Linking hydrology and geomorphology on the Middle Rio Grande with habitat conditions for the Rio Grande Silvery Minnow

Jacob G. Mortensen[1], Robert K. Dudley[1,2], Steven P. Platania[1,2], Thomas F. Turner[2]
Pierre Julien[3], Sydney Doidge[3], Ari Posner[4], Drew Baird[5], Nate Bradley[5], Nathan Holste[5]

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[1] ASIR, LLC – Albuquerque, NM, [2] Museum of SW Biology (Fishes), University of NM – Albuquerque, NM
[3] Colorado State University, Dept. of Civil and Environmental Engineering – Fort Collins, CO
[4] U.S. Bureau of Reclamation – AAO, Albuquerque, NM, [5] U.S. Bureau of Reclamation – TSC, Denver, CO

Holste, 2016

Middle Rio Grande

Hydrology

- Reduced magnitude, duration, and frequency of peak flows
- Increased duration and frequency of low flows

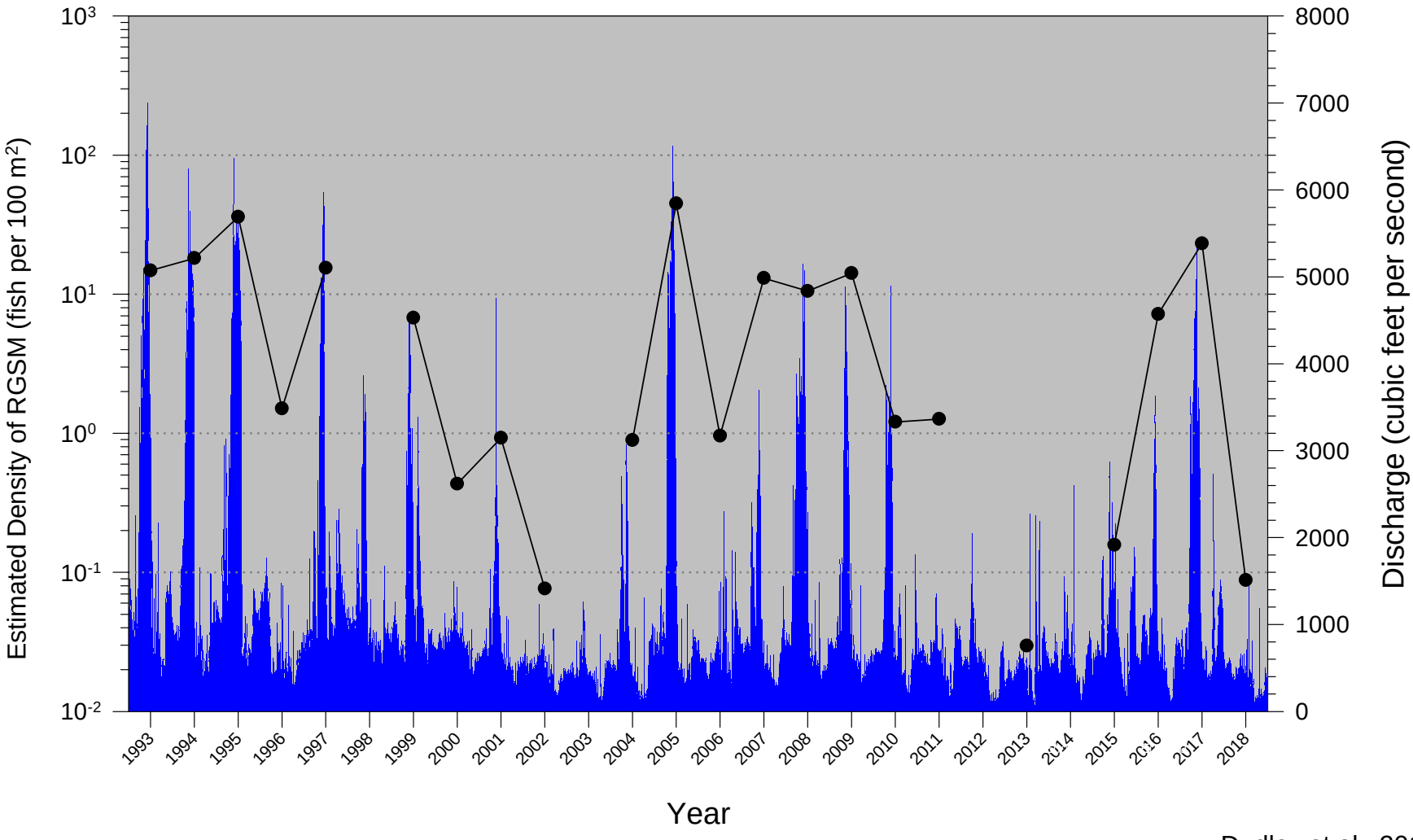
Geomorphology

- Reduced width – channel narrowing
- Reduced sediment supply
- Bed degradation – channel incision

