Photo Credit: RG Howells

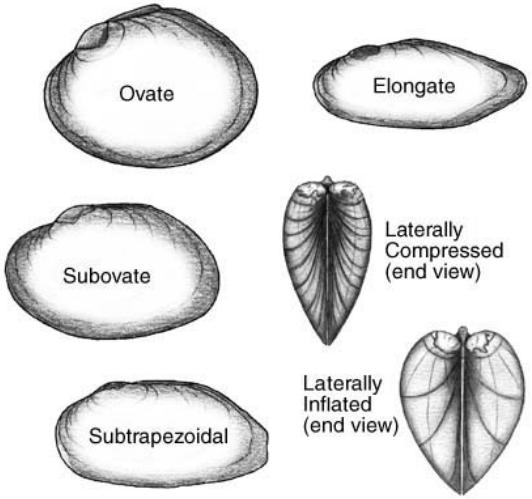
Central Texas Mussels: The animal inside the shell

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)

Photo - D. Strayer



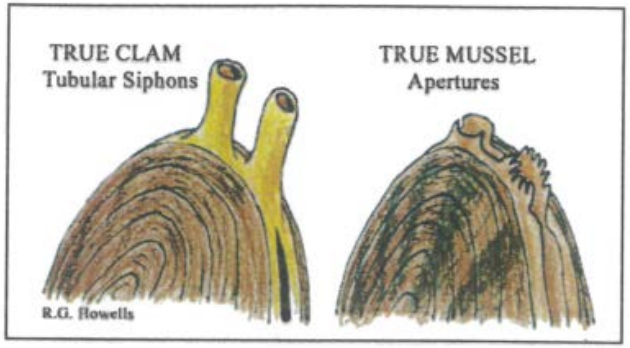
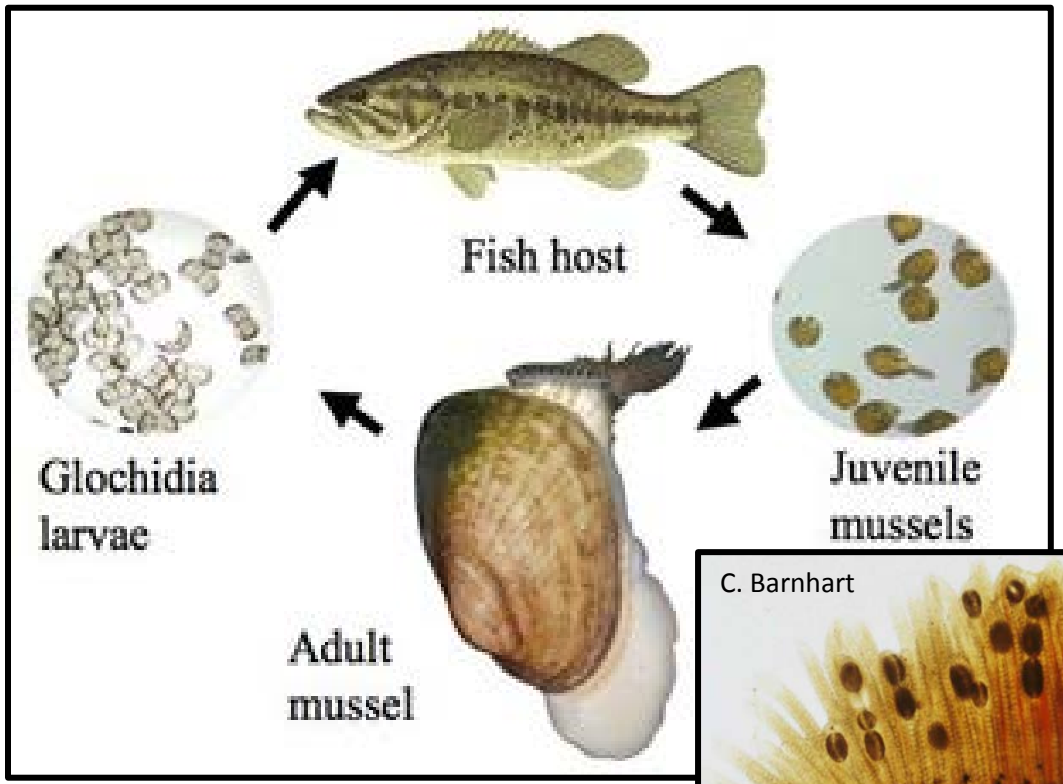


