# Clean River Program
# Guadalupe Basin Steering Committee

## Assessment of spatial variation in community assemblages and population condition of ESA-proposed Guadalupe Orb (*Cyclonaias necki*) and False Spike (*Fusconaia mitchelli*) mussels in data limited portions of the Guadalupe and San Marcos Rivers

## March 15, 2023

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Aquatic Biologist
Guadalupe-Blanco River Authority

# GBRA Overview

- Created by State of Texas in 1933
- 10-County District
- Self-Supporting Operations
  - GBRA cannot levy or collect taxes, assessments, or pledge the general credit of the State of Texas.
  - Revenue is derived from different customers associated with:
    - Water Supply
    - Wastewater Services
    - Hydroelectric Power
    - Laboratory
    - Recreation
  - Combined, GBRA's water and wastewater operations serve over 350,000 individuals daily.

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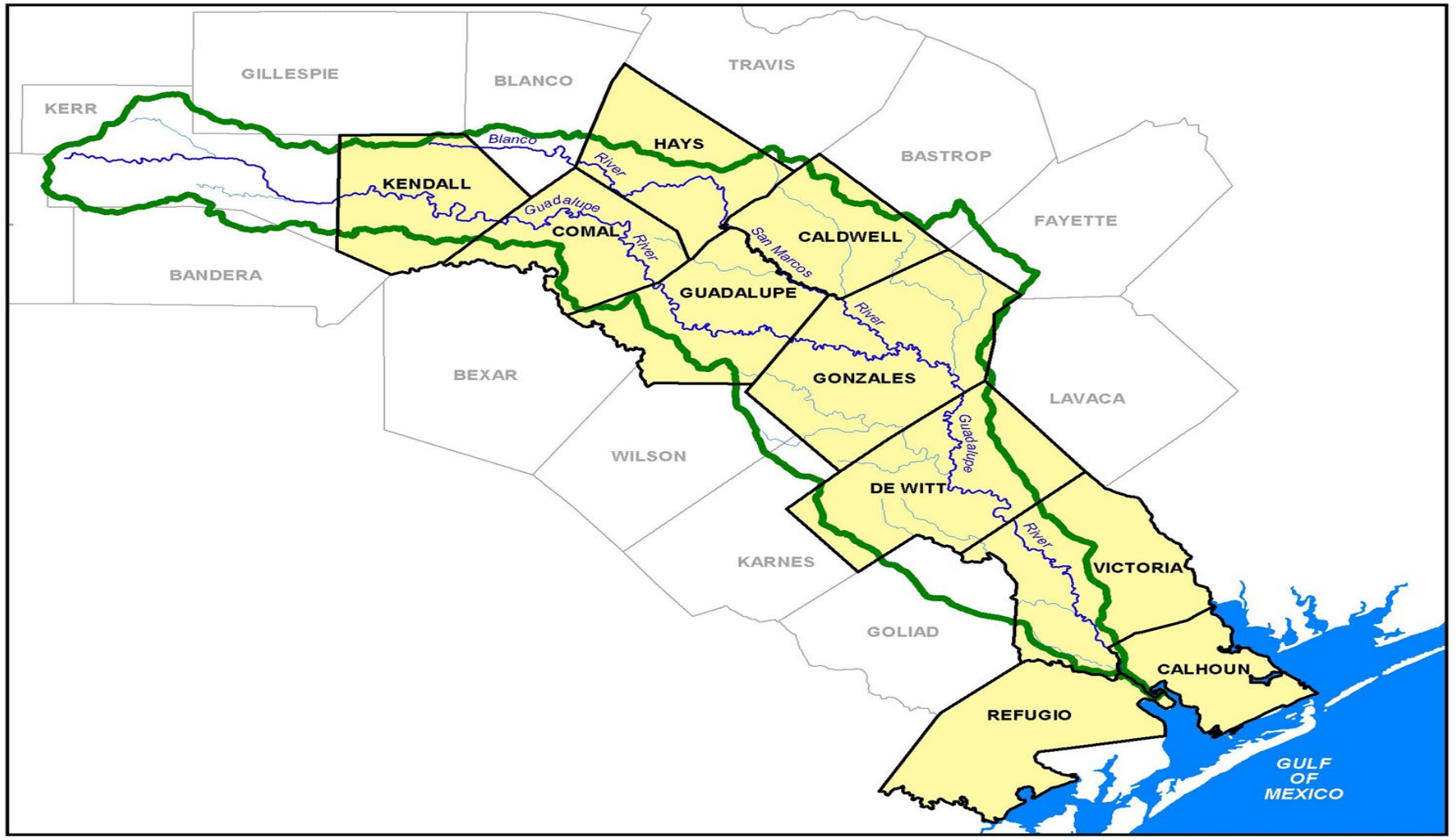
# GBRA Statutory District

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# Freshwater Mussels in Guadalupe River Basin

- ~24 mussel species in Guadalupe Basin (Randklev et al. 2020)
- 3 species proposed for ESA endangered status (USFWS 2021)

  - Guadalupe Orb (*Cyclonaias necki)*

  - Guadalupe Fatmucket (*Lampsilis bergmanni)*

  - False Spike (*Fusconaia mitchelli*)

