Central Texas Mussels:
The animal inside the shell

US Fish and Wildlife Service
Texas Parks and Wildlife
Texas Comptroller
November 1, 2017
What are freshwater mussels?

• Bivalve (two shells) invertebrates that filter feed on algae, detritus, and phytoplankton
• Ancient family *Unionidae* that evolved from marine ancestors
• Fossil records show North American appearance in the Devonian period (416-365 million years ago)
Mussel Life Cycle

• Unique life history, including parasitic juvenile life stage
• Fish host generalist or specialist depending on mussel species
• Host fish movements affect mussel recruitment and distribution
Why are mussels important?

• Mussels are a part of the base of the “food pyramid”
• Mussels provide a food resource (not only for humans)
• Mussels provide ecological services that provide economic value
• Mussels are indicators of ecosystem health
Mussel Diversity

- North America contains more species of mussels than any other continent! Alabama is the “Amazon” of mussels
- 298 recognized species (in North America alone) occur in every continent except Antarctica
- ~52 species occur in Texas

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of taxa</th>
</tr>
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<tbody>
<tr>
<td>Nearctic</td>
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<td>Mississippi River basin</td>
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<td>Gulf Coast drainages</td>
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<td>India–Burma</td>
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<tr>
<td>Australasia</td>
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</table>

Figure: Haag, 2012
Table 3.1. Worldwide diversity of freshwater mussels (Order Unionoida)
Mussels in Peril

- Nearly 300 recognized species in North America alone
- Southeast USA is the global biodiversity hotspot for freshwater mussels
- Over 72% of the 300 species have state or federal T&E protection

Stein et al. 2000
Habitat Requirements

Varies by Species**

- Suitable Substrate
- Water Quality
- Water Quantity
- Host fish(es)
- Food availability
Altered hydrology affects freshwater mussels

- Two types of dam
  - Hypolimnetic – large dams with bottom release
  - Epolimnetic – small dams (<10m) top release

Photo: Mike Perkins
Water quality affects freshwater mussels

- Nutrient and sediment loading
- High water temperatures
- Low dissolved oxygen
- Contaminants

Other threats to native mussel populations include:
- Changes in land cover and land use
- Interactions with invasive species
- Loss of fish hosts
- Extreme climate events
Texas Freshwater Mussels

• Fifteen mussel species are considered state-threatened by the Texas Parks and Wildlife Department (TPWD).
Threatened Freshwater Mussels (Bivalvia: Unionidae) of Texas

- Pusconaia askewi
  - Texas Pigtoe
  - TFWD-Threatened

- Pusconaia lanariscens
  - Triangle Pigtoe
  - TFWD-Threatened

- Lampsis braeacta
  - Texas Fatmucket
  - TFWD-Threatened
  - ESA-Candidate

- Lampsis satura
  - Sandbank Pocketbook
  - TFWD-Threatened

- Obovaria jacksoniana
  - Southern Hickorynut
  - TFWD-Threatened

- Fleurobeta riddelli
  - Louisiana Pigtoe
  - TFWD-Threatened

- Poponaias popei
  - Texas Hornshell
  - TFWD-Threatened
  - ESA-Candidate

- Potamilus amphichlaenus
  - Texas Heelsplitter
  - TFWD-Threatened
  - ESA-Candidate

- Potamilus meteckayi
  - Salina Mucket
  - TFWD-Threatened

- Quadrula aurea
  - Golden Orb
  - TFWD-Threatened
  - ESA-Candidate

- Quadrula houstonensis
  - Smooth Pimpleback
  - TFWD-Threatened
  - ESA-Candidate

- Quadrula antillarum
  - False Spike
  - TFWD-Threatened

- Quadrula petrina
  - Texas Pimpleback
  - TFWD-Threatened
  - ESA-Candidate

- Truncilla cognata
  - Mexican Fawnsfoot
  - TFWD-Threatened

- Truncilla macrodon
  - Texas Fawnsfoot
  - TFWD-Threatened
  - ESA-Candidate

Production of this poster was generously supported by the Texas Department of Transportation and Texas Parks and Wildlife. All photography and poster layout by Charles Randilev, IRNR, Texas A&M University.

