Microhabitat Preferences of Federally Threatened Freshwater Mussel Species in Coastal Plain Streams

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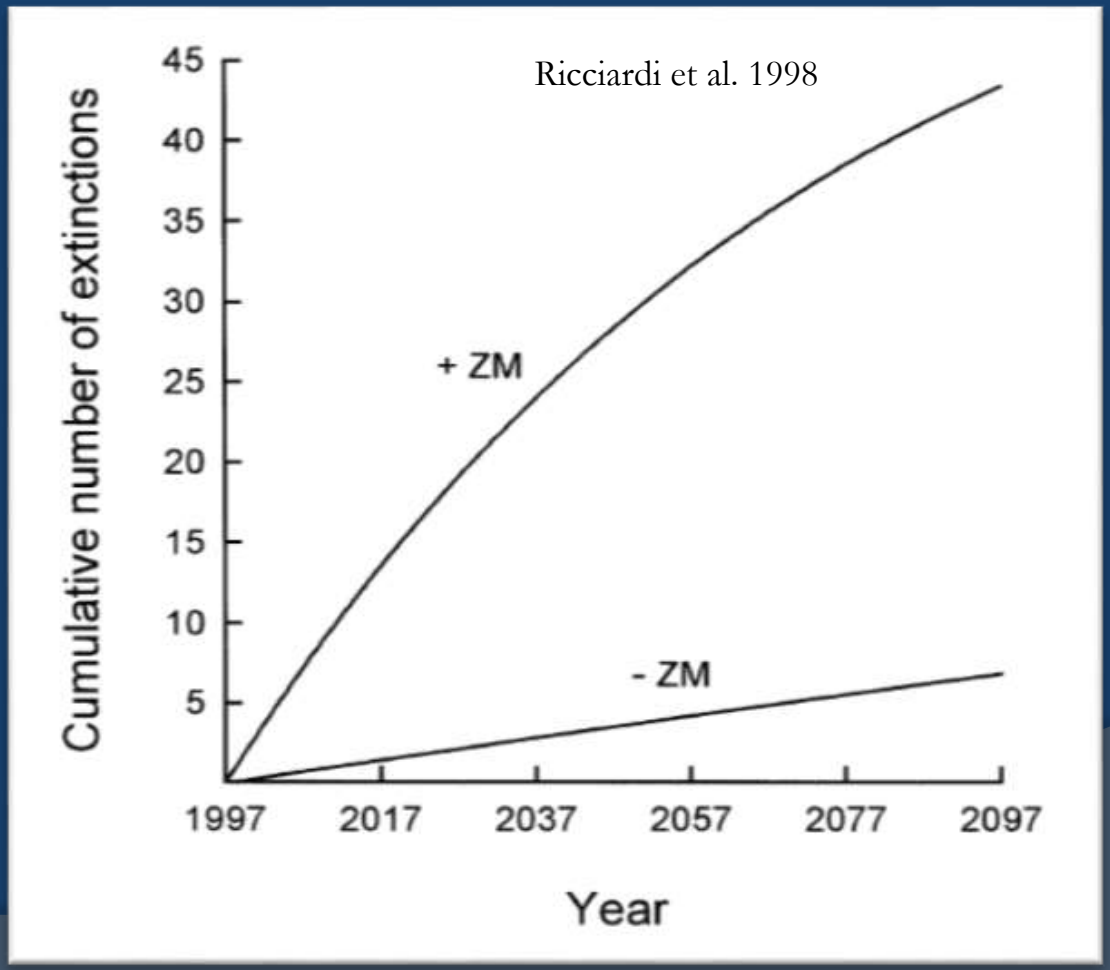
Background

- North America – ~50 genera and 300 species
- More than 2/3 species vulnerable to extinction
- Alabama – 60% U.S. species
- About 68% AL species imperiled or extinct

