

A case study on the Santa Cruz River: Can Treated Wastewater Support Desert Fishes?

Drew Eppehimer, Kelsey Hollien, Zach Nemec, Hamdhani, Larissa Lee, David Quanrud, Michael Bogan
School of Natural Resources and the Environment
University of Arizona



WRRC Brown Bag Seminar
March 28th, 2019
Tucson, Arizona

Funding

Lincoln Institute Babbitt Dissertation Fellowship
Southern Arizona Environmental Management Society
UA Graduate and Professional Student Council
UA WRRC 104b Grant Program
WaterReuse Arizona



LINCOLN INSTITUTE
OF LAND POLICY



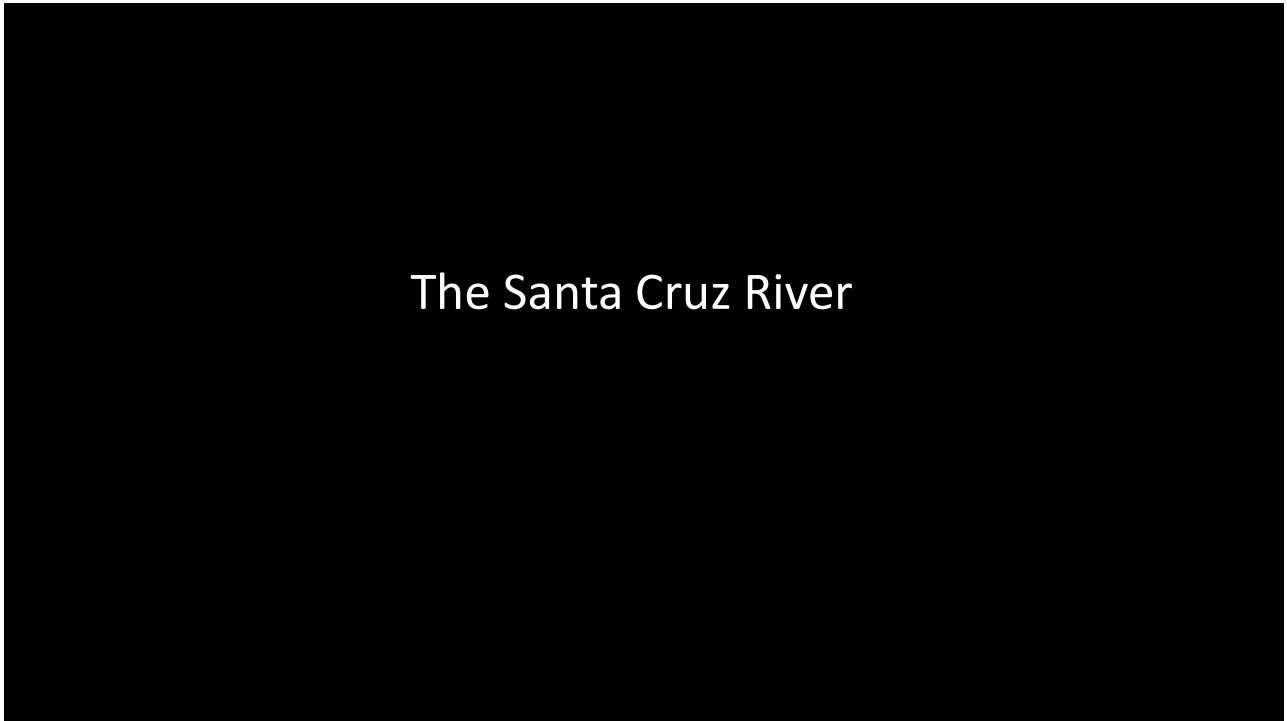
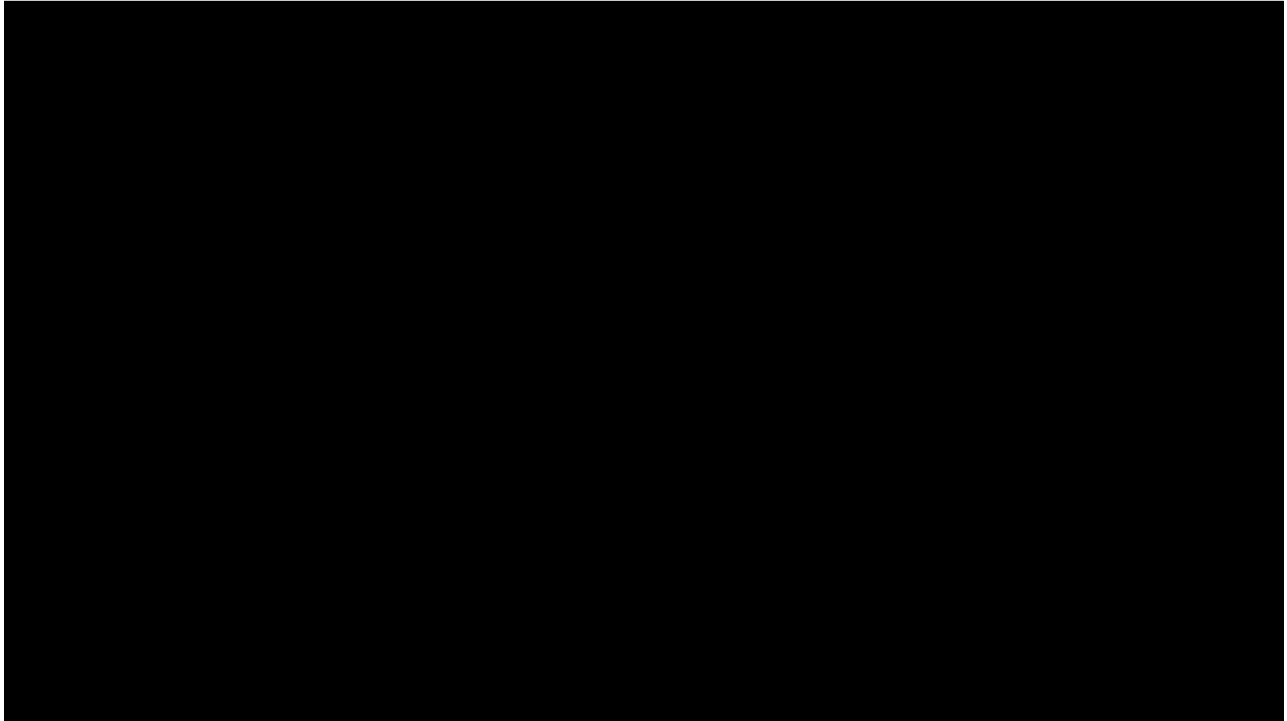
SAE
MS



COLLEGE OF
AGRICULTURE
& LIFE SCIENCES
WATER RESOURCES
RESEARCH CENTER

GRADUATE &
PROFESSIONAL
STUDENT COUNCIL





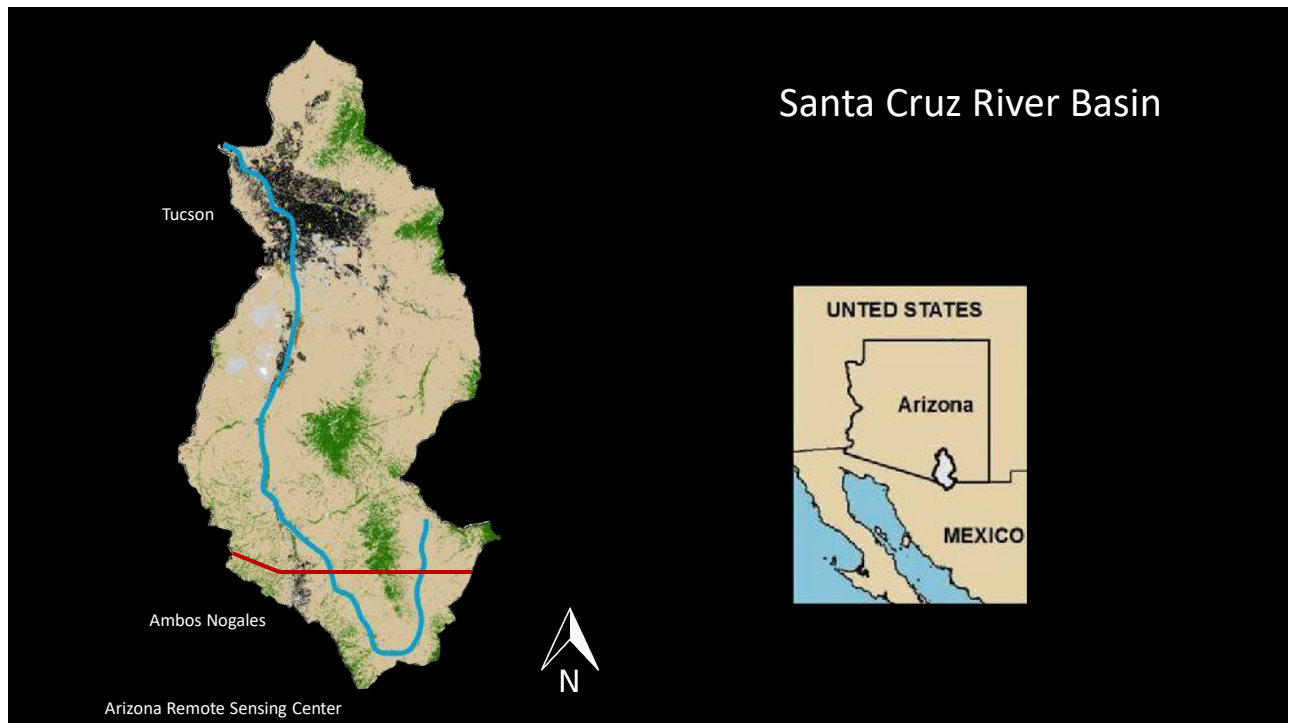




Photo Credit: Jeff Smith



Photo Credit: Hamdhani



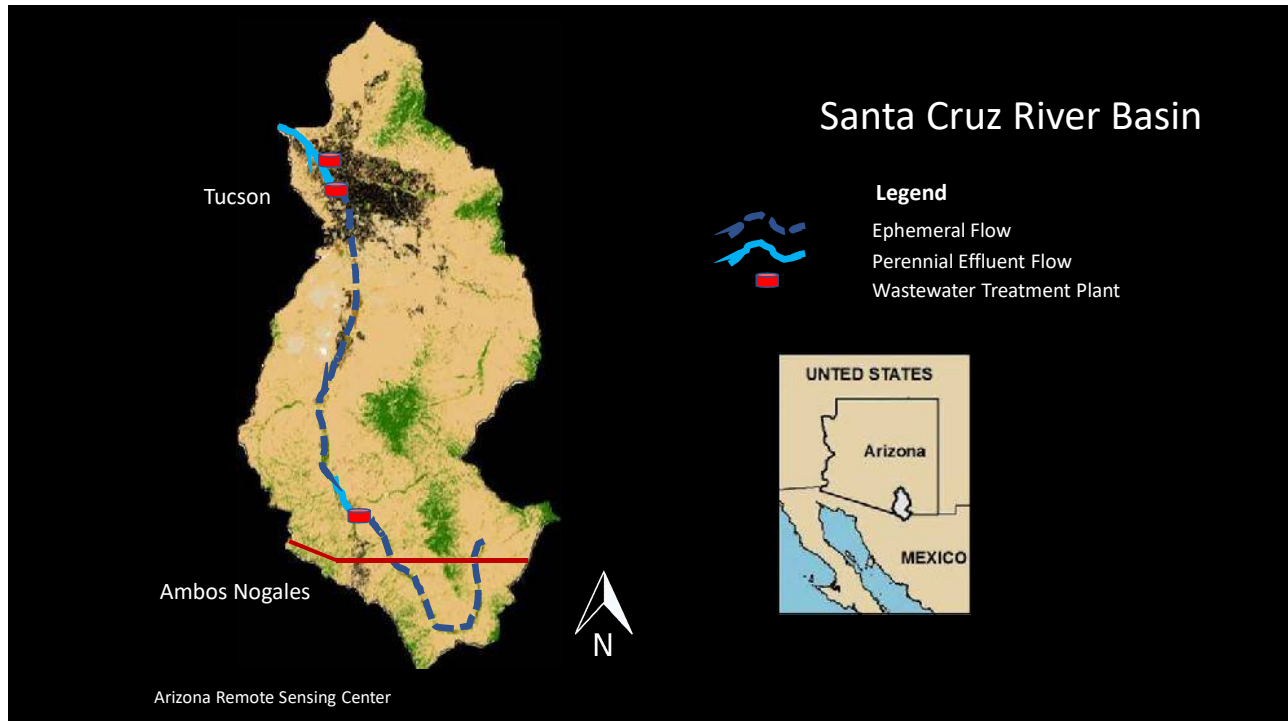
Photo Credit: Hamdhani

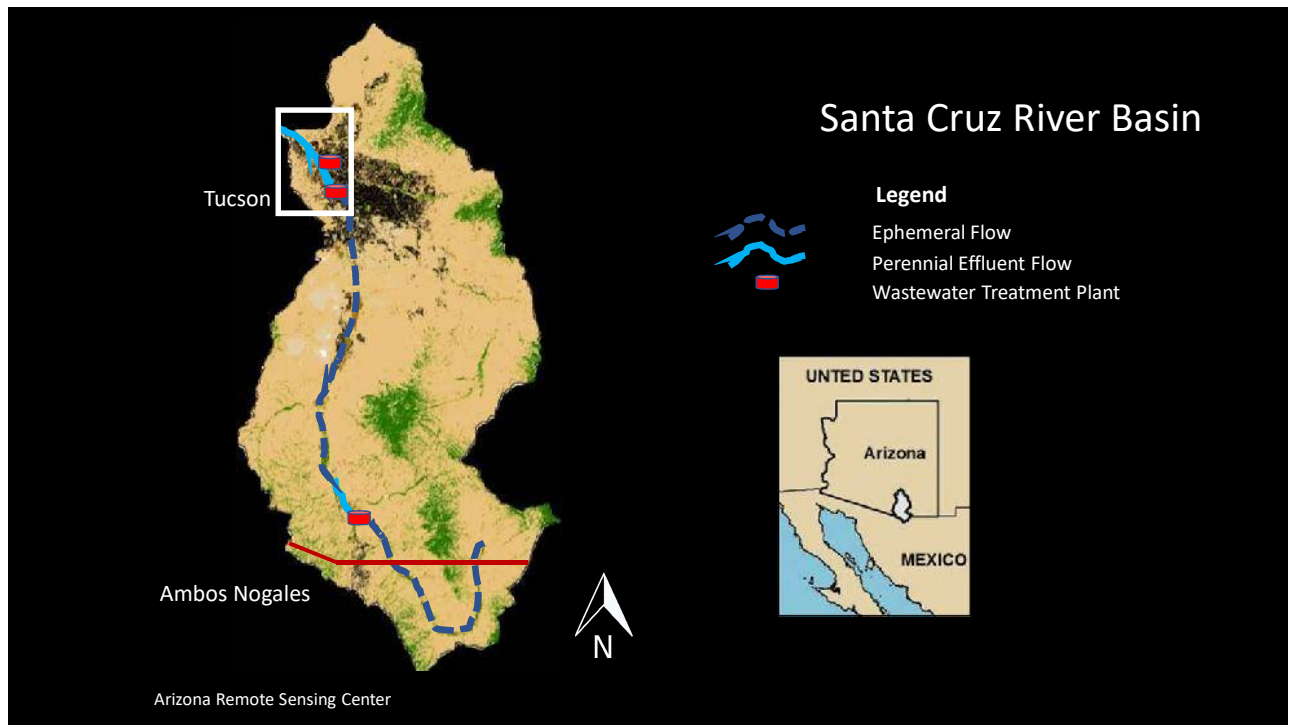
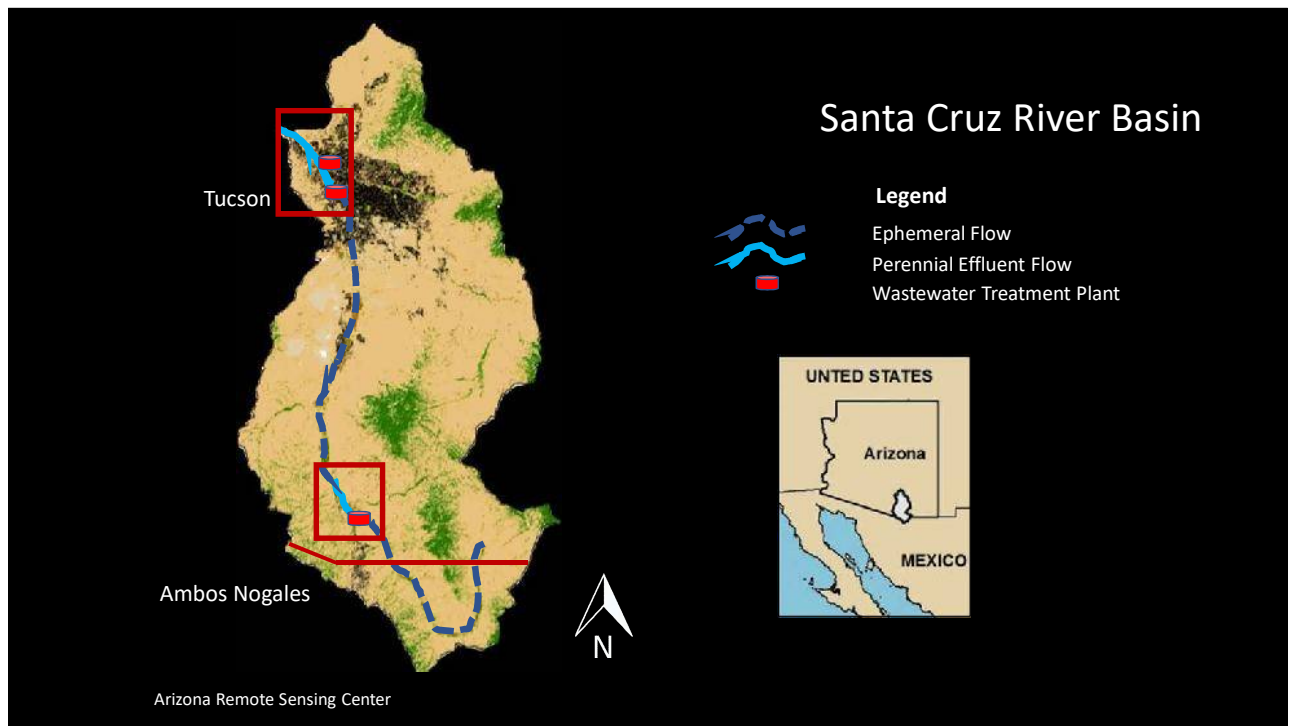