Rio Grande Silvery Minnow Habitat

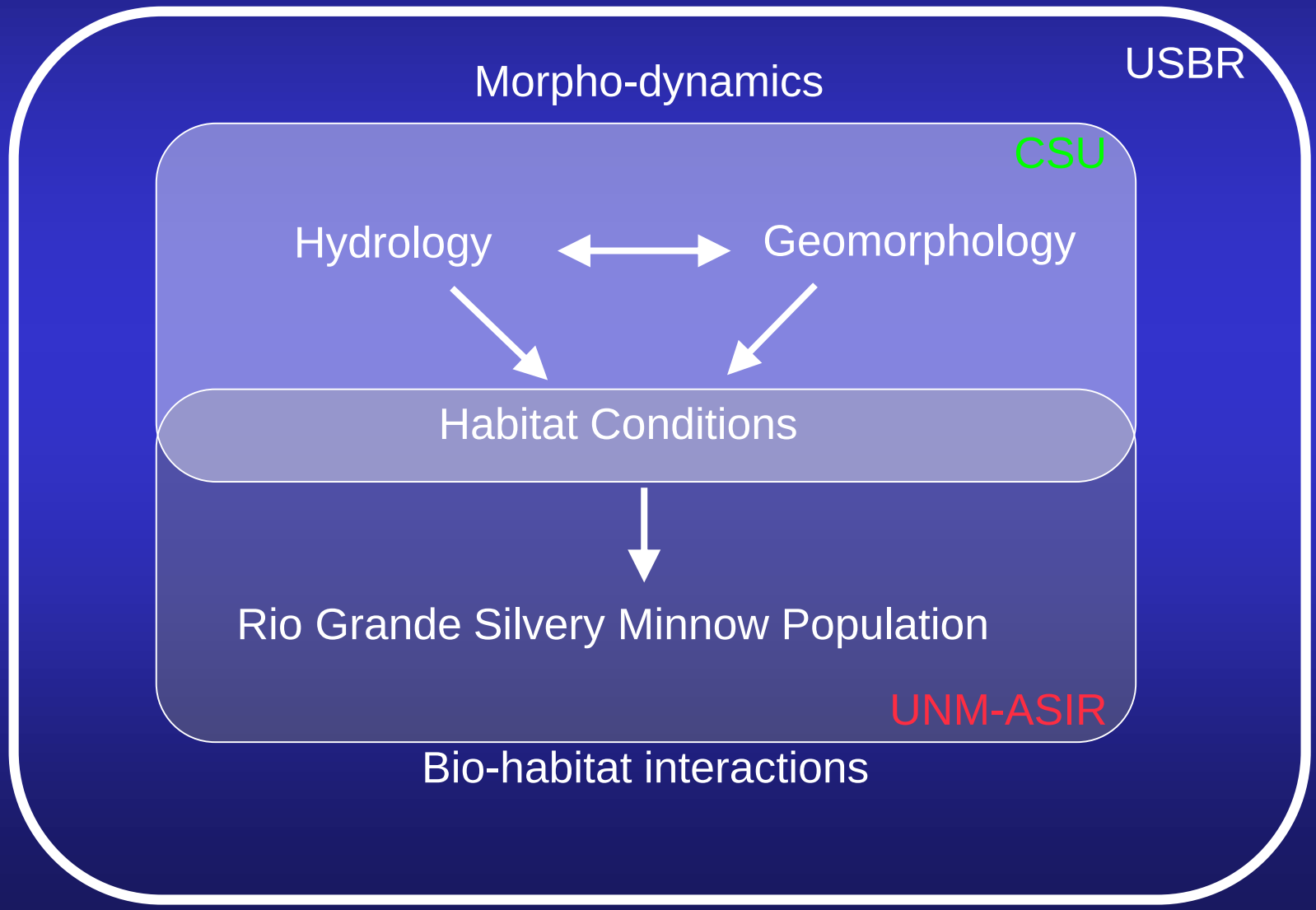
- Increased velocities
- Increased depths
- Reduced floodplain connectivity