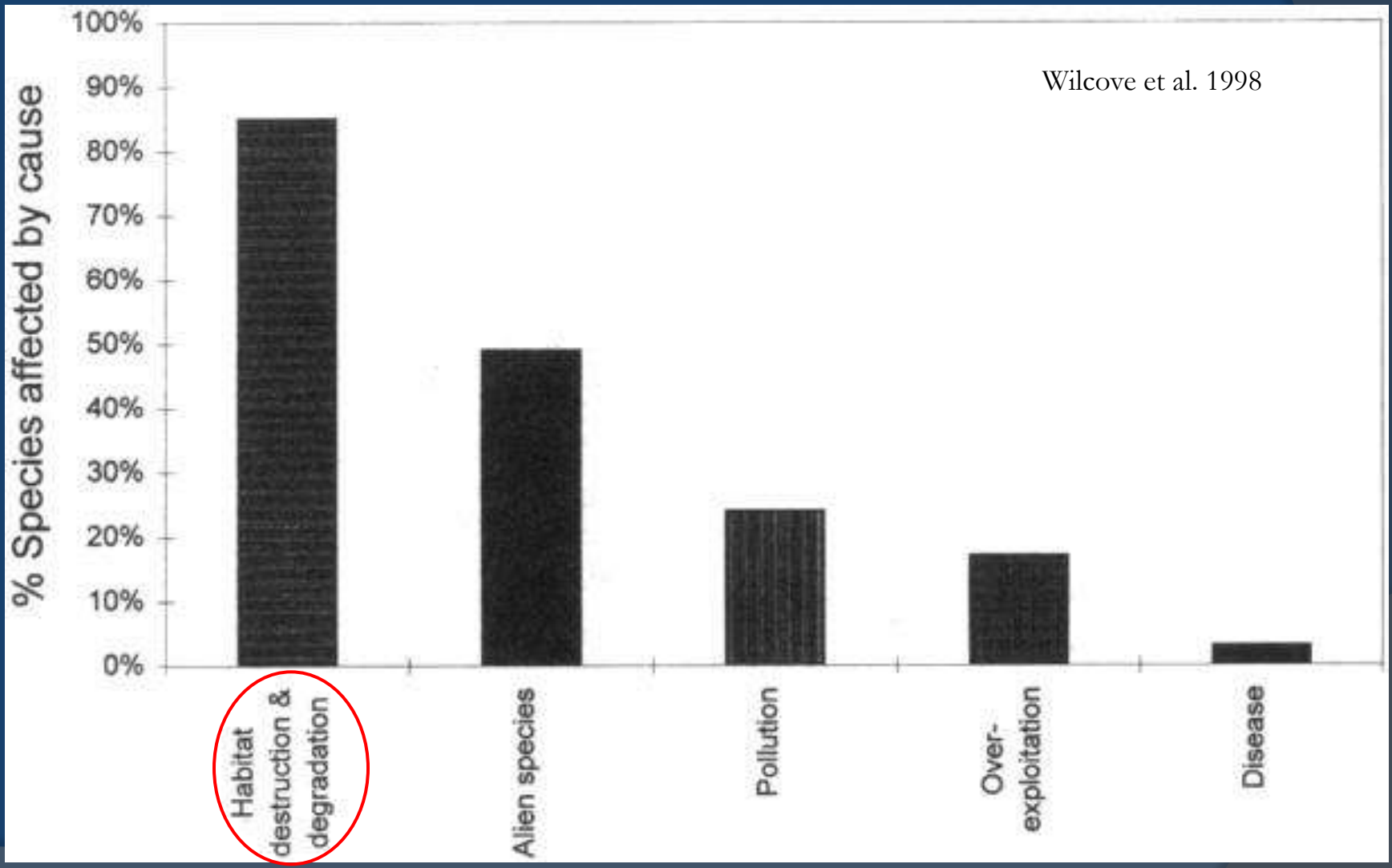
http://commons.wikimedia.org/wiki/File:Group_of_Margaritifera_margaritifera.jpg

http://www.paconserve.org/e-conserve/winter-07/images/mussel-lure-1-8-meg.jpg

- Extinction rate per decade
  - Current – 1.2%
  - Future – 6.4%



Major threat to most faunal groups - Habitat degradation and loss



Federal Register Volume 77, Number 196 (November 2012)

Endangered	Threatened
Margaritifera marrianae	*Fusconaia burkei*
Fusconaia rotulata	*Fusconaia escambia*
Obovaria choctawensis	*Pleurobema strodeanum*
Ptychobranchus jonesi	*Hamiota australis*

Pleurobema strodeanum

Fusconaia burkei

Hamiota australis

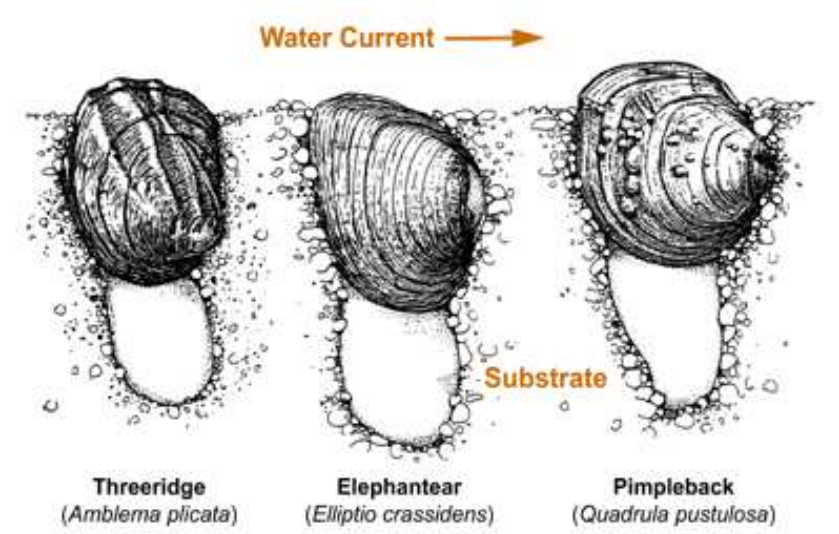
What we studied

- Microhabitat - focus
- Instream habitat – brief summary
- Shear stress – brief summary

Note:

- This is the first study where each mussel was sampled and variables measured on an individual mussel basis (n = 499)
- Also, the first study where habitat variables were measured for federally threatened species

- **Why is Microhabitat important?**
  - Limited mobility
  - Inability to actively select habitats



http://www.museum.state.il.us/ismdepts/zoology/mussels/intro_habitat.html

Microhabitat for mussels

Hydrologic

- Water depth –
  - distribution
- Current velocity –
  - O_2 supply
  - waste transport
  - substrate stability
  - excess siltation

Microhabitat for mussels

Substrate

- Sediment –
  - basic physical medium to live
  - avoid unfavorable conditions
- Compaction –
  - how firm mussels held