Photo Credit: CH2M



Photo Credit: Drew Eppehimer





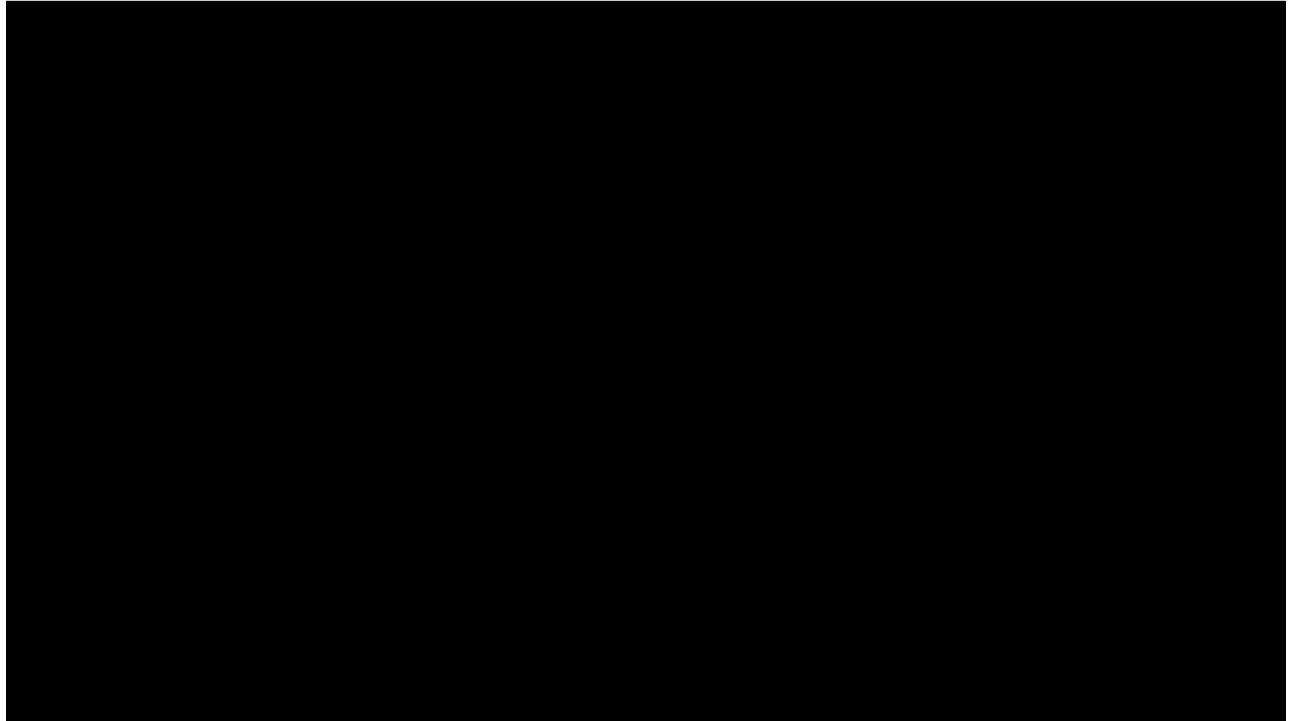
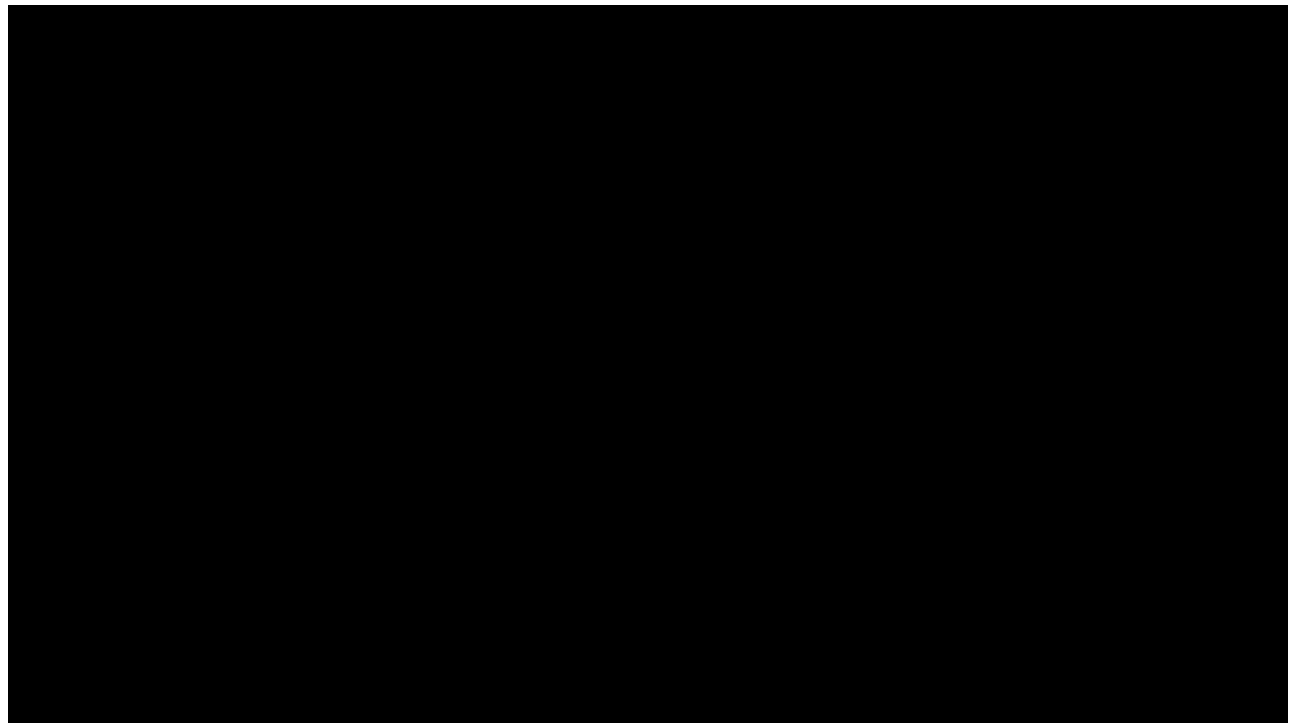
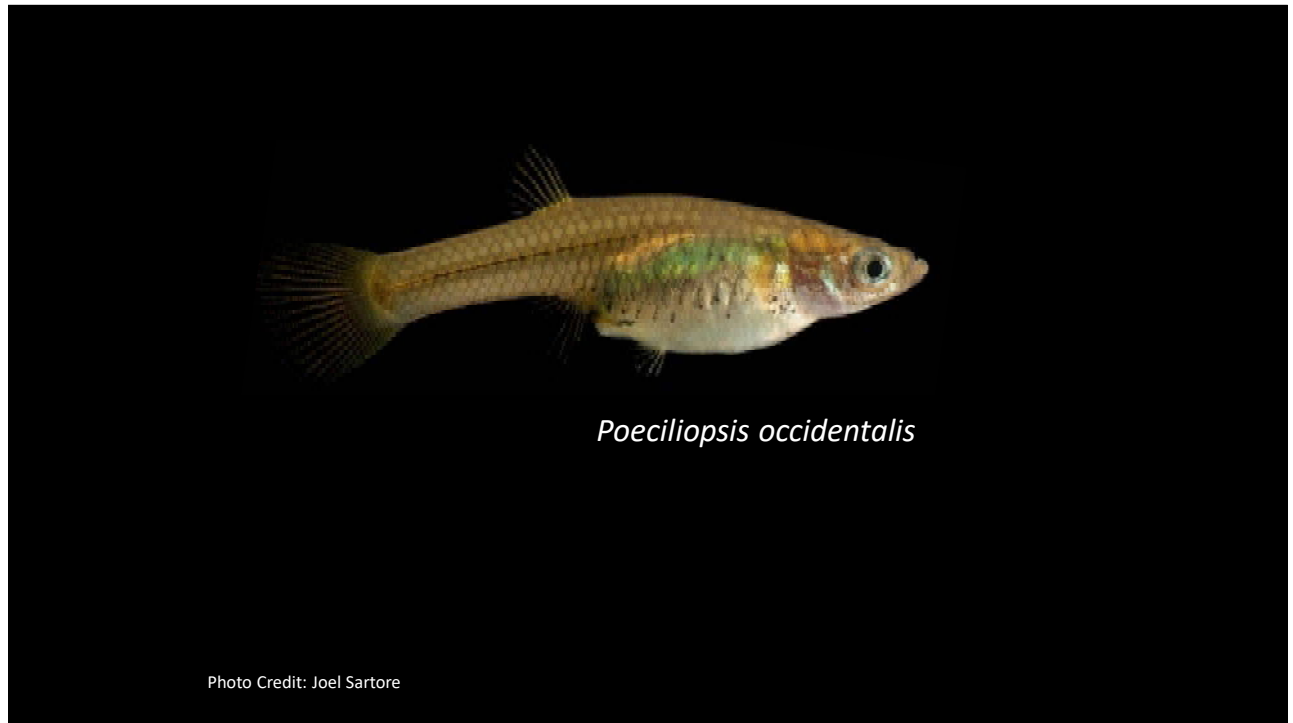


Photo Credit: Michael Bogan

Photo Credit: Michael Bogan



Photo Credit: Hamdhani

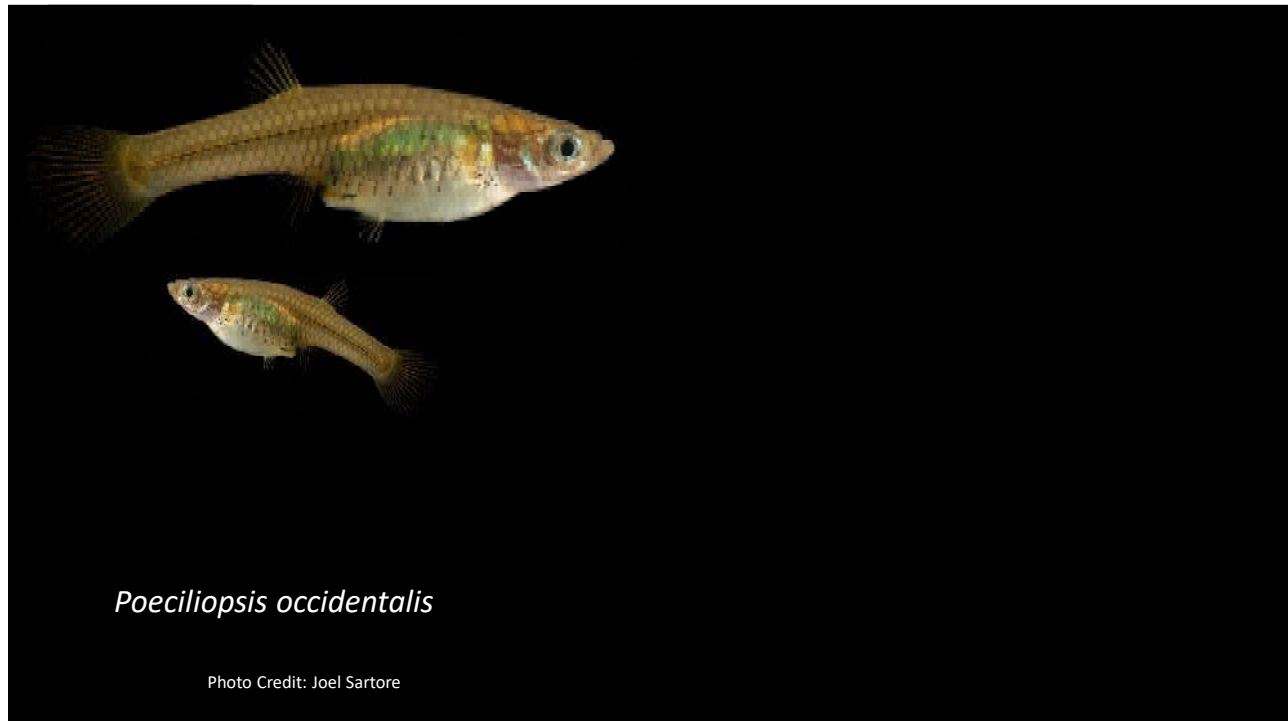


What are the implications of using treated wastewater as habitat for desert fishes?

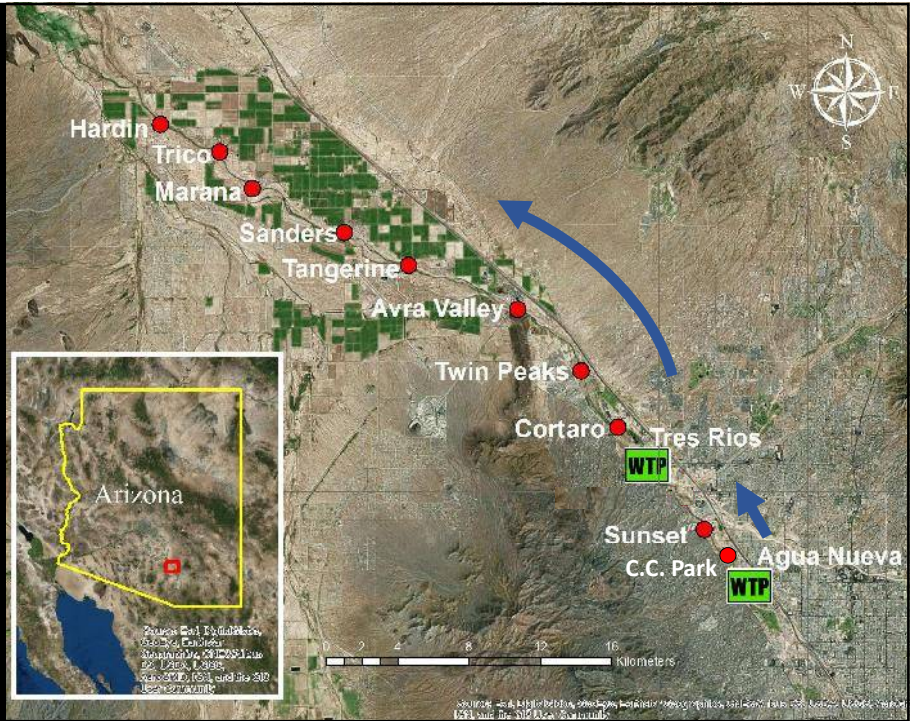
What are the implications of using treated wastewater as habitat for desert fishes?