Middle Rio Grande – RGSM Biology/Ecology



Dudley et al., 2019

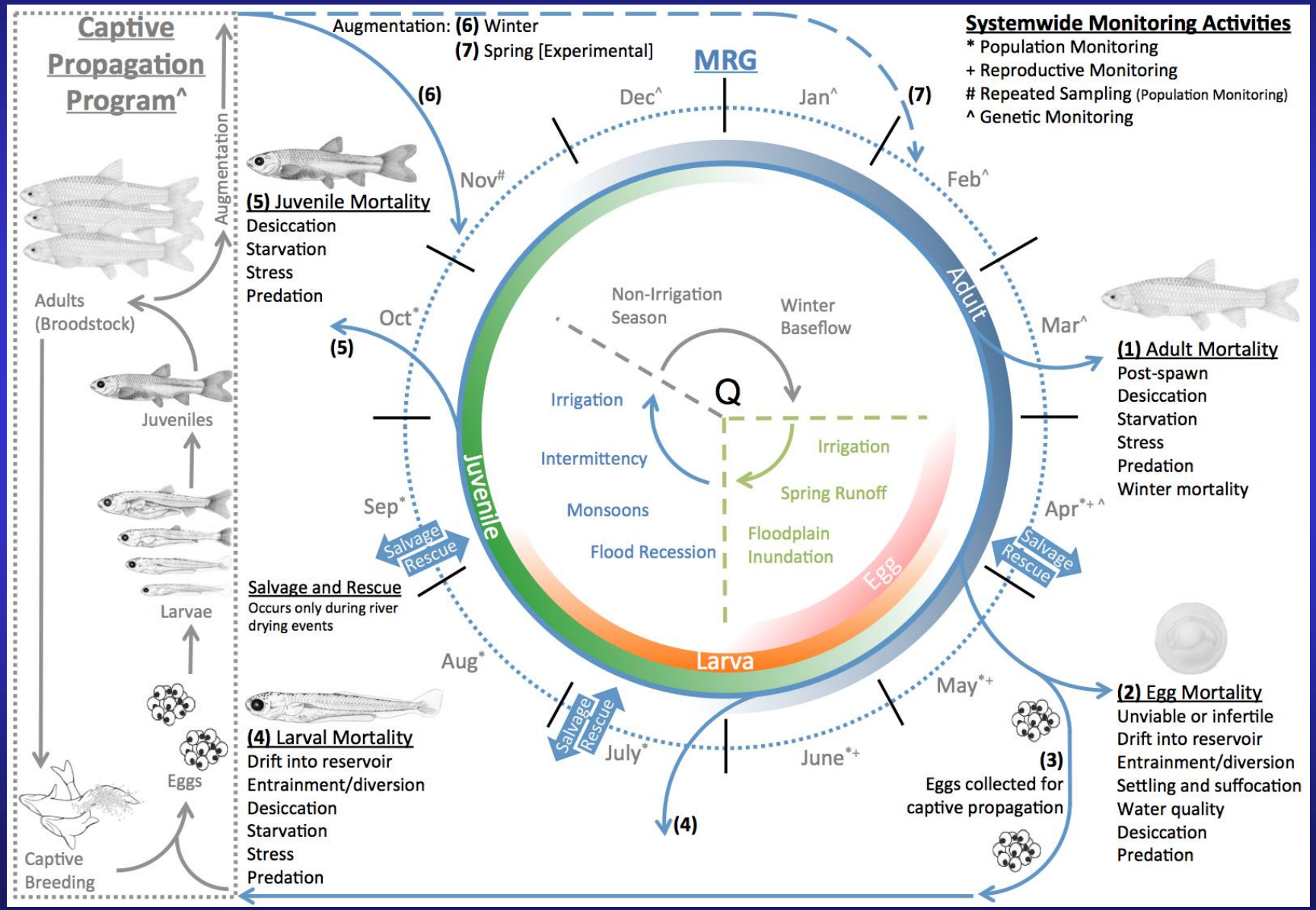
Project Overview



Project Objectives

1. Provide current understanding of bio-habitat conditions needed for the RGSM during primary life-stages (RGSM Bio-Habitat Syntheses).
2. Improve understanding of the morpho-dynamic processes (geomorphic, hydrologic, hydraulic, sediment, and vegetation) on the Middle Rio Grande through an analysis of collected information (Reach Reports).
3. Improve understanding of the specific morpho-dynamic processes that influence bio-habitat conditions for RGSM (Reach and Linkage Reports).
4. Delineate and understand the linkages between fluvial morpho-dynamics, bio-habitat conditions, and the RGSM population (Linkage Reports).
5. Provide recommendations for data collection efforts that may help to inform notable data gaps in the linkages between the morpho-dynamics and biological-habitat conditions for the RGSM (Linkage Reports).
6. Provide recommendations for innovative river management practices that may be viable given linkages made between the morpho-dynamics and biological-habitat conditions for the RGSM (Linkage Reports).