- Instream habitat –
  - sediment stability
  - leaf pack, root mat, root wad, woody debris, and log

Objectives

- Determine microhabitat variables at locations where individuals of 3 threatened and a common mussel species were found; and if differences existed among preferences
  - depth
  - current velocity
  - substrate compaction level
  - sediment particle size

Methods

- Sites
  - Blue Springs State Park (BS) - W Fork Choctawhatchee River, Barbour County, AL
  - Eightmile Creek, Walton County, FL
    - Eightmile Creek Site 1 (8M1)
    - Eightmile Creek Site 2 (8M2) – 150 m upstream
- Sampling
  - 5 person hours
  - Wadeable sites

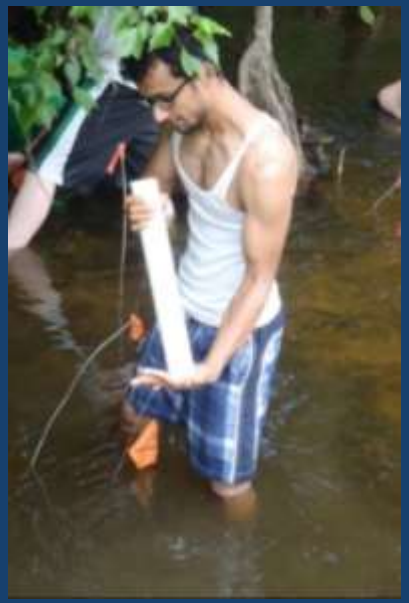
- A species specific color coded flag (w/ unique #) was inserted in the sediment
- Individuals of mussel species were removed, tagged, measured, and returned



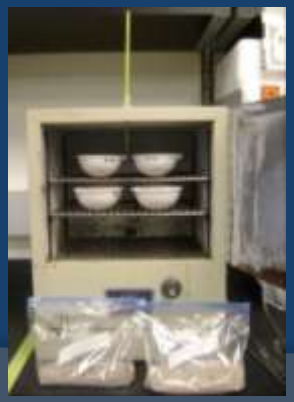



- Depth and current velocity - Pygmy Current Meter
- Compaction - Rod (1.41 cm)

- Sediment collection - PVC pipe (5.08 cm)


- Oven dried at 105 °C for 24 hours




- Grain size determination (sieved):

- 2 mm (no. 10)
- 1 mm (no. 18)
- 0.5 mm (no. 35)
- 0.250 mm (no. 60)
- 0.125 mm (no. 120)
- 0.063 mm (no. 230)

Data Analysis

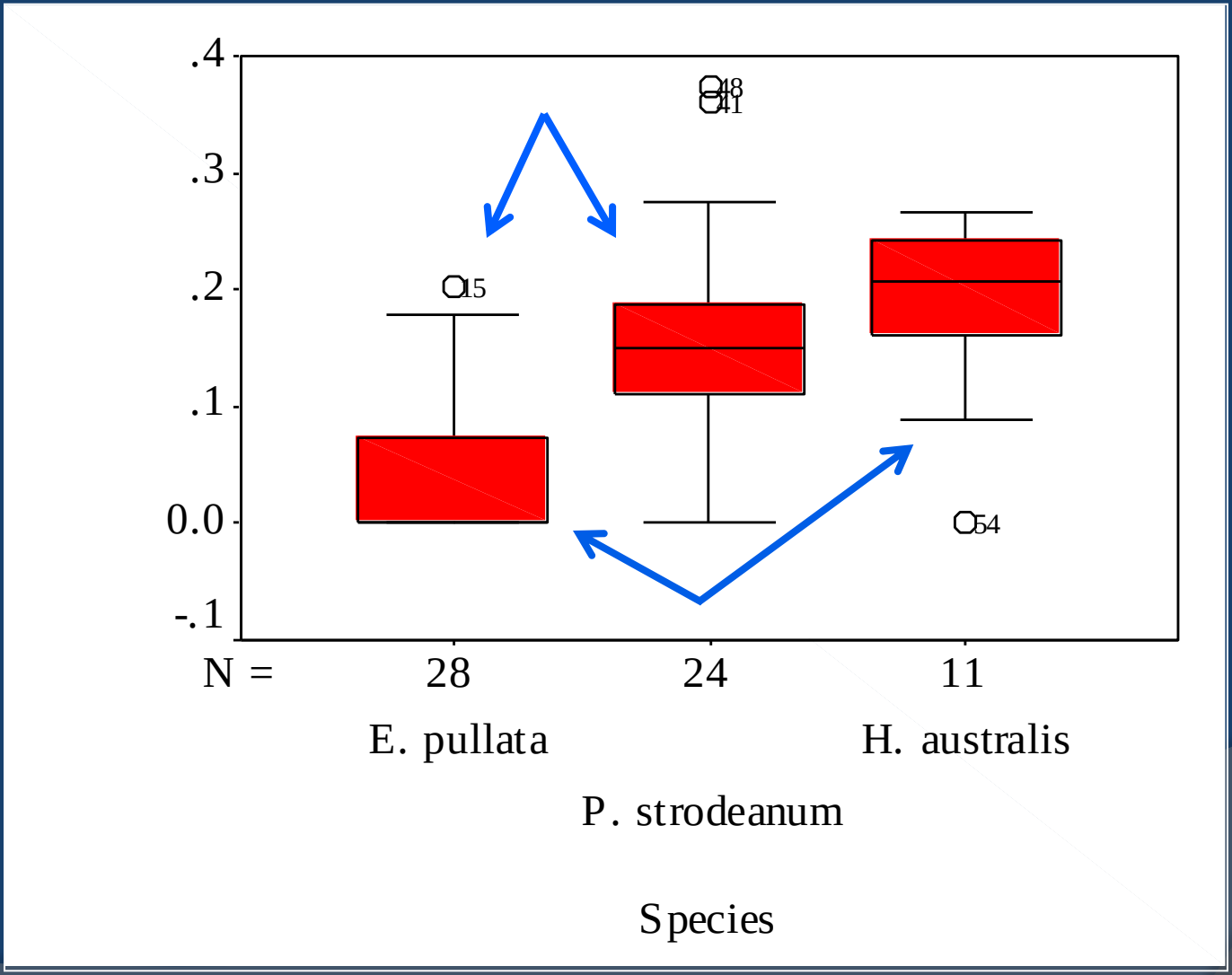
- Kruskal-Wallis H-test
  - differences in microhabitat variables among species
- If sig. diff., Bonferroni's correction applied to α
  - then Mann-Whitney U-tests
- Compaction (Pressure) = Force/Area (N/m^2)
  - expressed as kPa