- Large sections of basin have not been surveyed for mussels

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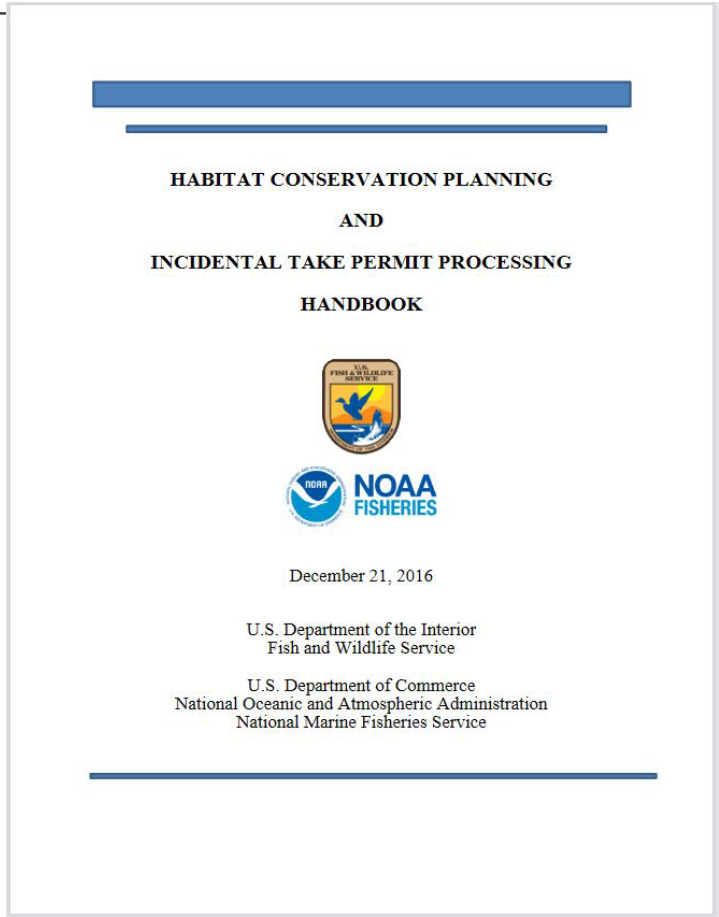
# Guadalupe River Basin Habitat Conservation Plan

- Reduce uncertainty of future water supply and wastewater treatment activities.
- Provide protections for rare species
- Ascertain operational impacts.
- Scheduled for completion in 2026



HABITAT CONSERVATION PLANNING

AND

INCIDENTAL TAKE PERMIT PROCESSING

HANDBOOK

NOAA FISHERIES

December 21, 2016

U.S. Department of the Interior
Fish and Wildlife Service

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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# Survey Goals

- Verify/confirm historical records
- Assess rare species population condition
- Assess spatial variation in assemblages
- Inform GBRA Habitat Conservation Plan


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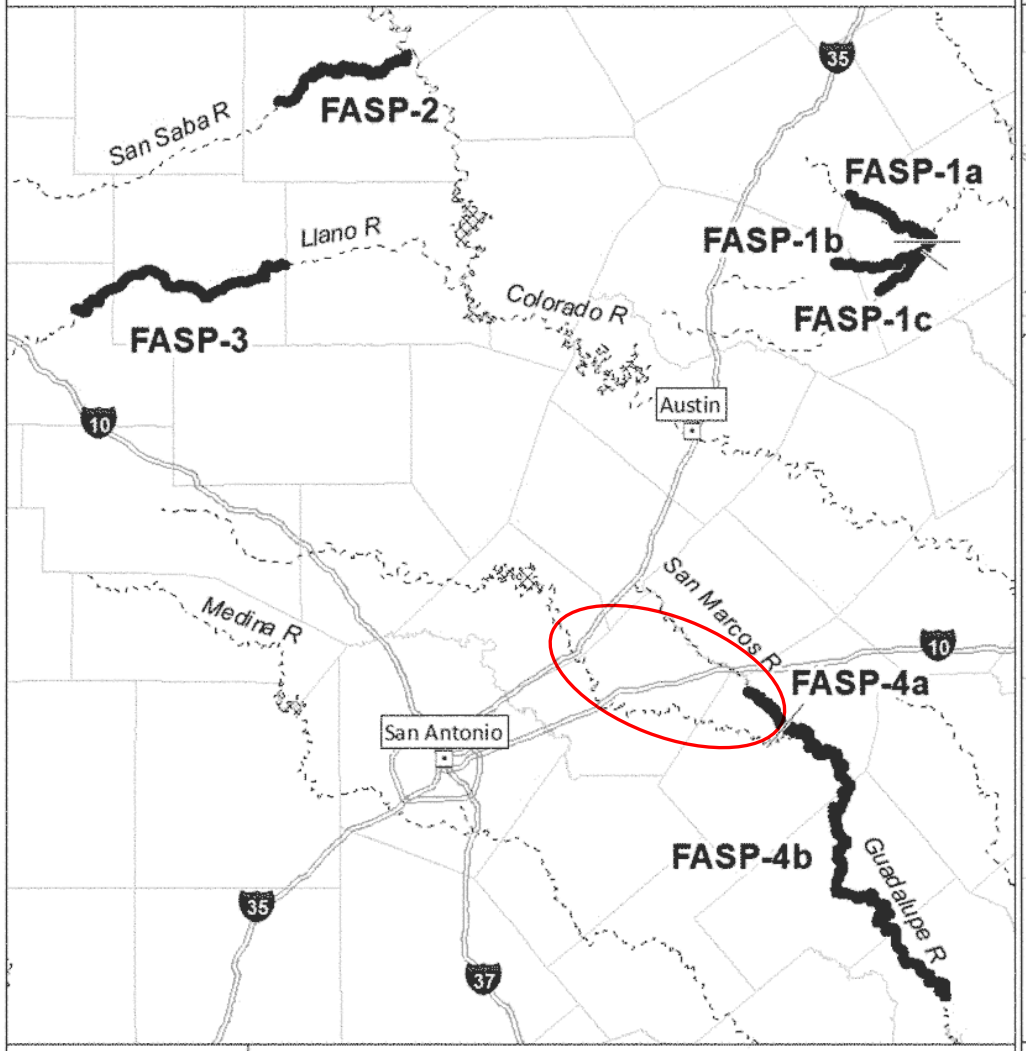
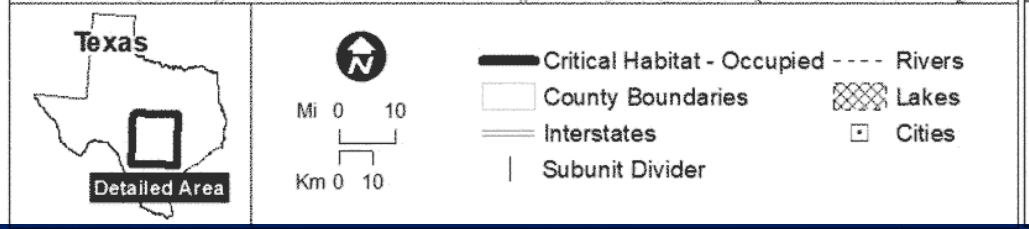
## Critical Habitat for False Spike - Unit Overview

