Refining Quagga Habitat Suitability Models

Amy H. Yarnall, Carra C. Carrillo, Safra Altman, Emily Russ, Jacque A. Keele,
Sherri F. Pucherelli, Yale J. Passamaneck, Aaron C. Murphy, and Todd M. Swannack

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USBR – ERDC collaboration

- Collaboration began in FY 2014
  - This project began in FY 2021
- Collaboration with ERDC Integrated Ecological Modeling Team & USBR Ecological Research Lab
- Combined field-based expertise and ecological modeling to develop quantitative toolkit to (1) forecast potential dispersal of invasive mussels and (2) quantify if water levels are correlated with established populations

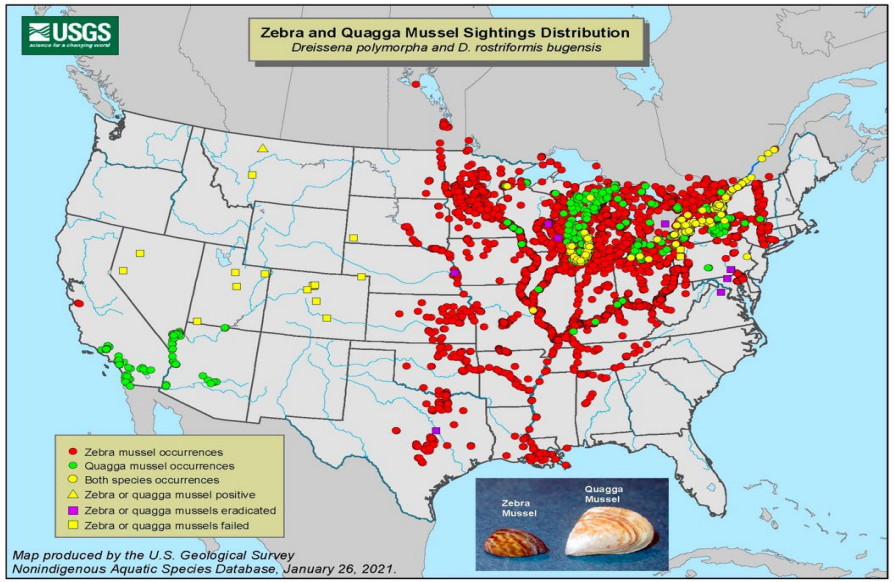
Not pictured: Aaron, Amy,, Emily, Safra

USBR

Jacque Keele, Sherri Pucherelli, Yale Passamaneck, Aaron Murphy

ERDC

Todd Swannack, Safra Altman, Carra Carrillo, Emily Russ, Amy Yarnall

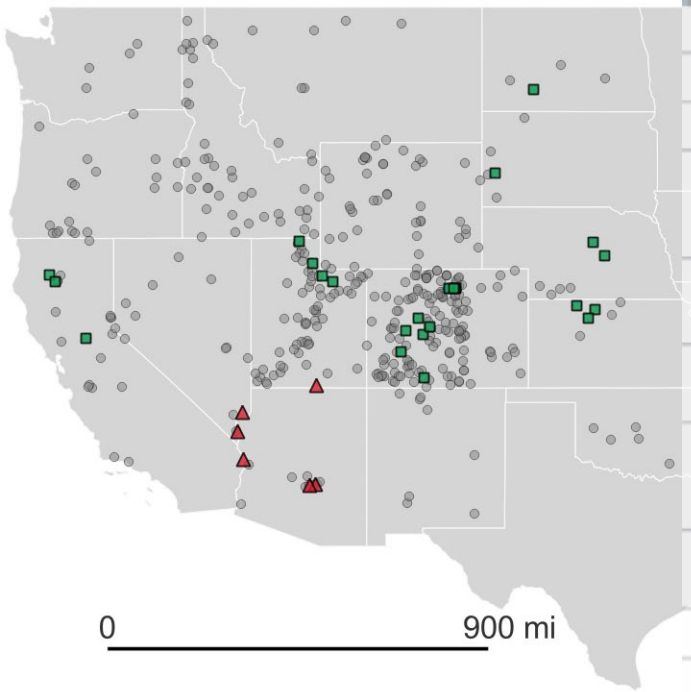


Dreissenid mussels

- Highly invasive aquatic species
- Introduced in 1986 (zebra) and 1989 (quagga)
- $1 billion in damage annually
- Big questions:
  - Where will they go next?
  - What drives successful colonization?
  - What are the water quality parameters that link to habitat suitability? *(Work in collaboration with SRP)*
  - How does water management relate to population status? *(This project)*