Free poster copies are available to educational, state, or federal management agency personnel. For posters or information email: Charles Randilev, PhD
crandilev@ag.tamu.edu
Texas Freshwater Mussels

• Fifteen mussel species are considered state-threatened by the Texas Parks and Wildlife Department (TPWD).

• Twelve of these 15 are currently being considered, or have been proposed, for listing under the Endangered Species Act (ESA).
Threatened Freshwater Mussels (Bivalvia: Unionidae) of Texas

- *Pusconaia askewi* Texas Pigtoe TFWD-Threatened
- *Pusconaia lancensisa* Triangle Pigtoe TFWD-Threatened
- *Lampsilis bracteata* Texas Fatmucket TPWD-Threatened ESA-Candidate
- *Lampsilis satura* Sandbank Pocketbook TPWD-Threatened
- *Obovaria jacksoniana* Southern Hickorynut TPWD-Threatened

- *Plecostoma riddellii* Louisiana Pigtoe TFWD-Threatened
- *Popenaias popeii* Texas Hornshell TPWD-Threatened ESA-Candidate
- *Potamilus amphiphloea* Texas Heelsplitter TPWD-Threatened
- *Potamilus metnekophi* Salina Mucket TPWD-Threatened
- *Candona aurea* Golden Orb TPWD-Threatened ESA-Candidate

- *Quadrula houstonensis* Smooth Pimpleback TFWD-Threatened ESA-Candidate
- *Quadrula mitchelli* False Spike TFWD-Threatened
- *Quadrula petrina* Texas Pimpleback TPWD-Threatened ESA-Candidate
- *Truncilla cohnina* Mexican Fawnfoot TPWD-Threatened
- *Truncilla macrodon* Texas Fawnfoot TPWD-Threatened ESA-Candidate

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Texas Freshwater Mussels

- Fifteen mussel species are considered state-threatened by the Texas Parks and Wildlife Department (TPWD).
- Twelve of these 15 are currently proposed for listing under the Endangered Species Act (ESA).
- Six species are considered candidates for federal Endangered Species Act (ESA) protections by the U.S. Fish and Wildlife Service (Service).
- Candidate means that a 12-month finding recommended T or E, but no listing rule has been proposed (warranted but precluded).
Threatened Freshwater Mussels (Bivalvia: Unionidae) of Texas

- *Pusconaia askewii*: Texas Pigtoe
  - TFWD-Threatened
- *Pusconaia lancensia*: Triangle Pigtoe
  - TFWD-Threatened
- *Lampsilis braecta*: Texas Fatmuck et
  - TFWD-Threatened
  - ESA-Candidate
- *Lampsilis satura*: Sandbank Pocketbook
  - TFWD-Threatened
- *Obovaria jacksoniana*: Southern Hickorynut
  - TFWD-Threatened
- *Pleonoma mridella*: Louisiana Pigtoe
  - TFWD-Threatened
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- *Potamillus amphicheaenus*: Texas Heelsplitter
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  - ESA-Candidate

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USFWS Evaluation Time Table

- FY 2018 – Central Texas Mussels
  - False spike, Texas fatmucket, Texas pimpleback, and Texas fawnsfoot

- FY 2019 – East Texas Mussels
  - Louisiana pigtoe, triangle pigtoe, Texas heelsplitter

- FY 2020 – Texas Quadrula
  - Golden orb and Smooth pimpleback

- FY 2022 – Rio Grande Mussels
  - Mexican fawnsfoot and Salina mucket
Central Texas Mussels (FY18)

• Texas fatmucket, *Lampsilis bracteata*
• Texas pimpleback, *Quadrula petrina*
• False spike, *Fusconaia mitchelli*
• Texas fawnsfoot, *Truncilla macrodon*
Central Texas Mussels: River Basins of Interest

- **Brazos River**
  - (Upper and Lower)
  - Clear Fork
  - Navasota River
  - Little River
- **Colorado River**
  - (Upper and Lower)
  - Concho River
  - San Saba River
  - Llano River
  - Pedernales River
  - Onion Creek
- **Guadalupe River**
  - (Upper and Lower)
  - San Marcos River
Texas fatmucket, *Lampsilis bracteata*