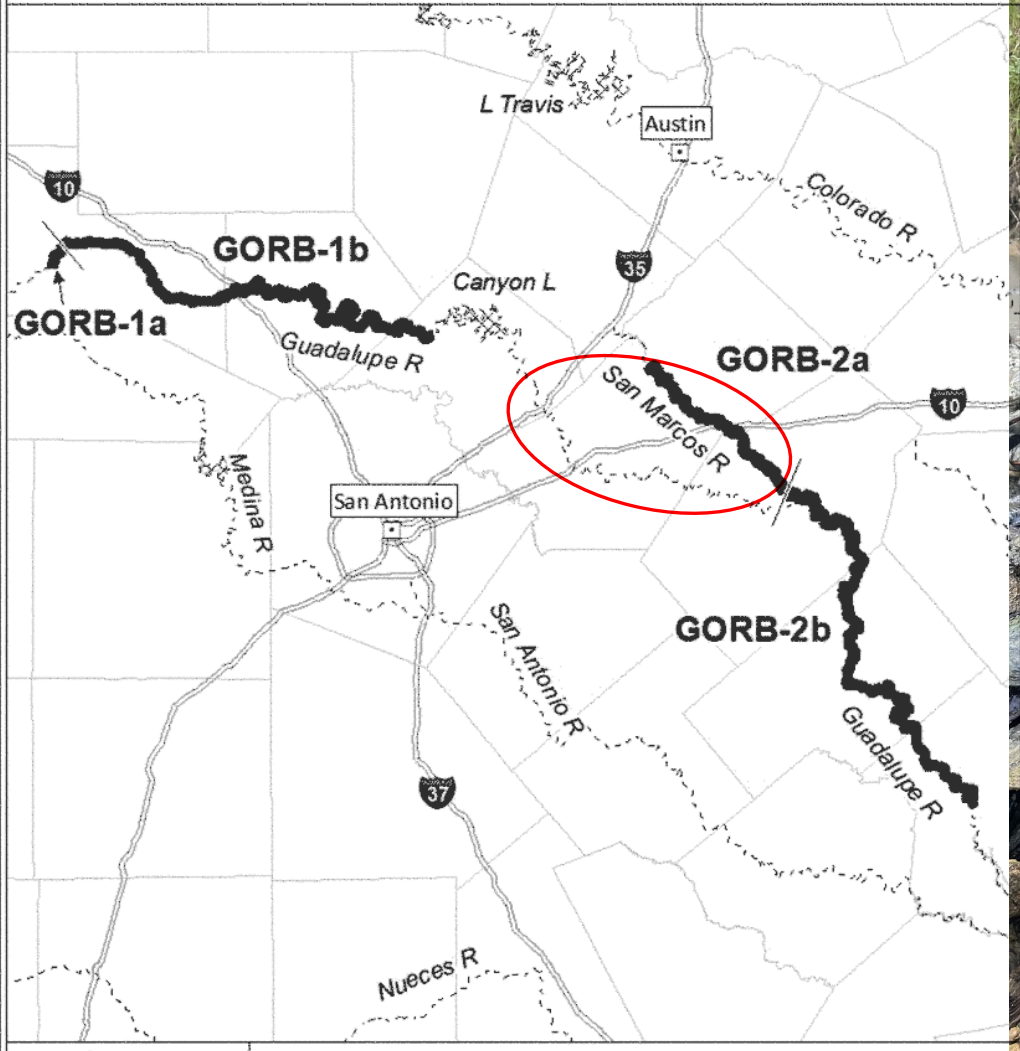



Mi 0 10
Km 0 10

- Critical Habitat - Occupied
- County Boundaries
- Interstates
- Subunit Divider
- Rivers
- Lakes
- Cities