Study system

n = 42



Parameter	Dreissenid Infestation Thresholds
Salinity	<5 ppt
Calcium	>25 mg/L[1]
pH	7.4-9.5
Substrates	Prefer hard substrates but may be found on soft substrates
Depth in lake	Surface to >120 m; Prefer depths <30 m
Temperature-range for survival	5-30°C[1]
Temperature- optimal for reproduction and growth	16°C
Temperature-minimum for reproduction	9°C[1]
Lethal Temperature	32-35°C
DO- minimum required for survival	>2 mg/L[1]

United Water Conservation District, 2017

Established = 6

not shown Suspect = 12

Negative = 24

Western U.S. susceptible waterbodies

- Most Western US reservoirs have favorable conditions for quagga colonization
- Western US reservoirs are hydrologically different from well studied invaded waterbodies
- Hydrology characteristics have been less extensively studied

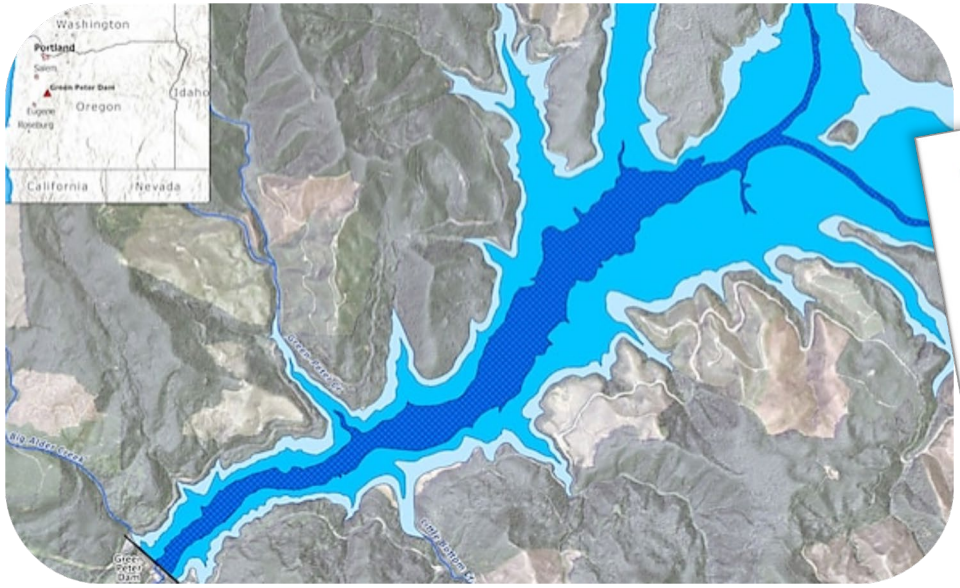
Drawdown event definition

Criteria for event start:

1. The water level decreases by ≥0.2 ft from the day prior (Day 0) and
2. remains at or below that threshold for ≥5 consecutive days.

