited more often for early detection
- How much area? (sites that are 16 miles long and sites that are ¼ mile long)
    - Look at the variability in the system
    - Pilot data to determine what the error is and what is acceptable – determine what the trade-offs are in the sampling design to see what happens to the precision and variability of the data
- Smaller quadrat will decrease your variability (100 m as opposed to 500m)

Other key considerations:

- Determining the sampling frame is key: This is how we define a sampling population (physical location or genetic)
    - This is specific to species – animal that is stuck in a system and cannot move out of it
    - Strata – edge vs. open water
    - Some sites are random and some are stratified random
- Centralized database for all the data – that USFWS can access to determine the analysis understanding the efforts from the states and then BOR can be in line with it

    - Comparing within streams, not across streams
    - Measure the stream width as an index (effort per area) and CPUE as an index
- Alternate years? – you lose antecedent reference; you lose that when you sample every three years.
- Occupancy trends in riffles in 2-3 miles – gets at how animals use space Prioritize those that need to be sampled

<u>Next Steps and Assessing Trade offs</u>

- Spatially assessing data sets – how many sites in a stream do you need to quantify what is there
- Allocation of effort – to detect 80% of what is there; use the existing data to prioritize efforts
- Determine your sampling size based on the level of variability you are willing to accept
- Sample size for trends using the data that exists
- Survey design and use simulation and when does the model get violated
- Agency meeting – objectives, state interests, needs
    - Monitoring approaches
    - Simulations based on existing datasets
    - Basean network
    - Get example from Michael – send to Jason
        - 1-day workshop on objectives (agencies, species leads from USFWS, etc.)
        - Post-doc to run the simulations
        - Webinars to keep updated/virtual meetings
- Add spatial variability in NM, but AZ has both fixed and random site
- Add some CPUE on the AZ side
- BOR needs guidance from AGFD and NMDGF
    - Prioritize what streams are most important

Participants
Scott Bonar - panelist
Julie Carter
Michael Colvin – panelist
Doug Duncan
Bryan Ferguson
Tim Frey
Keith Gido
Jason Kline
Kent Mosher
James Peterson – panelist
Tony Robinson
Bill Stewart
David Stewart – panelist
Jill Wick
Charles Yackulic – panelist

Facilitators:
Carrie Eberly
Andi Rogers
Jason Kline

Appendix A – Native Fish Monitoring Workshop #2: Background information and discussion questions

Expert Panel:

Michael Colvin	(Mississippi State University)
Scott Bonar	(U. S. Geological Survey)
Keith Gido	(Kansas State University)
James Peterson	(Oregon State University)
David Stewart	(U. S. Fish and Wildlife Service)
Charles Yackulic	(U. S. Geological Survey)

1. Priority Species and Recovery Criteria

The Gila River Basin Native Fishes Conservation Program (Program) is responsible for monitoring streams within the Gila River basin in Arizona and New Mexico. The purpose of this long-term monitoring is to monitor the status of wild populations of the following listed/candidate fishes: Gila Topminnow, Spikedace, Loach Minnow, and Gila Chub/Roundtail Chub. To assist the expert panel in their evaluation and review of Reclamation's long-term monitoring protocol, below is brief life history information on the Program's focus species.

Gila Topminnow (*Poeciliopsis o. occidentalis*)

Description:
- 1 – 2 inches in length
- Tan to olive in color
- Breeding males may become blackened with yellow/orange fins.

Reproduction:
- Life span is approximately 1 year.
- Young may reach sexual maturity in a few weeks to several months.
- Reproductive season normally occurs from April through November.
- Internal fertilization and development.
- Females may carry two broods simultaneously at different development stages or may store sperm packets for later fertilization of eggs.
- Typical brood size ranges from 10 - 15 young with larger broods produced during the summer.

Habitat:
- Prefer shallow waters with low to moderate flow.
- Prefer dense aquatic vegetation and algal mats.
- Occupy springs, ponds, cienegas, backwaters, interrupted and perennial streams/rivers.