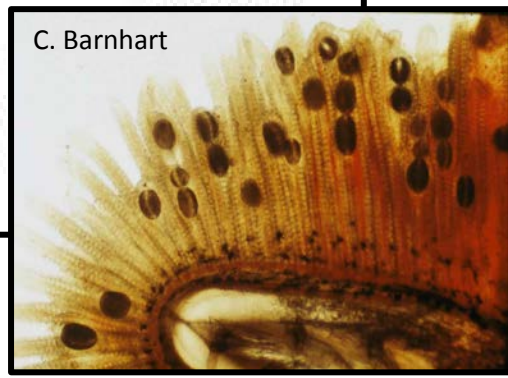
Photo – R. Howells

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

G. Pandolfi - FWS

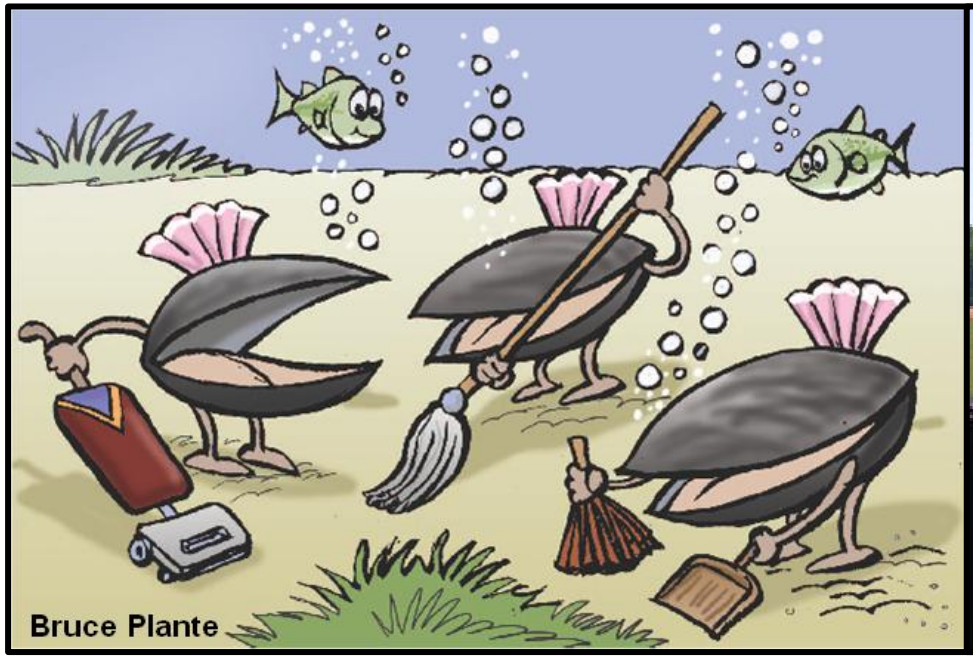


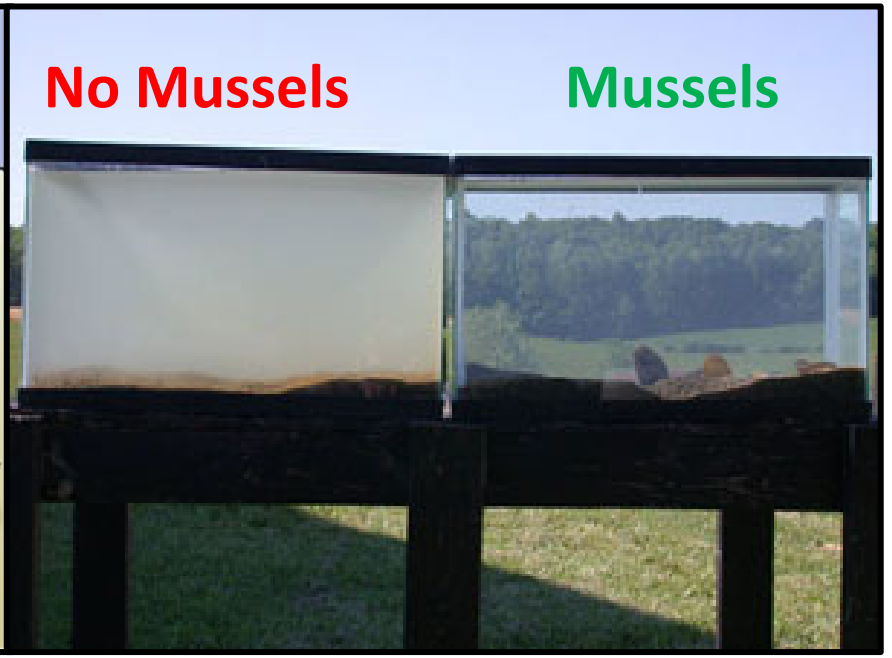


C. Barnhart

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

Photo’s: G. Pandolfi-FWS and Mark Fisher-TxDOT

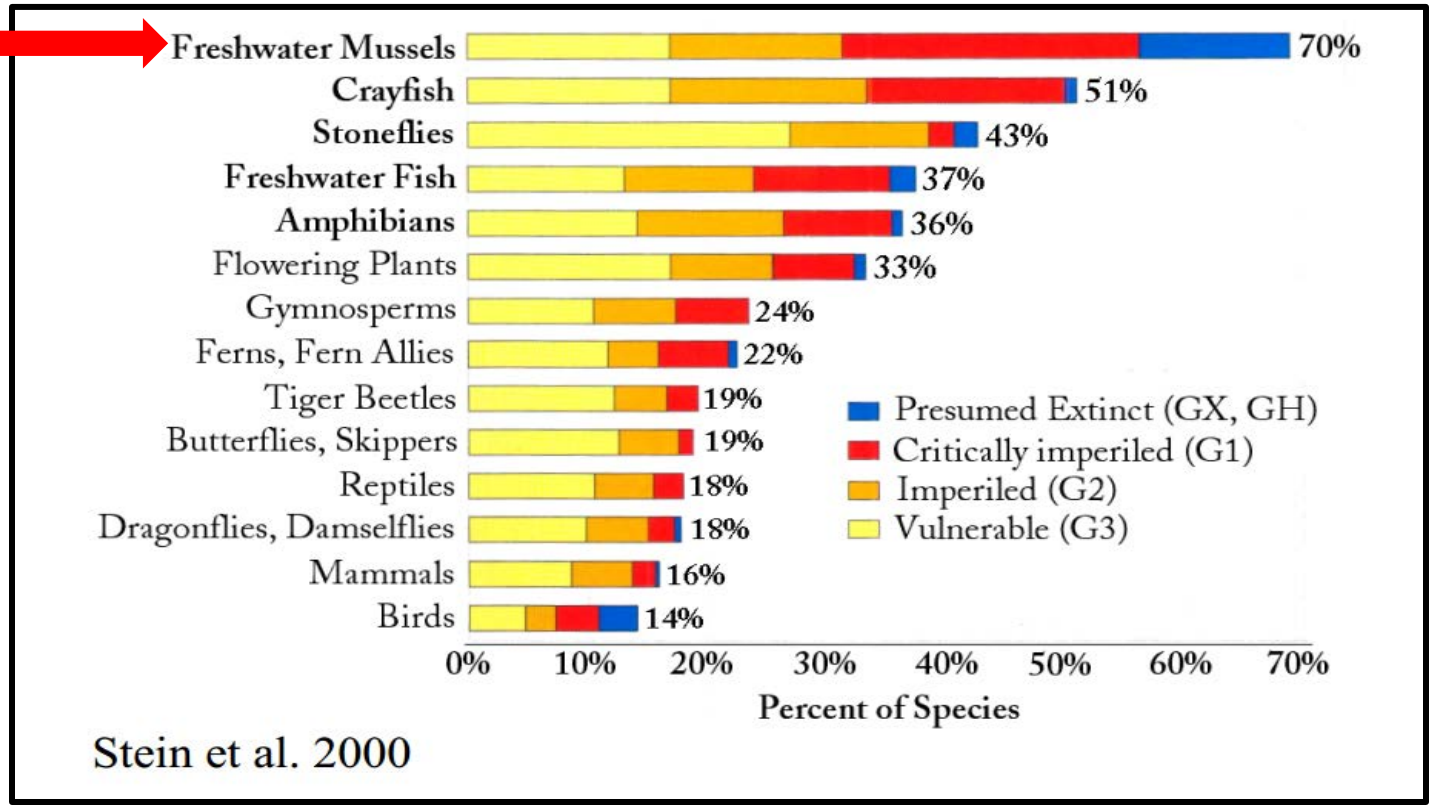
Figure: Haag, 2012

Table 3.1. *Worldwide diversity of freshwater mussels (Order Unionoida)*

Region	Number of taxa
Nearctic	**302**
Mississippi River basin	133
Gulf Coast drainages	147
Atlantic Coast drainages	52
Peninsular Florida	14
Pacific Coast drainages	7
Neotropica	**172**
Mesoamerica	102
Amazon–Orinoco basins	42
Paranà–Paraguay basins	41
Afrotropica	**85**
Congo River basin	34
Nile River basin	26
Western Africa	22
Paleartica	**45**
Japan–Sakhalin	17
Amur–Beringia	14
Europe	11
Indotropica	**219**
Indochina	91
Yangtze–Huang basins	63
India–Burma	54
Australasia	**33**