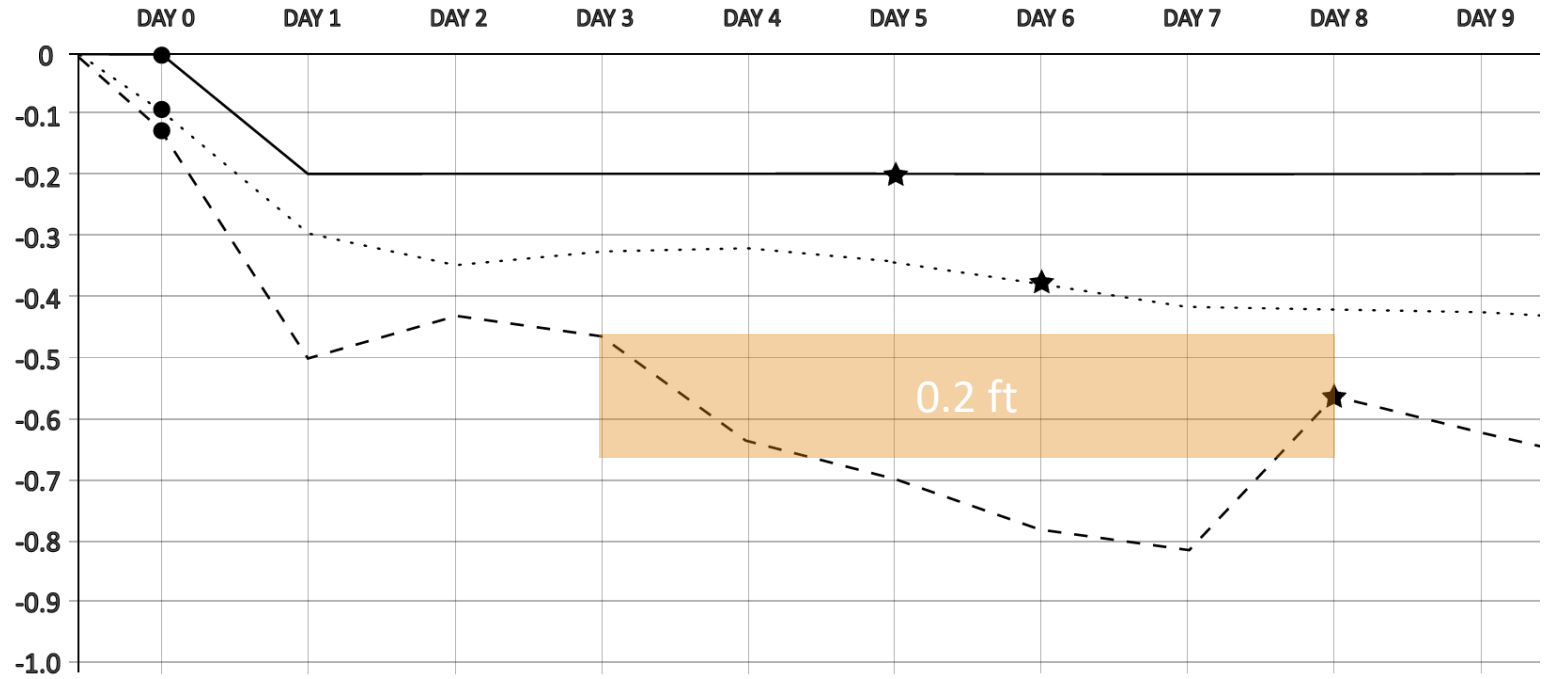
Criterion for event end:

1. Triggered on Day 5 or beyond if the water level is within 0.2 ft of or surpasses the level of 5 days prior.



Green Peter Lake
Deep Drawdown to
780 Feet (NGVD29)

US Army Corps of Engineers
Portland District



Drawdown properties examined

Annual frequency (no. y^{-1})	Mean interval duration (d)	Mean duration (d)	Percent of year in drawdown (%)
Mode season of occurrence	Mean elevation change (ft)	Mean rate of elevation change (ft d^{-1})	Mean elevation percent change (%)