Food Habits:
- Ominivorous; detritus, amphipod crustaceans, aquatic insect larvae (especially mosquitos).

Range:
- Historically, Gila Topminnow were found in most streams within the Gila River basin.
- Currently, there are 9 to 11 natural populations and about 70 reintroduced populations.
- Elevations below 5,000 feet.

Recovery Criteria:

1999 Draft Revised Gila Topminnow Recovery Plan
- Downlisting Criteria
  - Minimum Viable Population
    - Contain at least 500 overwintering adults
    - Possess an adequate representation of all age classes and cohorts
    - Evidence of reliable annual recruitment
  - Population Types Required
    - Level 1: Natural populations
    - Level 2: Reintroduced populations that persist a minimum of 10 years with little to no human intervention.
    - Level 3: Reintroduced populations that are unable to persist for at least 10 years without human intervention.

<u>Spikedace (*Meda fulgida*)</u>
Description:
- Rarely exceeds 3 inches in length
- Olive-gray to light brown above, and silver side with black specks/blotches on back and upper side.
- Breeding males may have bright, brassy yellow head and fins.

Reproduction:
- Life span is typically 1 to 2 years; however, some individuals may live up to 3 to 4 years.
- Reproductive season normally occurs in spring and summer and is initiated in response to stream discharge and water temperature.
- Males patrol shallow, sand-gravel riffles where current is moderate. Females are typically approached by multiple males. Gametes are deposited into the water column or on substrate. Eggs are adhesive and demersal based and likely adhere to substrates.
- Females may be fractional spawners, with elapsed periods of a few days to several weeks between spawnings.
- Fecundity of individual females ranges from 90 to 250 ova and is significantly correlated with both length and age.

Habitat:
- Prefer flowing water (1 – 2 feet/second) with depths of less than 1 meter.
- Prefer broad, shallow areas above sand-gravel substrates.
- Typically occupy the downstream ends of riffle and eddies, as well as upstream portions of shear zones.

Food Habits:
- Carnivorous; primarily feed on aquatic and terrestrial insects entrained in stream drift; however, they may feed on the fry of other fish during certain seasons.

Range:
- Historically, Spikedace were common and locally abundant throughout the upper Gila River basin.
- Currently, Spikedace occur in Aravaipa Creek, Blue River, Fossil Creek, Spring Creek, and Hot Springs Canyon in Arizona. In New Mexico, Spikedace occur in the San Francisco River, upper Gila River, and tributaries.

Recovery Criteria:
1991 Spikedace Recovery Plan (2019 Draft Amendment)
- Downlisting Criteria
    - Population Types Required
        - Remnant Populations
            - Trends of recruitment and population size indices considered stable or positive over the most recent rolling 10-year period.
            - Conduct annual monitoring.
        - Replicate Populations
            - Self-sustaining, as shown by persistence and reproduction, for five consecutive years following the last stocking effort at each site.
            - Conduct annual monitoring.

<u>Loach Minnow (*Tiaroga cobitis*)</u>
Description:
- Rarely exceeds 2.6 inches in length
- Olive in color with darker blotches. White spots around base of dorsal fin and ventral portion of caudal fin. Elongated body that is little compressed and flattened vertically.
- Breeding males develop bright red-orange coloration at the bases of paired fins, on adjacent fins, on the base of caudal opening, and often on abdomen.

Reproduction:
- Life span is typically 1 to 2 years; however, some individuals may live up to 3 years.
- Reproductive season varies by location, but normally occurs in early spring/late winter through summer.
- Spawning occurs in riffles where adhesive eggs are deposited on the underside of flattened rocks. The number of eggs deposited per rock ranges from 5 to 250 (populations average 52 to 63 eggs per rock). Eggs hatch in 5 to 6 days.
- Fecundity of individual females range from about 150 to 250 mature ova, and generally increases with size.