Potential issues

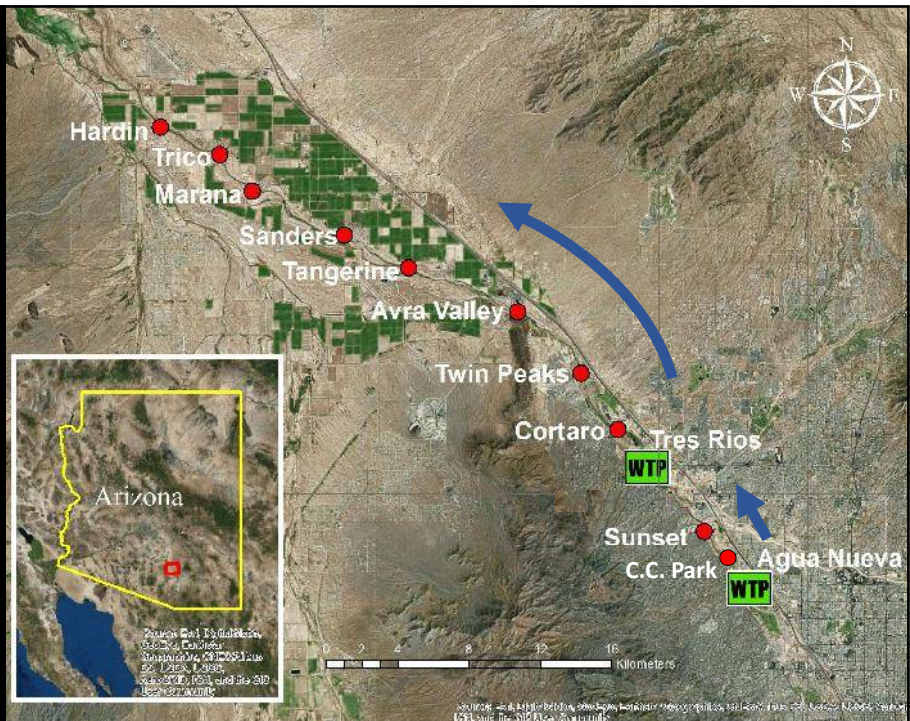
1. Impacts from artificial flow regime?
2. CECs changing sex morphology?
3. Altered diets?



Sampling



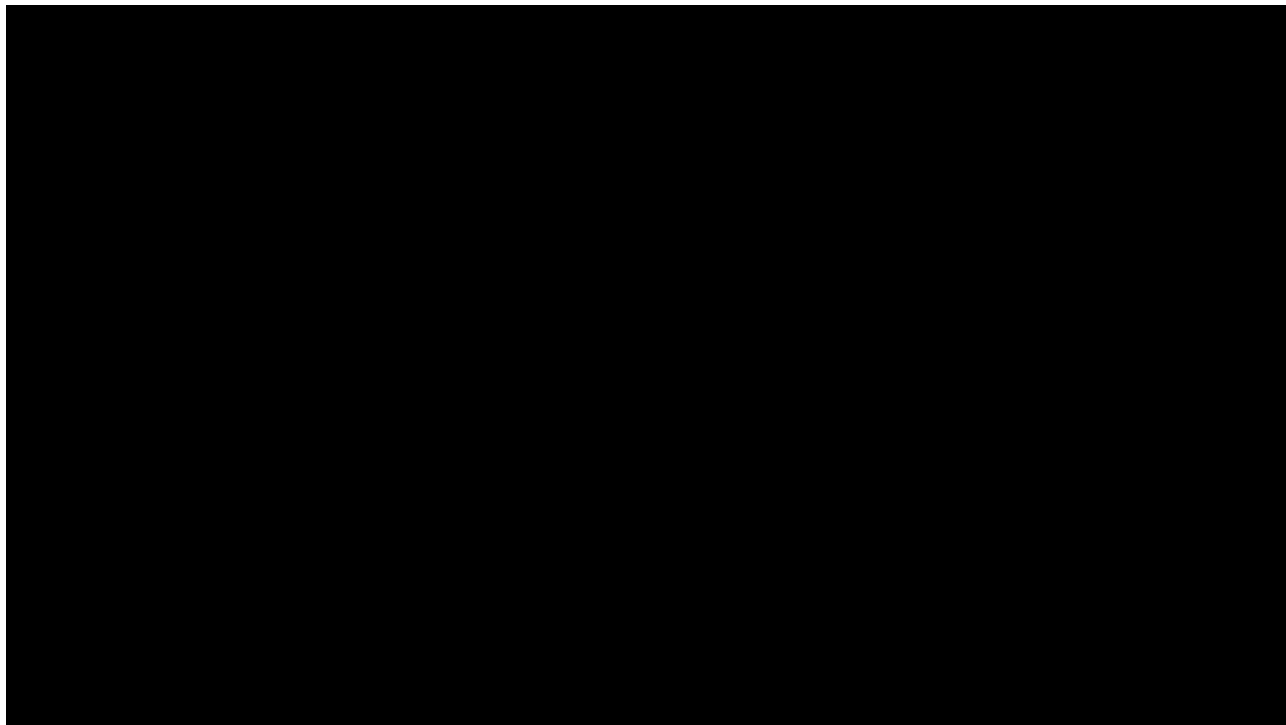
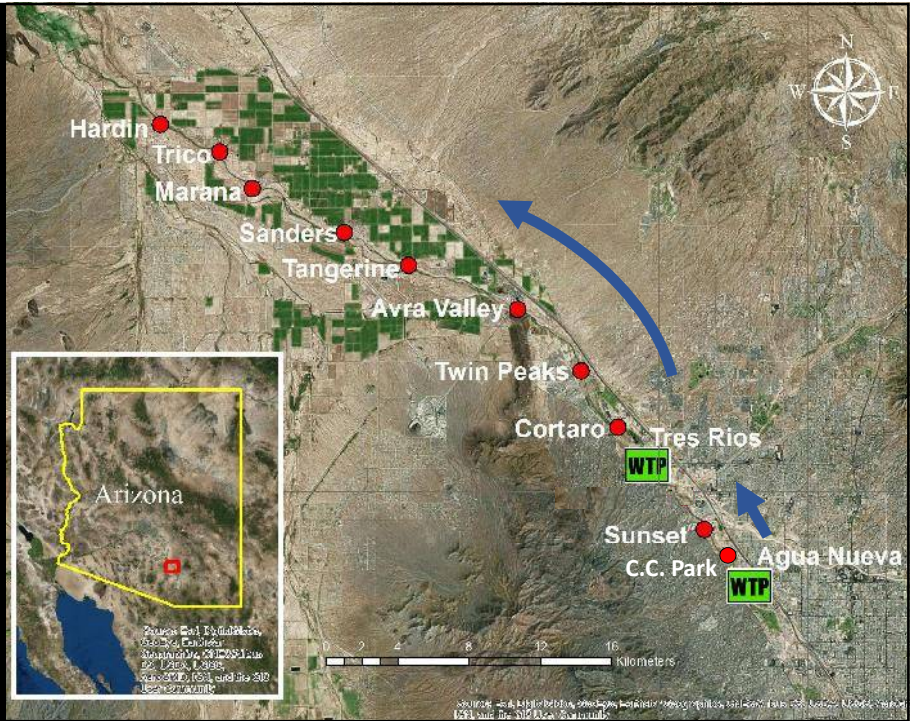
10 sites
~4km apart
2 WRFs
150m transect



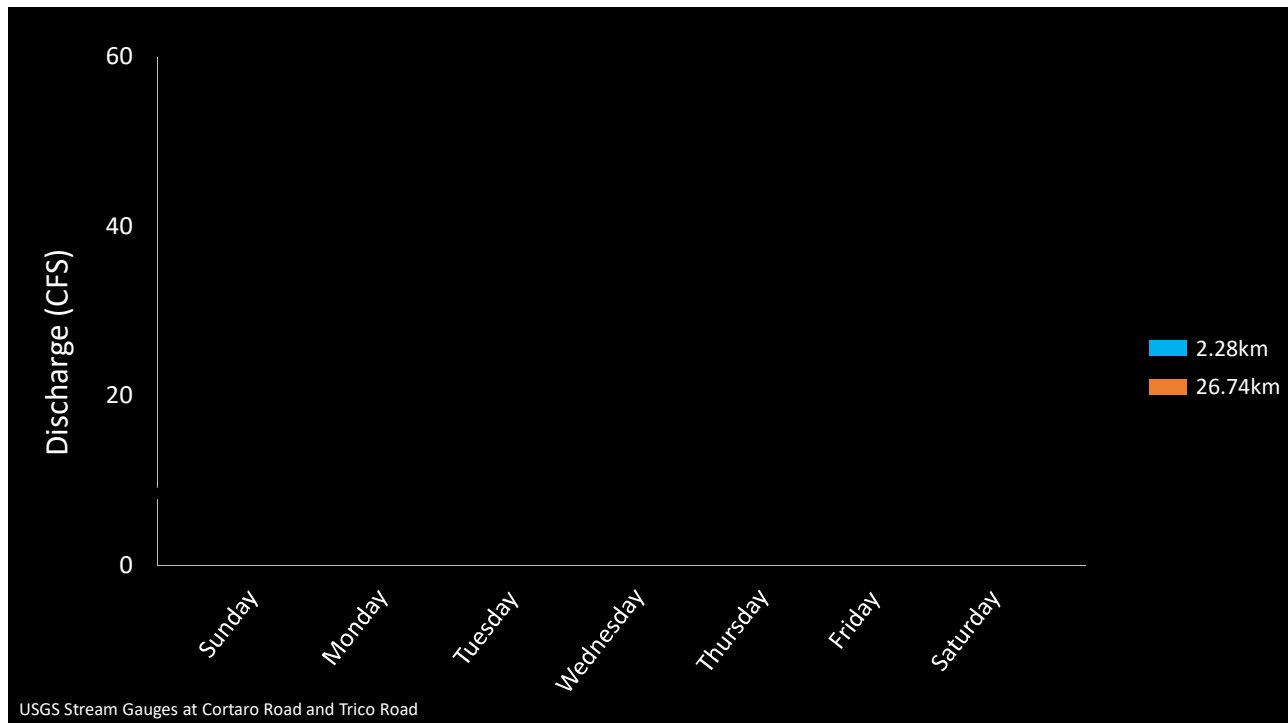
Sampling

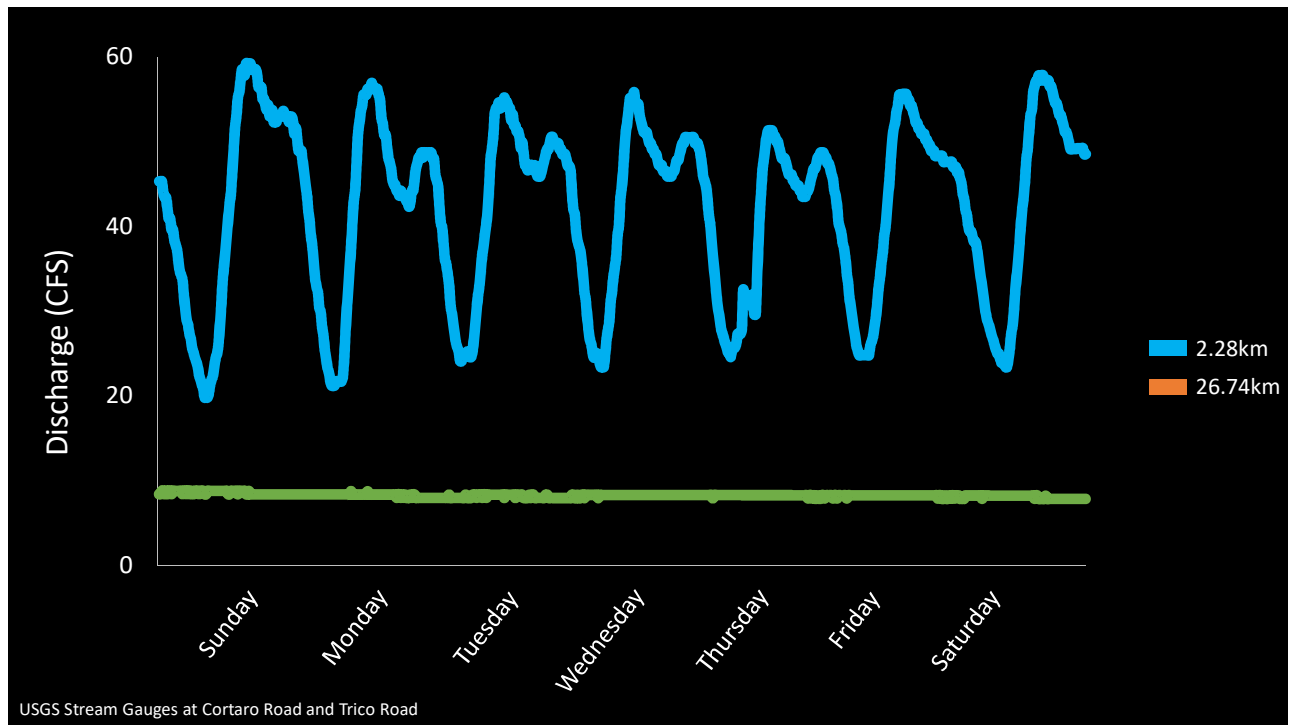
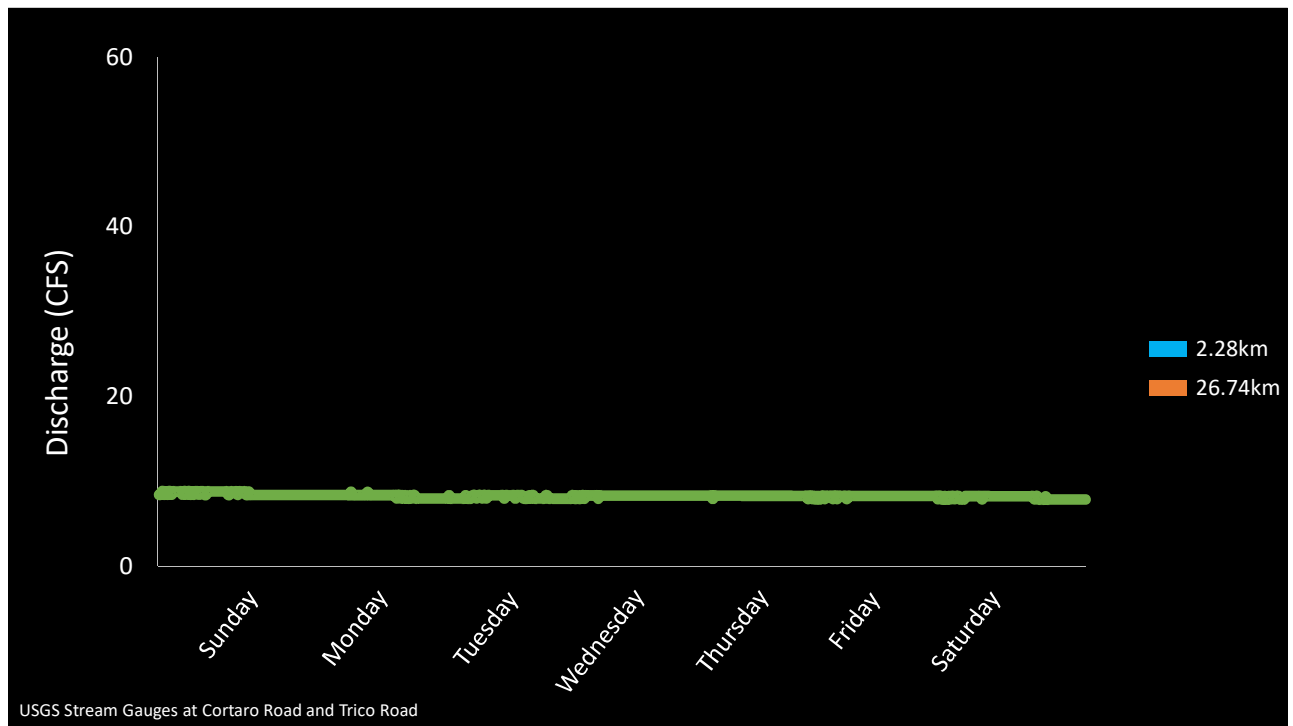
- 10 sites
- ~4km apart
- 2 WRFs
- 150m transect

