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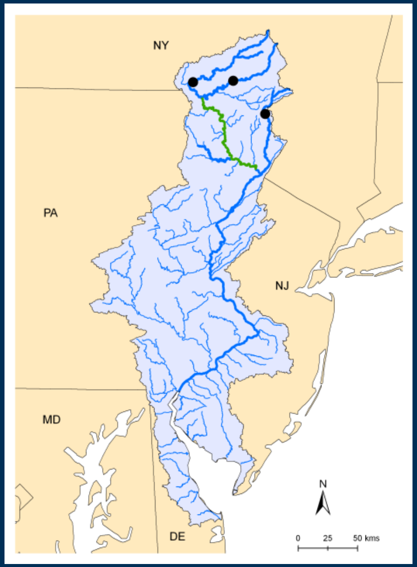
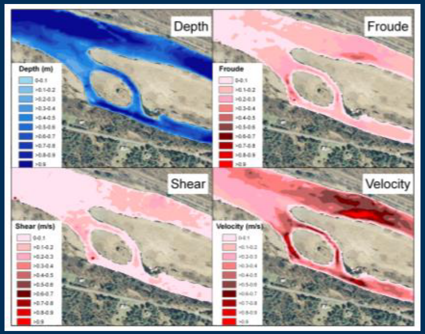
Dwarf wedgemussel: A review of current knowledge in Delaware River





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U.S. Department of the Interior
U.S. Geological Survey

Dwarf wedgemussel

Why do we care about this mussel?

- **Species listed as endangered**
  - **Implications**

Overview

What are we going to talk about:

- Distribution, Status and Demographics
- Host Fish Assessments
- Habitat Needs:
  - Water Quality
  - Ecological Flows
  - Landscape Variables
- Conclusions

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Distribution, Status, Demographics: Range-wide