## Critical Habitat for Guadalupe Orb - Unit Overview





Mi 0 10
Km 0 10

- Critical Habitat - Occupied
- County Boundaries
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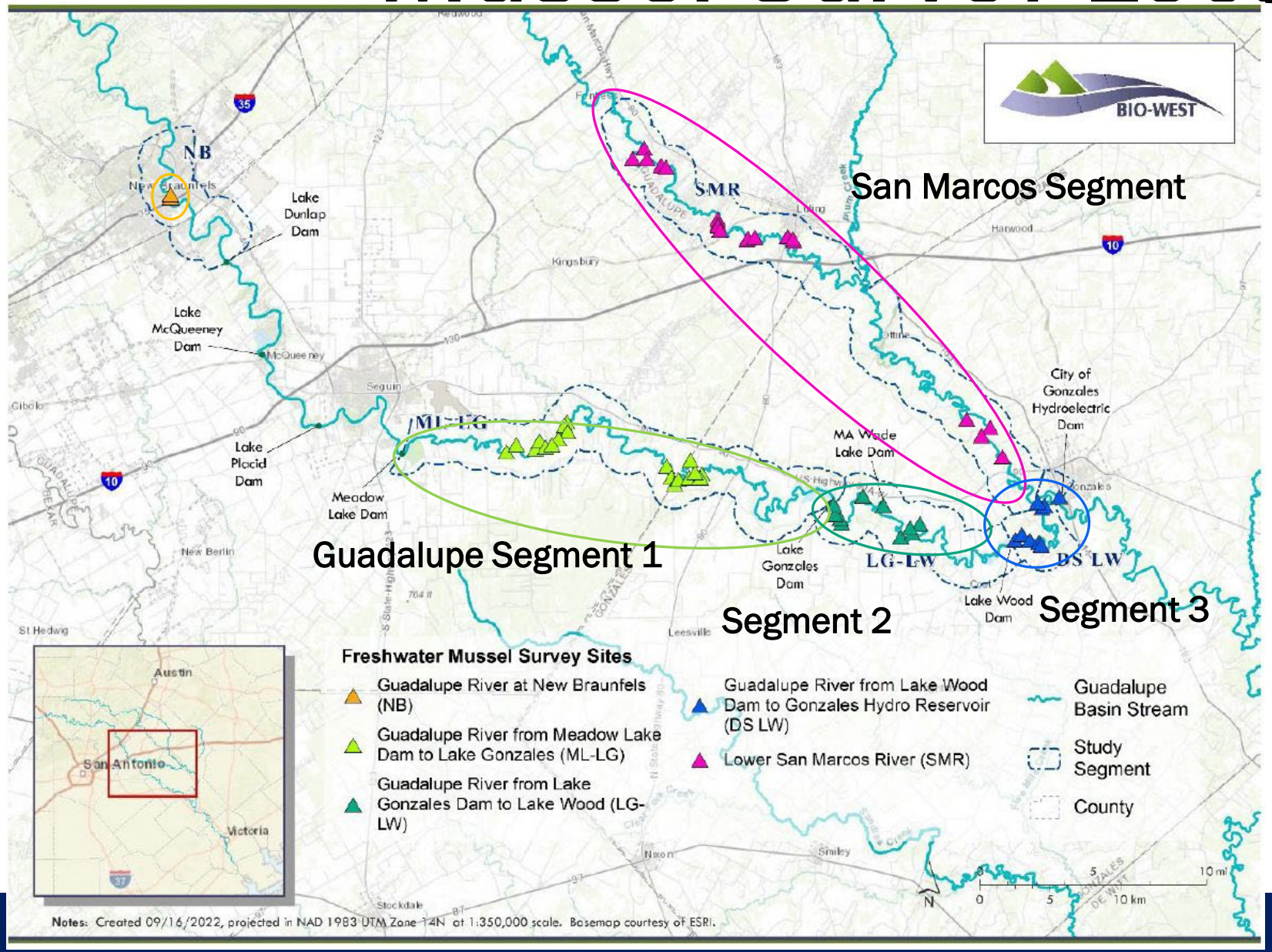
# Mussel Survey Locations




## 5 Study Segments

NB = Guadalupe at New Braunfels

Guadalupe Segment 1 (ML-LG) = Guadalupe from Meadow Lake to Lake Gonzales

Guadalupe Segment 2 (LG-LW) = Guadalupe from Lake Gonzales to Lake Wood

Guadalupe Segment 3 (DS LW) = Guadalupe from downstream of Lake Wood to City of Gonzales Hydro

San Marcos River Segment (SMR) = Lower San Marcos River

# Study Methodology

- 60 survey sites
- 55 wadeable (<1.5 meters)
  - 4 person hours (p-h) /site
- 5 non-wadeable (>1.5 meters)
  - 1 meter SCUBA transects perpendicular to flow
- Shell lengths (All rare & 20 per site other)
- Mesohabitat & Substrate recorded.
- Genetic tissue confirmation (UT Austin).

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# Analysis Methods

- New Braunfels Segment Excluded (n=2 Sites)
- Community composition summarized by segment
  - Species richness, species counts, total counts, & % relative abundance
- Kruskal-Wallis tests ($\alpha = 0.05$) of community trends between segments
  - Species richness, diversity (Shannon diversity index), & evenness
- Box-plots to visualize grouping trends

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# Analysis Methods Continued

## Assemblage Structure Analysis

- Species with <5% site occurrences omitted (Smith 2006).
- Bray-Curtis Dissimilarity Index to generate distance matrix between sites.
- MANOVA ($\alpha = 0.05$, permutations = 1000) assemblage structure differences
- NDMS to visualize differences in assemblage structure.

## Rare Mussel Population Demographics

- CPUE & Size Structure between segments
- %Relative abundance of sub-adult Guadalupe Orbs

