Forest Stewards Guild
putting the forest first

Zuni bluehead sucker companion water quality monitoring

Short report

Photo courtesy of Angela Palacios (USFWS)

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INTRODUCTION

The Zuni bluehead sucker (*Catostomus discobolus yarrowi*) (ZBS) is a federally listed endangered (since 2014) subspecies of fish that was formerly widespread within the Little Colorado and San Juan River drainages of Arizona and New Mexico (Figure 1). In New Mexico, its populations have been reduced by 90% (USFWS 2019) and it is now restricted to isolated, shaded pools and riffle habitats with coarse substrates in the Zuni Mountains and Pueblo of Zuni. The Rio Nutria watershed, represented by two sites in this study, is among three strongholds for wild populations of the subspecies, the others being Agua Remora, represented by three sites in this study, and Rose Creek, the area of highest ZBS abundance among six New Mexico sub-populations surveyed in 2021 (Johnson 2021).

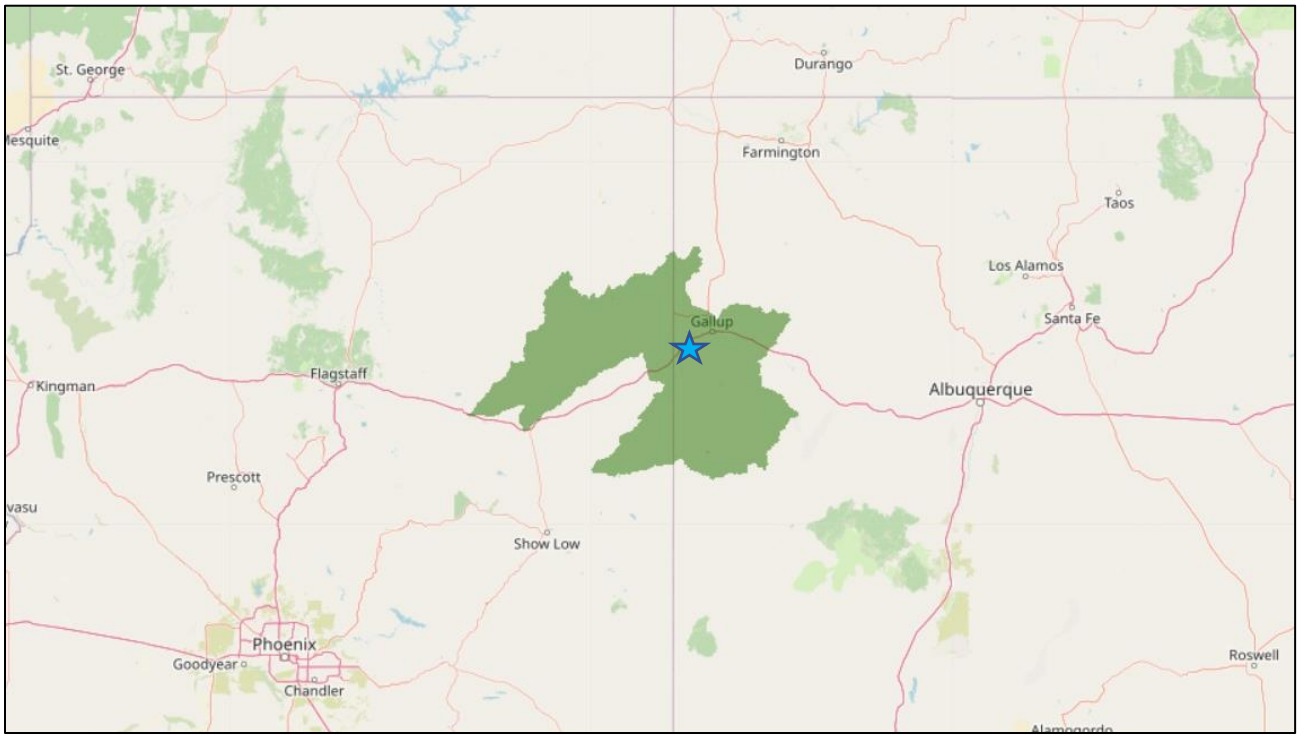

Figure 1. A global range map of the Zuni bluehead sucker (*Catostomus discobolus yarrowi*) (green polygon) and the location of this study (blue star).