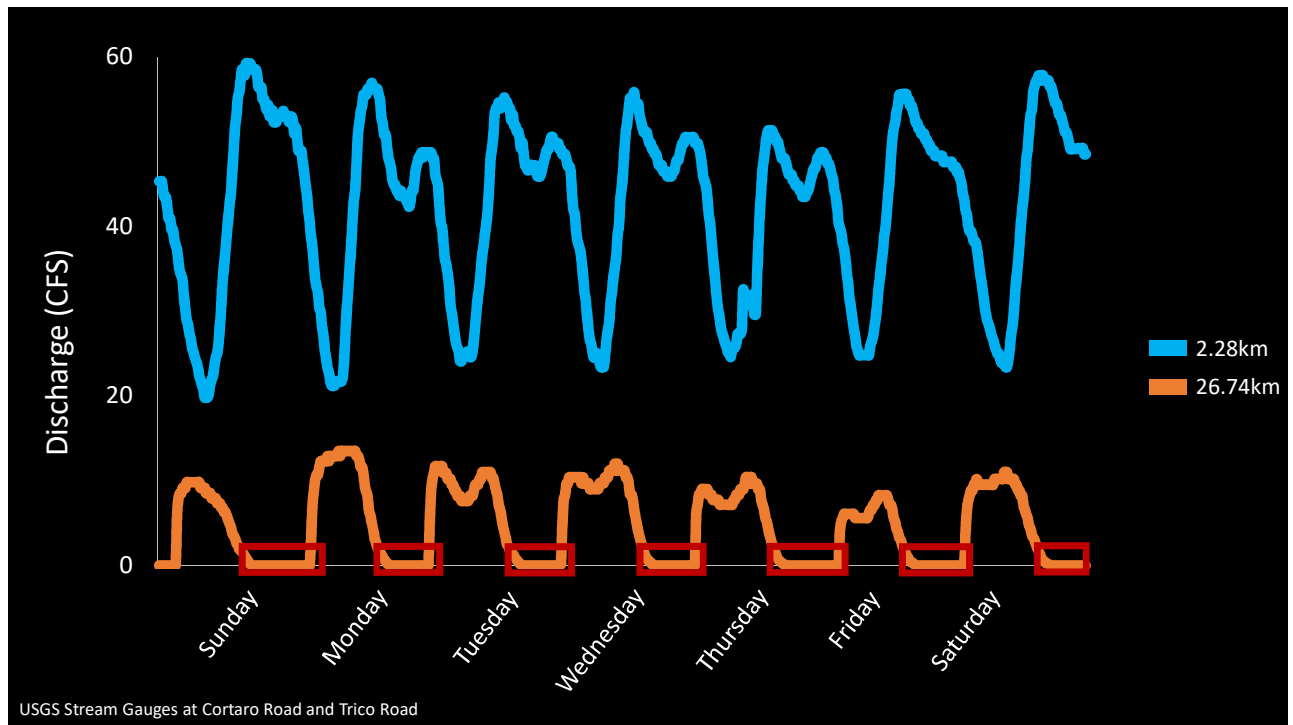
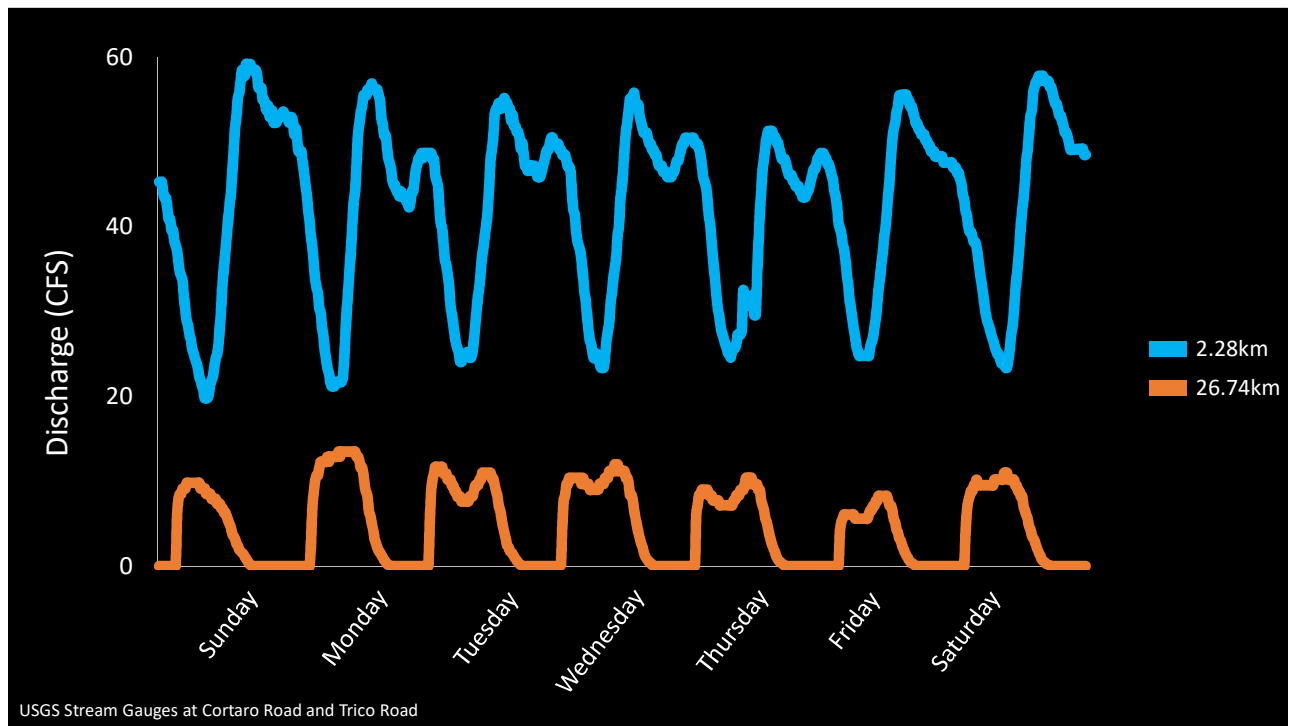
- Water quality
- Invertebrates
- Mosquitofish

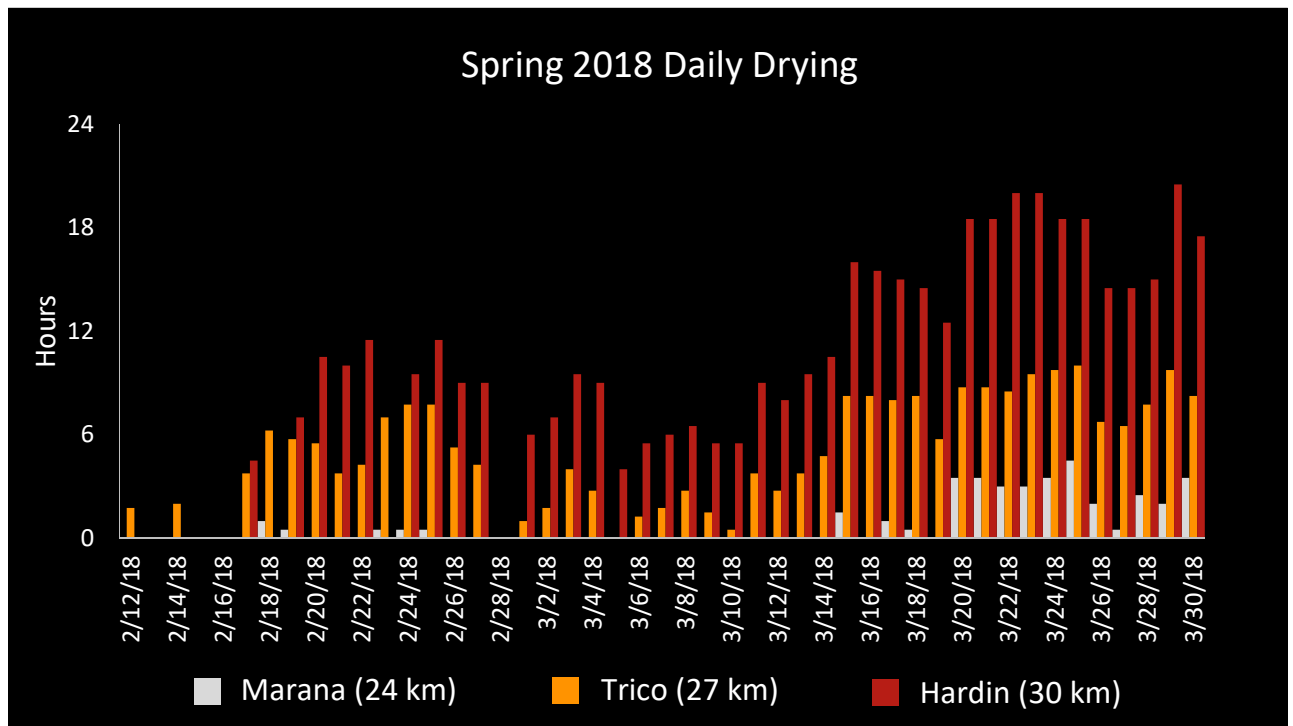


Impacts from an Artificial Flow Regime?









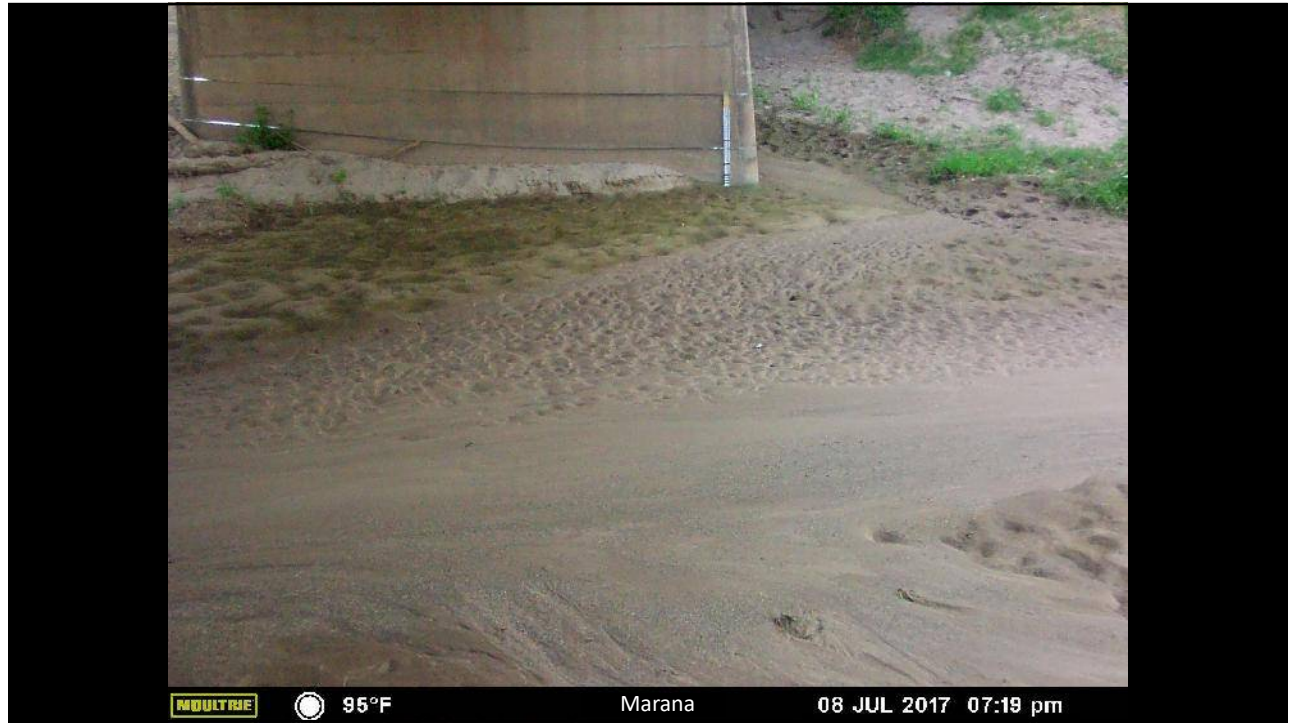


Photo Credit: Michael Bogan



Artificial Flow Regime

Quantification of a single drying event, Spring 2019: 7.5km

Artificial Flow Regime

Quantification of a single drying event, Spring 2019: 7.5km

Mosquitofish- 0

Artificial Flow Regime

Quantification of a single drying event, Spring 2019: 7.5km

Mosquitofish- 0

Common Carp- 1



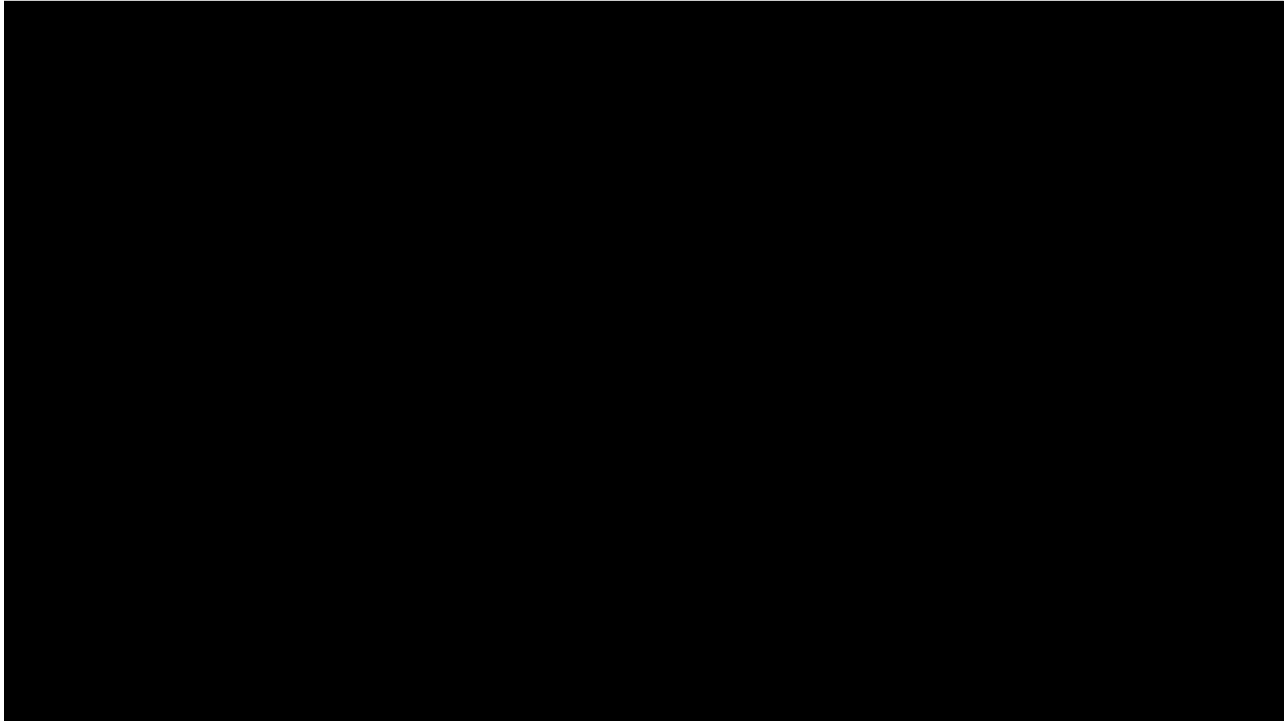
Photo Credit: Hamdani

Artificial Flow Regime

Low number of mortalities

- Declining fish densities in general

Ecological impacts of effluent discharge patterns
(Halaburka et al. 2013)



CECs Changing Sex Morphology?