Frequency Duration Seasonality Magnitude Rate

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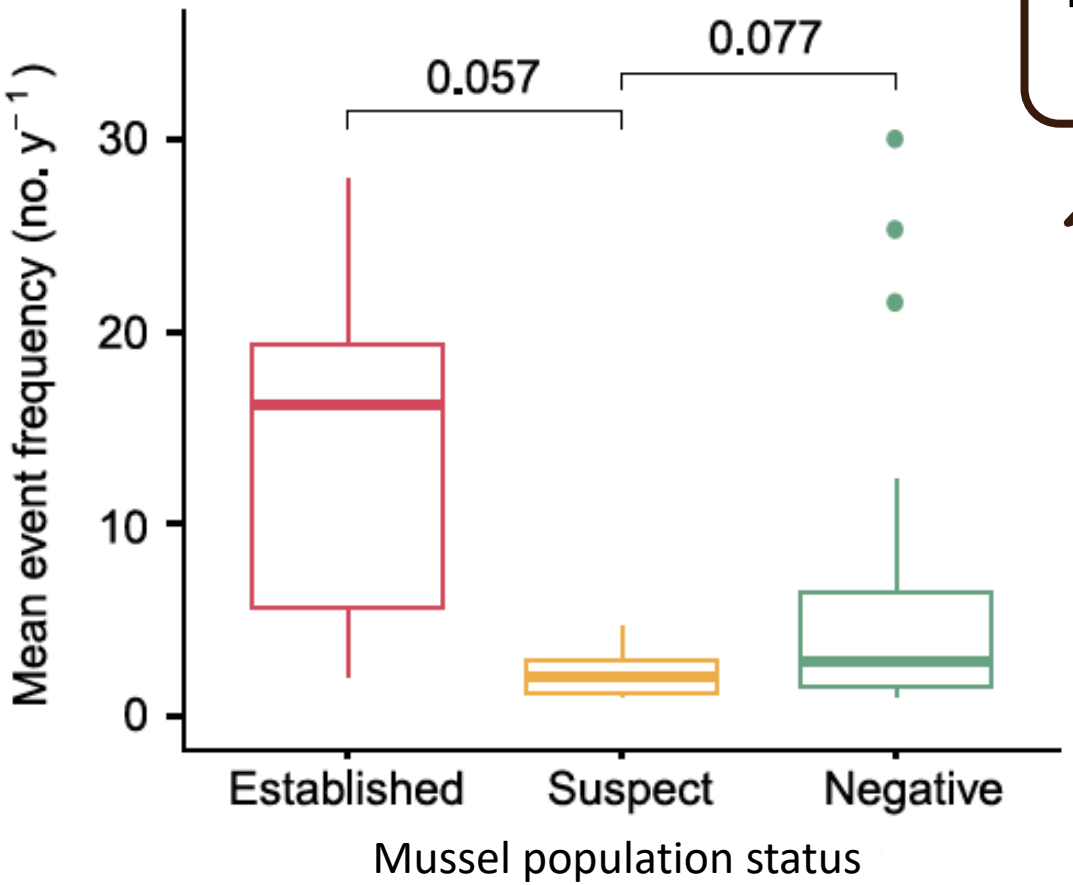
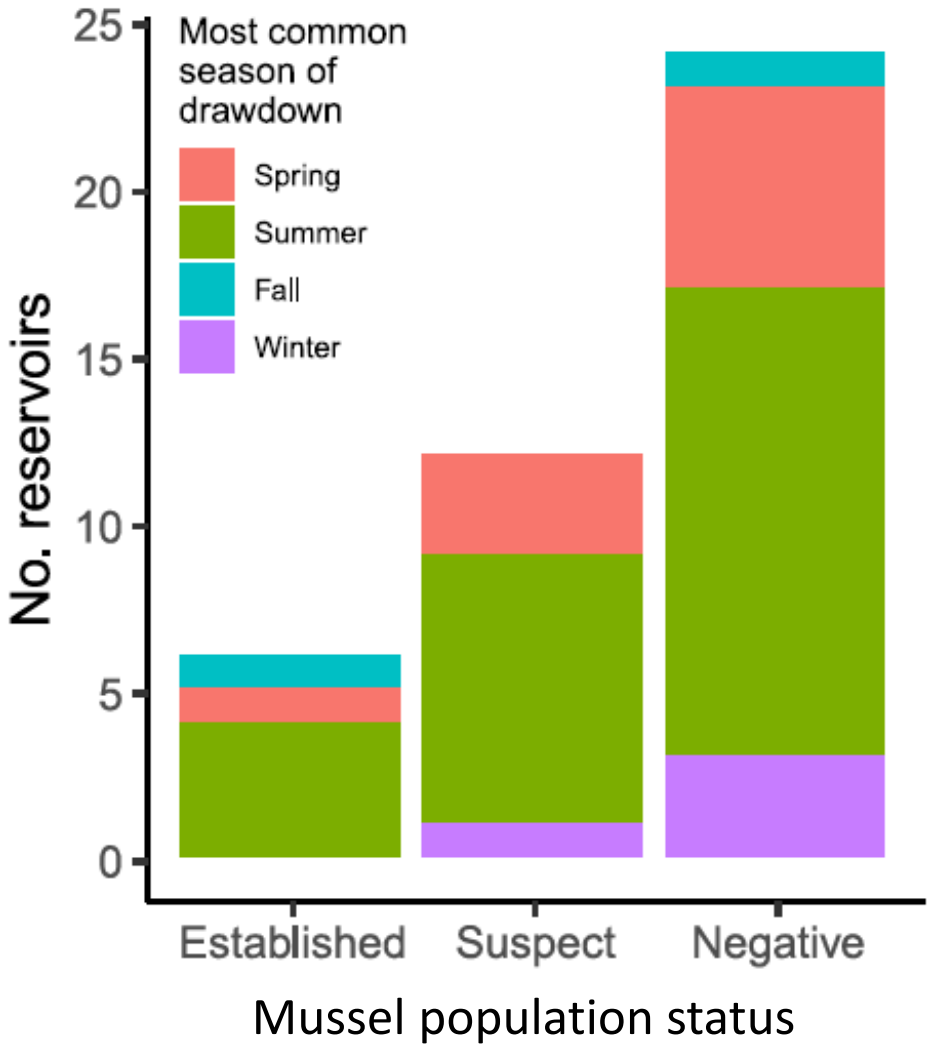
Annual frequency (no. y^{-1})