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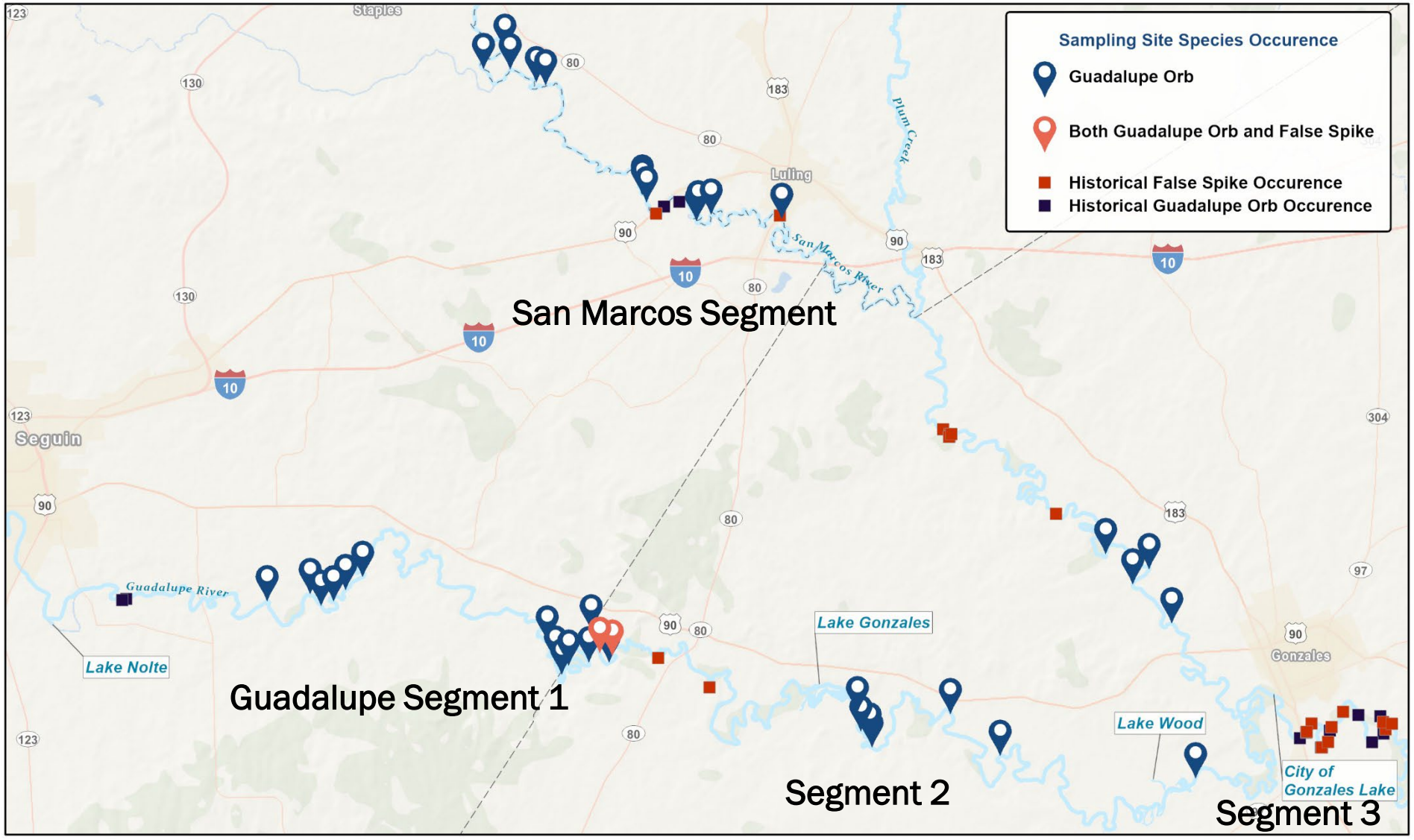
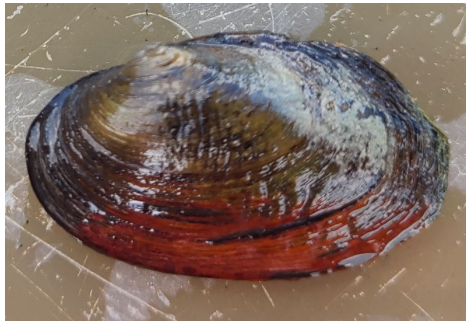
# Rare Mussel Species Findings




- 38 Sites with Guadalupe Orb (577 total)

- 2 Sites with False Spike (3 total)



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# Mussel Assemblage Community Composition

| Scientific Name | Common Name | ML-LG | | LG-LW | | DS LW | | SMR | |
|---|---|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % | # | % |
| *Amblema plicata* | Threeridge | 62 | 5.71 | 1787 | 76.79 | 7376 | 93.26 | 555 | 32.76 |
| *Arcidens confragosus* | Rock Pocketbook | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 1 | 0.06 |
| *Cyclonaias necki* | Guadalupe Orb | 183 | 16.87 | 27 | 1.16 | 1 | 0.01 | 366 | 21.61 |
| *Cyclonaias pustulosa* | Pimpleback | 695 | 64.06 | 97 | 4.17 | 39 | 0.49 | 433 | 25.56 |
| *Cyrtonaias tampicoensis* | Tampico Pearlymussel | 3 | 0.28 | 52 | 2.23 | 162 | 2.05 | 2 | 0.12 |
| *Fusconaia mitchelli* | False Spike | 3 | 0.28 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| *Lampsilis hydiana* | Louisiana Fatmucket | 1 | 0.09 | 2 | 0.09 | 4 | 0.05 | 2 | 0.12 |
| *Lampsilis teres* | Yellow Sandshell | 16 | 1.47 | 36 | 1.55 | 16 | 0.20 | 13 | 0.77 |
| *Megalonaias nervosa* | Washboard | 48 | 4.42 | 286 | 12.29 | 307 | 3.88 | 206 | 12.16 |
| *Pyganodon grandis* | Giant Floater | 0 | 0.00 | 2 | 0.09 | 0 | 0.00 | 0 | 0.00 |
| *Toxolasma texasiense* | Texas Lilliput | 0 | 0.00 | 0 | 0.00 | 1 | 0.01 | 0 | 0.00 |
| *Tritogonia verrucosa* | Pistolgrip | 74 | 6.82 | 38 | 1.63 | 3 | 0.04 | 116 | 6.85 |
| | **Total Sites** | 19 | | 11 | | 9 | | 19 | |
| | **Total Person-hours** | 76.00 | | 44.00 | | 24.10 | | 73.60 | |
| | **Species Richness** | 9 | | 9 | | 9 | | 9 | |
| | **Total Counts** | 1085 | | 2327 | | 7909 | | 1694 | |

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Table comparing counts (#) and relative abundance (%) of freshwater mussel assemblages in 4 segments.