CECs and Sexual Morphology

Hormone dependent sexual dimorphism



Male



Female

Photo Credit: Joel Sartore

CECs and Sexual Morphology

Hormone dependent sexual dimorphism



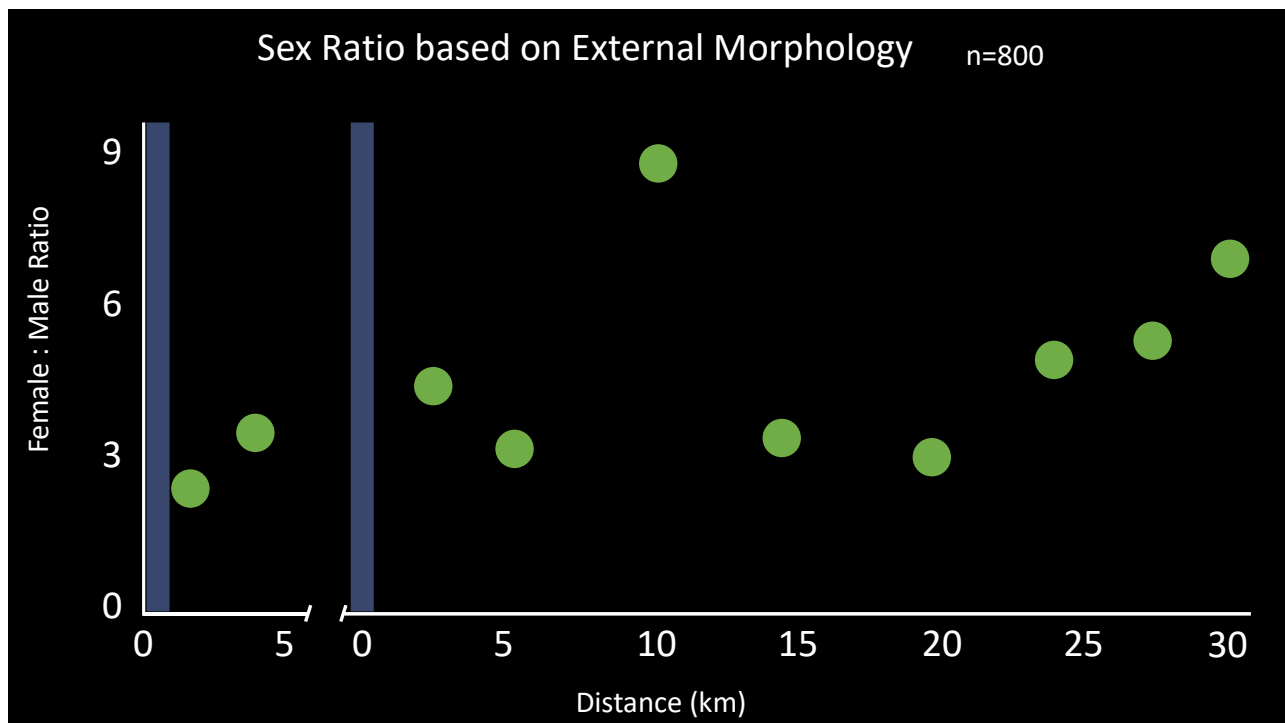
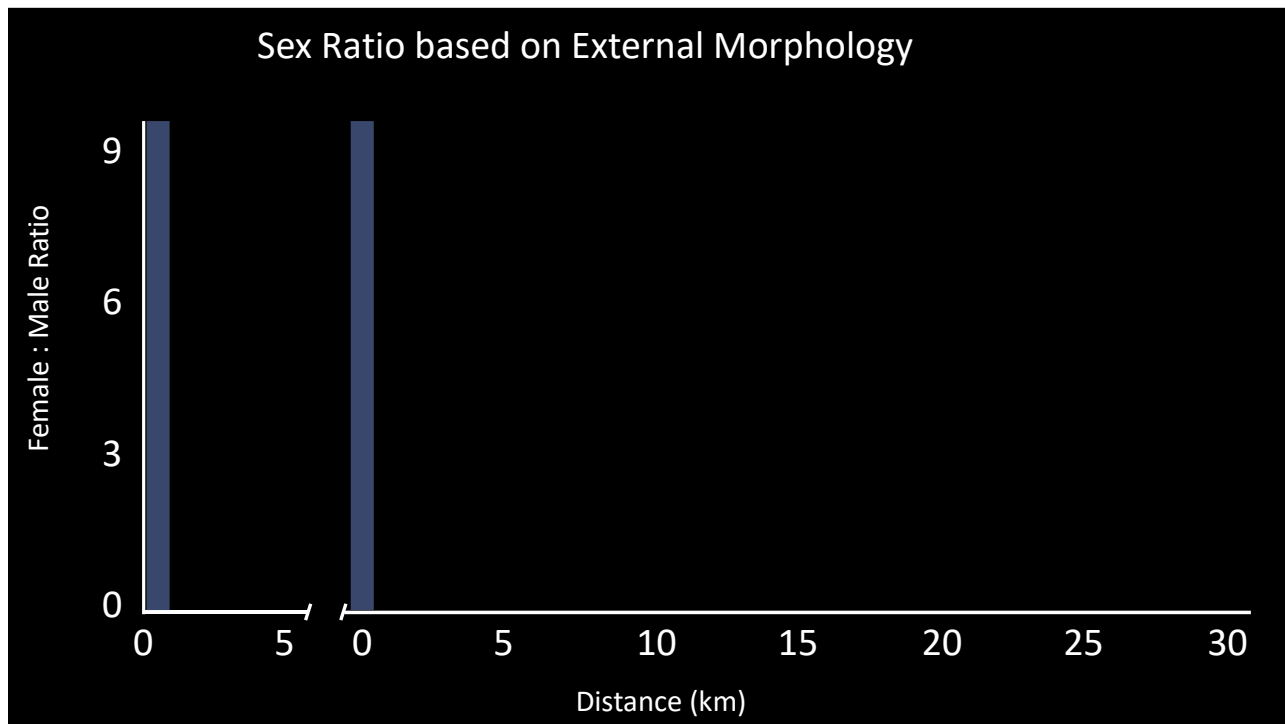
Gonopodium

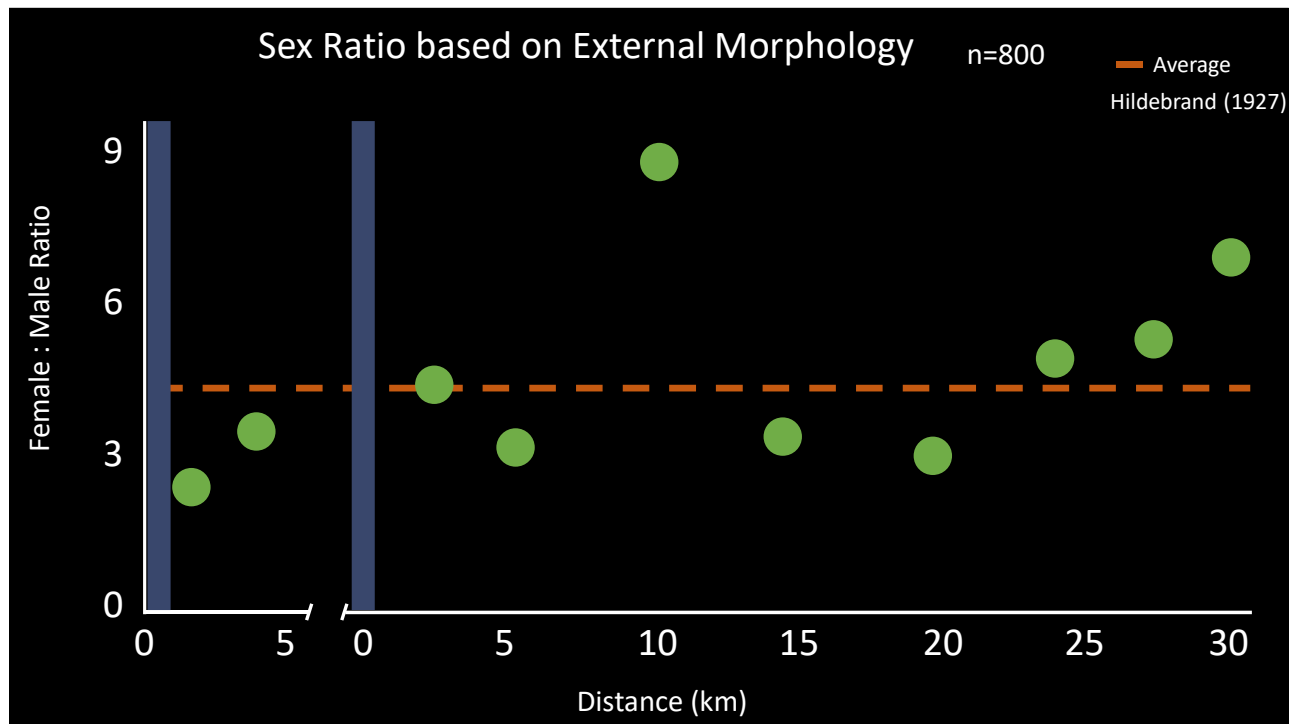
Male



Female

Photo Credit: Joel Sartore

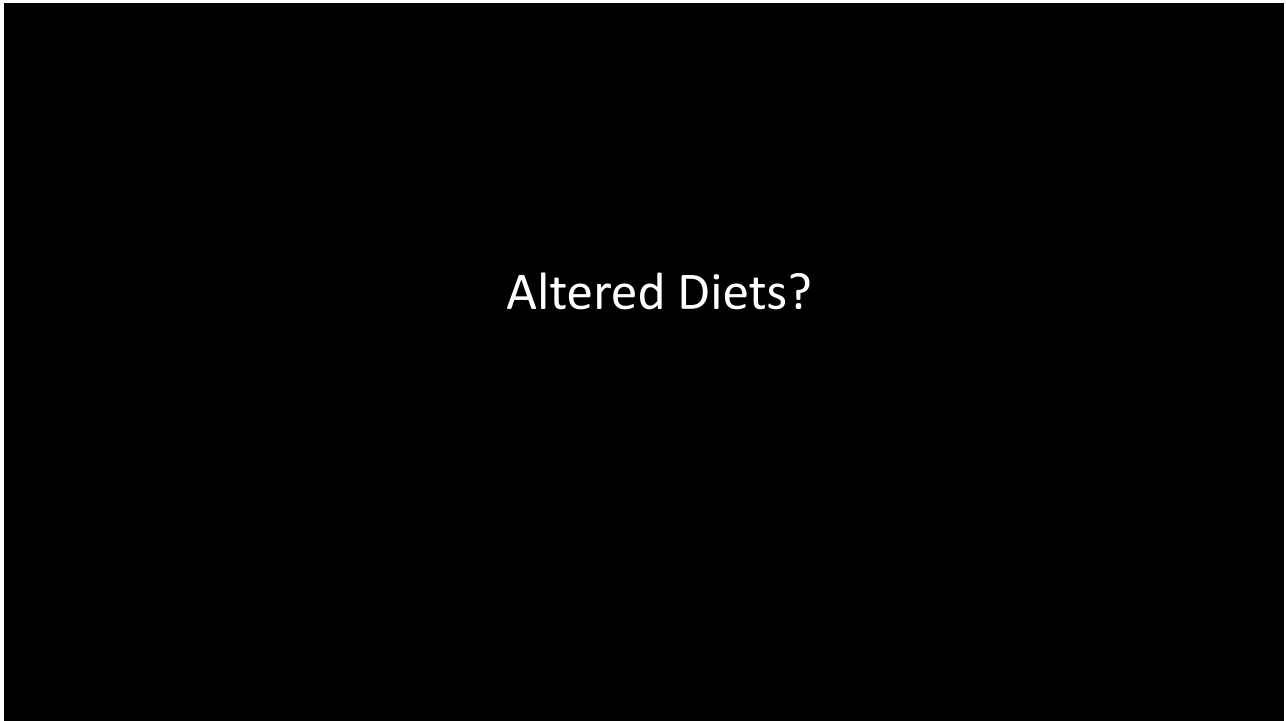
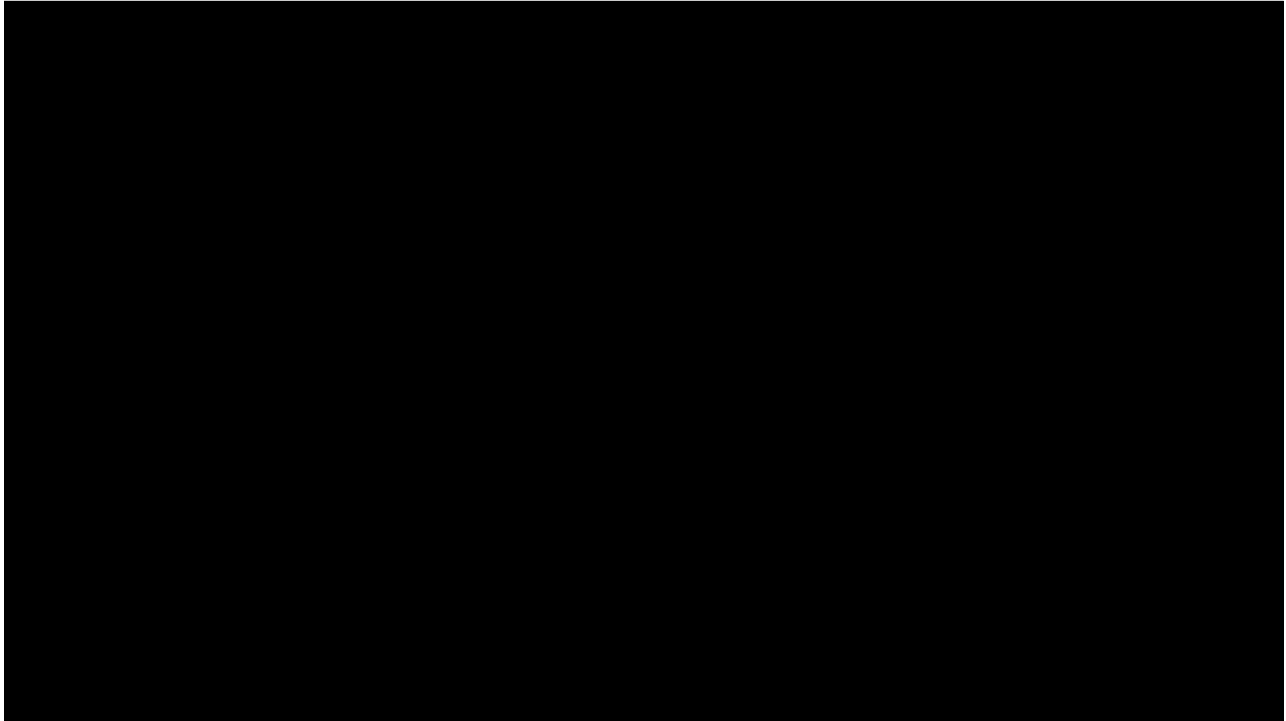


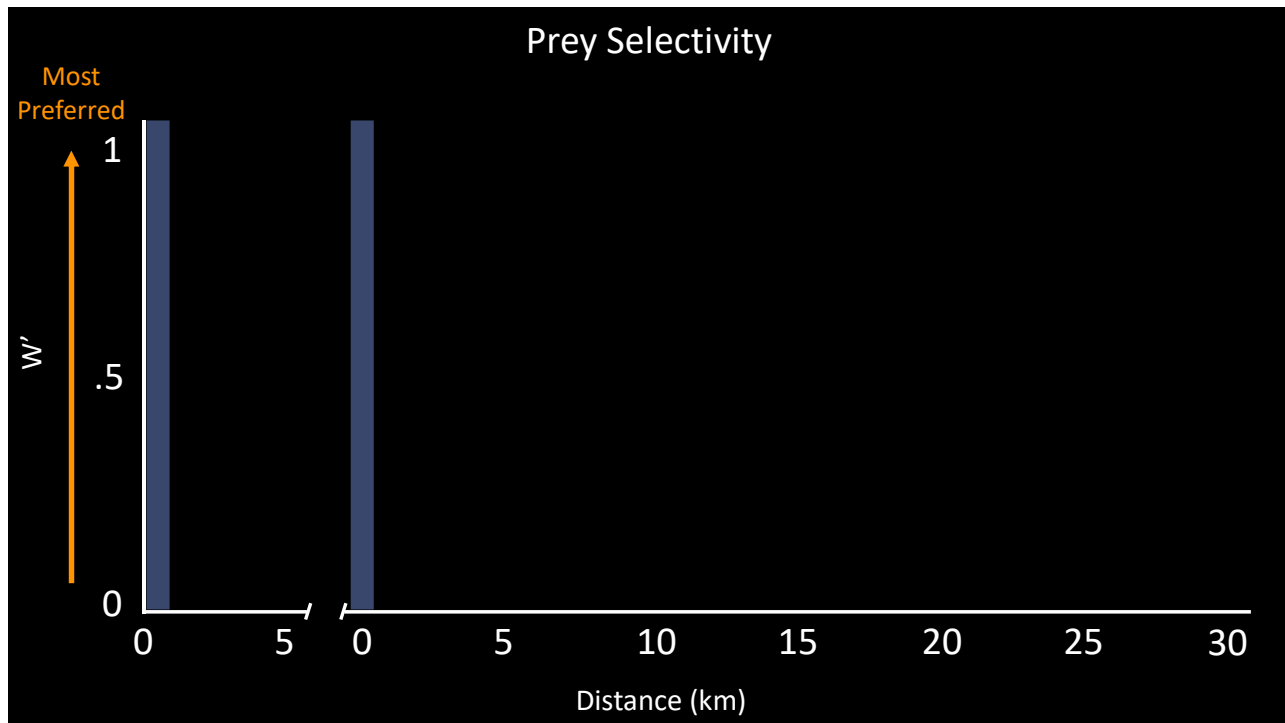
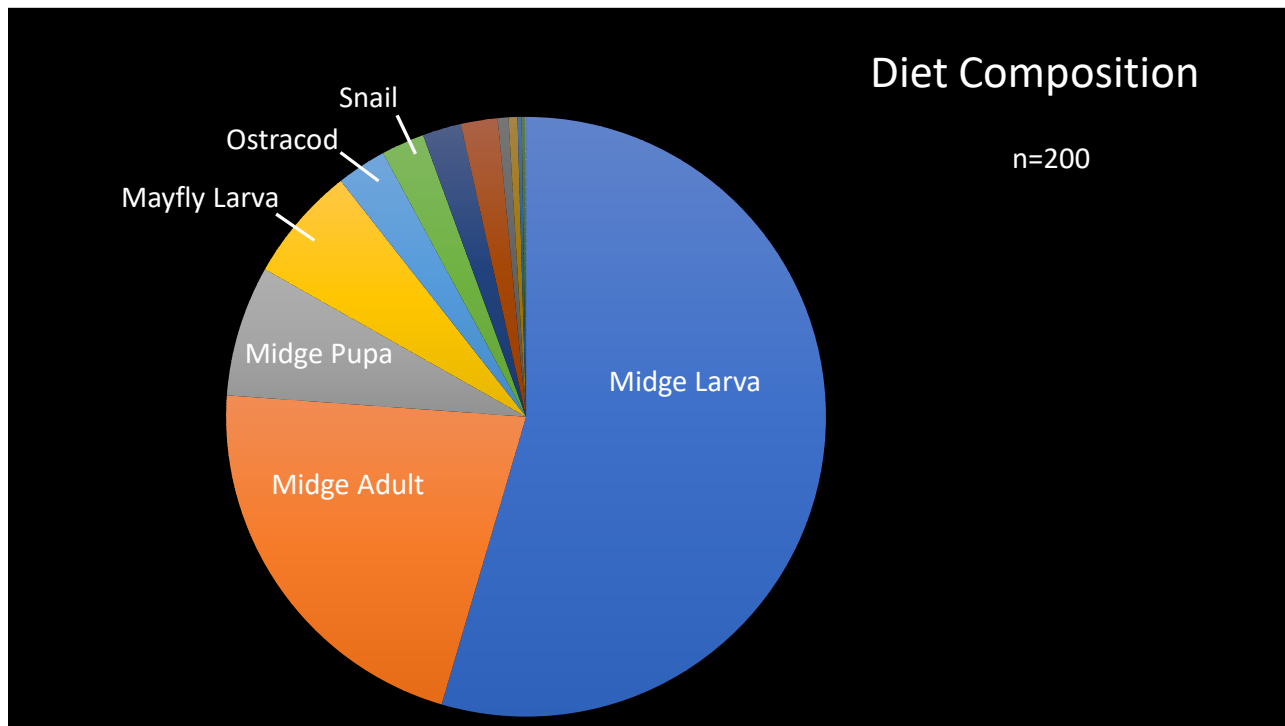