Threats to the Zuni bluehead sucker include: 1) sedimentation, which is exacerbated by livestock grazing and wildfire, 2) climate change-induced increases in water temperature, decreasing water levels, and frequent and severe floods, and 3) competition with non-native species including green sunfish (*Lepomis cyanellus*), fathead minnows (*Pimephales promelas;* present at Agua Remora Lower Pool but absent at Tampico Draw) (Johnson 2021), and crayfish (*Orconectes virilis*). In the 1960s, the US Fish and Wildlife Service (USFWS) dumped piscicides in the Rios Pescado and Nutria to clear habitat for rainbow trout (*Oncorhynchus mykiss*) sport fishing, decimating ZBS and other fish populations in the process. It is unclear to what extent populations in the lower reaches of these watersheds have recovered.

Zuni bluehead sucker populations have been systematically surveyed since the early 1990s by the USFWS, Pueblo of Zuni, New Mexico Department of Game and Fish, US Forest Service (USFS) and The Nature Conservancy. Graduate researchers from the University of New Mexico (UNM) (Frus 2016, Collis 2020) have also made significant contributions to the scientific understanding of this subspecies.

Since 2013, the Forest Stewards Guild (the Guild), in collaboration with UNM, Great Old Broads for Wilderness, Native Plants Society of New Mexico, River Source, Inc., USFS, and others, has monitored water conditions in the Rio Nutria headwaters to gain a better understanding of the ecological conditions that support the persistence of ZBS, whose rapid range contraction and small, fragmented populations make it vulnerable to escalating threats and declining habitat quality.

OBJECTIVE

The primary objective of this study is to document variance in physicochemical parameters such as water temperature, water level, dissolved oxygen, and pH in ZBS habitat within the Zuni Mountains Collaborative Forest Landscape Restoration Program (CFLRP) footprint. In doing so the study aims to define the ecological envelope within which the ZBS persists in the intermittent streams of the Rio Nutria watershed (Figure 2). This monitoring will also enable researchers to evaluate the impacts of future management actions taken in the surrounding forested watershed on the aquatic environment.

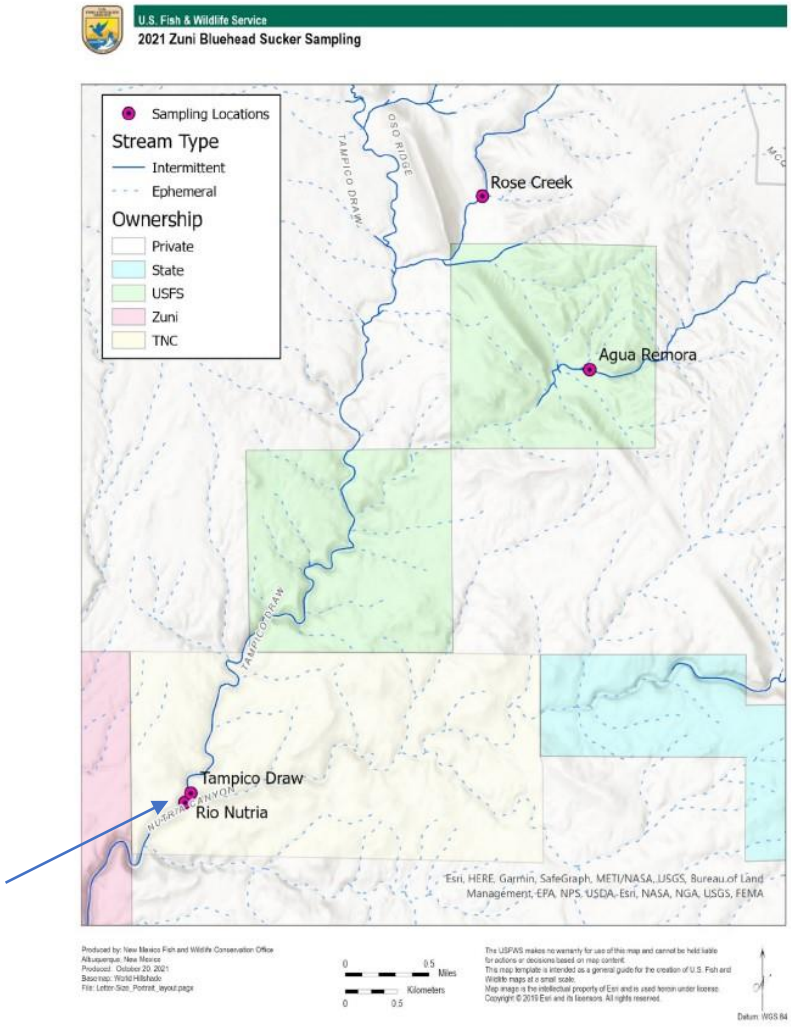

Figure 2. Map of Zuni bluehead sucker sampling locations (USFWS) and the Tampico Draw study site (indicated by the blue arrow). Map courtesy of USFWS.