Mussels in Peril

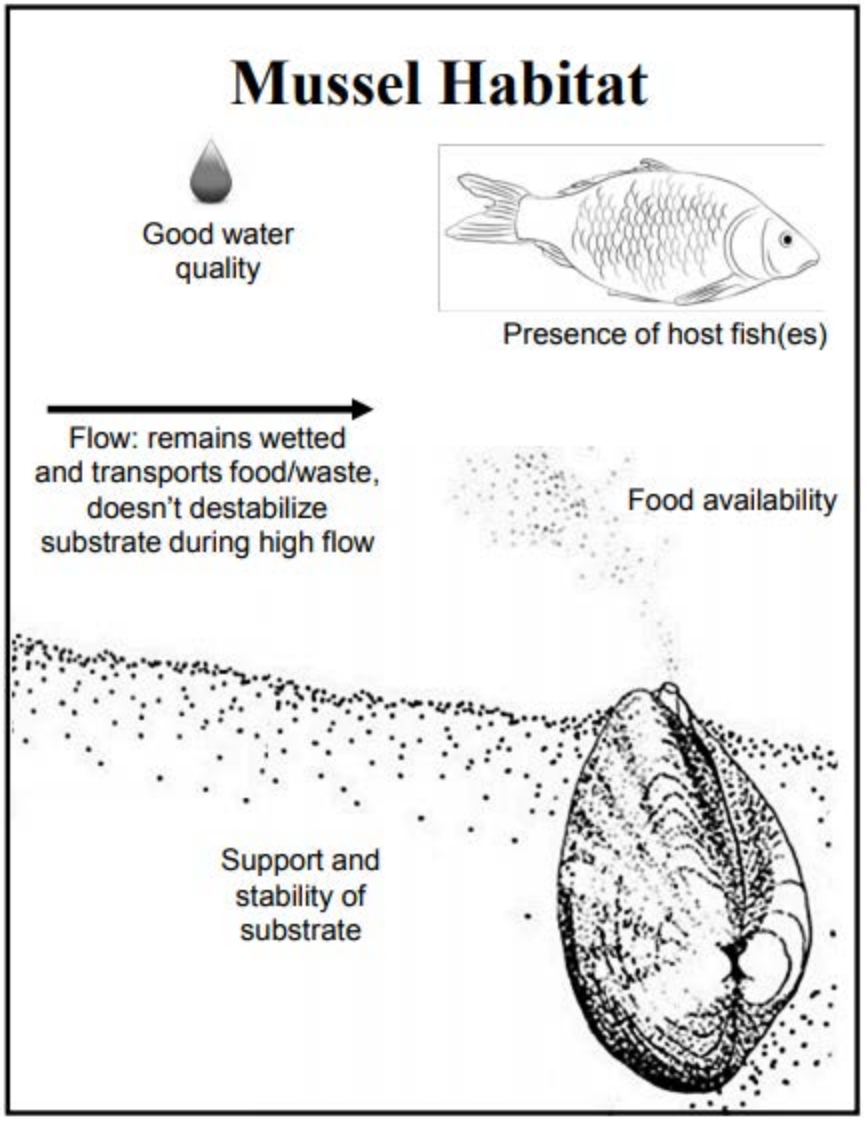
- Nearly 300 recognized species in North America alone
- Southeast USA is the global biodiversity hotspot for freshwater mussels
- Over 72% of the 300 species have state or federal T&E protection



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

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

Fusconaia askewi
Texas Pigtoe
TPWD-Threatened

Fusconaia lananensis
Triangle Pigtoe
TPWD-Threatened

Lampsilis bracteata
Texas Fatmucket
TPWD-Threatened
ESA- Candidate

Lampsilis satura
Sandbank Pocketbook
TPWD-Threatened

Obovaria jacksoniana
Southern Hickorynut
TPWD-Threatened

Pleurobema riddellii
Louisiana Pigtoe
TPWD-Threatened

Popenaias popeii
Texas Hornshell
TPWD-Threatened
ESA-Candidate

Potamilus amphichaenus
Texas Heelsplitter
TPWD-Threatened

Potamilus metnecktayi
Salina Mucket
TPWD-Threatened

Quadrula aurea
Golden Orb
TPWD-Threatened
ESA-Candidate

Quadrula houstonensis
Smooth Pimpleback
TPWD-Threatened
ESA-Candidate

Quadrula mitchelli
False Spike
TPWD-Threatened

Quadrula petrina
Texas Pimpleback
TPWD-Threatened
ESA-Candidate

Truncilla cognata
Mexican Fawnsfoot
TPWD-Threatened

Truncilla macrodon
Texas Fawnsfoot
TPWD-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 Randklev, IRNR, Texas A&M University

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Charles Randklev, PhD
crandklev@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

Fusconaia askewi
Texas Pigtoe
TPWD-Threatened

Fusconaia lananensis
Triangle Pigtoe
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Lampsilis bracteata
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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

Fusconaia askewi
Texas Pigtoe
TPWD-Threatened

Fusconaia lananensis
Triangle Pigtoe
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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

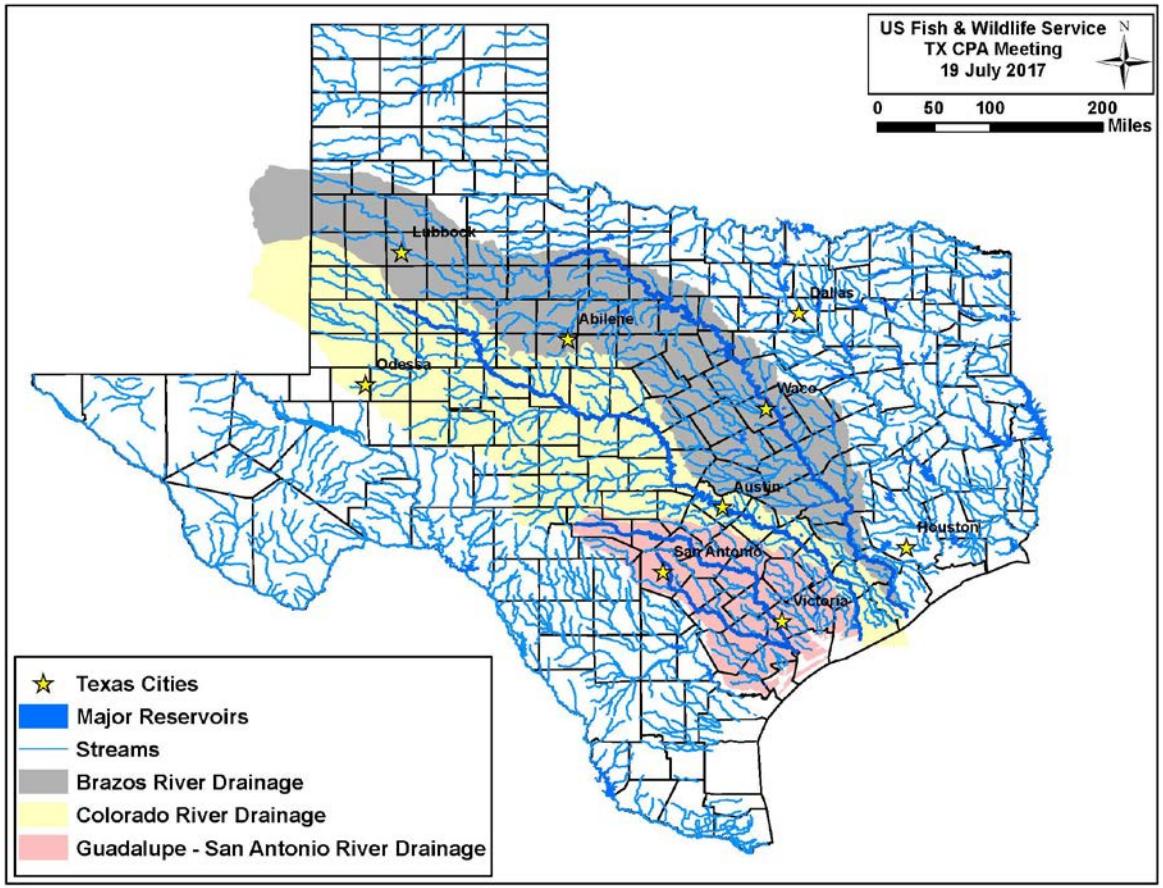
Central Texas Mussels (FY18)