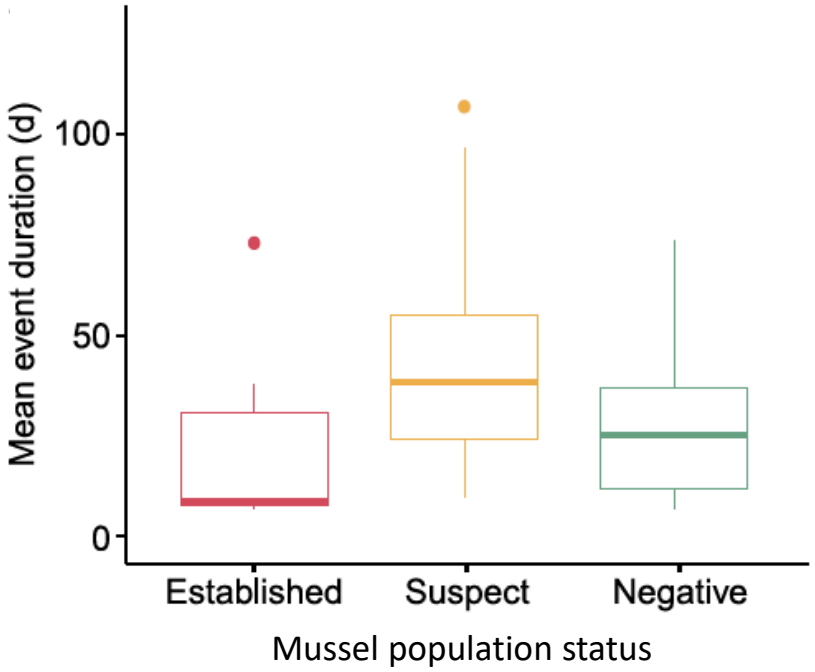
Established reservoirs experience more frequent drawdowns