The methodologies employed in this study include:

1) spot water quality measurements of dissolved oxygen, pH, dissolved solids, and specific conductance. A total of 51 spot water quality samples were taken at five sites: Agua Remora Upper Pool (n=8), Middle Pool (n=8), and Lower Pool (n=7); and Tampico Draw Above (n=13) and Below (n=15) the Confluence with the Rio Nutria; and

2) automatic logger (Solinst and HOBO) measurements of water temperature and pressure (psi) recorded at fixed intervals, typically every half hour. This data has been collected intermittently since 2014.

Figure 3. Surveyor at Tampico Draw Below Confluence within The Nature Conservancy's Rio Nutria Reserve in November 2022.

WATER TEMPERATURE

Zuni bluehead sucker thermal tolerances are not well understood; however, rising temperatures are likely to pose a threat to the subspecies (USFWS 2019) given that as water temperatures rise, dissolved oxygen concentrations and water levels concomitantly decline.

Water temperature was recorded automatically by loggers installed at each of the two Tampico Draw sites at the rate of 48 measurements / day. Both pools typically maintain a depth of around 18 inches. Results show consistently higher median temperatures at the Below Confluence pool (13.5° – 15.2° C) as compared to the Above Confluence pool (12.1° – 13.2° C) (Figure 4), likely because the Below Confluence pool is less shaded. Both sites show vulnerability to occasional critical warming (above 30° C), as occurred in 2014 Above the Confluence and 2015 Below the Confluence. Maximum temperature tends to be reached in June or July although in one case (2021 Above Confluence) it was reached in September.

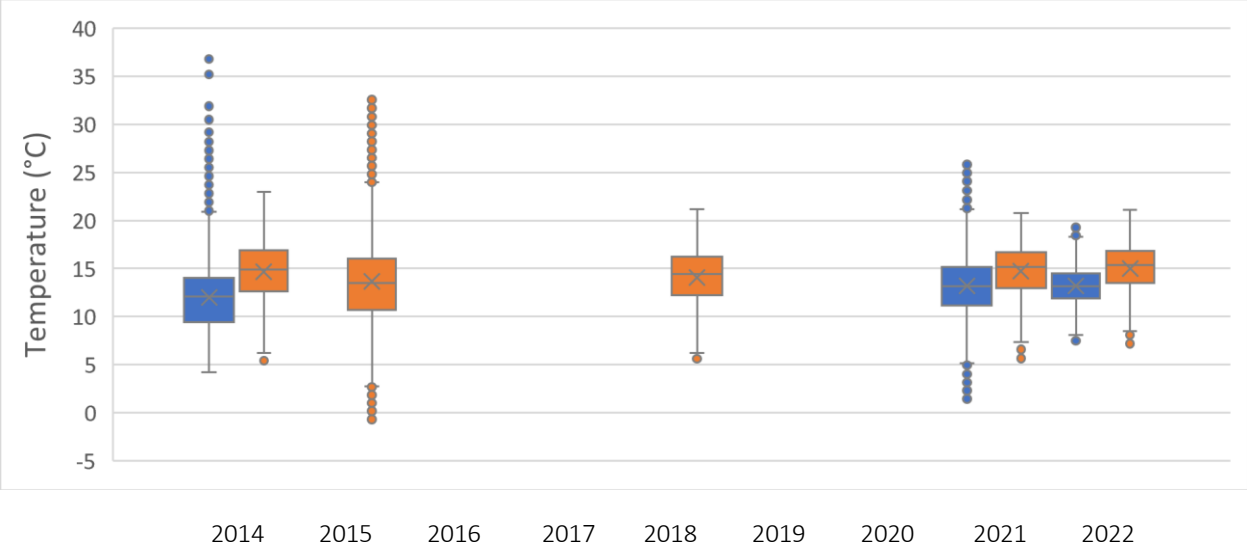

Figure 4. Water temperatures recorded at Tampico Draw Below (orange) and Above (blue) the Confluence with the Rio Nutria between May 15th and October 13th of 2014 - 2022. The gray center lines denote median values while boxes contain 25th to 75th percentile (i.e., quantile) temperatures. Points denote outlying values that fall beyond the 5th and 95th percentiles (represented by error bars), respectively.