RGSM Bio-Hab Syntheses – Life History Model



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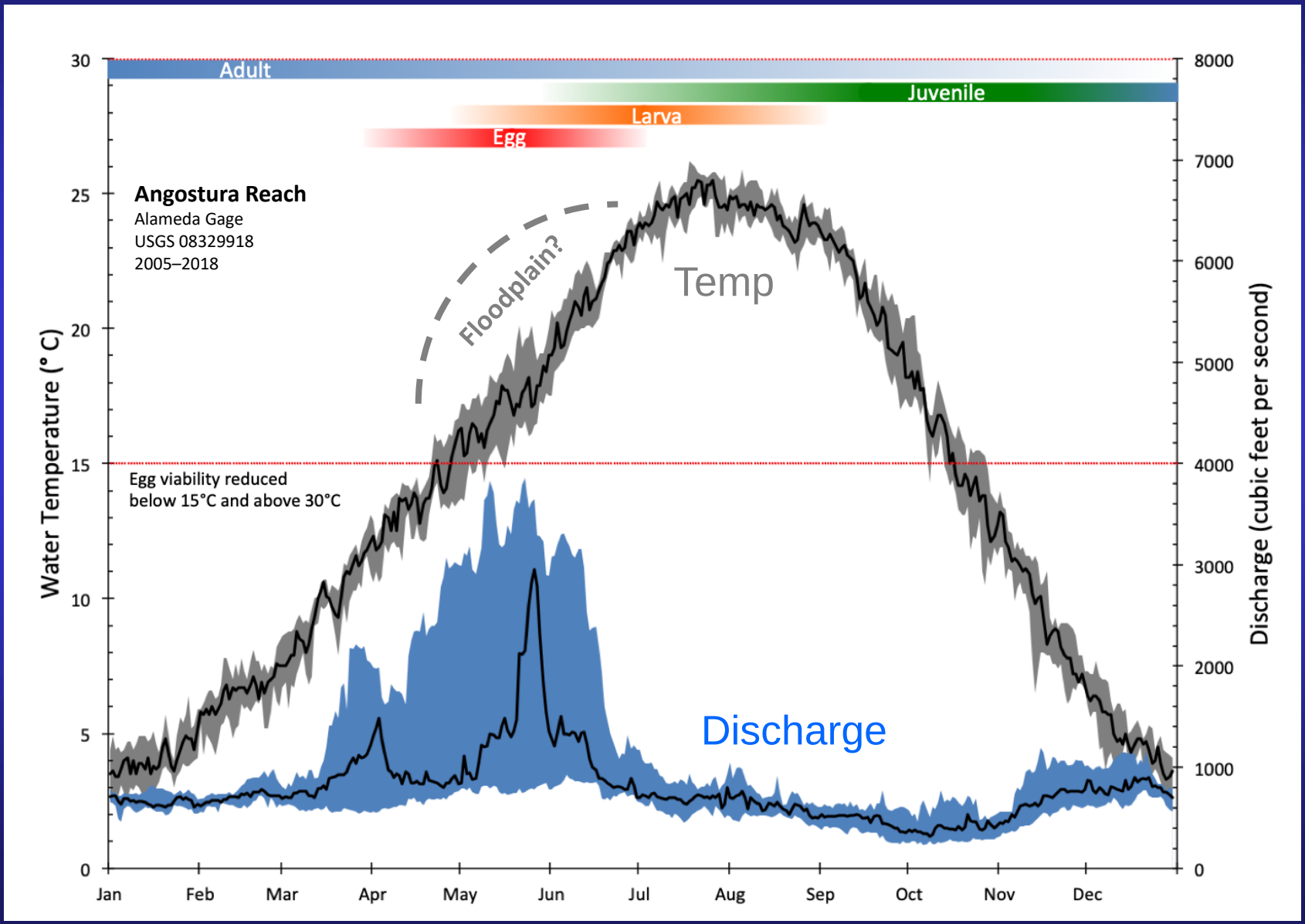
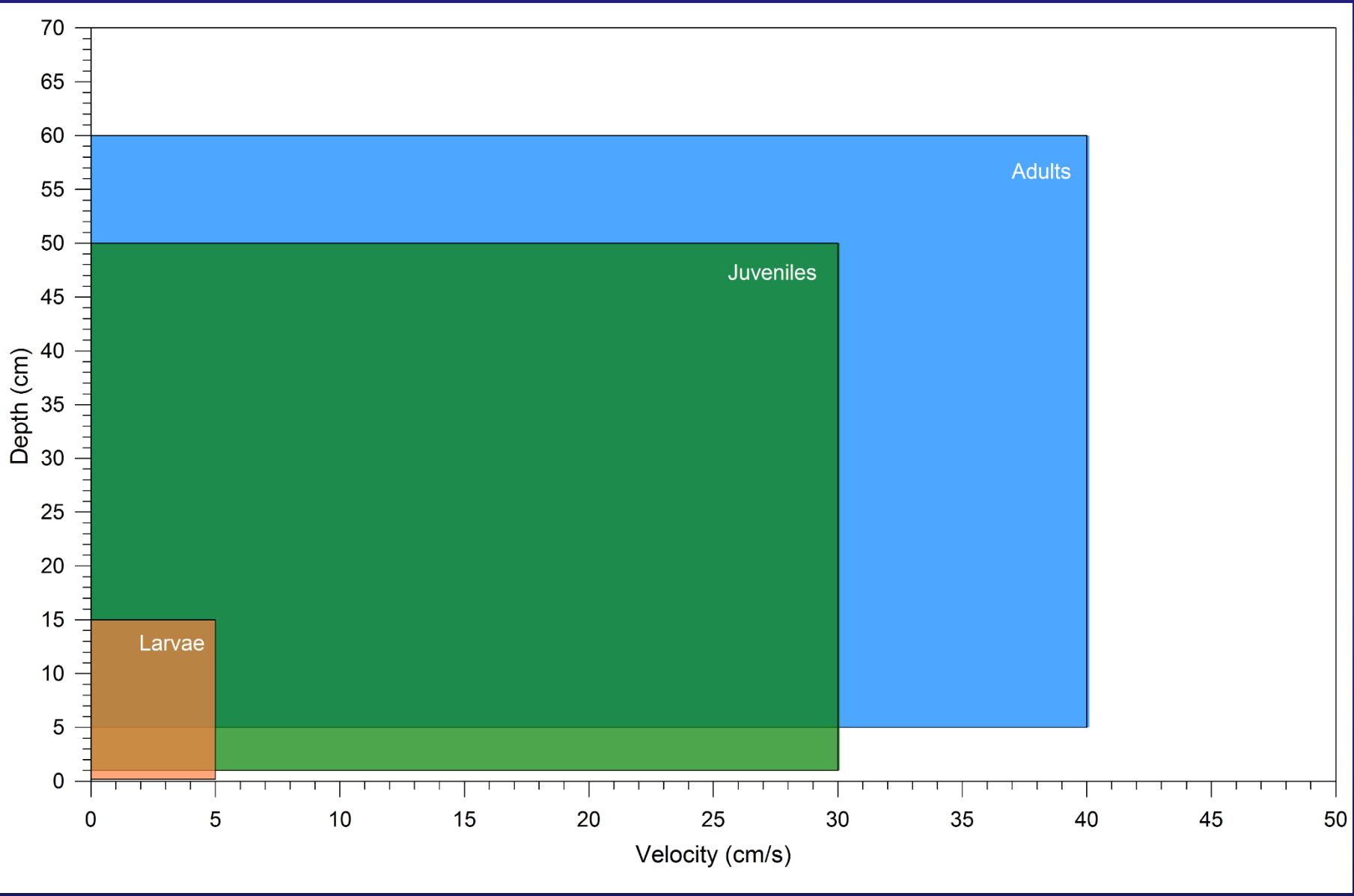


RGSM Bio-Hab Syntheses – Habitat Criteria



Data and Methods

Data:

Channel surveys (USBR)
- agg/deg lines
- 1918 – 2018 (1992–2012)

Stream gaging stations (USGS)
- Discharge, sediment

RGSM Research and Monitoring (UNM-ASIR)
- Habitat use studies
- Pop. Monitoring 1993–2018

Methods:

Geomorphic characteristics

Subreach delineation

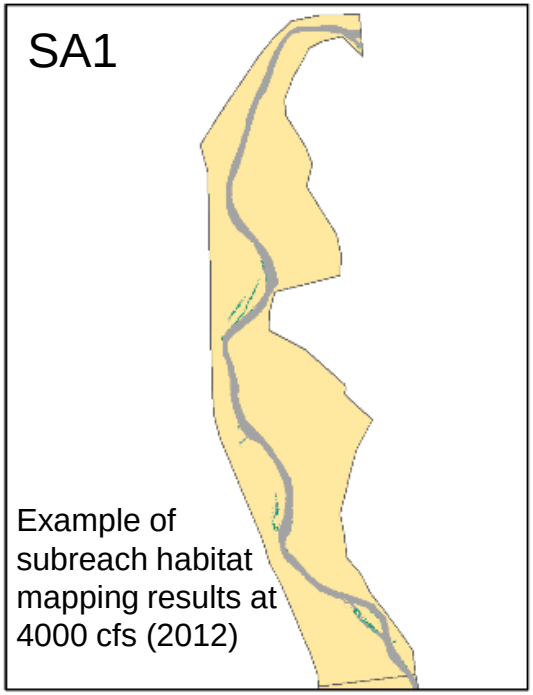
Hydraulic modeling (HEC-RAS)