Mode season of occurrence



Mode seasonality does not differ among statuses

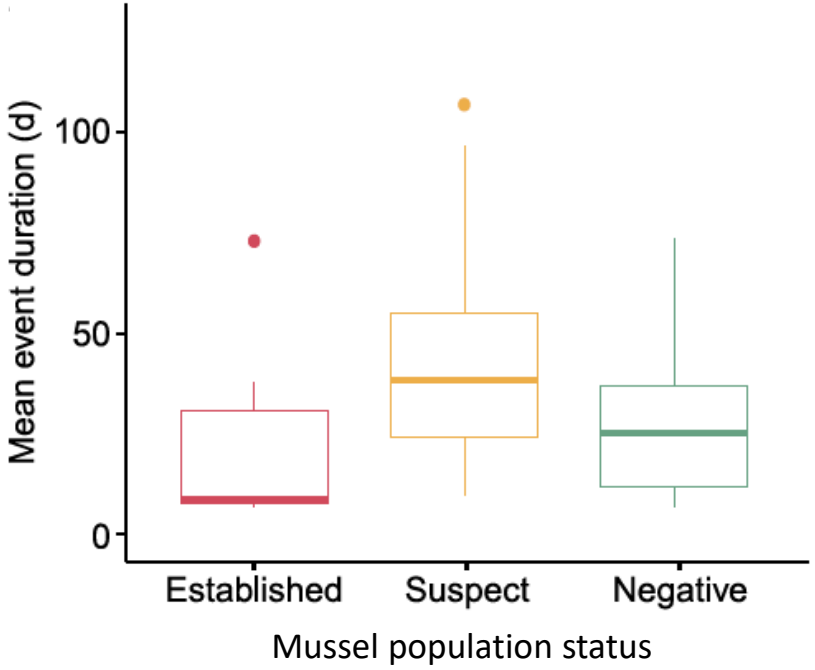
Mean duration (d)

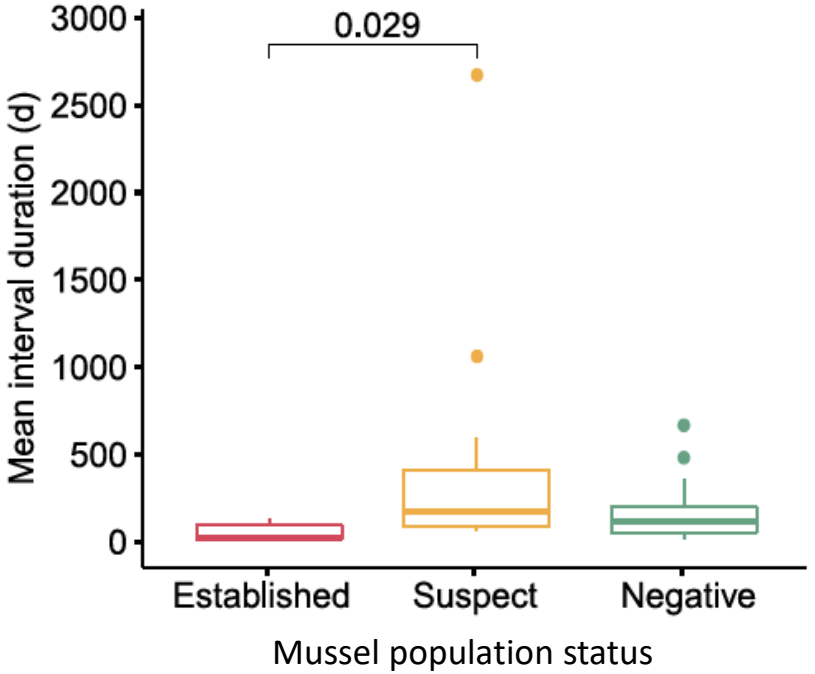


Event durations are 4x longer in suspect reservoirs

Mean duration (d)

