



Urbanization increases isolation of a threatened fish species in East Texas streams: A 20-year perspective

Zachary Hutchens & Carmen G. Montaña, PhD
Department of Biology, Stephen F. Austin State University, Nacogdoches TX



Abstract

We investigated the habitat associations, abundance, and movements of the Sabine shiner (*Notropis sabiniae*) in streams within the La Nana Creek watershed of East Texas, where the species was assessed about 20 years ago by Williams and Bonner (2006). We hypothesized that habitat modification due to urbanization has decreased the population size of this fish in this watershed. Using the same methodology and study sites as the previous study, we collected 312 individuals over four seasons (from Fall 2020 to Summer 2021), 160 of these were tagged with 76 being later recaptured. Only 7 individuals were tagged from La Nana Creek with no recaptures. Our population surveys reported lower abundance of Sabine shiner compared to the previous study and suggest that small isolated populations inhabit Banita Creek and La Nana Creek, in reaches less than 1.5 km containing moderate flow and gravel substrate.

Introduction

Urbanization can directly impact aquatic ecosystems causing significant habitat alterations and changes in stream biota. Many fish species are vulnerable to these alterations. The Sabine shiner (*Notropis sabiniae*, Fig. 1A), a small benthic cyprinid (Family Cyprinidae) that inhabits shallow run and riffle habitats of tributaries of major rivers in drainages of eastern Texas. Due to habitat alterations this fish is currently listed as a Species of Greatest Conservation Need (SGCN) by the State of Texas. The last report evaluating the status and life history of this species in east Texas was conducted about 20 years ago [1], suggesting high abundance of Sabine Shiner inhabiting creeks within the La Nana Creek watershed, Nacogdoches Texas. Over 20 years, Nacogdoches' population has increased by 2.9 thousand residents [2] consequently increasing changes in land use including urban development.

Objective: To re-assess the population status of Sabine shiner in Banita Creek and La Nana Creek, Nacogdoches county, Texas (Fig. 1B).

Hypothesis: Changes in land use over 20-years (e.g., urbanization) has reduced the population of Sabine shiner to more confined suitable habitats.

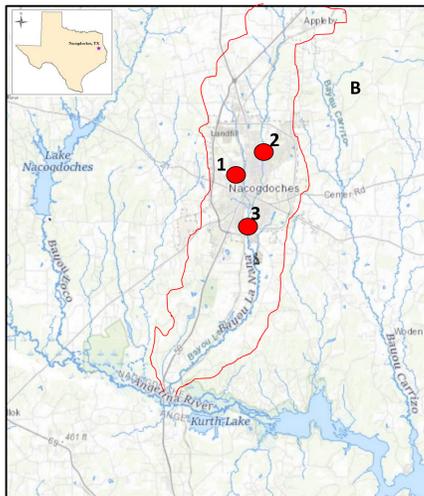


Figure 1A. Threatened species: Sabine shiner (5mm length) (Photo: Kevin Conway).

Figure 1B. Map showing the sampling sites within La Nana Creek (LNC) watershed in Nacogdoches County. Site 1 is located at Banita Creek and sites 2 (at HWY-7) and Site 3 (at HWY-224) are located over La Nana Creek. Sites run through the city of Nacogdoches, an urbanized watershed.

Methods

Surveys were conducted during four seasons: Fall 2020, Winter 2020, Spring and Summer 2021. A seine net was used to collect the fish.
- **Environmental conditions:** Habitat and water quality were assessed at each site. A multiparameter YSI-meter was used to measure water quality.
- **Population abundance** was estimated (number individuals/season) and body size of the individuals were measured.
- **Movements of the Sabine Shiner** within/among creeks was assessed using the Visible Implant Elastomer (VIE) tagging system.

Streams Environmental Assessment

There were significant differences in the environmental conditions between Banita and La Nana creeks (Fig. 2). Banita Creek upstream has less canopy cover, more gravel substrate, less soil exposure and lower turbidity compared to the site downstream and those from La Nana Creek. A PCA separated the sampling sites along two gradients, PCA-1 defined by local habitat conditions and PCA-2 defined by turbidity and nutrients in the water column (Fig. 2).