Results

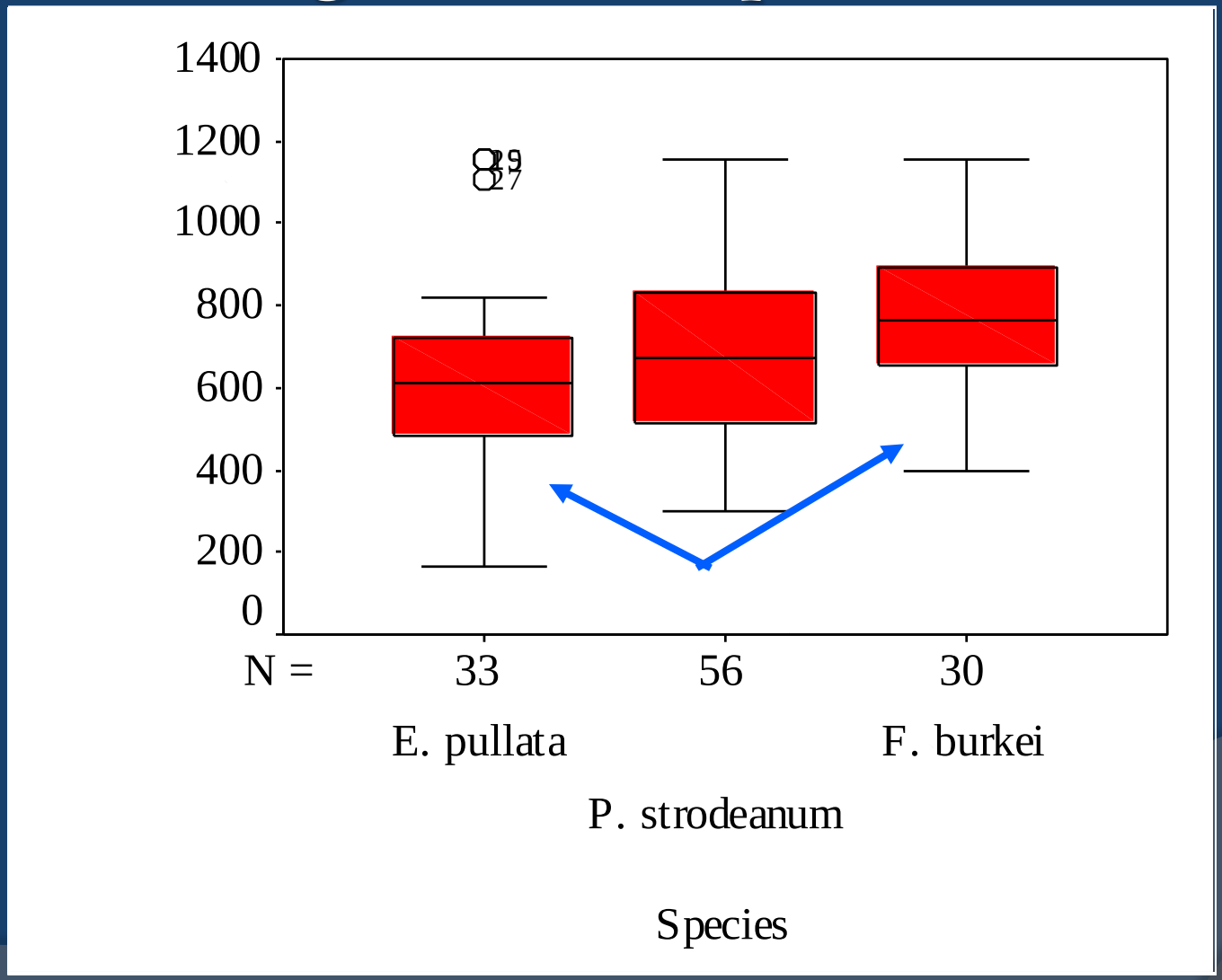
	Common species	Threatened species		
Sites	*Elliptio pullata*	*Pleurobema strodeanum*	*Fusconaia burkei*	*Hamiota australis*
BS	28	24	2	11
8M1	33	56	30	3
8M2	33	183	85	11
Total	94	263	117	25