# Mussel Assemblage Community Composition

| Scientific Name | Common Name |
|---|---|
| *Amblema plicata* | Threeridge |
| *Arcidens confragosus* | Rock Pocketbook |
| *Cyclonaias necki* | Guadalupe Orb |
| *Cyclonaias pustulosa* | Pimpleback |
| *Cyrtonaias tampicoensis* | Tampico Pearlymussel |
| *Fusconaia mitchelli* | False Spike |
| *Lampsilis hydiana* | Louisiana Fatmucket |
| *Lampsilis teres* | Yellow Sandshell |
| *Megalonaias nervosa* | Washboard |
| *Pyganodon grandis* | Giant Floater |
| *Toxolasma texasiense* | Texas Lilliput |
| *Tritogonia verrucosa* | Pistolgrip |

- **13,015** mussels from **12 species** observed over **218 p-h** across 60 sites.
- **Guadalupe Orb found in all 4 study segments.**
- **Guadalupe Orb Relative Abundance (4.43%)**
- Guadalupe Segment 1: **Guadalupe Orb (16.87%)**
- Guadalupe Segment 2: **Guadalupe Orb (1.16%)**
- Guadalupe Segment 3: **Guadalupe Orb (0.01%)**
- SMR (San Marcos River): **Guadalupe Orb (21.61%)**

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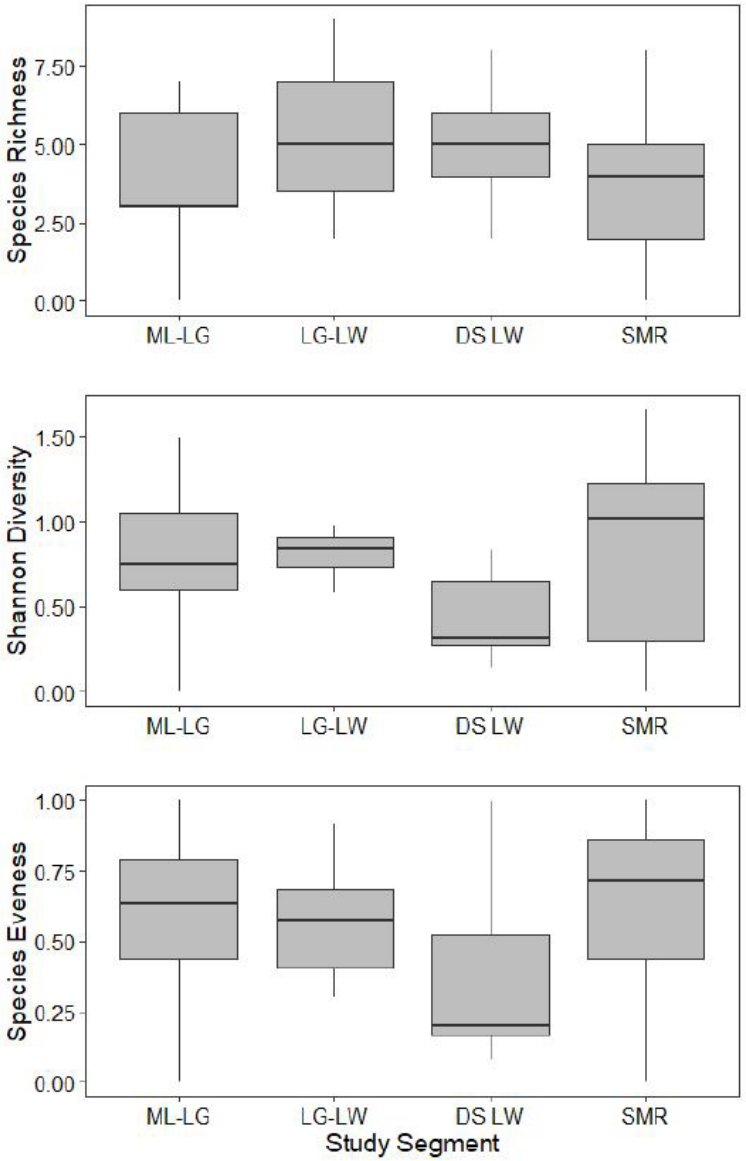
# Mussel Community Trends




Kruskal-Wallis tests ($\alpha = 0.05$)

Species Richness ($\chi_2 = 5.66$, $p = 0.13$)

Shannon Diversity Index ($\chi_2 = 6.98$, $p = 0.07$)

Species Evenness ($\chi_2 = 2.94$, $p = 0.40$).

**No significant variation.**

San Marcos Segment had higher Diversity & Species Evenness

Guadalupe Segment 3 had lower  Diversity & Species Evenness.