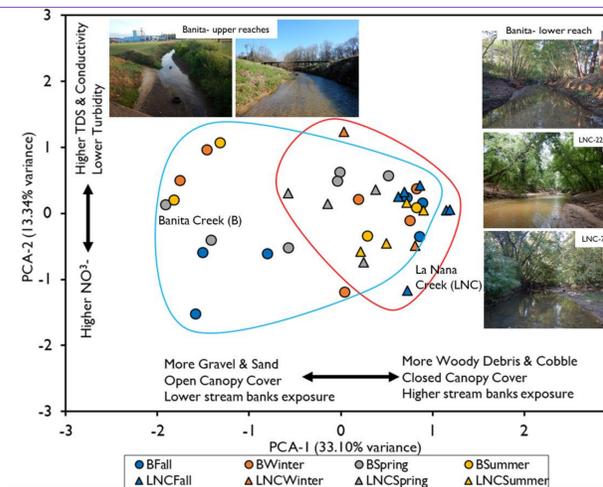


Figure 2. Principal component analysis (PCA) based on habitat variables measured across four seasons (Fall and Winter 2020; Spring and Summer 2021) Each dot represents a sampling event at each stream. PERMANOVA test: Stream identity: F: 5.01, P<0.0005 Seasons: Fall was significantly different from other seasons (P<0.002)

Population Status and Body size

312 individuals were reported over four seasons. This number is lower compared to Williams and Bonner's study (N= 1246) (Fig. 3). On average, body size of Sabine Shiner varied among seasons (Fig. 4), with larger individuals found in fall and summer seasons.

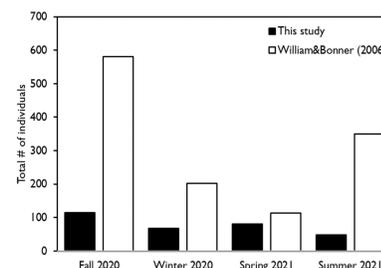


Figure 3. Comparison of Sabine shiner population abundance between surveys conducted by Williams & Bonner (2006) and results from this study (2020-2021).

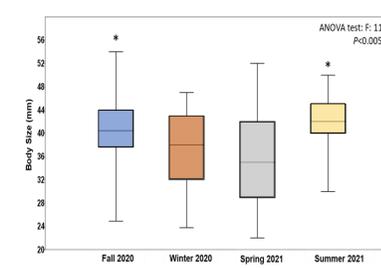


Figure 4. Boxplots of the mean and standard deviation of the body size (standard length, mm) of individuals of Sabine shiner collected across seasons in Banita and LNC. ANOVA: F=11.8, P<0.003

Results

Sabine Shiner & Stream Movements

A total of 160 Sabine shiners were tagged and released between Fall 2020 and Summer 2021 (Table 1). For Banita, 153 were tagged (Figure 5) with 76 individuals recaptured. In La Nana, only 7 individuals were tagged during summer 2021 at one location LNC-HWY-224 with no recaptures. Recaptures in Banita occurred within a stretch (<1.5 Km) of the stream where fish were collected, tagged and released.

Table 1. Seasonal tagging events (mark and recapture) of Sabine Shiner in Banita Creek and La Nana Creek (LNC).

Site	Season	Total collected	# Tagged	# Recaptured
Banita	Fall	115	57	54
Banita	Winter	81	36	19
Banita	Spring	68	40	3
Banita	Summer	41	20	0
LNC-224	Fall			
LNC-224	Winter	No specimens collected		
LNC-224	Spring			
LNC-224	Summer	7	7	0
LNC-7	Fall			
LNC-7	Winter	No specimens collected		
LNC-7	Spring			
LNC-7	Summer			

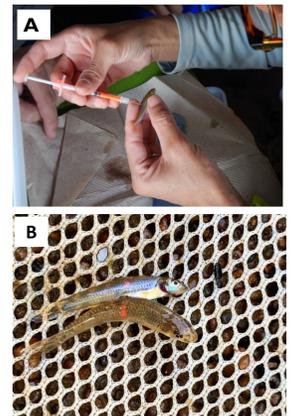


Figure 5. Photos depicting A) tagging the fish with VIE and B) recaptured individuals

Discussion

We did find Sabine shiner in both Banita and Nana creeks. However, our population abundance was lower compared to Williams and Bonner (2006), who reported stable and abundant populations in both creeks. Habitat assessment revealed significant differences between streams with most of the variance explained by substrate and water quality. Our tagging-recapture system suggests isolation of this fish within small stretches of Banita and La Nana creeks, where individuals are moving within short distances less than 1.5 km, in areas associated with running water and gravel substrate.

Conclusions

Populations of Sabine shiner showed significant decline in abundances in both Banita and La Nana creek compared to a previous survey in the same streams. Also, populations from each creek appear to be isolated. Our findings will have important contributions for continued habitat management and restoration of this species and other small minnows in east Texas that are considered SGCN by the State of Texas.

Acknowledgements

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References

- Williams, C.S. and T.H. Bonner: 2006. Habitat Associations, Life History and Diet of the Sabine Shiner *Notropis sabiniae* in an East Texas Drainage. *Am. Midl. Nat.*, 155:84-102.
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Zachary Hutchens
Department of Biology, Stephen F. Austin State University, Nacogdoches TX
zacharyhutchens2000@yahoo.com
(936)-553-0818