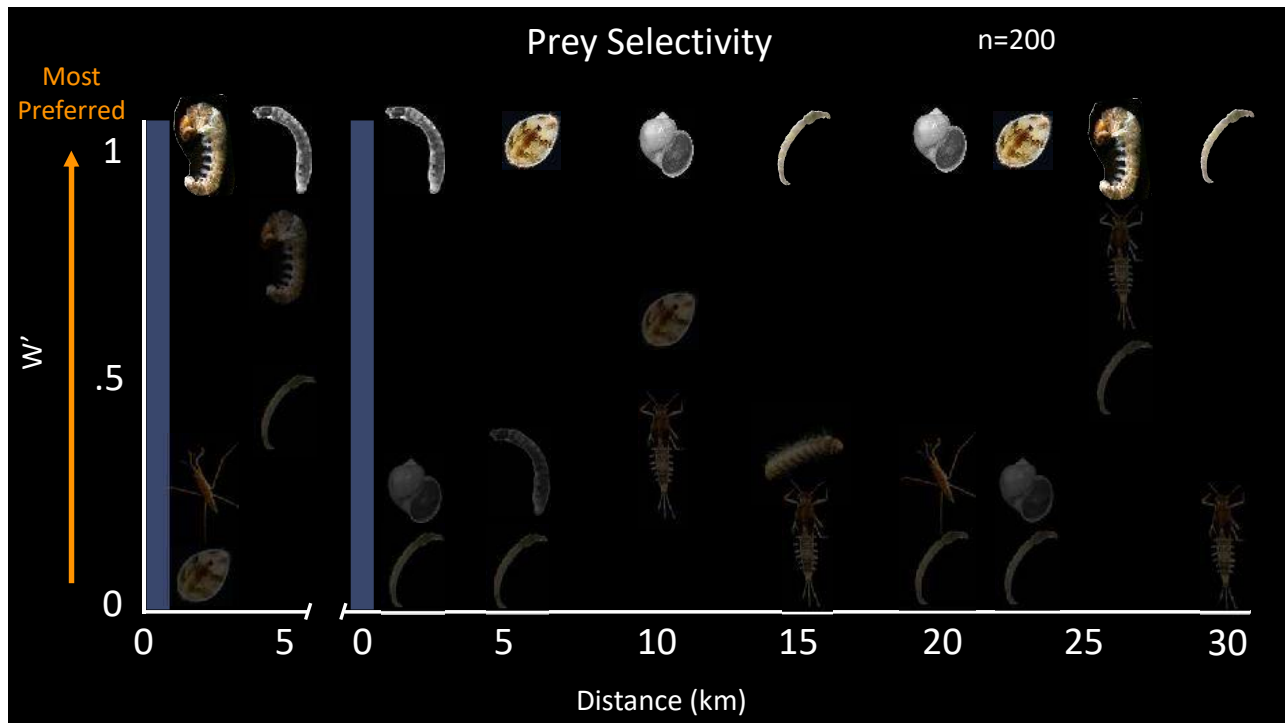
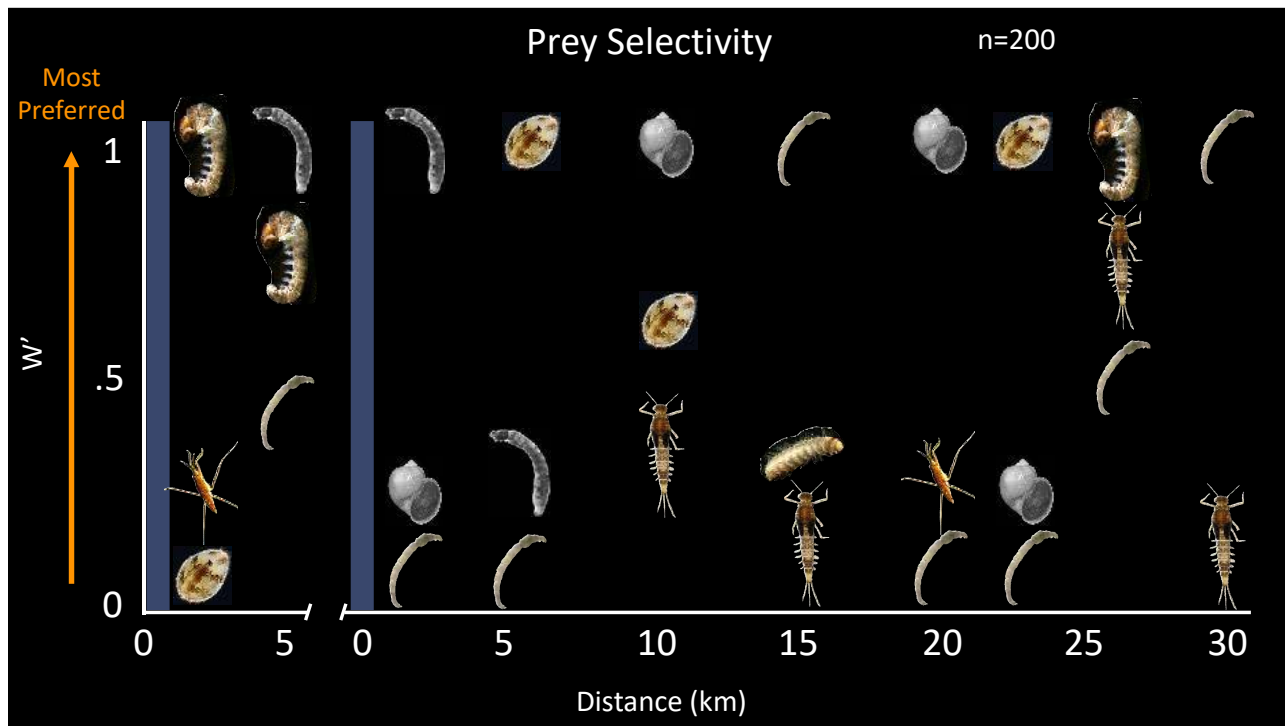
CECs and Sexual Morphology

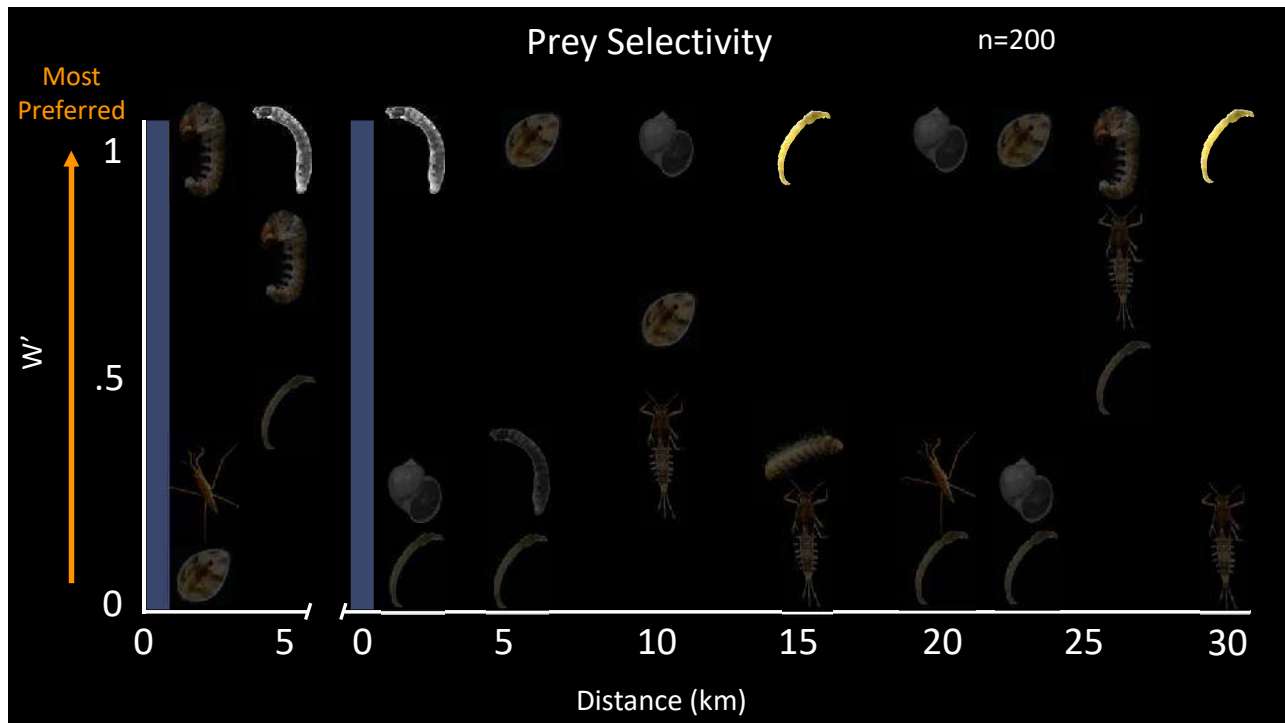
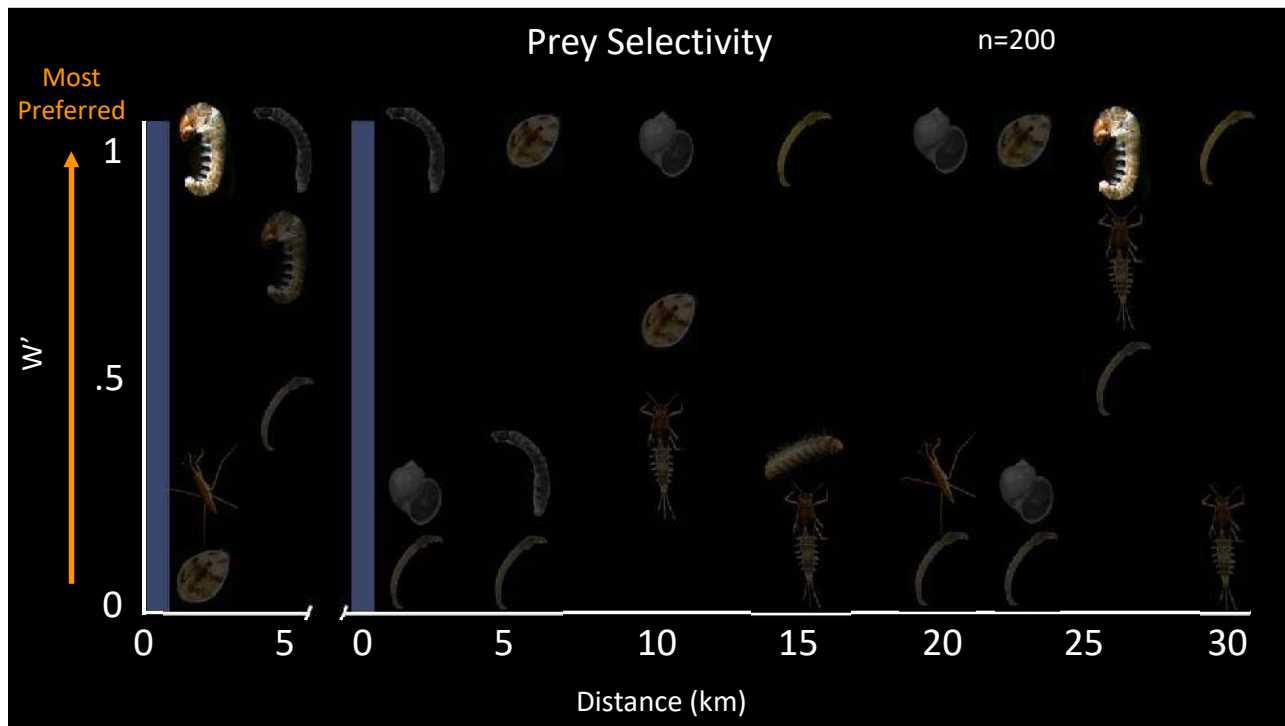
No evidence of unusual sex ratios

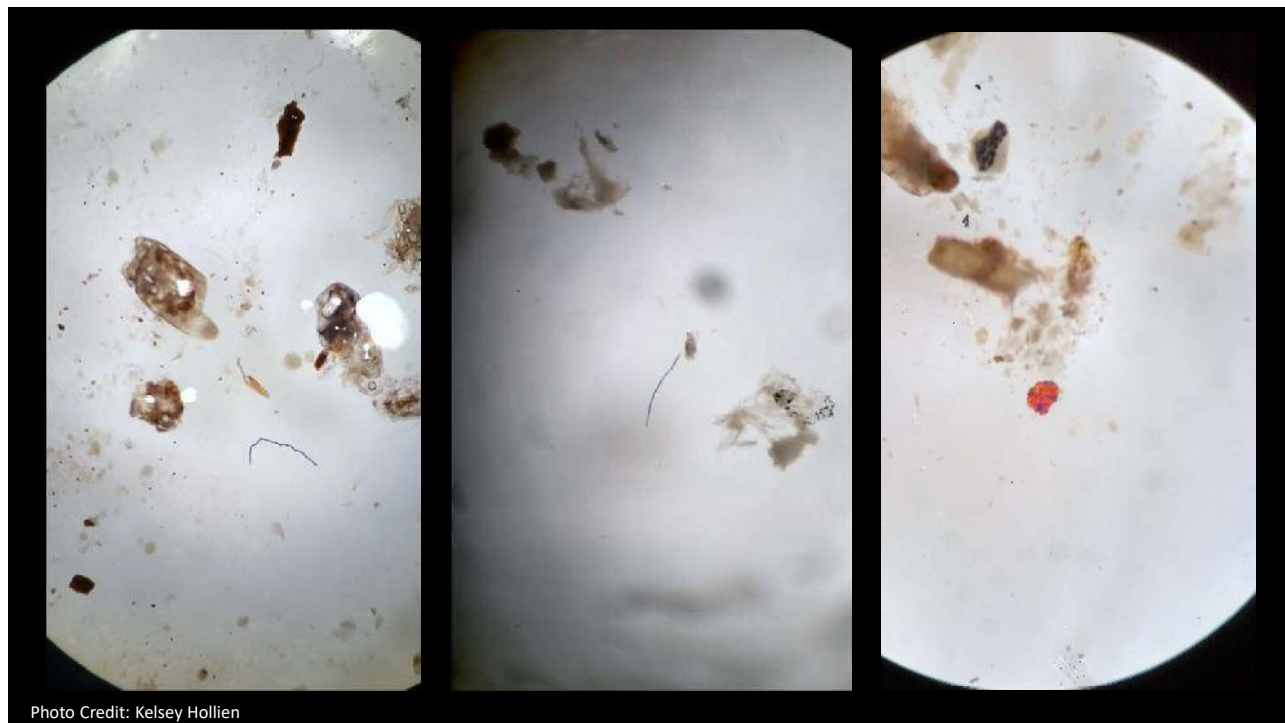
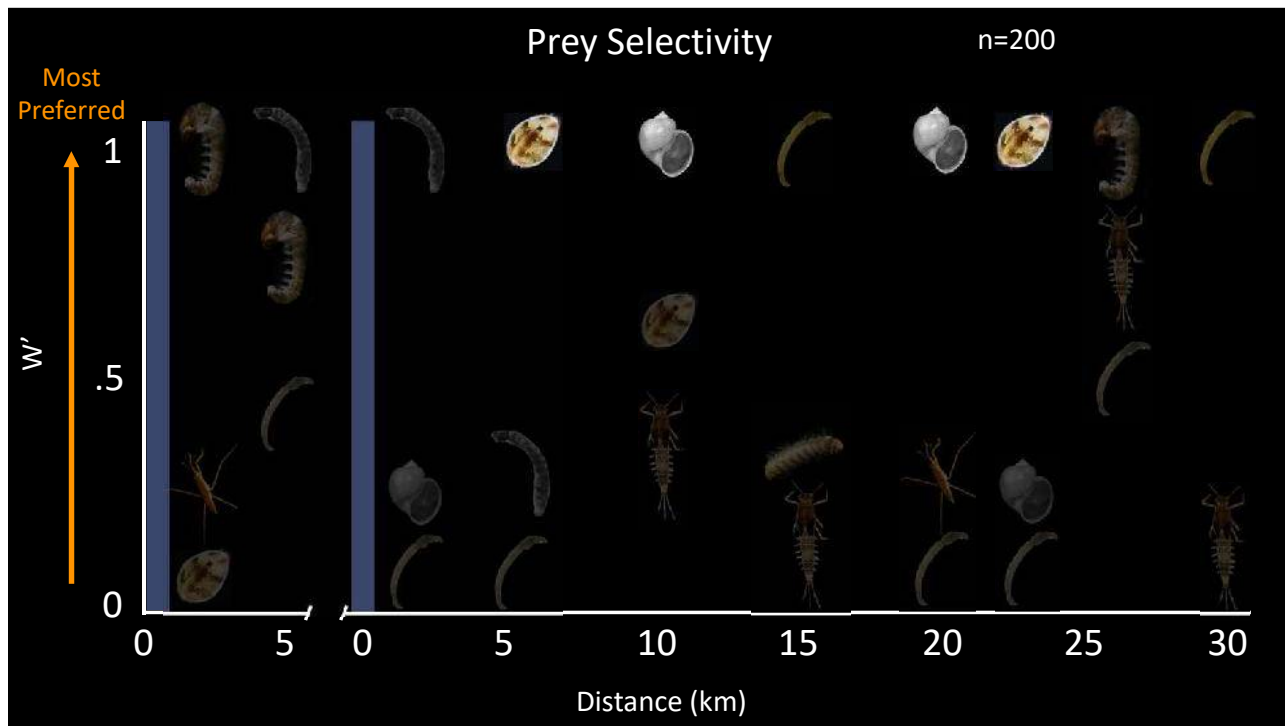
No longitudinal trends in relation to WRF proximity