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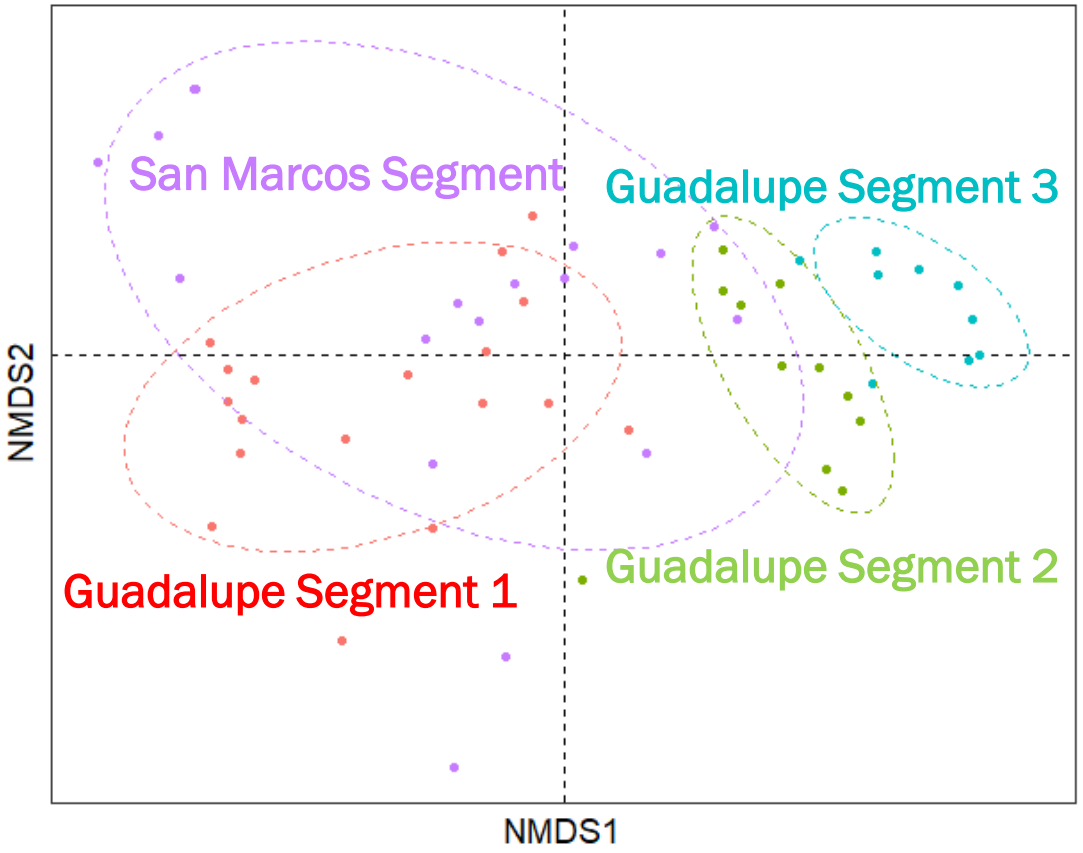
# Multidimensional Scaling Analysis of Assemblage Structure




- Analyzed 8 species at 56 sites
- MANOVA (α = 0.05, permutations = 1000)
- River segments differences detected (SS = 4.84, F = 11.64, p<0.001)
- NDMS analysis stress value = 0.13
- <20 stress value is adequate (Quinn & Keough 2022)
- Dashed Ellipses represent 80% confidence intervals
- Upstream Segments had highest variation
- Downstream Segments 2 & 3 most similar

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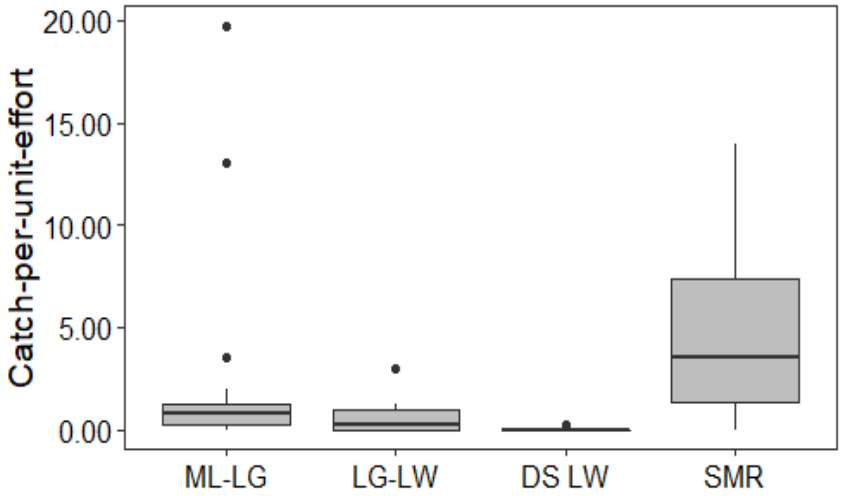
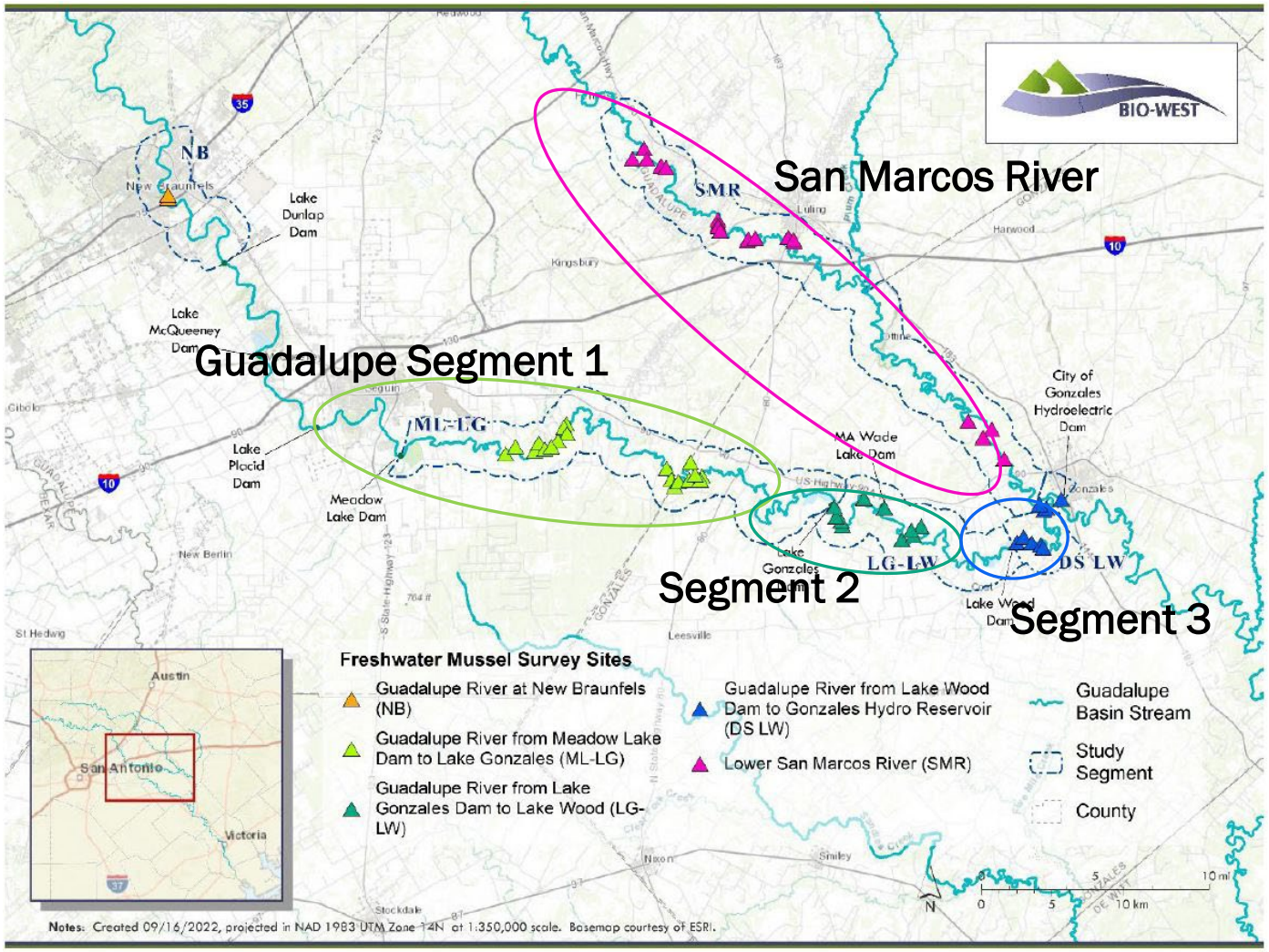
Biplot displaying ordination axes of nonparametric multidimensional scaling analysis for freshwater mussel assemblages in 4 segments.