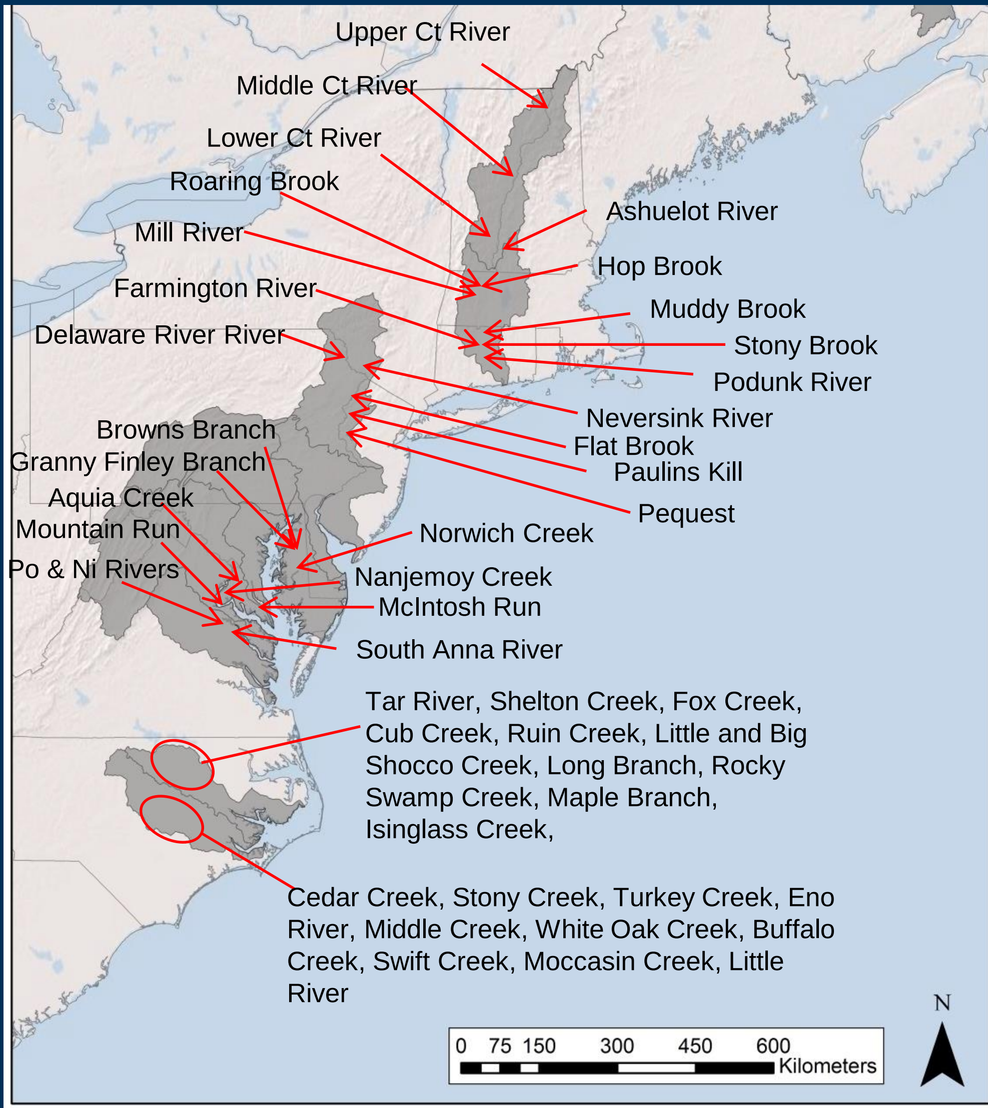

*Table created using: US Fish and Wildlife Service. "Dwarf wedgemussel (Alasmidonta heterodon) 5-year review: summary and evaluation." *US Fish and Wildlife Service, Concord, NH* (2007).

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** Preliminary Information-Subject to Revision. Not for Citation or Distribution. **

Distribution, Status, Demographics: Range-wide

Rank	Lat	Long	Site	State	River	Watershed	Est. River Length	Last Obs	Last Survey
High+	44.4071	-71.7395	Upper CT River, mainstem	NH/VT	Connecticut River	Connecticut River	16·18 miles	2001- 2005 (select sites)	2002, 2004
High	41.8600	-75.2288	Delaware River, mainstem	PA/NY	Delaware River	Delaware River	21 miles	2000 - 2001	2002
High	41.4425	-74.6004	Neversink River	NY	Neversink River	Delaware River	9 ± miles	2006, 2007	2009
High	41.1726	-74.8610	Big Flat Brook	NJ	Flat Brook	Delaware River	25 miles	2006 - 2007	2008 - 2009
High	41.1937	-74.8431	Little Flat Brook	NJ	Flat Brook	Delaware River	7 miles	2006 - 2007	2008 - 2009
High	41.1163	-74.7151	Paulins Kill	NJ	Paulins Kill	Delaware River	34 miles	2007	2017
High	38.3236	-76.6475	McIntosh Run	MD	McIntosh Run	Potomac River	~4km	2005	2005
High	42.9838	-72.3076	Ashuelot River, Golf Course	NH	Ashuelot River	Connecticut River	2 ± miles	2004, 2005	
High	39.1597	-75.9834	Browns Branch	MD	Browns Branch	Souteast Creek	~4km	2002	2004
High	42.4467	-72.6325	Upper Mill/Whately	MA	Mill River	Connecticut River	18 ± miles	2001-2005	2005, 2001

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Distribution, Status, Demographics : Delaware River

Location	Presence/Absence	Qualitative Survey	Quantitative Survey
DR Mainstem	2006, 2008, 2010, 2012, 2016, 2019	2000 - 2001	2002
Lower DR Mainstem		2013	
Neversink, NY	2012	2006 – 2007	2009
Flatbrook, NJ	2010, 2012, 2018, 2019	2006 – 2007	2008 - 2009
Paulins Kill, NJ	2016, 2019	2007	2017