- **Texas fatmucket**, *Lampsilis bracteata*
- **Texas pimpleback**, *Quadrula petrina*
- **False spike**, *Fusconaia mitchelli*
- **Texas fawnsfoot**, *Truncilla macrodon*

Photo credit: G. Pandolfi, C. Stevens; FWS

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



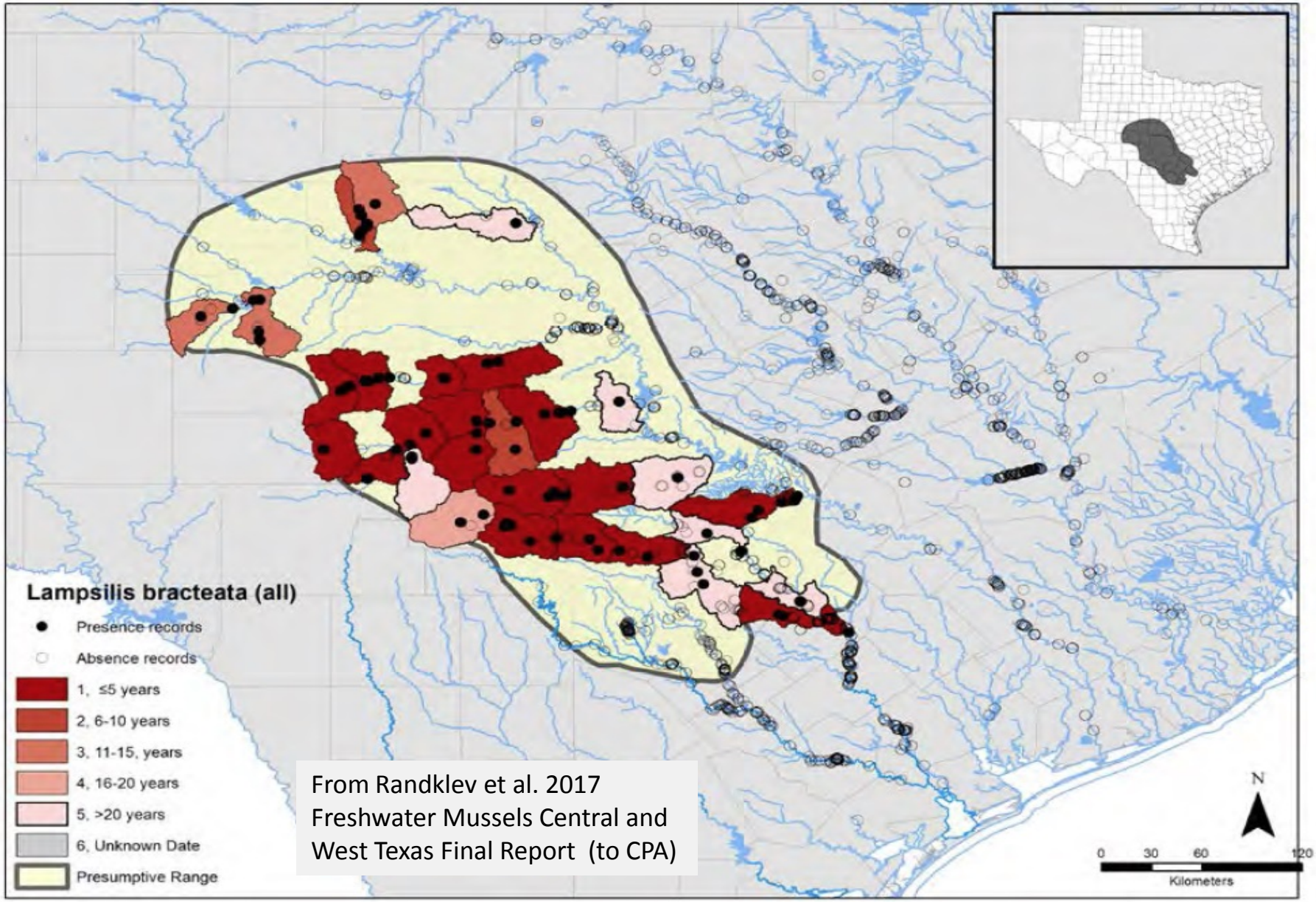
Texas fatmucket, *Lampsilis bracteata*

- 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*)



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

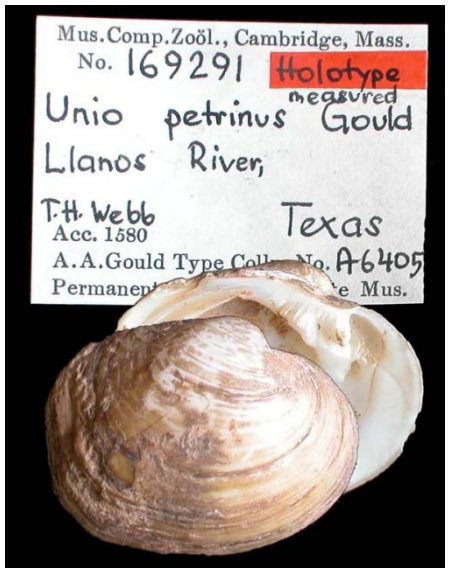
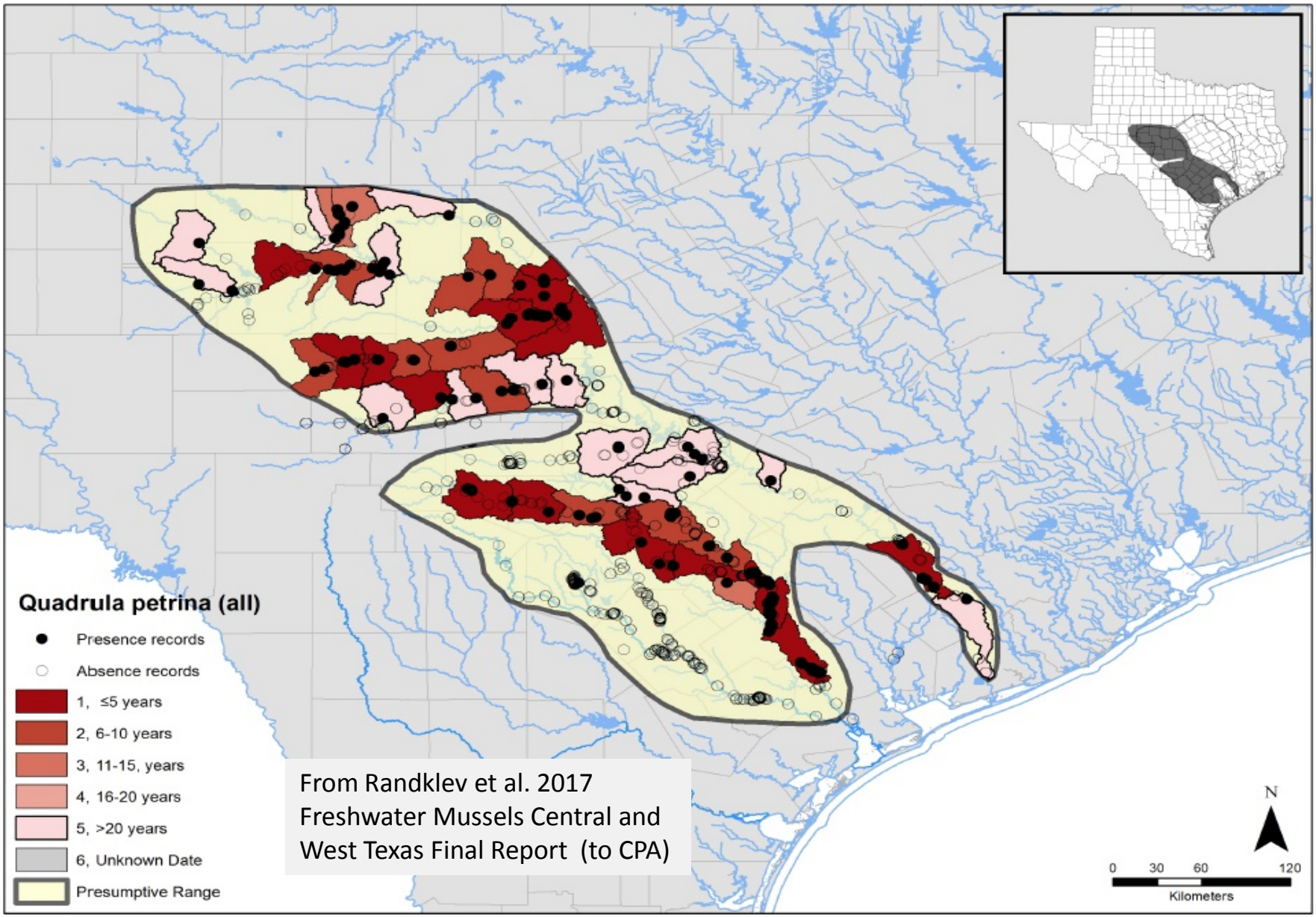