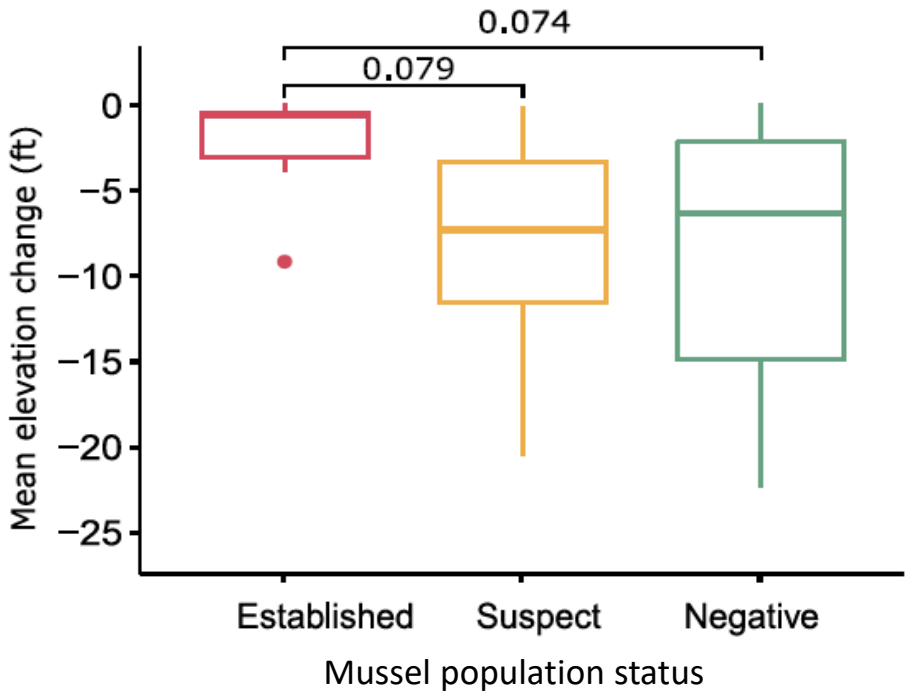
Mean interval duration (d)





Interval durations are significantly longer in suspect reservoirs

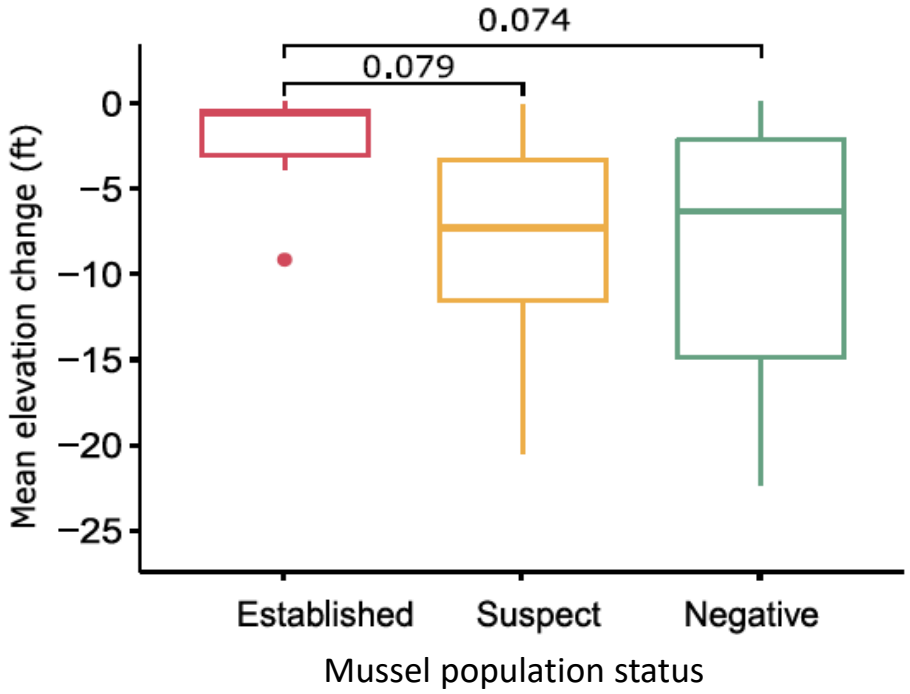
Mean elevation change (ft)