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Delaware River Basin Commission
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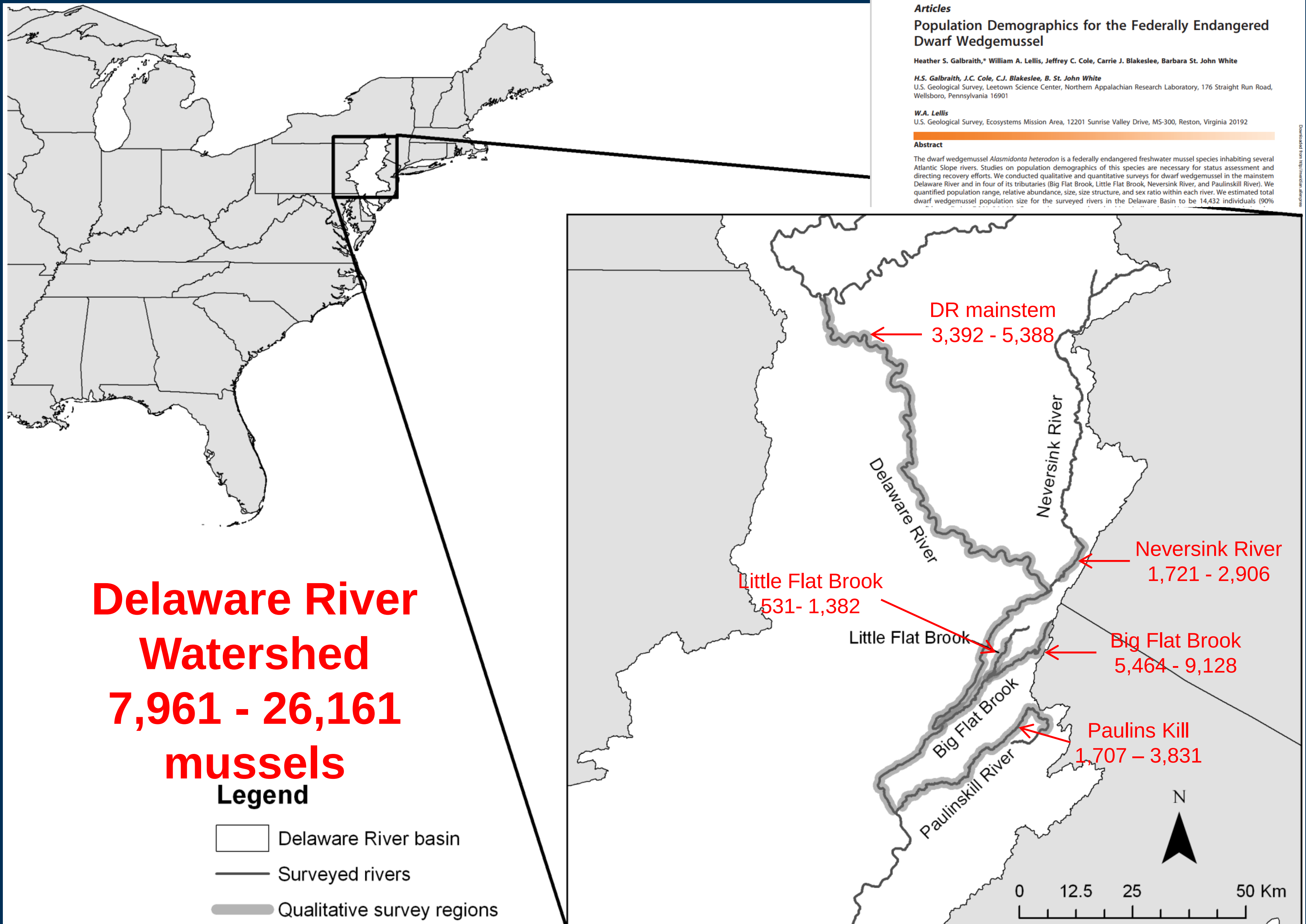
UNITED STATES OF AMERICA

NATIONAL PARK SERVICE

U.S. FISH & WILDLIFE SERVICE



Articles

Population Demographics for the Federally Endangered Dwarf Wedgemussel

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Abstract

The dwarf wedgemussel *Alasmidonta heterodon* is a federally endangered freshwater mussel species inhabiting several Atlantic Slope rivers. Studies on population demographics of this species are necessary for status assessment and directing recovery efforts. We conducted qualitative and quantitative surveys for dwarf wedgemussel in the mainstem Delaware River and in four of its tributaries (Big Flat Brook, Little Flat Brook, Neversink River, and Paulinskill River). We quantified population range, relative abundance, size, size structure, and sex ratio within each river. We estimated total dwarf wedgemussel population size for the surveyed rivers in the Delaware Basin to be 14,432 individuals (90%