Photo credit: MUSSELp

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)

Photo credit: FWS

Conservation Map – Texas pimpleback (*Quadrula petrina*)



False spike, *Fusconaia mitchelli*

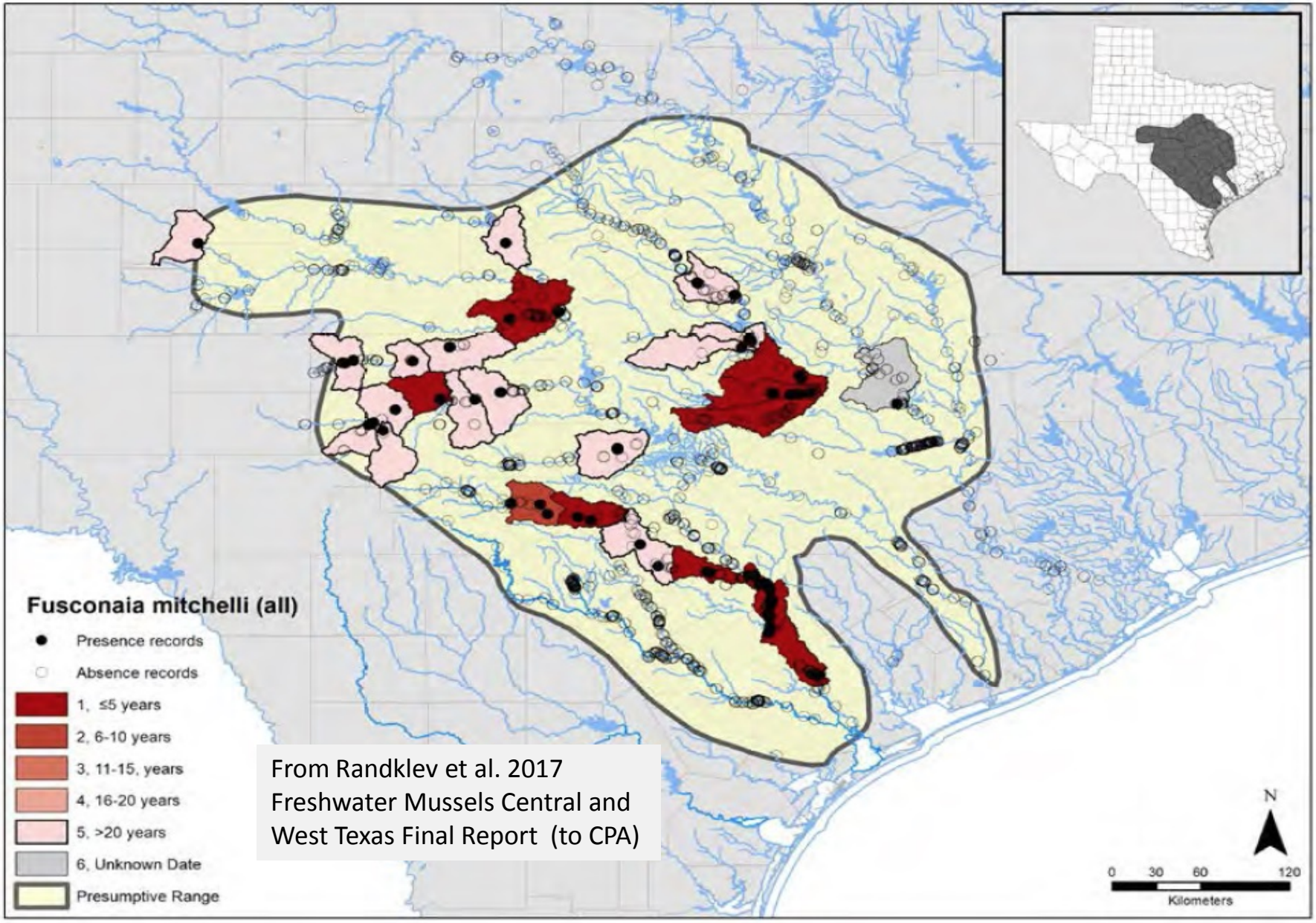
- Riffle and pool habitats (Randklev et al., 2017)
- Primarily found in gravel/cobble substrates
- Host: red shiner, blacktail shiner

Photo credit: MUSSELp

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)

Photo credit: FWS

Conservation Map – false spike (*Fusconaia mitchelli*)



From Randklev et al. 2017 Freshwater Mussels Central and West Texas Final Report (to CPA)