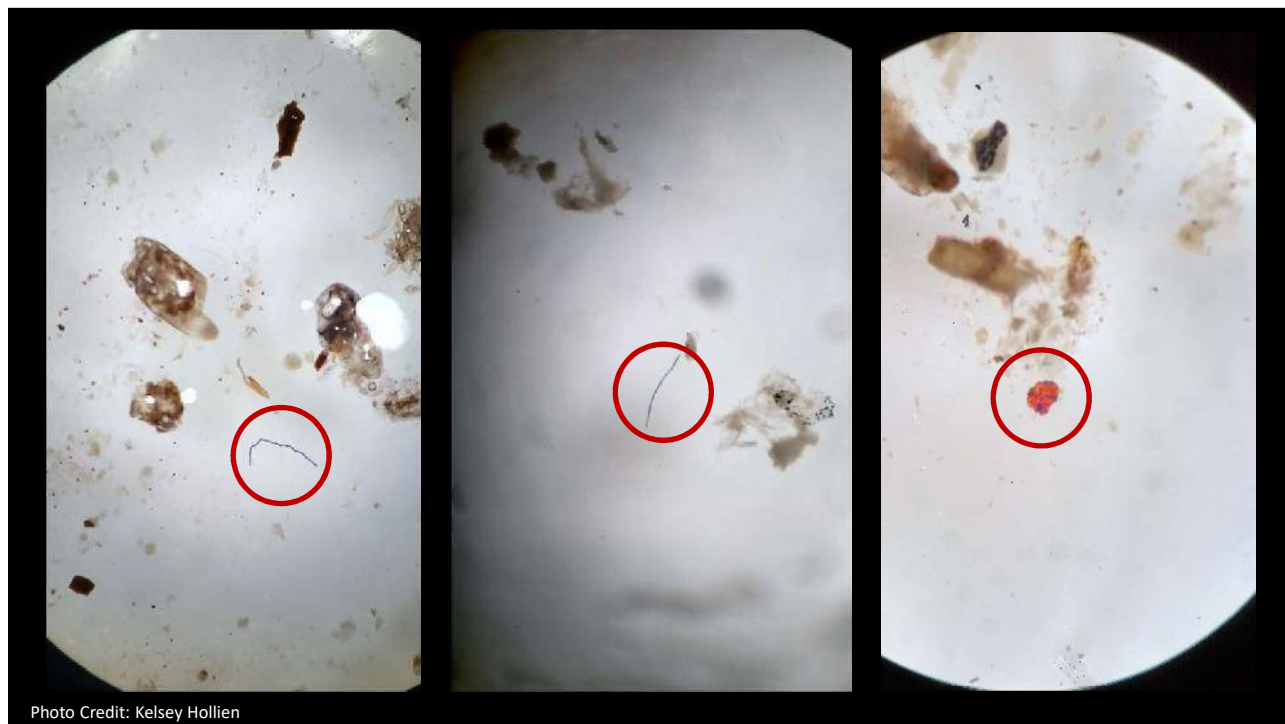












Microplastics



Microplastics

Where do they come from?

- WRFs
- Runoff



Photo Credit: Michael Bogan

Microplastics

Found as far as 30 km downstream from outfall



Photo Credit: Michael Bogan

Microplastics

Found as far as 30 km
downstream from outfall

0.21 fragments/m³
5.56 beads/m³
12,000 fibers/m³



Photo Credit: Michael Bogan

Microplastics

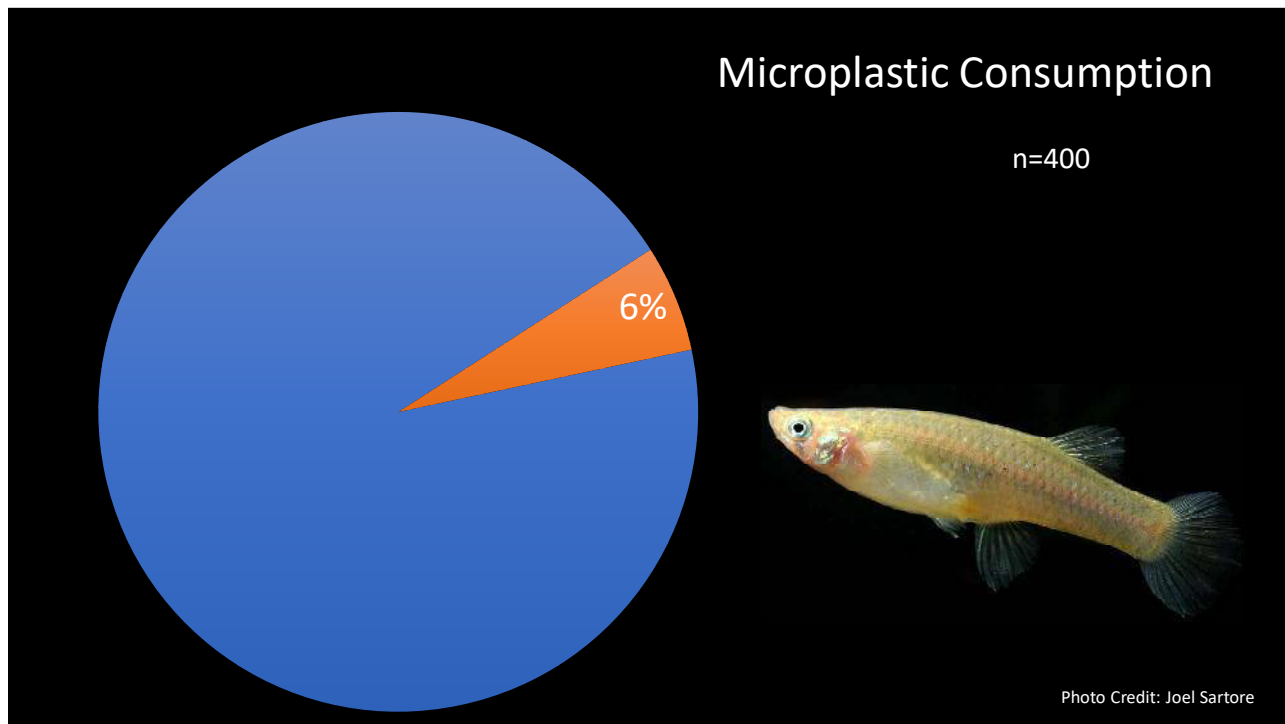
Found as far as 30 km
downstream from outfall

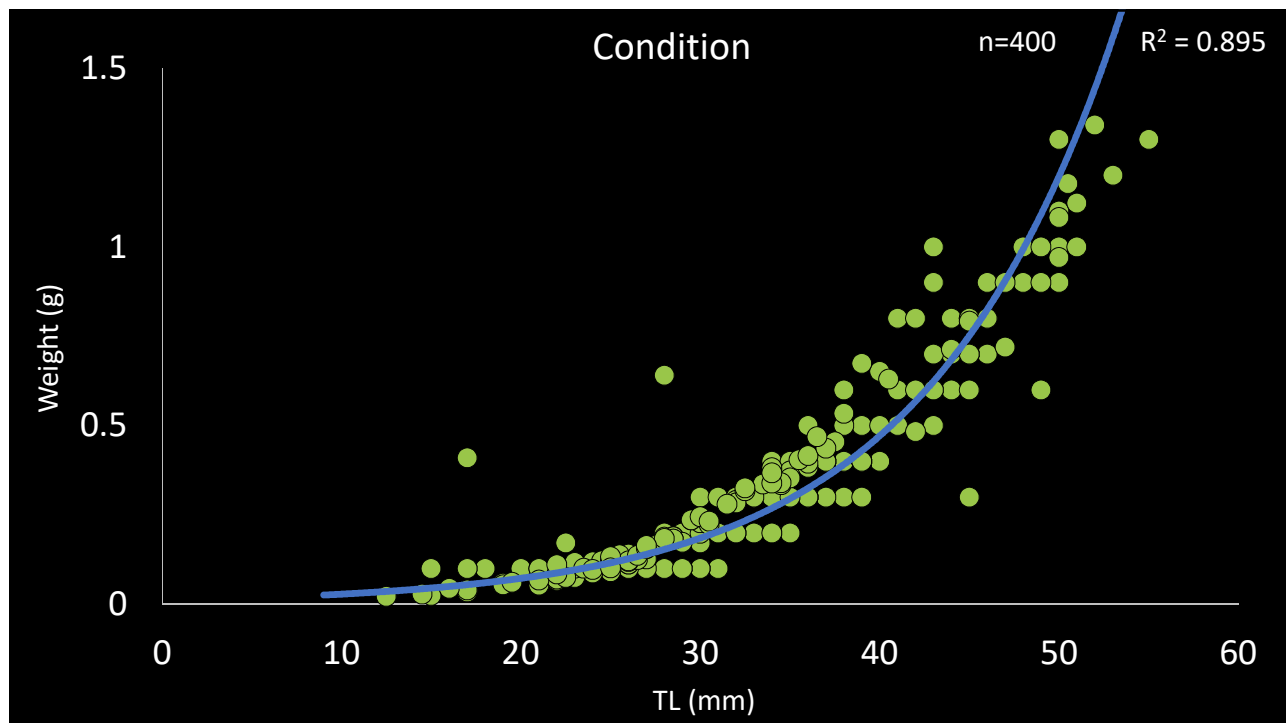
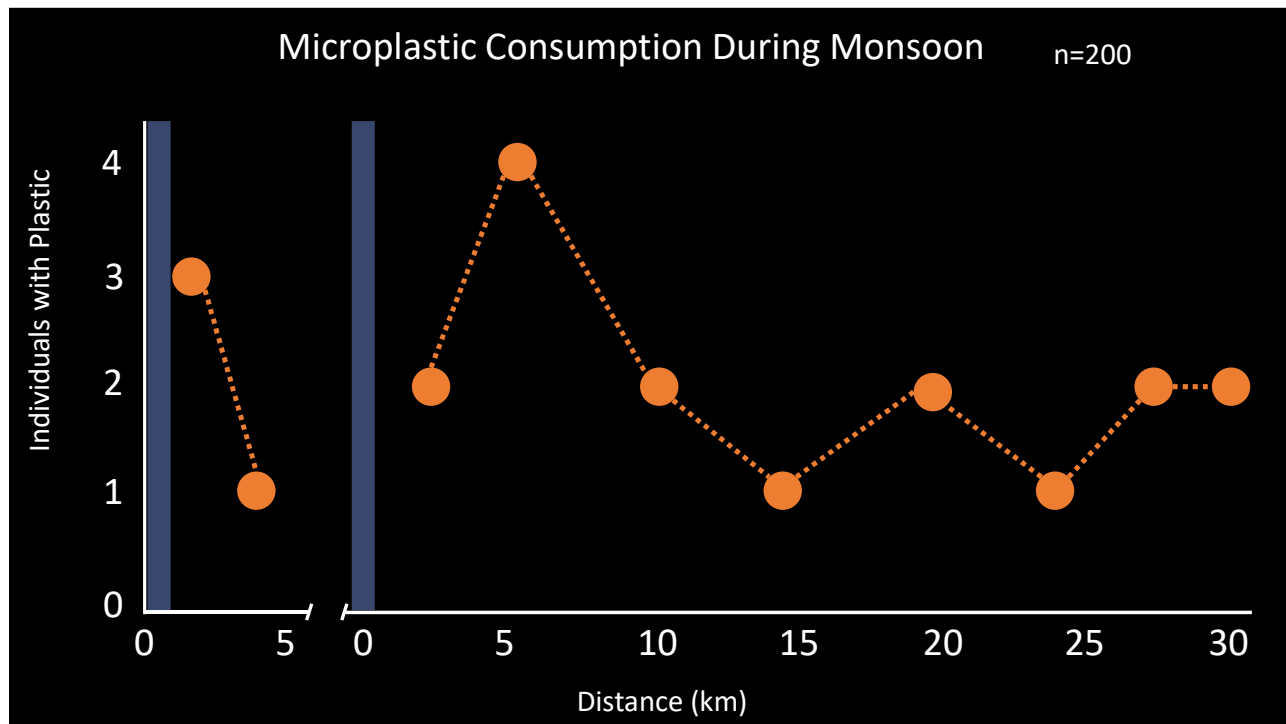
0.21 fragments/m³
5.56 beads/m³
12,000 fibers/m³

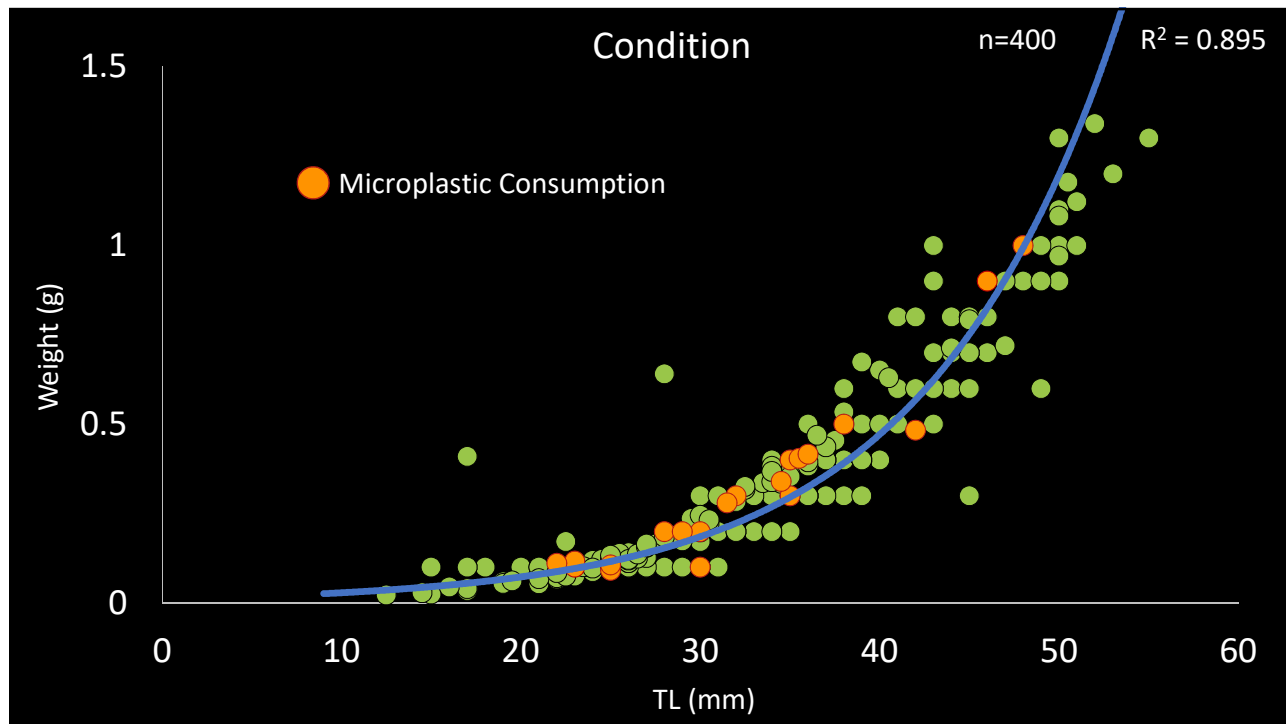
4 - 160,000 fibers/m³
(Gasperi et al 2015; Talvitie et al 2015)