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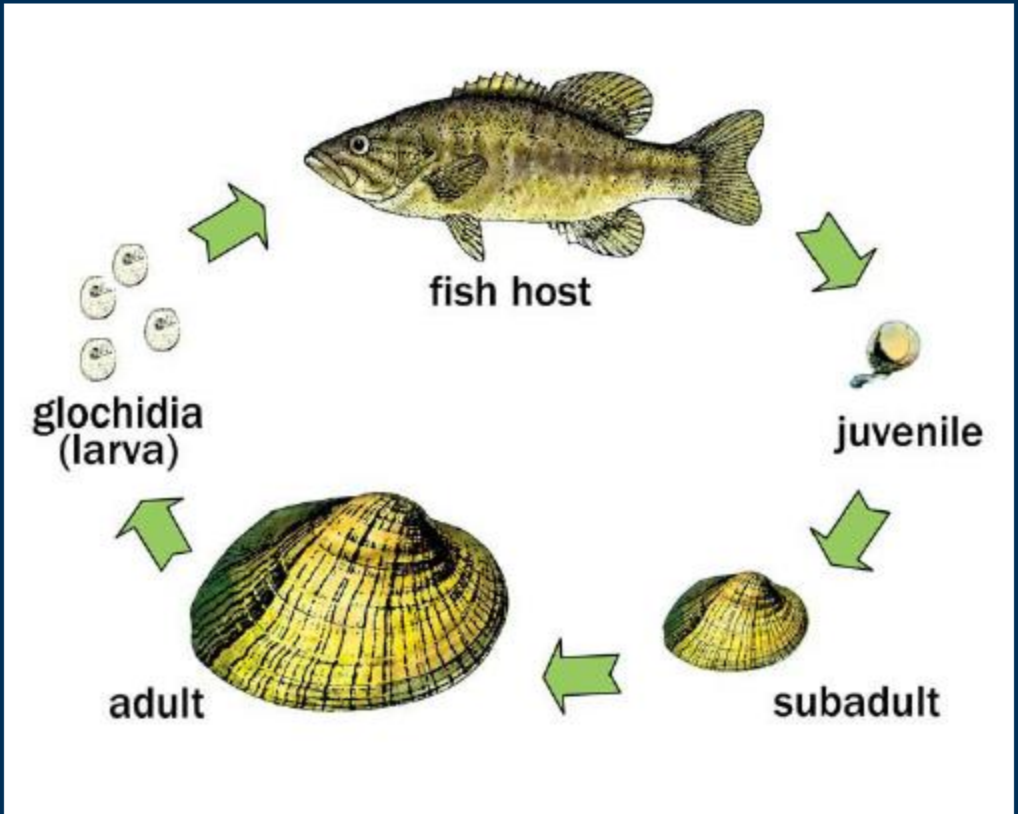
Host Fish Assessment

- Fish are important part of a healthy mussel population



(Fig 4. Wolfe & Emrick. 2011)

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Host Fish Assessment: Delaware Basin

- 32 fish tested in Delaware River (White et al. 2017)
  - Slimy Sculpin had best transformation
  - Striped Bass and Tessellated Darter 2^{nd} and 3^{rd}
- Glochidia have been observed on tessellated darter in field
- Some common species not tested yet
  - Shad, Herring, American eel
- Host fish differs by river system
  - Delaware River study (White et al. 2017) most relevant to basin

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Water Quality: Delaware Basin

- **Dwarf wedgmussels are sensitive to water quality**
  - **Ca <27mg/L** (Strayer 1993, Campbell & Prestegaard 2016)
  - **Specific Conductance <250**μS/cm (Campbell & Prestegaard 2016)
  - **Chlorine** (Valenti et al.2006, Wang et al.2007)
  - **Copper** (Wang et al.2007)
  - **Ammonia** (Wang et al.2007)

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Ecological Flow Needs

- Includes all components of flow and flow-dependent variables
  - Velocity
  - Depth
  - Other flow-related properties:
    - Shear stress, Froude, Reynold’s number
    - Substrate
  - Change in water levels
  - Temperature
  - Linked to water quality
    - Flow quantity related to temperature

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Ecological Flow Needs: Delaware Basin
Velocity, Substrate, and Depth

- **Moderate velocity areas with uniform flow** (Strayer & Ralley 1993, Maloney et al. 2012, Parasiewicz et al. 2012, and Michaelson & Neves, 1995)
- **Areas with fine sediment** (Strayer & Ralley 1993, Michaelson & Neves, 1995)
- **Moderately deep, slow-flowing, and non-turbulent habitat** (Strayer & Ralley 1993, Maloney et al. 2012, Parasiewicz et al. 2012, Michaelson & Neves, 1995, and Galbraith et al. 2016)
- **"Stable"** (Maloney et al. 2012) **and "persistent" habitats** (Strayer & Ralley 1993, Maloney et al. 2012, and Galbraith et al. 2016)
- **Need to understand the interactions between flow regime and water quality**