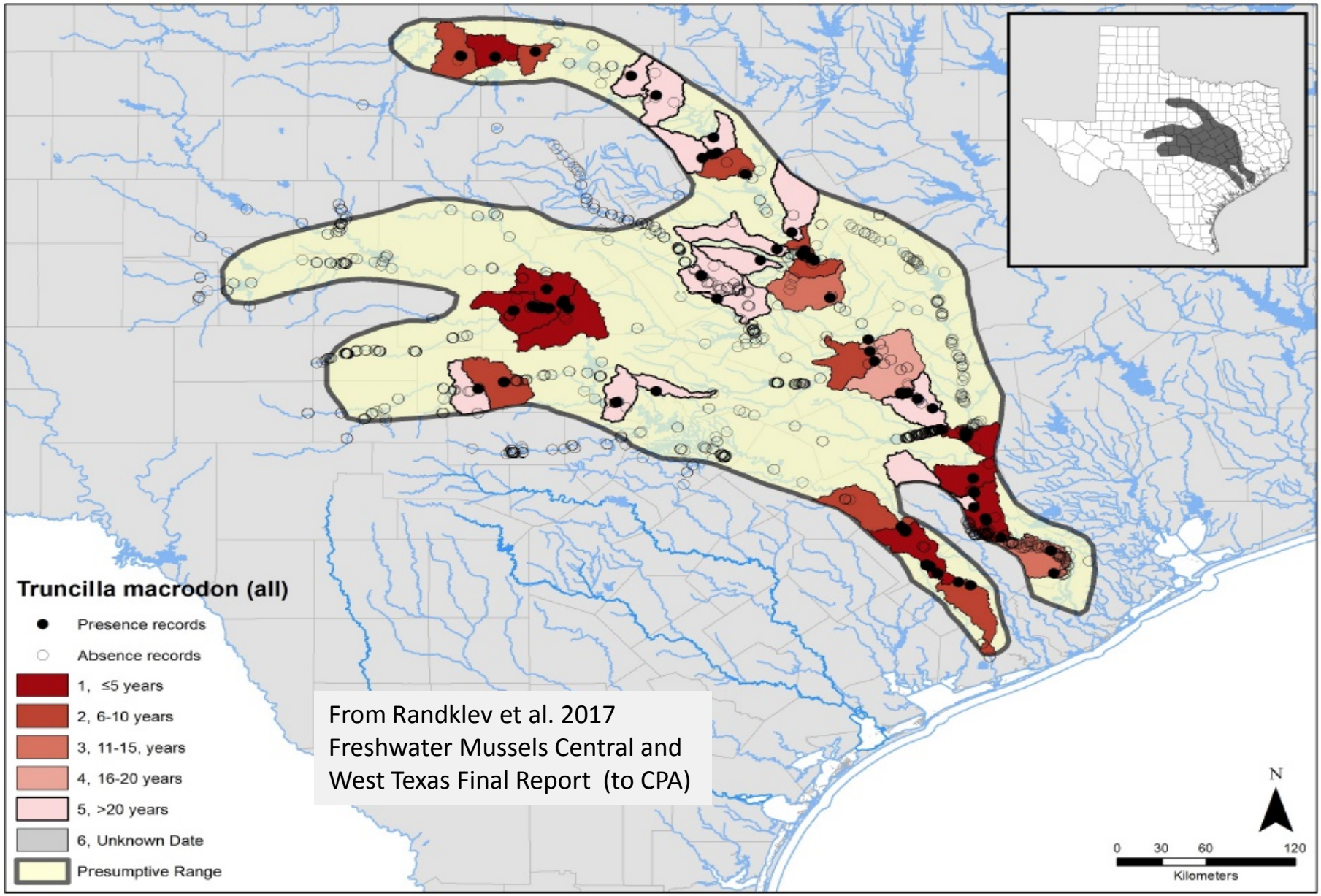
Texas fawnsfoot, *Truncilla macrodon*

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

Photo credit: MUSSELp

Photo credit: FWS

Conservation Map – Texas fawnsfoot (*Truncilla macrodon*)



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

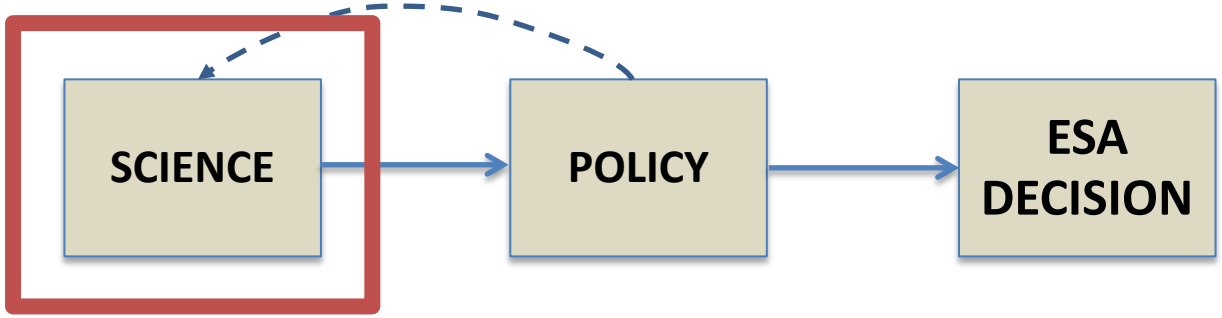
by Texas State University, Auburn University, Biowest, and FWS

- 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

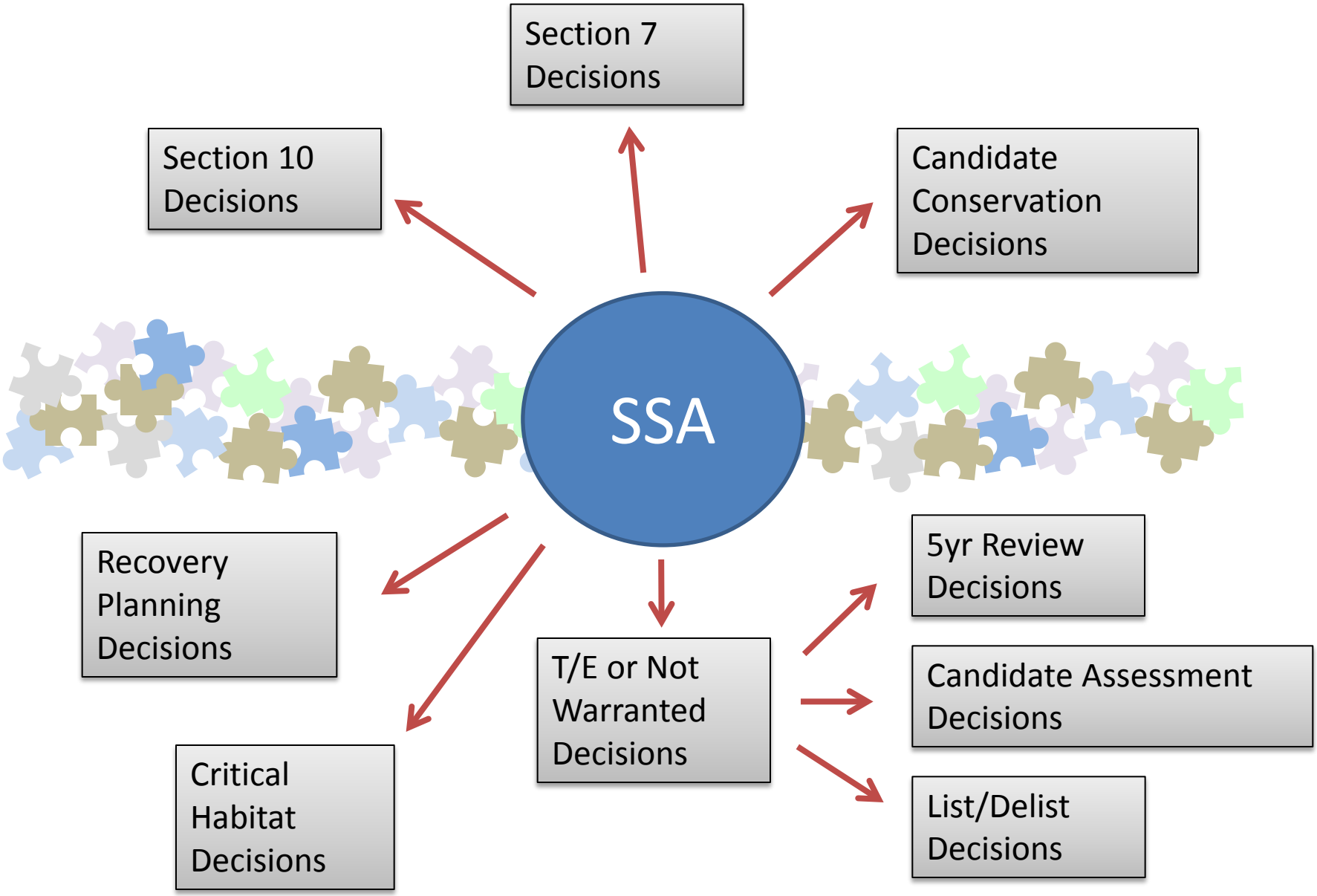
- Starting in 2015, CPA has held regular public meetings to provide information for interested stakeholders
  - FWS updates on species status assessment process
  - Presentations by CPA-funded researchers
  - Updates on research funded by other agencies
  - Educational presentations on species and habitat