Habitat:

- Prefer moderate to swift velocities with gravel to cobble substrates.
- Restricted almost exclusively to bottom dwelling habitat due to a reduced gas bladder.
- Occupy shallow, rocky riffles of mainstem rivers and tributaries.

Food Habits:

- Carnivorous; opportunistic benthic insectivores that feed primarily on riffle-dwelling larval emphemeropterans, simuliid, and chironomid dipterans.
- Actively seek their food among bottom substrates, rather than pursuing items in the drift.

Range:

- Historically, Loach Minnow were endemic to the upper Gila River basin.
- Currently, Loach Minnow occur in the White River, North and East forks of the White River, Aravaipa Creek, Blue River, and Campbell Blue River in Arizona. In New Mexico, Loach Minnow occur in the San Francisco River, upper Gila River, and tributaries.

Recovery Criteria:

1991 Loach Minnow Recovery Plan (2019 Draft Amendment)

- Downlisting Criteria
    - Population Types Required
        - Remnant Populations
            - Trends of recruitment and population size indices considered stable or positive over the most recent rolling 10-year period.
            - Conduct annual monitoring.
        - Replicate Populations
            - Self-sustaining, as shown by persistence and reproduction, for five consecutive years following the last stocking effort at each site.
            - Conduct annual monitoring.

<u>Gila Chub (*Gila intermedia*)</u>

Note: Gila Chub was previously considered a distinct species from Headwater Chub (*Gila nigripes*), and Roundtail Chub (*Gila robusta*); however, the Joint Committee on the Names of Fishes reclassified the three species as one entity (Roundtail Chub [*Gila robusta*]) in 2016. The species formerly known as Gila Chub is listed as endangered; whereas, Headwater Chub and Roundtail Chub are not listed (however, both species were candidates when Reclamation begin the long-term monitoring program). Reclamation's current protocol is set up to monitor all populations previously known as Gila Chub, Headwater Chub, and Roundtail Chub.

Description:

- Females can reach up to 10 inches in length, whereas males rarely exceed 6 inches in length.
- Small-finned, deep-bodied, and chunky
- Darkish in color; sometimes lighter on belly and speckled with grey.
- Breeding males may develop red or orange on lower parts of the head and body and on bases of the pectoral, pelvic, and anal fins.

Reproduction:

- Typically reach sexual maturity in 2 to 3 years.
- Reproductive season normally occurs in late spring through summer.
- Spawning typically occurs over beds of submerged aquatic vegetation.
- Fecundity of Gila Chub in Turkey Creek, New Mexico ranged from 600 to 3,546, whereas Gila Chub spawned in the laboratory yielded 300 to 2,000 eggs per individual.
- Eggs are demersal, adhesive, ovoid, and translucent.

Habitat:

- Prefer quiet, deeper waters with terrestrial vegetation, boulders, root wads, fallen logs, and thick overhanging or aquatic vegetation.
- Adults typically occupy deep pools and eddies below areas with swift currents.
- Young-of-the-year typically occupy shallow water among plants or debris.

Food Habits:

- Omnivorous; prefer terrestrial and aquatic insects, but also feed on aquatic vegetation and organic debris.

- Young actively feed throughout the day.
- Adults are crepuscular feeders and may consume small-bodied fishes, if available.

Range:

- Gila Chub occur in headwater streams of the Gila River basin, as well as in the San Pedro and Santa Cruz River systems.
- Elevations below 5,500 ft

Recovery Criteria:

2015 Draft Gila Chub Recovery Plan

- Downlisting Criteria
  - Population Types Required
    - Remnant Populations
      - Trends of recruitment may be adequate if the regression slope of catch-per-unit-effort (CPUE) estimates of young-of-year during autumn monitoring is zero or positive over the most recent 10-year period.
      - Additionally, the regression slop of CPUE for the total population must not be negative over that same period.
    - Replicate Populations
      - Same criteria as above.