Total individuals (individual habitat data points) - 499

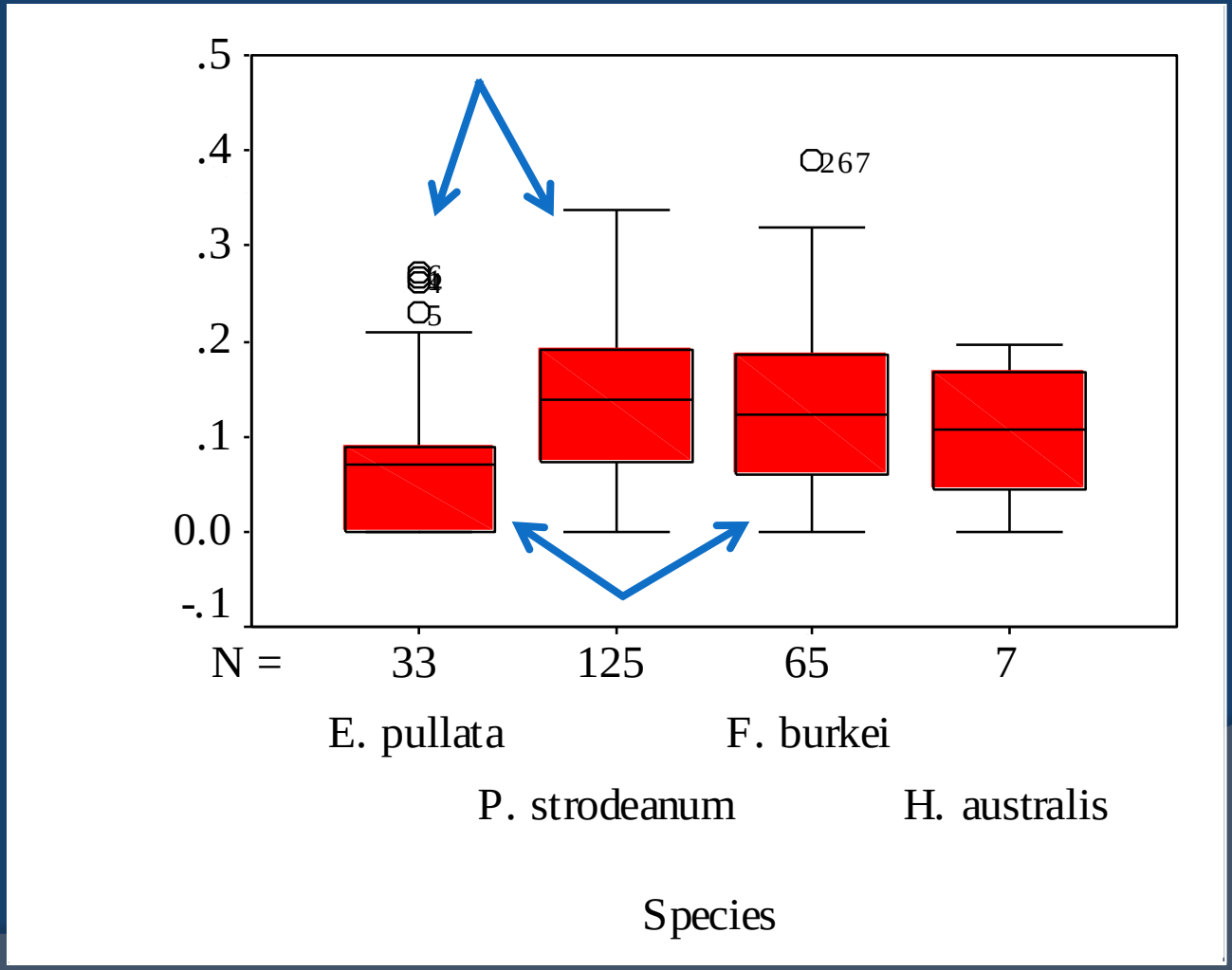
- **BS** – current velocity ($p < 0.001$) was significantly different among the mussel species



- **8M1** – depth ($p < 0.001$), current velocity ($p < 0.001$), and compaction ($p = 0.023$) were significantly different among the mussel species



- **8M2** – depth (p = 0.001) and current velocity (p = 0.004) were significantly different among the mussel species



Sediment size classes

- BS – Gravel, coarse sand, and medium sand were significantly different between *P. strodeanum* and *H. australis*, and gravel and medium sand between *E. pullata* and *H. australis* ($p < 0.05$)