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Habitat: *Thermal*

- **Thermally sensitive relative to other species** (White et al. 2017, Galbraith et al. 2020, Cole et al. 2018, and Briggs et al. 2013)
  - **Prefer cooler water temperatures compared to other mussel species**
- **Still require thermal queues for basic life history, growth, and survival**
  - **Do not exceed natural variability in magnitude, frequency, and duration**
- **Host fish are generally cooler temperature species as well** (Raymond & Rinne 1980, Feminella & Matthews 1984, Galbraith et al. 2012)
  - **Groundwater shown to be important component of habitat** (Briggs et al. 2013)

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DWM life cycle: Thermal effects

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Gametogenesis

Delayed or no gametogenesis; increased prevalence of sterilizing trematodes

Spawning and fertilization

Delayed or no spawning; stress-induced release of sperm

Gravid females brood young

Delayed or no brood development; brood abortion

Reduced infestation rates on host fish; delayed transformation on host fish

Glochidial release and host attachment

***Yellow blocks indicate what happens from water temperatures outside of optimal range*

Citations: Hruska 1992; Matteson 1948; McMurray et al. 1999; Watters 2000 (and references included in citations)

Ecological Flow Needs: Delaware Basin
Change in water levels/emersion

- **Callicoon site gets occluded 424 – 452 cfs** (Maloney et al. 2012, Cole et al. 2018)
- **Minimally wetted (10 cm)** (Cole et al. 2018)
    - **Over DWM – 558 cfs**
    - **Over all mussels – 929 cfs**

- **Sensitive to dewatering** (Galbraith et al.2020, Cole et al. 2018, Campbell 2014)
    - **No dewatering behavior**
    - **Die if dewatered**
    - **Dewatered themselves**
    - **Intolerant to emersion (gaping in 60% after 30 min)**

Received: 19 April 2017 | Revised: 12 April 2018 | Accepted: 13 April 2018
DOI: 10.1002/rra.3326

RESEARCH ARTICLE

WILEY

Using United States Geological Survey stream gages to predict flow and temperature conditions to maintain freshwater mussel habitat

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Behavioral responses of freshwater mussels to experimental dewatering

Heather S. Galbraith[1,3], Carrie J. Blakeslee[1,4], and William A. Lellis[2,5]

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Ecological Flow Needs: Additional Considerations

- **Flow and thermal variability linkages on reproduction and other life stages**
- **Implication of GW input and resulting thermal impacts** (Briggs et al 2013)
  - **Seasonal importance?**

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Landscape Variables

- Low levels of development, channel size, and % open canopy identified as important (Baldigo et al. 2008, Locke et al. 2003, Campbell 2014)
- Dams identified as bad for mussel and host fish (Baldigo et al. 2004, Baldigo et al. 2008, Locke et al. 2003)
- Flooding increases scouring which is bad for mussels
  - Likely to increase with climate change

Final Thoughts

- Delaware River is 2nd largest population
  - Need to protect populations with the basin
- River flow management is critical to species protection
- Climate change is going to increase this importance
- Overall in Delaware River
  - A lot of data on Dwarf wedgemussel habitat
  - Consistent data within the basin and across range
    - Velocity: 0.04-3.3 m/s
    - Temps: 10-30ºC
    - No emersion
    - Calcium: <27 mg/L
- Welcome future coordination with RFAC to explore ways flow management can be more protective of the species

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Thanks!

- Randy Bennett, USGS
- Ken Bovee, USGS
- Robert Deems, USGS
- David Dropkins, USGS
- Leanne Hanson, USGS
- Christopher Holmquist-Johnson, USGS
- William Lellis, USGS
- Kelly Maloney, USGS
- Erik Silldorff, Delaware River Keeper
- Daniel Spooner, LHU
- Terry Waddle, USGS
- Various field crews

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- **Table and map created from** US Fish and Wildlife Service. "Dwarf wedgemussel (Alasmidonta heterodon) 5-year review: summary and evaluation." *US Fish and Wildlife Service, Concord, NH* (2007).
- **Figure taken from: Wolf, Eric & Emrick, Verl. (2011). PROPAGATION AND CULTURE OF SPECIES AT RISK ATLANTIC PIGTOE.**

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Thermal Effects (slide 15) table created using

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