2. Gila River Basin Native Fish Monitoring

In 2011, Reclamation established a monitoring protocol for sampling the previously listed focus species under the Program's long-term monitoring program. To assist the expert panel in their evaluation and review of this protocol, below is a summary of the current sampling protocol.

<u>Reclamation Long-Term Native Fish Monitoring</u>

Purpose:

- Monitor the status of wild populations of Gila Topminnow, Spikedace, Loach Minnow, and Roundtail Chub (Gila Chub, Headwater Chub, Roundtail Chub).

Goals and Objectives:

- Detect each native species of interest (focus species) in each stream/stream reach.
- Provide an estimation of assemblage structure and the percent composition of the focus species and its co-occurring species (including non-natives).
- Provide a delineation of the distributions of listed/candidate species within occupied streams.

Sampling Protocol:

- Methods
  1. An initial 500 m site is established within the stream/ reach to detect the focus species.
  2. Once the focus species is detected, a fixed 100 m site is established.
     - The 100 m site should be quantitatively sampled according to procedures in Clarkson et al. (2011) which includes recording the number of individuals and species encountered within major mesohabitat types (pool, riffle, run) to determine assemblage structure.
  3. If focus species is rare (< 25 individuals), sampling will continue upstream for another 500 m focusing on preferred habitats of the focus species.
  4. If the focus species continues to remain rare, an attempt will be made to repeat the entire process at another access point within the stream where the species is expected or known to occur.
  5. A maximum of three sampling sites will be performed in this manner (unless the stream or site is too short to enable an expanded search).
  6. On repeat visits to the same stream in subsequent years, the initial search will be at the site where the species was last detected in the most abundance.
- Data collected includes:
  - Stream name
  - Site name
  - UTM coordinates
  - All fish captured are identified to species, sorted into age classes (Age-0 and Age-1+), and counted for each gear type and mesohabitat.
  - Effort is recorded by gear type and mesohabitat.

  - For 100 m sites, photos are taken in both upstream and downstream directions. A sketch is also created depicting station morphology and mesohabitat.
- Sampling Gear
  - Backpack electrofishing is the primary gear type utilized during sampling efforts; however, other methods may also be used in addition that are suited for capturing the focus species (e.g., minnow traps, seines, and dip nets for Gila Topminnow; hoop nets for Gila Chub/Roundtail Chub).
- Sampling Sites
  - 1 site for streams/reaches less than 5 miles.
  - 2 sites for stream/reaches between 5 – 10 miles.
  - 3 sites for stream/reaches greater than 10 miles.
- Sampling Schedule
  - The current stream list contains about 80 unique streams/water bodies.
  - Sites are monitored on serially-alternating basis (once every 4 to 5 years).
  - Repatriated sites are added to the stream list once a site has proven to be established and has not been augmented for a minimum of five years.
  - Reclamation's monitoring is not intended to duplicate any existing monitoring, and seeks to partner with other agencies, organizations, and individuals to share monitoring workloads.

<u>Partner Agency Native Fish Monitoring</u>

Reclamation also funds recovery actions under the Program that are aimed at the conservation of native fishes and include the monitoring of reintroduced populations and natural/established populations of the focus species. The goals and objectives of these monitoring efforts are typically to:

- Verify persistence of the focus species.
- Evaluate if relative abundance (based on the CPUE) of the focus species is stable or increases over time.
- Evaluate size-structure of the focus species population to detect reproduction and recruitment.
- Determine if species have dispersed outside of the stocking area (if a repatriated population).
- Determine percent composition of the focus species and its co-occurring species.
- Detect non-native fish species.

To assist the expert panel in their evaluation and review of Reclamation's long-term monitoring protocol and compare it to other on-going monitoring efforts, below is a summary of the current monitoring practices conducted by partner agencies funded under the Program to monitor reintroduced populations and natural/established populations of the focus species.