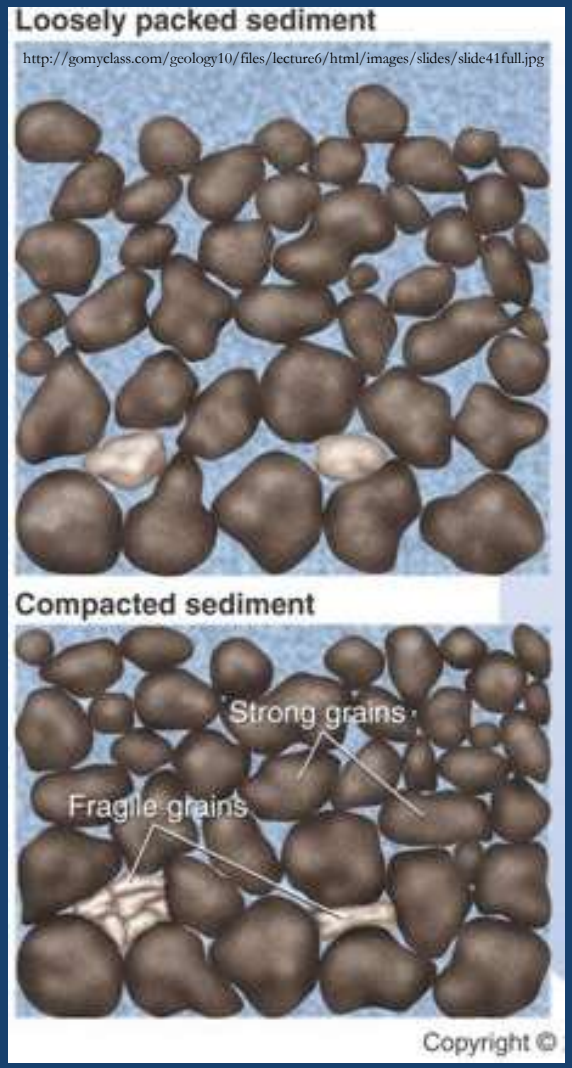
http://www.pilbarageology.com.au/product_images/p/392/untitled__17034_zoom.JPG

- 8M1 – Gravel and very coarse sand were significantly different between *E. pullata* and *F. burkei* ($p < 0.05$)

- 8M2 – Very fine sand was significantly different between *F. burkei* and *E. pullata* and *F. burkei* and *P. strodeanum* ($p < 0.05$)

Discussion

- *Elliptio pullata* tended to be present at lower depth, current velocity, and compaction
- More sensitive threatened species were limited to higher microhabitat variable values
- Greater depth – reduced effects of water level fluctuation and drought

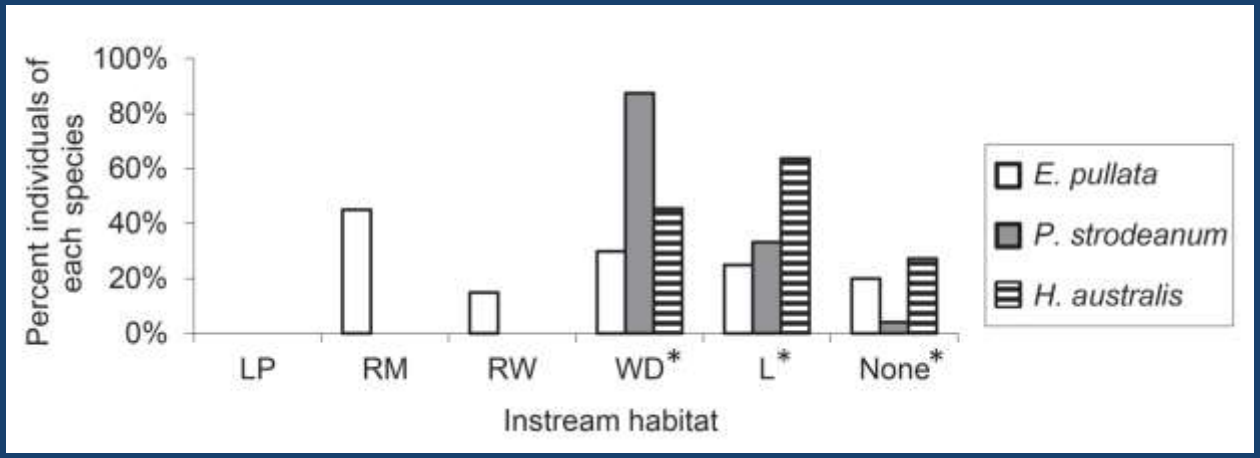


- Continuously flowing water has been linked to lower unionid mortality compared to no measureable current velocity
- More compact sediment is related to reduced sediment entrainment and higher stability

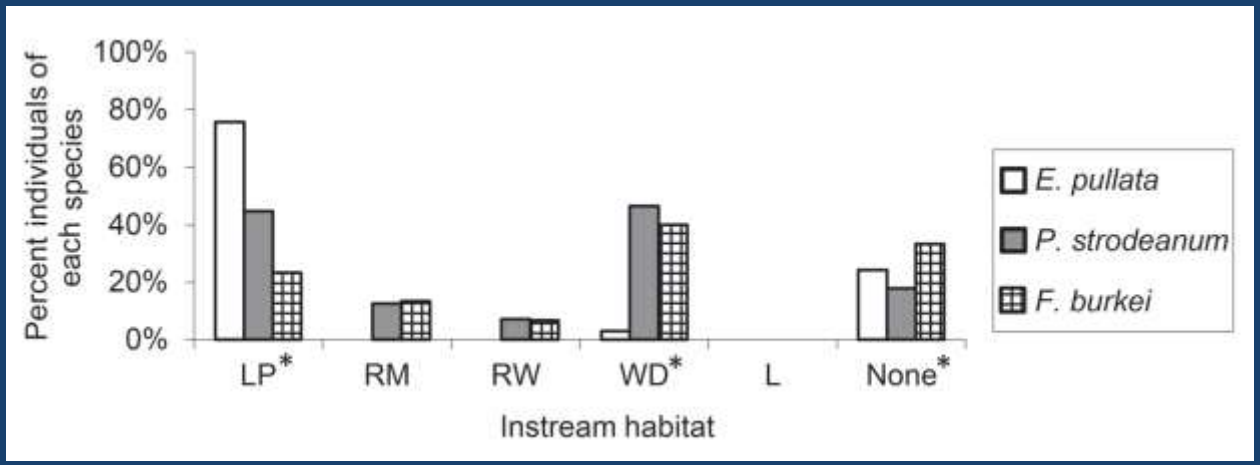
The threatened status of these species is likely due to habitat related stress