RGSM habitat criteria by life-stages

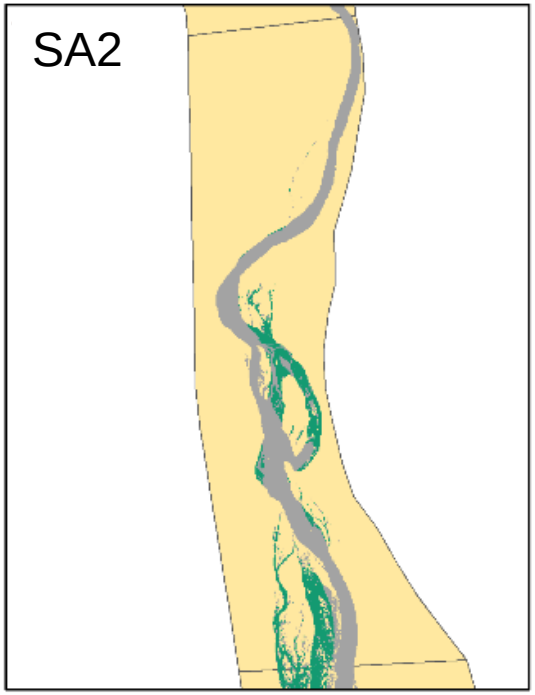
Habitat mapping

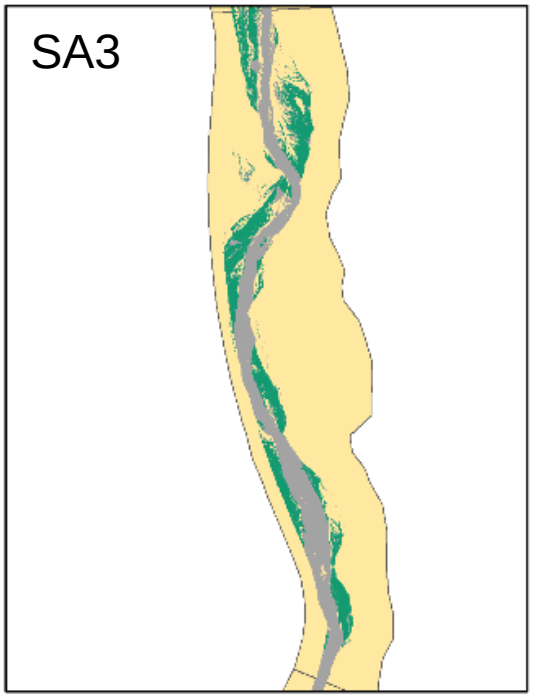
Flow-habitat relationships

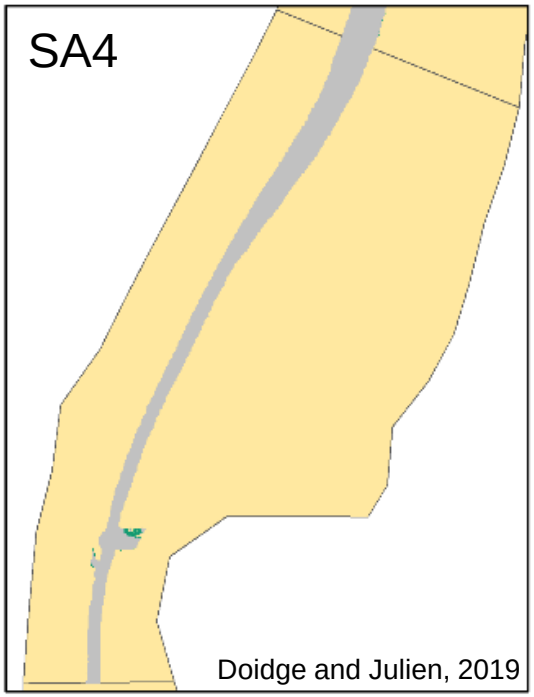
Time-integrated habitat metrics



Example of subreach habitat mapping results at 4000 cfs (2012)







Doidge and Julien, 2019

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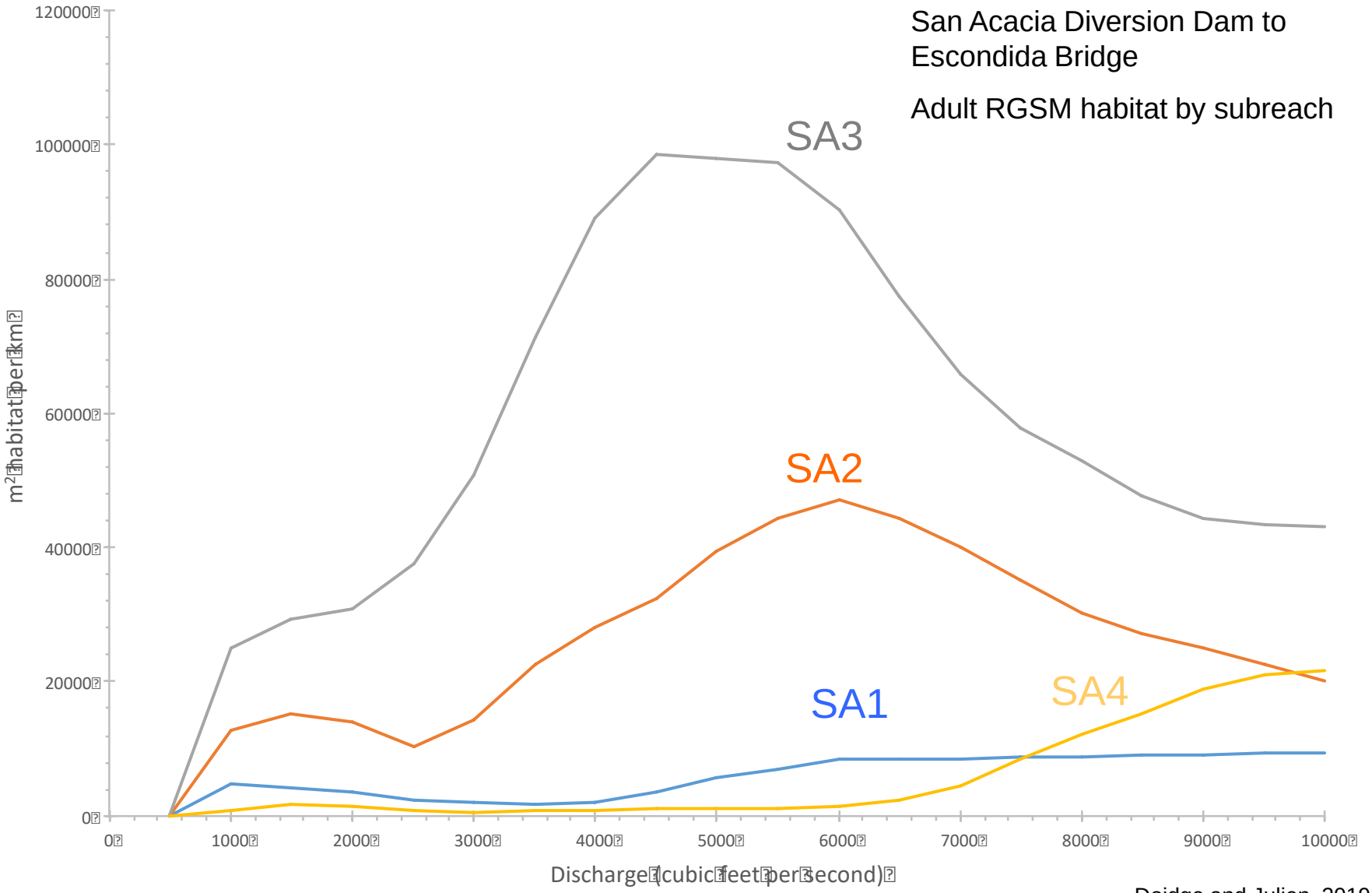
Preliminary Results – 2012 San Acacia Subreach