WATER LEVEL

Pressure data was captured automatically in pounds per square inch (psi) by loggers at the rate of 48 measurements / day at Tampico Draw Below Confluence in 2018, 2021 and 2022. Data from 2021 and 2022 were successfully calibrated for atmospheric pressure using hourly readings from the McGaffey

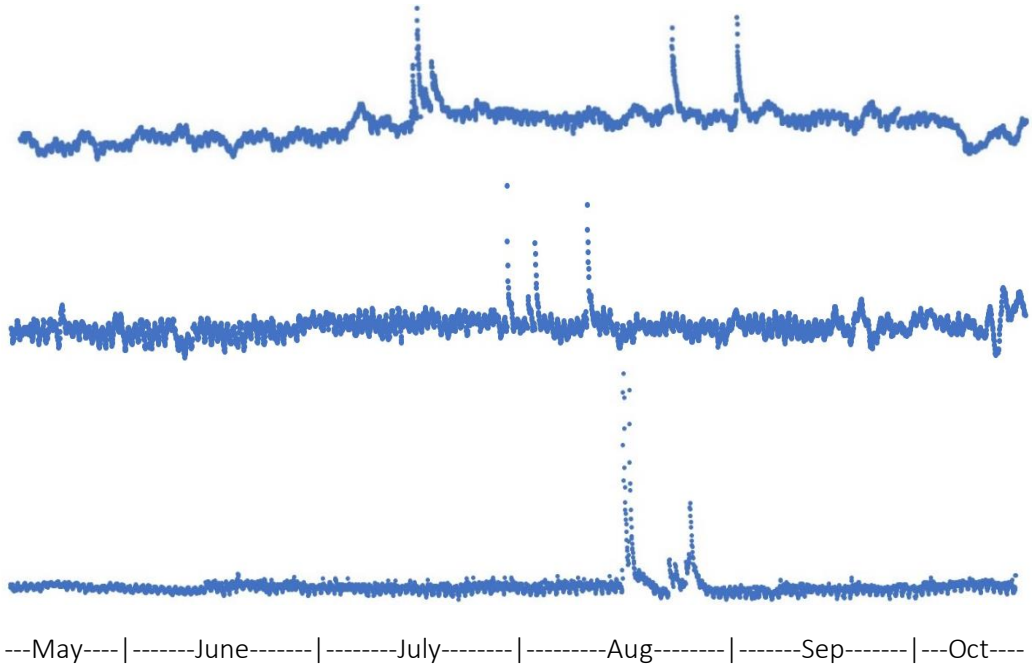

Figure 5. Water levels at Tampico Draw Below Confluence between May 15th and October 15th of 2018 (top), 2021 (middle), and 2022 (bottom).

RAWS weather station in the western Zuni Mountains. 2018 data was not calibrated as measurements were in units other than psi or inhg (inches of mercury).

Data from 2018, 2021, and 2022 show four to five discrete flood pulses per monsoon season (Figure 5). Pulses tend to cluster between July 14th and September 1st with individual events lasting 10 - 28 hours (median duration = 15 hours). Flood events have the potential to wash fish out of the system, while drought can lower water levels and dissolved oxygen to critical (i.e., fatal) thresholds.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is necessary for fish respiration, with levels above 5 mg / L considered acceptable, levels below 4 mg / L considered stressful, and mortality typically occurring below 2 mg / L (University of Florida 2023). Dissolved oxygen was intermittently recorded at five sites - three at Agua Remora and two at Tampico Draw. Zuni bluehead sucker have been observed at all five sites.

Dissolved oxygen levels from this study (n=20) were generally consistent with those published in Frus (2016), although sample sizes were too small for statistical validation. Four of the five sites surveyed in this study presented DO levels suitable for fish habitation, the exception being Agua Remora Upper Pool whose mean DO was 2.38 mg / L (Figure 6). Frus (2016) reported a mean of 1.49 for this pool with 83% of days being hypoxic (i.e., DO below 3 mg / L). At Agua Remora Lower Pool, this study found a mean DO of 6.89, compared to Frus' (2016) mean of 5.76 with 7% of days hypoxic.