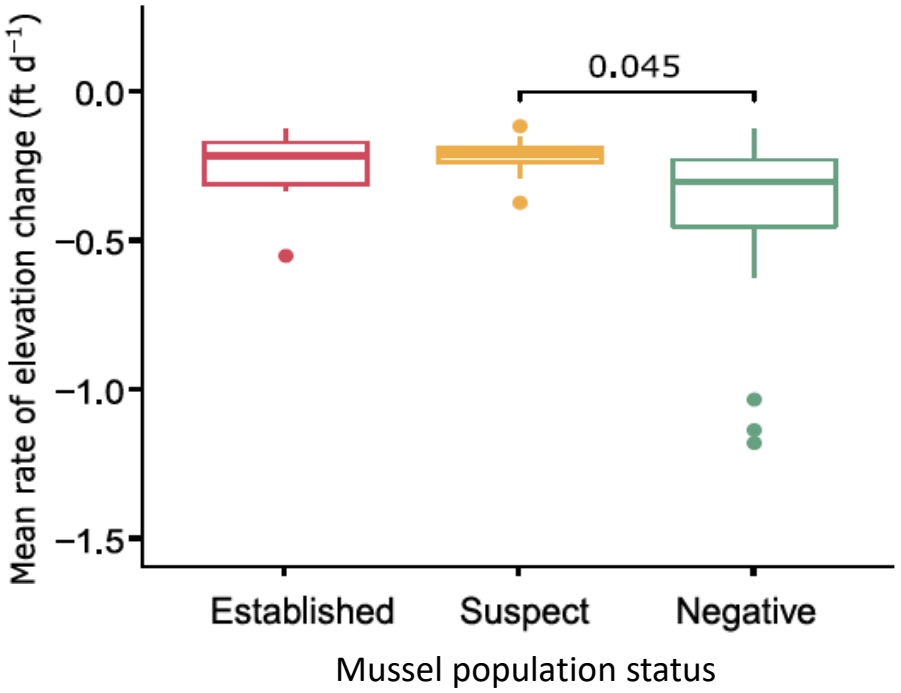


Suspect and negative reservoirs experience 5x larger drawdowns than established

Mean elevation change (ft)

Mean rate of elevation change (ft d^{-1})





Differences in rates do not appear to explain invasion dynamics

Drawdown properties with promise* for quagga invasion prevention

Mean elevation change (ft)

Mean duration (d)

*** Status comparisons are not statistically significant**

Magnitude

- Suspect & Negative 5x greater water level decline vs. Established
  - Larger drawdowns (≥7 ft) mean more benthos and proportion mussel population exposure
  - Established reservoirs have small-magnitude drawdowns
    - Mussel populations exist entirely below the level of water level decline

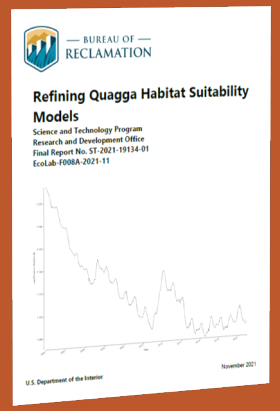
Duration

- Suspect 4x longer drawdowns vs. Established
  - Longer exposure periods (≥40 d) can negatively impact quagga mussel settlers and adults
  - Established reservoirs have shorter duration drawdowns
    - Sub-lethal exposure period

Established reservoirs have frequent, short-duration, small-magnitude drawdowns

- These reservoir storage dynamics more closely resemble natural lakes, to which quaggas are well adapted

Next steps...



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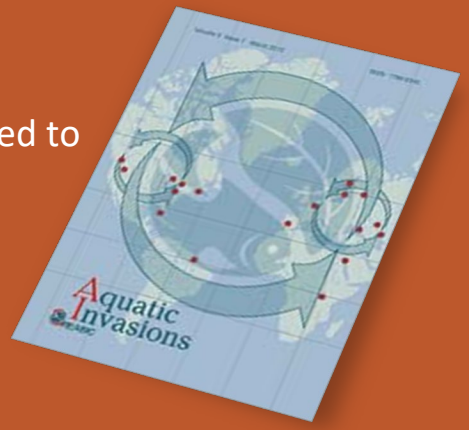

Drawdown magnitude and duration patterns observed in suspect reservoirs may inform invasion prevention strategies.

This work can help refine the boater behavior model to provide more accurate predictions of mussel colonization

Drawdown properties could be incorporated into further water quality analysis work underway in collaboration with the Salt River Project.

Photo courtesy of iStock/Getty Images

Questions?

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