Photo Credit: Michael Bogan



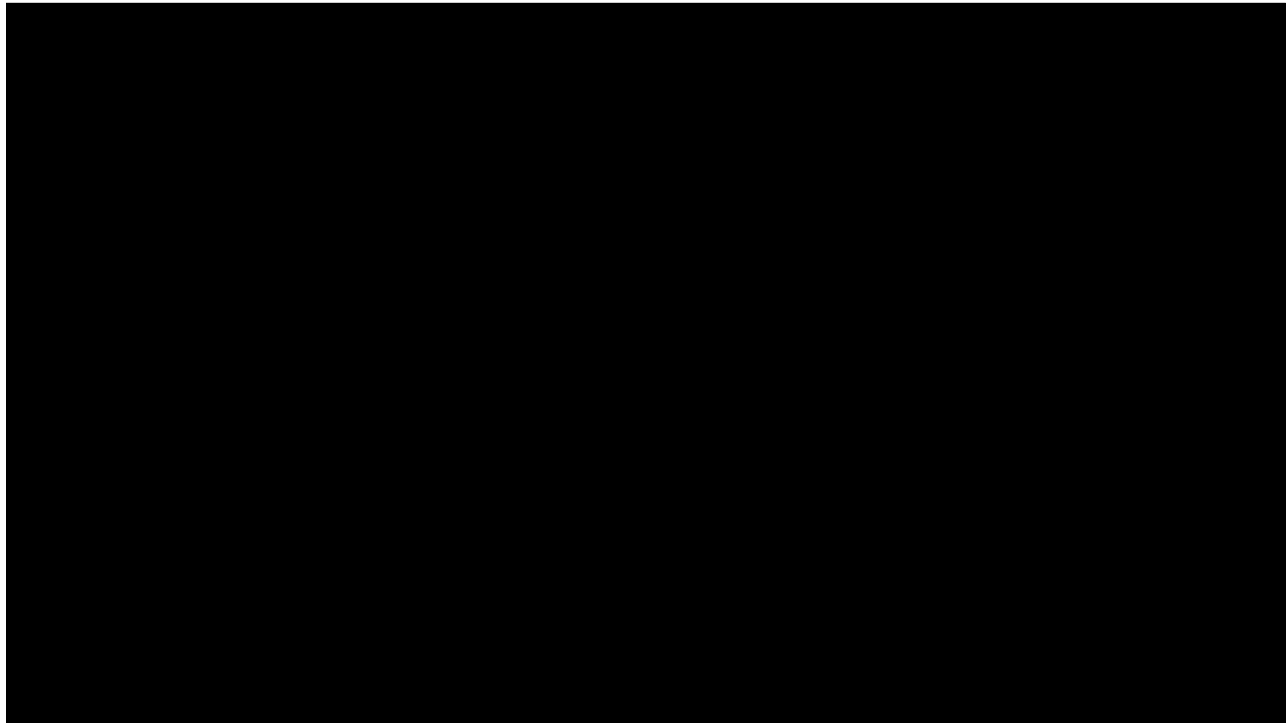




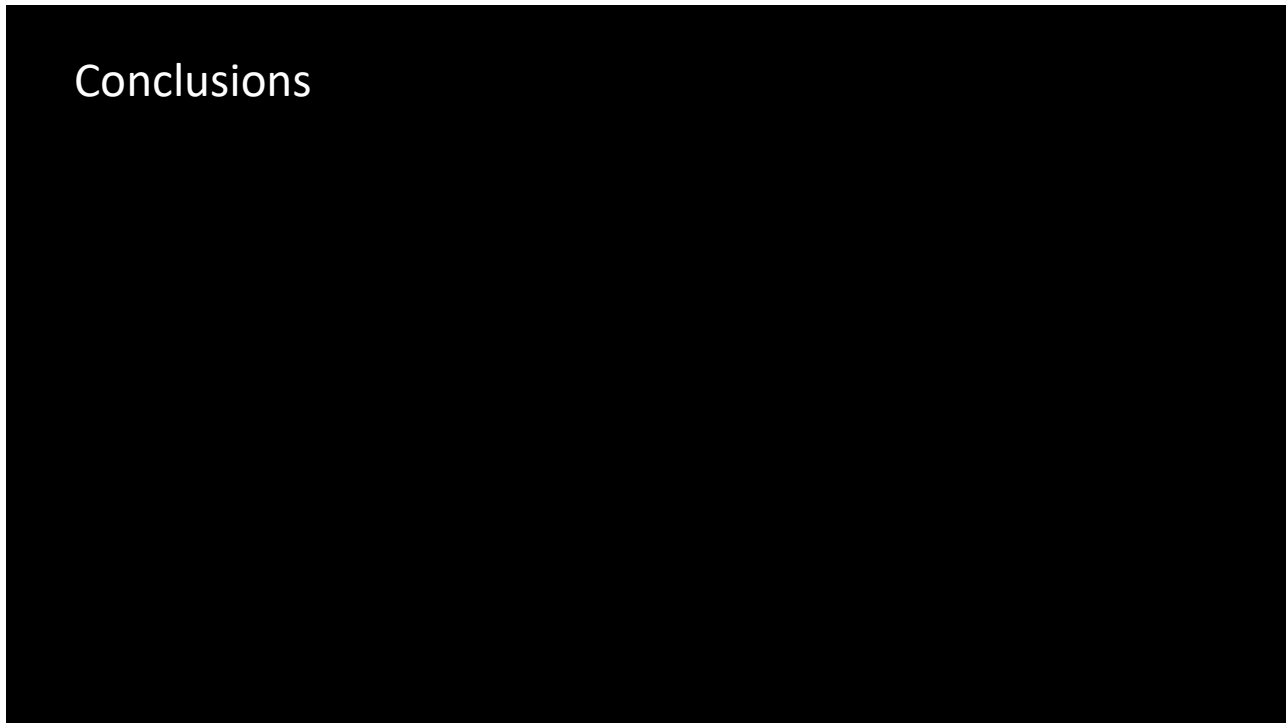
Altered Diets: Microplastics

Microplastic consumption rates were lower than anticipated

Based on fish condition, no apparent health impacts



Conclusions

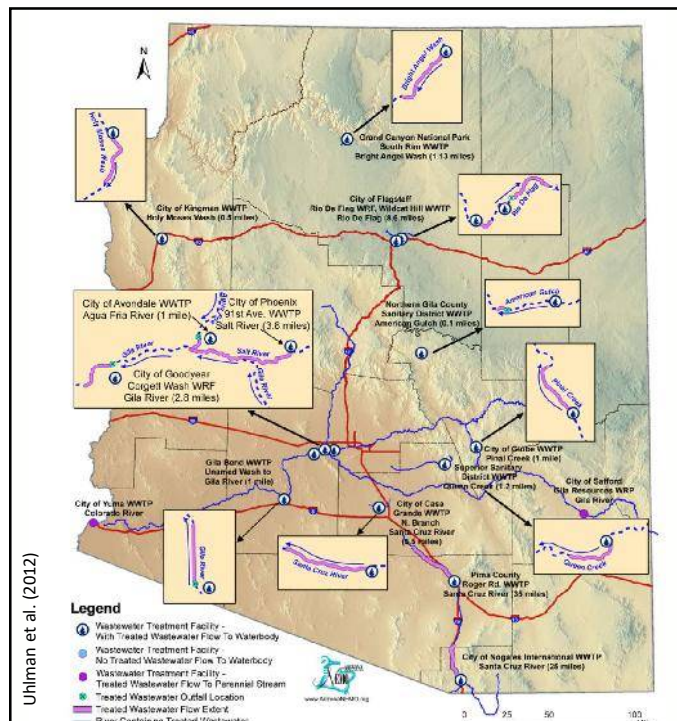


Conclusions

Living in treated wastewater does present challenges to fish

Some negative impacts were not as prominent as initially expected

Effluent systems should not be overlooked as refuge habitat for desert fishes



The Santa Cruz River is one of many effluent dominated systems in AZ.

~100 miles of effluent dominated flow in AZ

Uhlman et al. (2012)

Next Steps

- Increase sub sample size
- Continue processing microplastic samples
 - Spatial and temporal dynamics
 - Sediment deposition rates



Photo Credit: Margarethe Brummermann

References

- Angus, R. A., Stanko, J., Jenkins, R. L., & Watson, R. D. (2005). Effects of 17 α -ethynylestradiol on sexual development of male western mosquitofish (*Gambusia affinis*). *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 140(3-4), 330-339.
- Crivelli, A. J., & Boy, V. (1987). The diet of the mosquitofish *Gambusia affinis* (Baird and Girard)(Poeciliidae) in Mediterranean France.
- Doyle, C. J. and Lim, R. P. (2002). The effect of 17 β -Estradiol on the gonopodial development and sexual activity of *Gambusia holbrooki*. *Environmental Toxicology and Chemistry*, 21: 2719-2724. doi:10.1002/etc.5620211227
- Erguden, S. A. (2013). Age, growth, sex ratio and diet of eastern mosquitofish *Gambusia holbrooki* Girard, 1859 in Seyhan Dam Lake (Adana/Turkey). *Iranian Journal of Fisheries Sciences*, 12(1), 204-218.
- Halaburka, B. J., Lawrence, J. E., Bischel, H. N., Hsiao, J., Plumlee, M. H., Resh, V. H., & Luthy, R. G. (2013). Economic and ecological costs and benefits of streamflow augmentation using recycled water in a California coastal stream. *Environmental science & technology*, 47(19), 10735-10743.
- Hildebrand, S. F. (1927). Sex ratio in *Gambusia*. *The Biological Bulletin*, 53(5), 390-404.
- Pothoven, S. A., & Vanderploeg, H. A. (2004). Diet and prey selection of alewives in Lake Michigan: seasonal, depth, and interannual patterns. *Transactions of the American Fisheries Society*, 133(5), 1068-1077.
- Pyke, G. H. (2005). A Review of the Biology of *Gambusia affinis* and *G. holbrooki*. *Reviews in Fish Biology and Fisheries*, 15(4), 339-365. doi:10.1007/s11160-006-6394-x
- Uhlman, K., Eden, S., Rock, C., Westfall, E., & Sprouse, T. (2012). Effluent Dependent Streams of Arizona.
- Vanderploeg, H. A., & Scavia, D. (1979). Calculation and use of selectivity coefficients of feeding: zooplankton grazing. *Ecological modelling*, 7(2), 135-149.

1913



1981



Webb and Leake (2007)

Prey Selectivity

$$W' = (r_i/p_i) / (r_i/p_i)_{\text{preferred}}$$



(Vanderploeg and Scavia 1979; Pothoven and Vanderploeg 2004)

Brown Bag Seminar

by Hamdhani Hamdhani

Submission date: 04-Nov-2021 10:50AM (UTC+0700)

Submission ID: 1692631919

File name: Brown_Bag_Seminar_-.pdf (934.78K)

Word count: 659

Character count: 3905



Brown Bag Seminar - Testing the capability of freshwater algae to remove lead (Pb) from water and A case study on the Santa Cruz River: Can treated wastewater support desert fishes?

03/28/2019 -
12:00pm

BROWN BAG



(/events/25911/v

LOCATION:

WRRC, Sol Resnick Conference Room, 350 N. Campbell Ave., Tucson, AZ (<https://maps.google.com/maps?q=WRRC%2C+Sol+Resnick+Conference+Room%2C+350+N.+Campbell+Ave.%2C+Tucson%2C+AZ&hl=en&z=14&t=m>)

SPEAKER(S):

Amanda Minke, Student, Dept. of Hydrology and Atmospheric Science

Drew Eppheimer, Ph.D. student, Arid Land Resource Sciences Program

DATE:

03/28/2019 - 12:00pm to 1:15pm Arizona Time

 [Testing the capability of freshwater algae \(https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/Minke-104b.pdf\)](https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/Minke-104b.pdf)

 [A case study on the Santa Cruz River \(https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/Eppheimer-104b.pdf\)](https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/Eppheimer-104b.pdf)

[View the Recorded Webinar Here \(https://youtu.be/V1Eajczrxag\)](https://youtu.be/V1Eajczrxag)

This Brown Bag will feature presentations by UA students who received research grants in 2018 through the WRRC from the Water Resources Research Act, Section 104(b) grant program. This program fosters regionally important research on water and related issues and encourages students and young scientists to pursue careers in water resources.

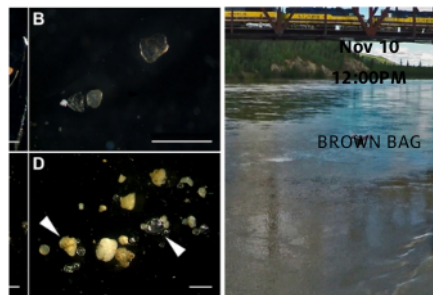
Human exposure to lead is a global-priority environmental health concern and affects many places in Arizona. Amanda Minke's presentation describes a project investigating the removal of lead from drinking water using common freshwater algae. Preliminary results have revealed some of the factors that control the effectiveness of algal lead removal.

Portions of the Santa Cruz River that have not had perennial flow since the mid-1900s have been artificially reborn with treated wastewater. Drew Eppheimer's presentation will explore the health effects of effluent-dominated aquatic habitat on native fish, including fluctuating water levels, emerging https://wrrc.arizona.edu/events/brown-bag/brown-bag-seminar-testing-capability-freshwater-algae-remove-lead-pb-water-and-case?utm_source=WRR... 1/3

11/4/21, 11:45 AM Brown Bag Seminar - Testing the capability of freshwater algae to remove lead (Pb) from water and A case study on the Santa C... contaminants, and (3) altered diets, such as consumption of microplastic.

Amanda Minke is currently a sophomore at the University of Arizona, studying hydrology. Drew Eppheimer is a native of Arizona and currently a Ph.D. student of aquatic ecology at the University of Arizona. He has degrees in Spanish, environmental science, and natural resource management and has worked for the National Oceanic and Atmospheric Administration and the US Geological Survey.
Images Wikimedia Commons

Upcoming Events



Brown Bag Webinar: 104(b) Grant Program — Student Research

Contamination of our environment from microplastics (1 mm to 5 mm in size) is gaining significant public interest due largely to their emergence as an environmental and

[READ MORE \(/EVENTS/BROWN-BAG/BROWN-BAG-WEBINAR-104B-GRANT-PROGRAM\)](#)



WATER POLICY
AND MANAGEMENT
RESEARCH CENTER

We tackle key water policy and management issues, empower informed decision-making, and enrich understanding through engagement, education, and applied research.


GIVE TODAY ([HTTPS://WWW.UAFOUNDATION.ORG/NETCOMMUNITY/PAGE.ASPX?](https://www.uafoundation.org/netcommunity/page.aspx?PID=493&FID=DGZTQNL09YU%3D&FDESC=2WEXMP6YLLHQDJ62TD68EUGTAQYAZKCI7U6QEAQVUDFUG%2F7QDEL8QQ%3D%3D)


[PID=493&FID=DGZTQNL09YU%3D&FDESC=2WEXMP6YLLHQDJ62TD68EUGTAQYAZKCI7U6QEAQVUDFUG%2F7QDEL8QQ%3D%3D](https://www.uafoundation.org/netcommunity/page.aspx?PID=493&FID=DGZTQNL09YU%3D&FDESC=2WEXMP6YLLHQDJ62TD68EUGTAQYAZKCI7U6QEAQVUDFUG%2F7QDEL8QQ%3D%3D))


Keep up with our news and events with a subscription to our Weekly Wave.


[SUBSCRIBE \(/SUBSCRIBE\)](#)

Reach Out

 350 N Campbell Ave
Tucson, AZ 85719

 (520) 621-9591


 (520) 792-8518


 [EMAIL US \(/WRRRC-CONTACT\)](#)

 [DIRECTORY \(/PERSONNEL-DIRECTORY\)](#)

Follow Us

 [\(HTTPS://WWW.FACEBOOK.COM/AZWRRRC\)](https://www.facebook.com/AZWRRRC)

 [\(HTTPS://TWITTER.COM/AZWRRRC\)](https://twitter.com/AZWRRRC)

 [\(HTTPS://WWW.YOUTUBE.COM/PLAYLIST?LIST=PLF6659FBB1D1BFC19\)](https://www.youtube.com/playlist?list=PLF6659FBB1D1BFC19)

Brown Bag Seminar

ORIGINALITY REPORT

1 %

SIMILARITY INDEX

1 %

INTERNET SOURCES

0 %

PUBLICATIONS

0 %

STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

1%

★ thebrainpan.me

Internet Source

Exclude quotes On

Exclude bibliography On

Exclude matches < 1%