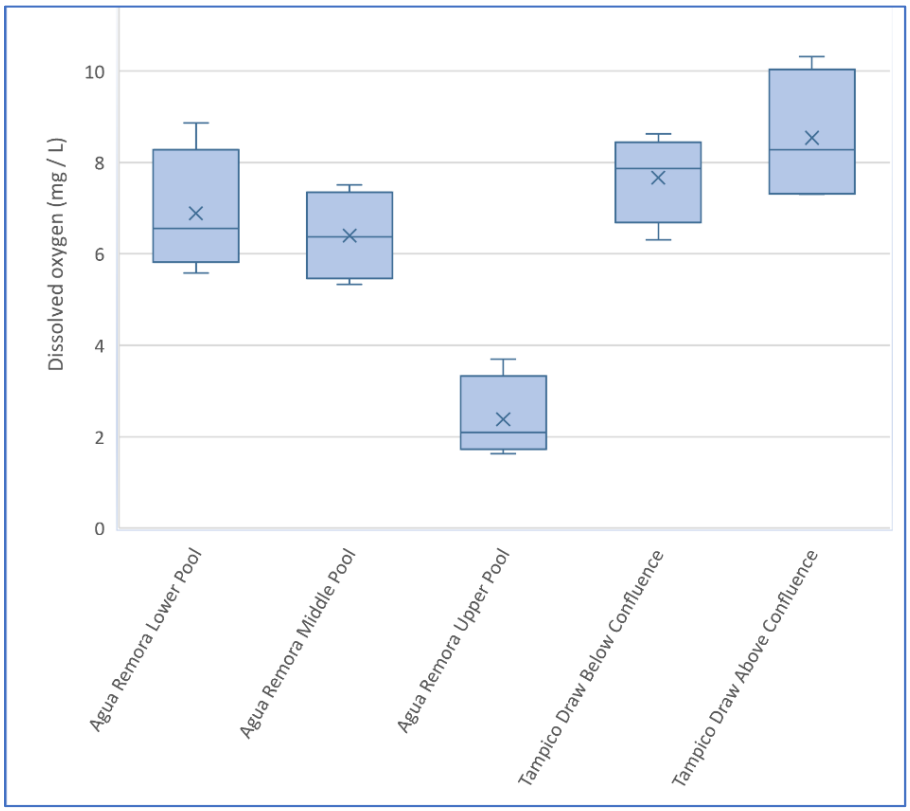

Figure 6. Median (lines inside boxes) and upper and lower quantiles (box edges) of dissolved oxygen measurements taken at five sites (n=4 for all sites).

pH, TOTAL DISSOLVED SOLIDS, and SPECIFIC CONDUCTANCE

The physicochemical makeup of water bodies varies depending on their source (e.g., spring-fed vs. rainfall) and influences the suitability of the aquatic environment for living organisms. pH, total dissolved solids, and specific conductance have been periodically collected at Agua Remora and Tampico Draw since 2013 (n=47). Our results show relatively little variance in these parameters between sites where ZBS occurs, with mean pH values of 7.82 - 8.23, mean total dissolved solids of 350 - 414 ppm, and mean specific conductance of 526 - 703 uS/cm (Table 1). These results are consistent with Frus' (2016) findings that ZBS locations 1) maintain pH neutrality (7.12 - 7.42 ± 0.6), and 2) display specific conductance values below 700 uS/cm with less variability than pools where ZBS are absent. While we cannot rule out the possibility of ZBS surviving outside of these ranges, these findings show a consistent physicochemical makeup of areas where ZBS are present.

	----------Site----------				
Parameter	TDBC	TDAC	ARUP	ARMP	ARLP
pH	8.18	8.17	7.82	8.13	8.23
TDS (ppm)	414	367	350	362	376
Specific conductance (uS/cm)	666	703	556	561	526

Table 1. Average values of pH, total dissolved solids (TDS) and specific conductance at five study sites where ZBS are present. TDBC=Tampico Draw Below Confluence; TDAC=Tampico Draw Above Confluence; ARUP=Agua Remora Upper Pool; ARMP=Agua Remora Middle Pool; ARLP=Agua Remora Lower Pool.

CONCLUSIONS

This study details the ecological envelope within which the Zuni bluehead sucker persists in the aquatic environment of the Rio Nutria watershed, one of its global strongholds. The Guild and its partners will continue to monitor physicochemical parameters with special attention to dynamism in water temperature and flow. Through tighter coupling (both temporally and spatially) of water monitoring and Zuni bluehead sucker population surveys, researchers may be able to link changing environmental conditions to Zuni bluehead sucker population dynamics such as demographic structure, reproductive rate, and - in the worst case - extirpation.

FUTURE MONITORING RECOMMENDATIONS

- Install a HOBO logger and collect spot water quality data at Rose Creek, home to the largest ZBS population surveyed in 2021 (Johnson 2021).
- Conduct regular riparian assessments of surrounding habitat to document baseline conditions and changes to vegetation (e.g., encroachment of cattails (*Typha spp*.)) and other geomorphological characteristics.
- Acquire a titration kit for more reliable sampling of dissolved oxygen levels.
- Perform calibration of all devices immediately prior to sampling.
- Configure HOBO loggers to capture one measurement per hour to synchronize with atmospheric pressure data from the McGaffey RAWS weather station.

REFERENCES

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