Gila Topminnow

- Sampling Protocol
  - In Arizona, monitoring methods vary depending upon habitat type. In streams, typically 20% of preferable habitat (pools/runs) is sampled using minnow traps (2 hour sets), seines, or dip nets. Sampling sites are located at the stocking site, as well as upstream and downstream within the reach that Gila Topminnow is expected to colonize. In ponds/springs, a minimum of 10 minnow traps are set (for 2 hours) and/or seine hauls/dip net sweeps are performed. All fish captured are enumerated and size classed/measured. Sampling effort by gear type is also recorded.
  - In New Mexico, monitoring consists of a minimum of three 100-200 m sites. These sites are located at the stocking site, as well as upstream and downstream within the reach that Gila Topminnow is expected to colonize. Survey gear may vary but is appropriate to the habitat. All fish captured are enumerated and size classed/measured. Sampling effort is also recorded.
- Sampling Schedule
  - In Arizona, a reintroduced population is monitored 1-month, 6-months, and 12-months post-stocking. It is then monitored annually for a minimum of three years (since the last stocking) to determine if Gila Topminnow persist and establish. Once established, the population is then typically monitored once every three years. Natural populations are also typically monitored once every three years.
  - In New Mexico, the population is monitored every autumn for five years (since the last stocking) to determine if Gila Topminnow persist and establish. Once established, the population is then typically monitored once every five years (or sooner if a stochastic environmental event occurs). Only reintroduced populations of Gila Topminnow currently occur in New Mexico.

Spikedace and Loach Minnow

- Sampling Protocol
  - In Arizona, monitoring is typically conducted by backpack electrofishing a combination of fixed and random 100 m sites (or 200 m sites in larger systems to capture a pool-riffle-run sequence) that encompass at least 20% of each stream reach. All fish captured are identified, counted, and measured/size classed at each habitat break (pool, riffle, run). Sampling effort is also recorded at each habitat break. Seine hauls and kick-seine electrofishing have also been conducted to monitor for Spikedace/Loach Minnow.
  - In New Mexico, monitoring consists of a minimum of three 100-200 m sites. These sites are located at the stocking site, as well as upstream and downstream within the reach that Spikedace is expected to colonize. Survey gear may vary, but typically consists of combination of backpack electrofishing, kick-seine electrofishing, and seine hauls. All fish captured are enumerated and size classed/measured. Sampling effort is also recorded.
- Sampling Schedule
  - In Arizona, a reintroduced population is monitored annually post-stocking for a minimum of five years (since the last stocking) to determine if Spikedace/Loach Minnow persist and establish. Once established, the population typically continues to be monitored annually. Natural populations are also typically monitored annually.
  - In New Mexico, a reintroduced population is monitored every autumn for five years (since the last stocking) to determine if Spikedace/Loach Minnow persist and establish. Once established, the population is then typically monitored once every five years (or sooner if a stochastic environmental event occurs). Natural populations are typically monitored once every five years; however, some populations are monitored annually.

Gila Chub/Roundtail Chub

- Sampling Protocol
  - In Arizona, monitoring methods vary depending upon habitat type. In wadeable streams, monitoring is typically conducted by backpack electrofishing a combination of fixed and random 100 m sites (or 200 m sites in larger system to capture pool-riffle-run sequence) that encompass at least 20% of each stream reach. All fish captured are identified, counted, and measured/size classed at each habitat break (pool, riffle, run). Sampling effort is also recorded. In non-wadeable streams, typically 20% of preferable habitat (pools/runs) is sampled using hoop nets (preferably overnight sets). In ponds, hoop nets are set (preferably overnight) and/or seine hauls are performed.
  - In New Mexico, monitoring consists of a minimum of three 100-200 m sites. These sites are located at the stocking site, as well as upstream and downstream within the reach that Gila Chub/Roundtail Chub is expected to colonize. Survey gear may vary but is appropriate to the habitat. All fish captured are enumerated and size classed/measured. Sampling effort is also recorded. Natural populations are typically monitored once every three years.
- Sampling Schedule
  - In Arizona, a reintroduced population is monitored annually post-stocking for a minimum of five years to determine if Gila Chub/Roundtail Chub persist and establish. Once established, the population is typically monitored once every three years; however, some populations are monitored annually.
  - In New Mexico, a reintroduced population is monitored every autumn for five years (since the last stocking) to determine if Gila Chub/Roundtail Chub persist and establish. Once established, the population is then typically monitored once every five years (or sooner if a stochastic environmental event occurs). Natural populations are typically monitored once every five years; however, some populations may be monitored annually.