Instream habitat

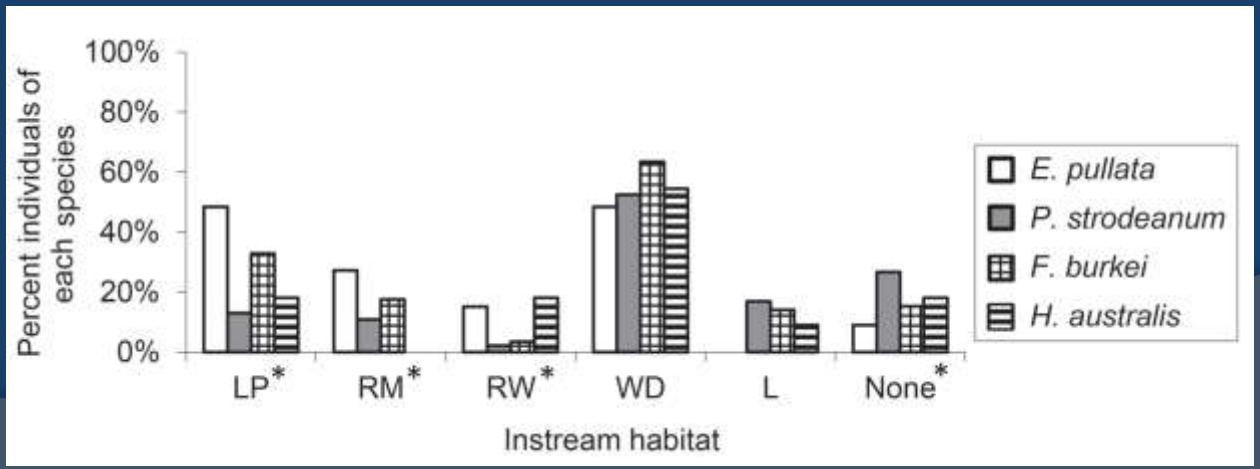
- Threatened species – almost exclusively associated with woody debris or logs at all sites
- Common species (*E. pullata*) – often exclusively with leaf pack or equally with leaf pack and woody debris (except BS)
- 67–96% had at least one instream habitat structure nearby