# Guadalupe Orb Abundance




- Kruskal-Wallis tests supported differences in CPUE ($\chi^2$ = 21.25, p<0.001
- Guadalupe Orb observed at 38 of 60 sites (63.33%); most frequent in SMR (84.21%), ML-LG (78.95%), & LG-LW (53.55%).
- Least frequent in LW DS (11.11%)
- Abundance highest in SMR (3.50 m/p-h)

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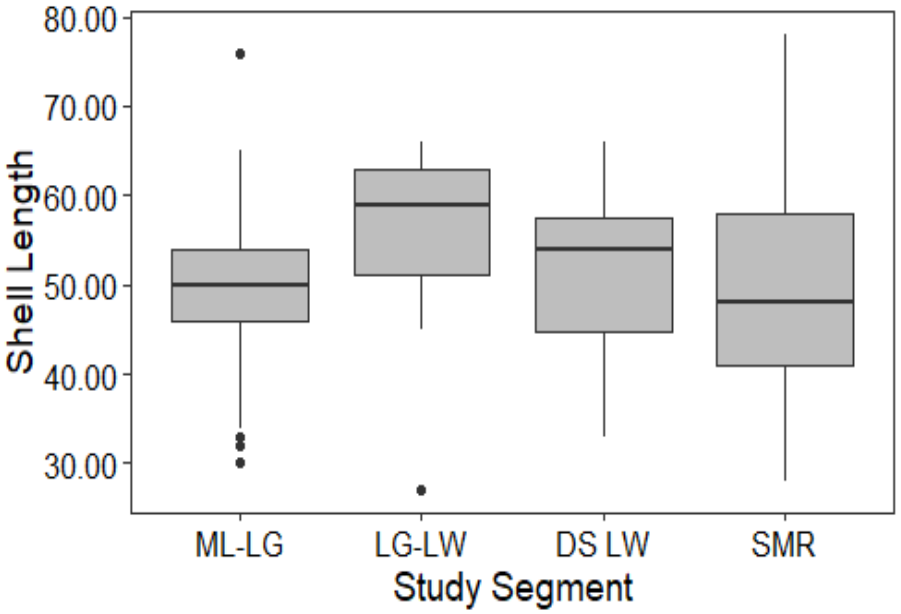
# Guadalupe Orb Size Structure




- Kruskal-Wallis tests supported differences in Shell Length ($\chi_2$ = 18.70, p<0.001)

- Median shell lengths lower in San Marcos River
  - San Marcos Segment (48mm)
  - Guadalupe Segment 1 (50mm)
  - Guadalupe Segment 2 (59 mm)
  - Guadalupe Segment 3 (54 mm)

- Sub-adults (<36mm) more frequent in San Marcos River Segment
  - San Marcos Segment (n=27, 7.99%),
  - Guadalupe Segment 1 (n=6, 3.63%),
  - Guadalupe Segment 2 (n=1, 4.35%),
  - Guadalupe Segment 3 (n = 1, 3.57%)

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# Conclusions

- **Guadalupe Orb populations appear to be healthier than previously documented.**
  - Significant spatial variation in abundance and shell lengths.
  - Evidence of subadult recruitment.

- **More distribution and abundance data needed.**

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# Questions?

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