- Found in bank and pool habitats (Randklev et al., 2017)
- Typically occurs in soft silty substrates
  - Silt deposits in solid bedrock cracks
  - Silt deposits in pool/bank habitats
- Host: bluegill, green sunfish, bass

Photo credit: MUSSELp

Photo credit: FWS
Conservation Map – Texas fatmucket (*Lampsilis bracteata*)

From Randklev et al. 2017
Freshwater Mussels Central and West Texas Final Report (to CPA)
Texas pimpleback, *Quadrula petrina*

- Found in riffle, pool and pool/run habitats; washed into “depositional pools”
- Typically occurs on gravel/cobble substrates
- Host: channel catfish

Could be two taxa; proposed phylogeny includes *Cyclonaias*; *Cyclonaias* has priority; *Cylconaias petrina* and *C. sp. cf. petrina*; (Randklev et al., 2017 – Task 4 p 272-296)
Conservation Map – Texas pimpleback (*Quadrula petrina*)

From Randklev et al. 2017
Freshwater Mussels Central and West Texas Final Report (to CPA)
False spike, *Fusconaia mitchellii*

- Riffle and pool habitats (Randklev et al., 2017)
- Primarily found in gravel/cobble substrates
- Host: red shiner, blacktail shiner

Was previously thought to have been extirpated before being discovered in the Guadalupe River near Gonzales in October 2011 (Randklev et al. 2012) and from fresh dead in the San Saba River summer 2011 (Randklev et al. 2013)
Conservation Map – false spike (*Fusconaia mitchelli*)

From Randklev et al. 2017
Freshwater Mussels Central and West Texas Final Report (to CPA)
Texas fawnsfoot, *Truncilla macrodon*

- Bank habitats and occasional backwaters (Randklev et al., 2016)
- Mostly sandy substrates
- Presumed fish host is freshwater drum

Photo credit: FWS

Photo credit: MUSSELP
Conservation Map – Texas fawnsfoot (*Truncilla macrodon*)

From Randklev et al. 2017

*Freshwater Mussels Central and West Texas Final Report (to CPA)*
Species Research Program

- Legislative funding for scientific research on federally petitioned or listed species that are found in Texas
- CPA identifies priority species based on the immediacy of U.S Fish and Wildlife Service (FWS) listing decisions (for petitioned species), gaps in scientific knowledge and potential economic impacts
- Research projects are designed to inform FWS species status assessment process
- CPA facilitates informal stakeholder work group meetings to provide updates on research efforts and FWS listing process
Funded Research Projects

- Aquatics in Delaware River
- Black Rail
- Blue Head Shiner
- Desert Massasauga
- Freshwater Mussels
- Louisiana Pine Snake
- Monarch Butterfly
- Plains Spotted Skunk
- Prairie Chub
- Spot-tailed Earless Lizard
- Sprague's Pipit
- Texas Kangaroo Rat
- Western Chicken Turtle
Central Texas Freshwater Mussels

- FWS determined the decline of mussels in Texas and throughout the U.S. is mainly due to **habitat loss and degradation** primarily caused by:
  - Impoundments
  - Sedimentation
  - Dewatering
  - Sand and gravel mining
  - Chemical contaminants

- Additional factors: nonnative species, inadequacy of existing regulatory mechanisms, climate change
Central Texas Freshwater Mussel Research
by Texas State University, Auburn University, Biowest, and FWS

• Population surveys
  • Brazos River
  • Colorado River
  • Guadalupe River

• Assess species’ response to threats identified by FWS
  • Temperature
  • Ammonia
  • Sedimentation
  • Salinity

• Long-term captive propagation study

• Final reports: February 2018 and February 2020
Freshwater Mussel Work Group

• Starting in 2015, CPA has held regular public meetings to provide information for interested stakeholders
  o FWS updates on species status assessment process
  o Presentations by CPA-funded researchers
  o Updates on research funded by other agencies
  o Educational presentations on species and habitat