BS – no leaf pack



8M1 – no logs



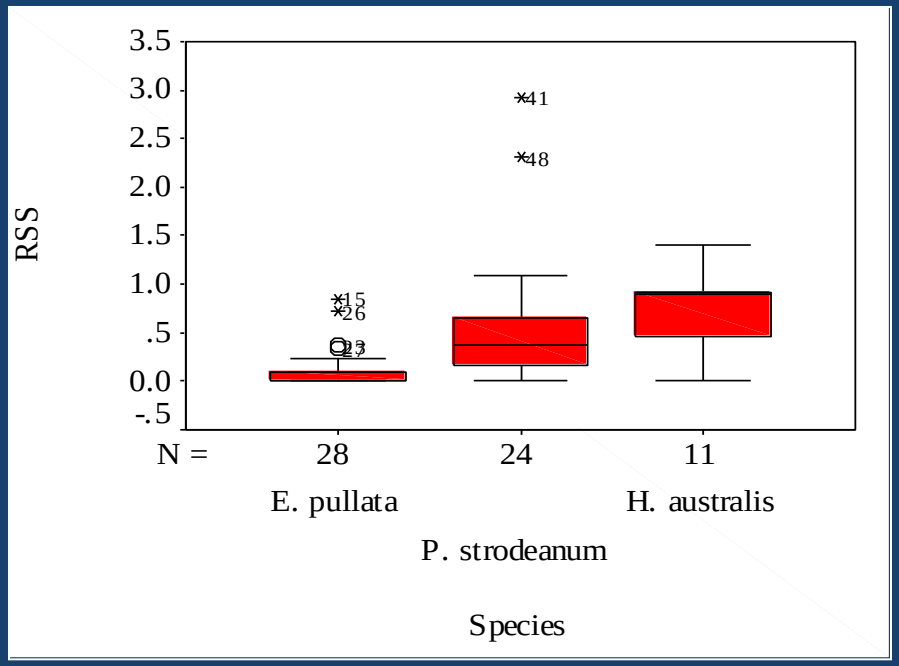
8M2

Shear stress

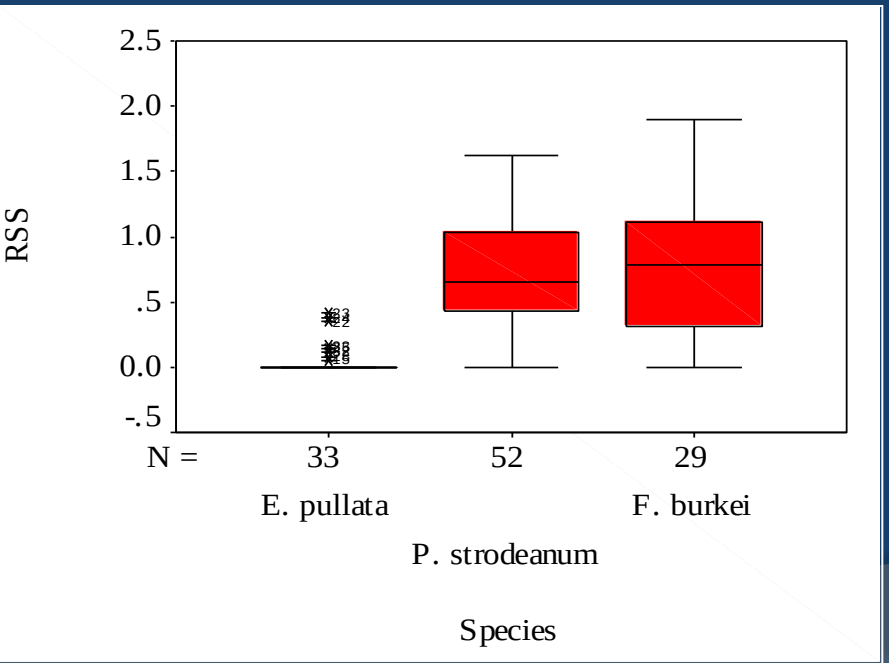
- RSS < 1 - no substrate movement
- RSS > 1 - water entrained the substrate
  - possibly unstable mussel microhabitats

- Except for *H. australis* at 8M2, threatened species always had significantly higher RSS than *E. pullata*
- Threatened species – 15% at BS and 8M2, and 31% at 8M1 had RSS > 1
- Only 15% of *E. pullata* at 8M2 had RSS > 1

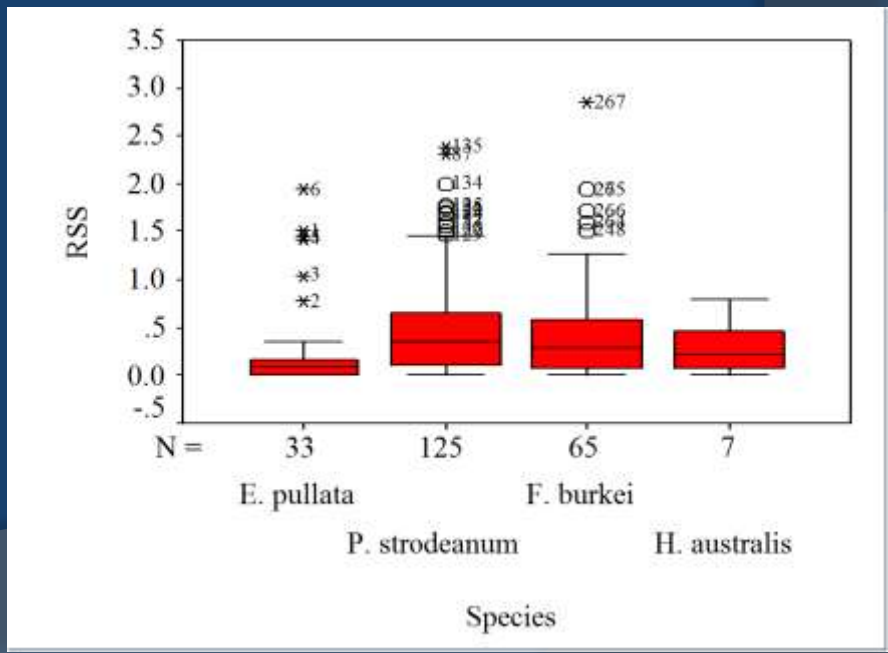
BS


RSS
3.5
3.0
2.5
2.0
1.5
1.0
.5
0.0
-.5
41
48
15
26
N =
28
24
11
E. pullata
H. australis
P. strodeanum
Species

8M1


RSS
2.5
2.0
1.5
1.0
.5
0.0
-.5
N =
33
52
29
E. pullata
F. burkei
P. strodeanum
Species

8M2


RSS
3.5
3.0
2.5
2.0
1.5
1.0
.5
0.0
-.5
267
6
3
2
N =
33
125
65
7
E. pullata
F. burkei
P. strodeanum
H. australis
Species

Summary and Conclusions

- *Elliptio pullata* preferred shallow and slow flowing water and loose sediment (usually streambanks)
- Threatened species preferred habitats with greater depth, current velocity, and compaction, with woody debris or logs for instream habitat, and with a higher RSS

Likely the major cause for declines – excess sedimentation

- Coastal Plain streams are becoming more sand-bottomed and shallower, which is suited to species such as *E. pullata*, while the species preferring deeper and faster flowing water and more compact sediment are in decline

- Until sediment input can be curbed on a large scale, the fate of many of our declining mussel species, as well as many others, may be sealed

- Habitat related factors should be the priority for conservation of these species

- Individual microhabitat approach using simple physical variables was successful in determining whether rare and threatened species used a different subset of specialized microhabitat than a common species

Acknowledgments

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Publications -

- Niraula et al. 2015. Microhabitat associations among three federally threatened and a common freshwater mussel species. American Malacological Bulletin 33(2), 1-9.
- Niraula et al. 2015. Instream habitat associations among three federally threatened and a common freshwater mussel species in a southeastern watershed. Southeastern Naturalist 14 (2), 221-230.
- Niraula et al. *In prep*. Determination of sediment stability for three federally threatened species of freshwater mussels.