- Webinar in Feb. 2018: Presentations on final TSU research report



Decision Elements	Risk Profile – Analysis	Risk Tolerance – Policy
Process	**SSA Framework**	**ESA Decision Making**
Who	**Team of Biologists**	**Decision Makers** (FWS Management)
How	**SSA Framework** (Scientific Analysis of Biological Information)	**Policy Judgment** (Societal Values)
When	**Throughout the SSA Analysis**	**AFTER the SSA Analysis**
Outcome	**Characterization of Viability**	**ESA Decision** (Interpret the policy and apply the science)

Species Status Assessment informs all ESA 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

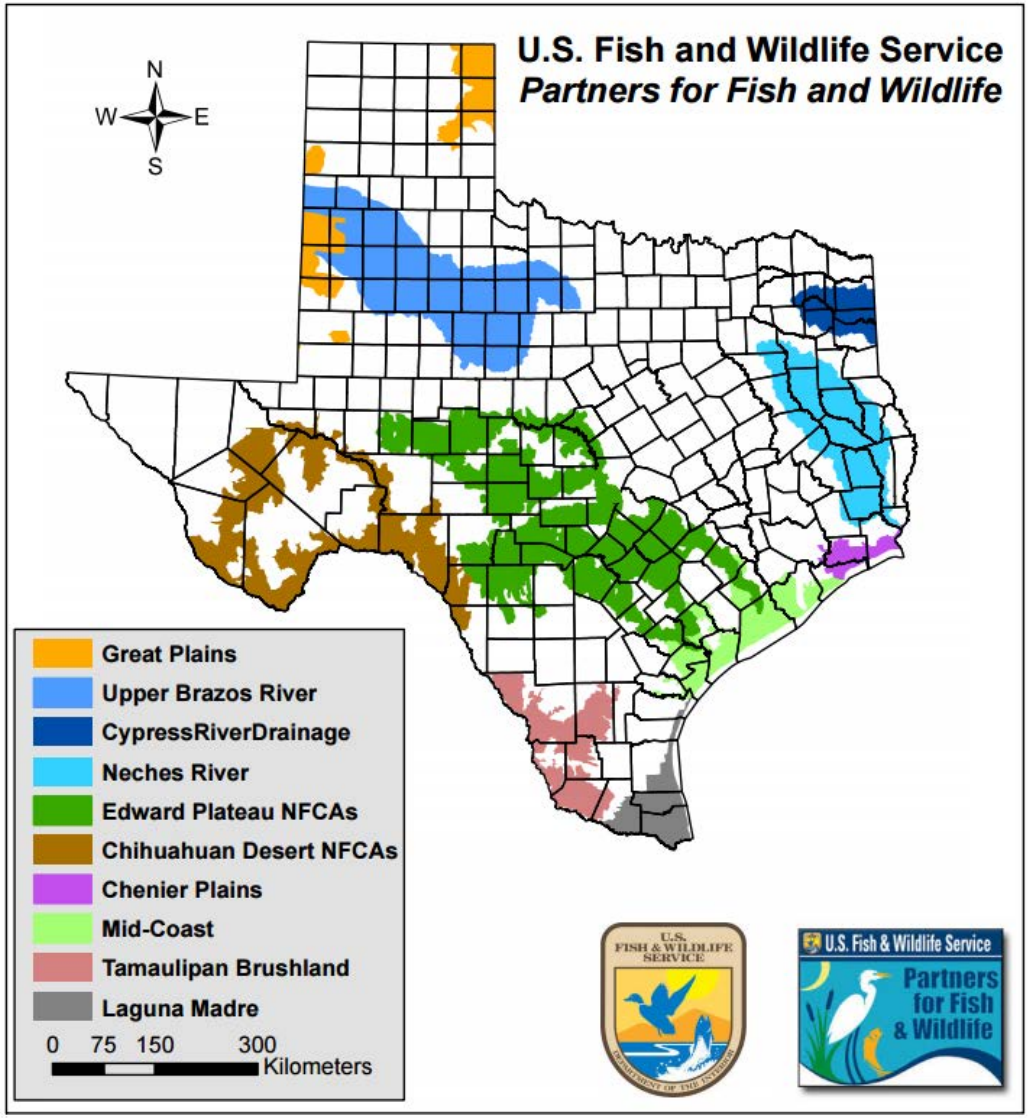
Habitat

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"**

Implementing the Texas Conservation Plan for the Dunes Sagebrush Lizard

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

USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

Working Lands for Wildlife

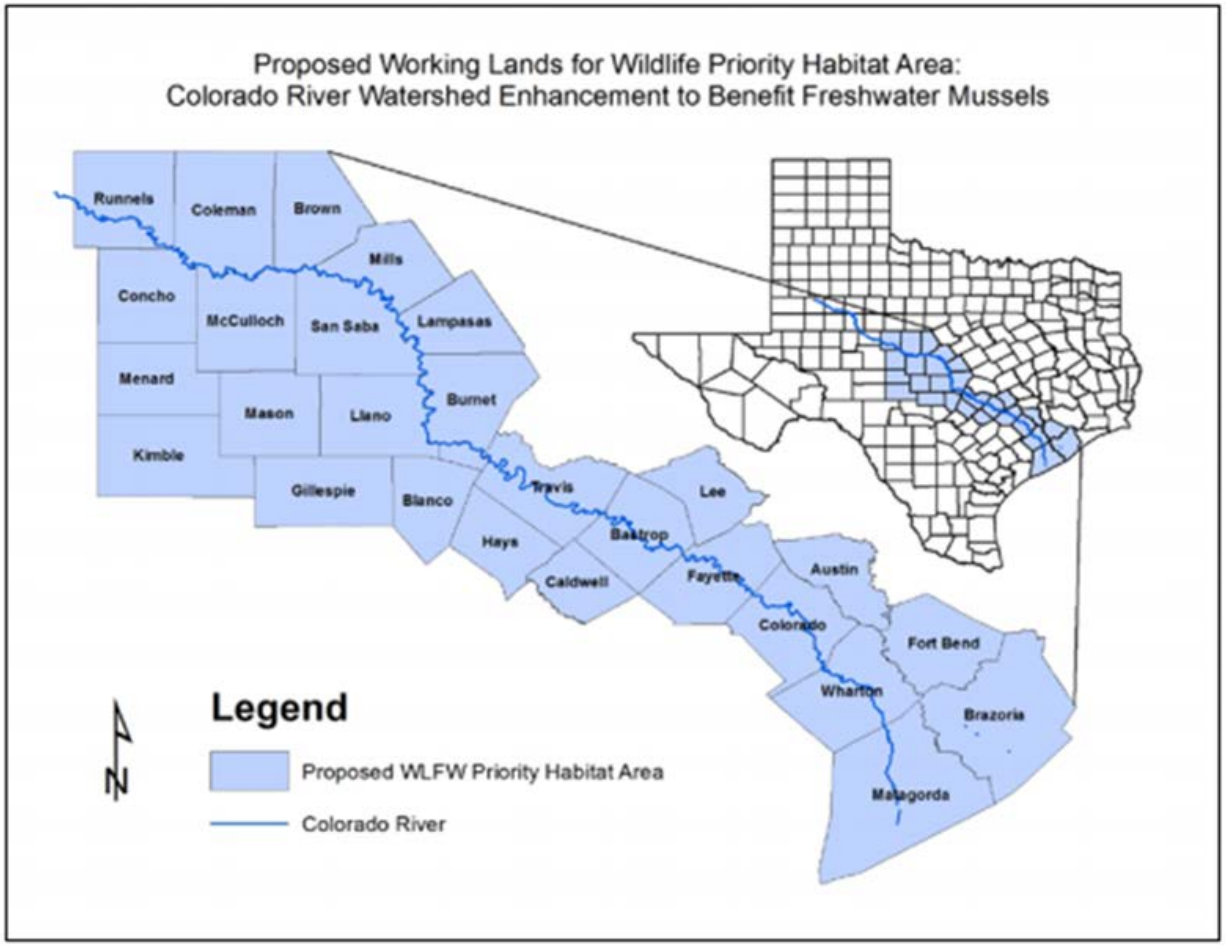


Table 1. Target at-risk freshwater mussel species known to occur historically in the Colorado River basin of Texas. Updated by USFWS from:
https://www.fws.gov/southwest/es/Documents/R2ES/Status_Table_Texas_Mussels_Oct_2011.pdf

Freshwater Mussel Propagation


Collecting freshwater mussel brood stock

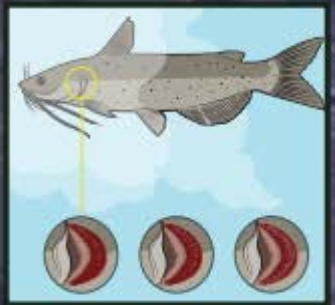
Checking gravidity

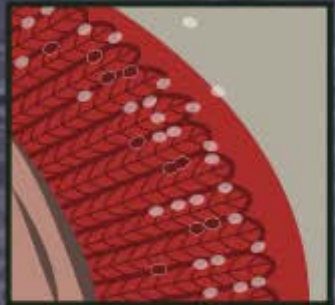

Extracting glochidia


Host fish in infestation bath

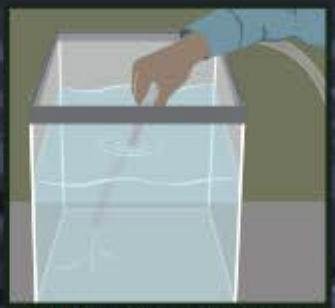

Adding glochidia to infestation bath


Host fish exposed to glochidia

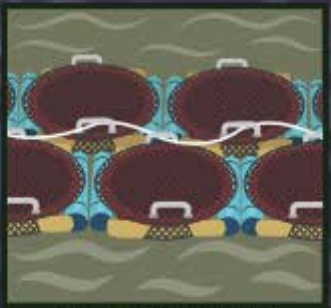

Glochidia attaching to fish gills

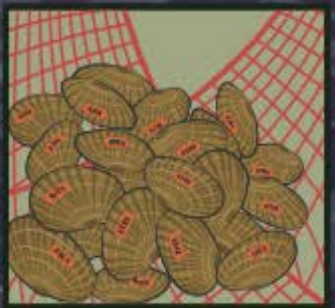

Close up of glochidia attaching to fish gill filaments


Maintaining fish while glochidia metamorphose into juveniles


Collecting newly metamorphosed juvenile mussels from the fish tank

Example indoor system for mussel culture

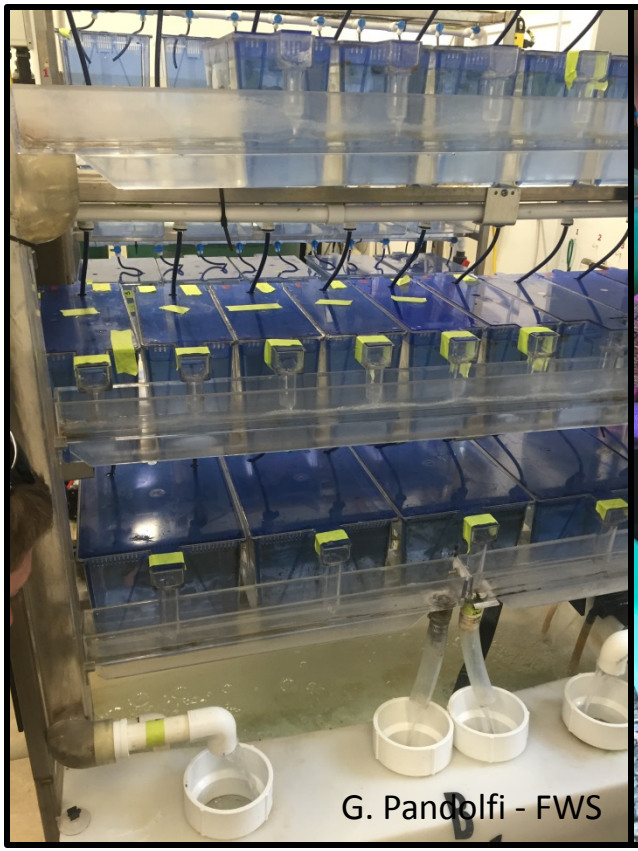

Example outdoor system for mussel culture


Tagged mussels for release


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

Embassy Suites by Hilton Austin Central
5901 North Interstate Highway 35
Austin, Texas

Questions?

G. Pandolfi - FWS