3. Discussion Questions

Example of Current Long-Term Native Fish Monitoring Protocols

6. Have you worked with these species or species similar life histories?
    a. What species?
    b. What approach have you taken to monitor these species over the long-term?
        i. How was monitoring prioritized for each population?
        ii. How did you incorporate habitat sampling into the protocol?
        iii. If multiple agencies were involved in the long-term monitoring, did they all use the same sampling protocol? If not, how did you deal with sampling differences across agencies?
        iv. How did you deal with jurisdictional boundaries?
        v. What type of study design was used (e.g., random, stratified random, fixed, other)?
        vi. Please provide example of the current monitoring protocol.

Reclamation Long-Term Native Fish Monitoring Protocol

7. Does Reclamation's current monitoring protocol provide the necessary data to best inform the recovery criteria for each focus species? See the recovery criteria section within the life history summaries for each species (Pages 1 – 5).

8. In addition to meeting the information needs for each species' recovery criteria, is Reclamation's current monitoring protocol sufficiently robust enough, both spatially and temporally, to detect a change in status and trends (over the most recent rolling 10-year period) in all habitat types and systems (i.e., interrupted habitat, large rivers, springs/ponds)? Particularly, in regard to the…
    a. Distribution of the focus species within a stream
    b. Fish species composition/assemblage
    c. Presence and abundance of nonnative aquatic species

9. Given each focus species' life history traits, their distributions across the Gila River basin, and funding limitations (current funds support the monitoring of about 15 streams per year), how would you develop a protocol to meet the monitoring and recovery needs referenced in Questions 2 and 3?

Recommendations for Designing a Long-Term Monitoring Plan

10. There are several entities currently conducting native fish monitoring in the Gila River Basin. The monitoring being completed by these different entities sometimes has different goals and utilizes different sampling protocols. For example, monitoring within a single stream in a given year may include (1) an entity conducting annual sampling of fixed 100 - 200 m monitoring sites, (2) an entity conducting an annual single-pass nonnative removal effort in a different 4 km section of the stream, (3) Reclamation sampling a few 100 - 500 m monitoring sites within a different section of stream once every three years, and (4) eDNA sampling to fill in the missing gaps between these sampling stations.
    a. Is it possible to compare these different data sets to determine population statuses and trends?
    b. How should Reclamation design its protocol to best contribute to these data sets, while also meeting the information needs for species status and recovery criteria?

11. Reclamation's funding currently supports the monitoring of about 15 streams/water bodies per year. Given the life history and recovery criteria for the focus species, what are the trade-offs of monitoring a stream every year versus every three years (i.e., 15 streams are monitored annually versus 45 streams monitored on a three-year rotation)?

12. Is there another type of abundance index (e.g., occupancy rate) that is more appropriate for monitoring populations of rare species than conventional catch rate indices?
    a. Should monitoring incorporate depletion, mark-recapture techniques, or other methods to determine capture probability and better estimate annual abundance? Provide examples for species with similar life histories.

13. How would you recommend incorporating new technologies, such as eDNA, into the sampling protocol?
    a. Are you aware of any other new technologies? If so, how would you incorporate them into a long-term monitoring protocol?