• Webinar in Feb. 2018: Presentations on final TSU research report
<table>
<thead>
<tr>
<th>Decision Elements</th>
<th>Risk Profile – Analysis</th>
<th>Risk Tolerance – Policy</th>
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</thead>
<tbody>
<tr>
<td>Process</td>
<td>SSA Framework</td>
<td>ESA Decision Making</td>
</tr>
<tr>
<td>Who</td>
<td>Team of Biologists</td>
<td>Decision Makers (FWS Management)</td>
</tr>
<tr>
<td>How</td>
<td>SSA Framework (Scientific Analysis of Biological Information)</td>
<td>Policy Judgment (Societal Values)</td>
</tr>
<tr>
<td>When</td>
<td>Throughout the SSA Analysis</td>
<td>AFTER the SSA Analysis</td>
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<tr>
<td>Outcome</td>
<td>Characterization of Viability</td>
<td>ESA Decision (Interpret the policy and apply the science)</td>
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Species Status Assessment informs all ESA Decisions

- Section 7 Decisions
- Section 10 Decisions
- Candidate Conservation Decisions
- T/E or Not Warranted Decisions
- 5yr Review Decisions
- Candidate Assessment Decisions
- List/Delist Decisions
- Critical Habitat Decisions
- Recovery Planning Decisions
SSA Framework

• Species Needs (taxonomy, life history, habitat, etc.)
• Species Current Condition (range, numbers, trend, etc.)
• Species Future Condition (ability to sustain populations in the wild)

• Individuals → Populations → Species

Habitat

Demographics
Population Resilience
Species Viability
Voluntary Habitat Restoration on Private Lands in Texas
Safe Harbor Agreement (SHA)

- For listed species
- For non-Federal lands
- Provides incidental take coverage for actions consistent with the Agreement
- Standard is a “net conservation benefit”
- Establishes a baseline that can be “returned to” at the end of the agreement (usu. 30-y)
Candidate Conservation Agreement (CCA)

• For not listed species
• Primarily with Federal Agencies, for federal lands, and States
• Identifies appropriate conservation actions designed to “remove or reduce threats”
• No Enhancement of Survival permit authorizing incidental take (no assurances)
• Federal agencies have special obligations for the conservation of listed species, as specified in section 7(a)(1) of the ESA
• Center of Excellence (CEHMM), Texas hornshell Oct 2017

Photo: Texas hornshell by Joel Lusk, FWS
Candidate Conservation Agreement with Assurances (CCAA)

- For not listed species
- For non-federal lands
- Can be paired with a CCA
- Encourages implementation of specific conservation measures
- Provides assurances for private landowners with a 10(a)(1)(A) Enhancement of Survival permit that authorizes incidental take if the species is later listed (regulatory certainty)
- **Standard is “net conservation benefit”**
Working Lands for Wildlife

- For listed species and candidates
- For federal actions (Farm Bill) on private lands
- Requires a programmatic Sec 7 Consultation and Formal Biological Opinion or Conference Opinion
- Providing “regulatory predictability” and exemption from “incidental take” for participating producers
Table 1. Target at-risk freshwater mussel species known to occur historically in the Colorado River basin of Texas. Updated by USFWS from:
Freshwater Mussel Propagation

1. Collecting freshwater mussel brood stock
2. Checking gravidity
3. Extracting glochidia
4. Host fish in infestation bath
5. Adding glochidia to infestation bath
6. Host fish exposed to glochidia
7. Glochidia attaching to fish gills
8. Close up of glochidia attaching to fish gill filaments
9. Maintaining fish while glochidia metamorphose into juveniles
10. Collecting newly metamorphosed juvenile mussels from the fish tank
11. Example indoor system for mussel culture
12. Example outdoor system for mussel culture
13. Tagged mussels for release
14. Releasing juveniles back to the wild
Mussel Propagation

- San Marcos Aquatic Resource Center
- Inks Dam National Fish Hatchery
- Uvalde National Fish Hatchery
Texas Freshwater Mussel Conservation and Stakeholder Summit

Hosted by the

Southwest Region of the U.S. Fish and Wildlife Service, Texas Parks and Wildlife Department, and the Office of the Texas Comptroller of Public Accounts

November 14-15, 2017

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Questions?