Doidge and Julien, 2019

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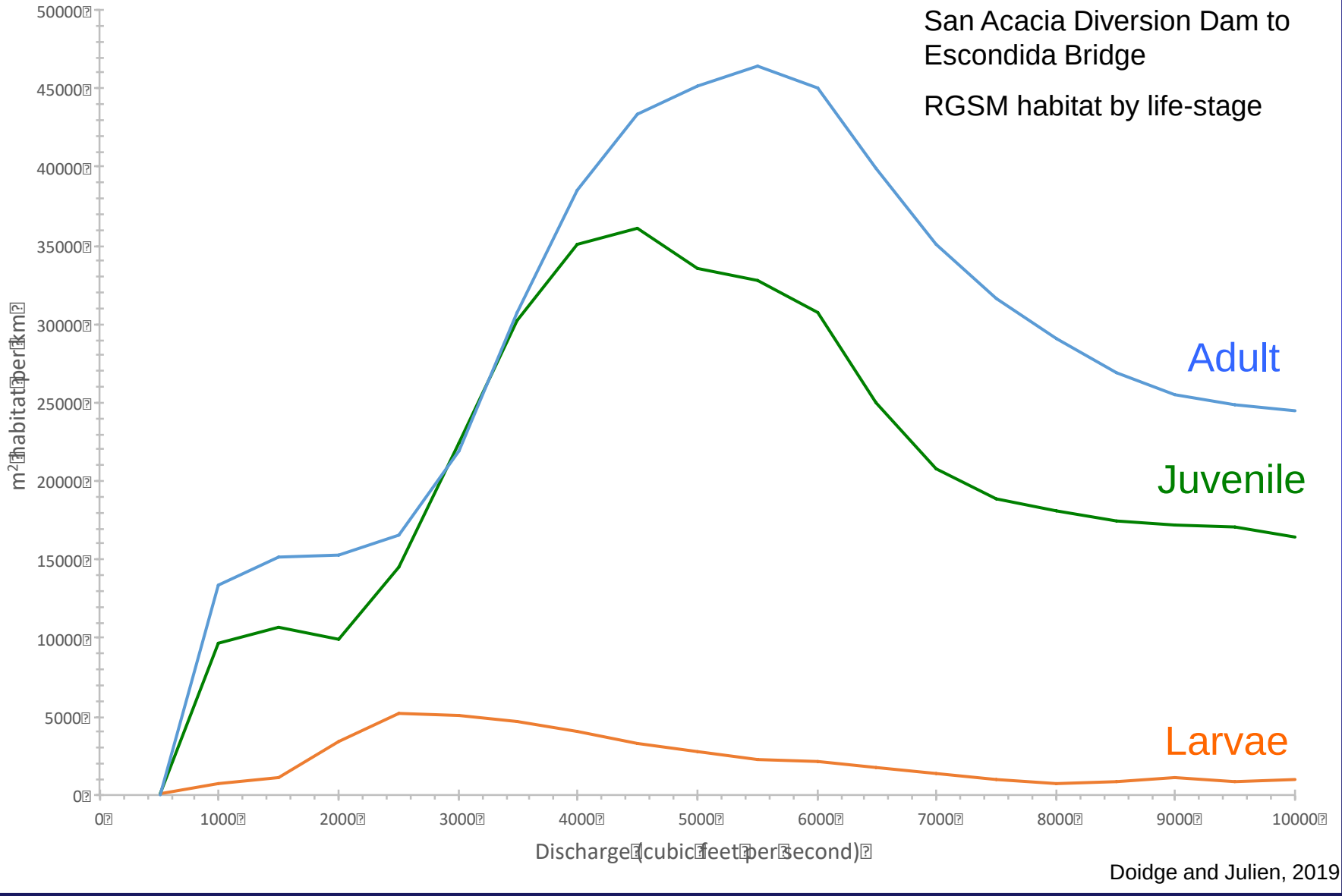

Doidge and Julien, 2019

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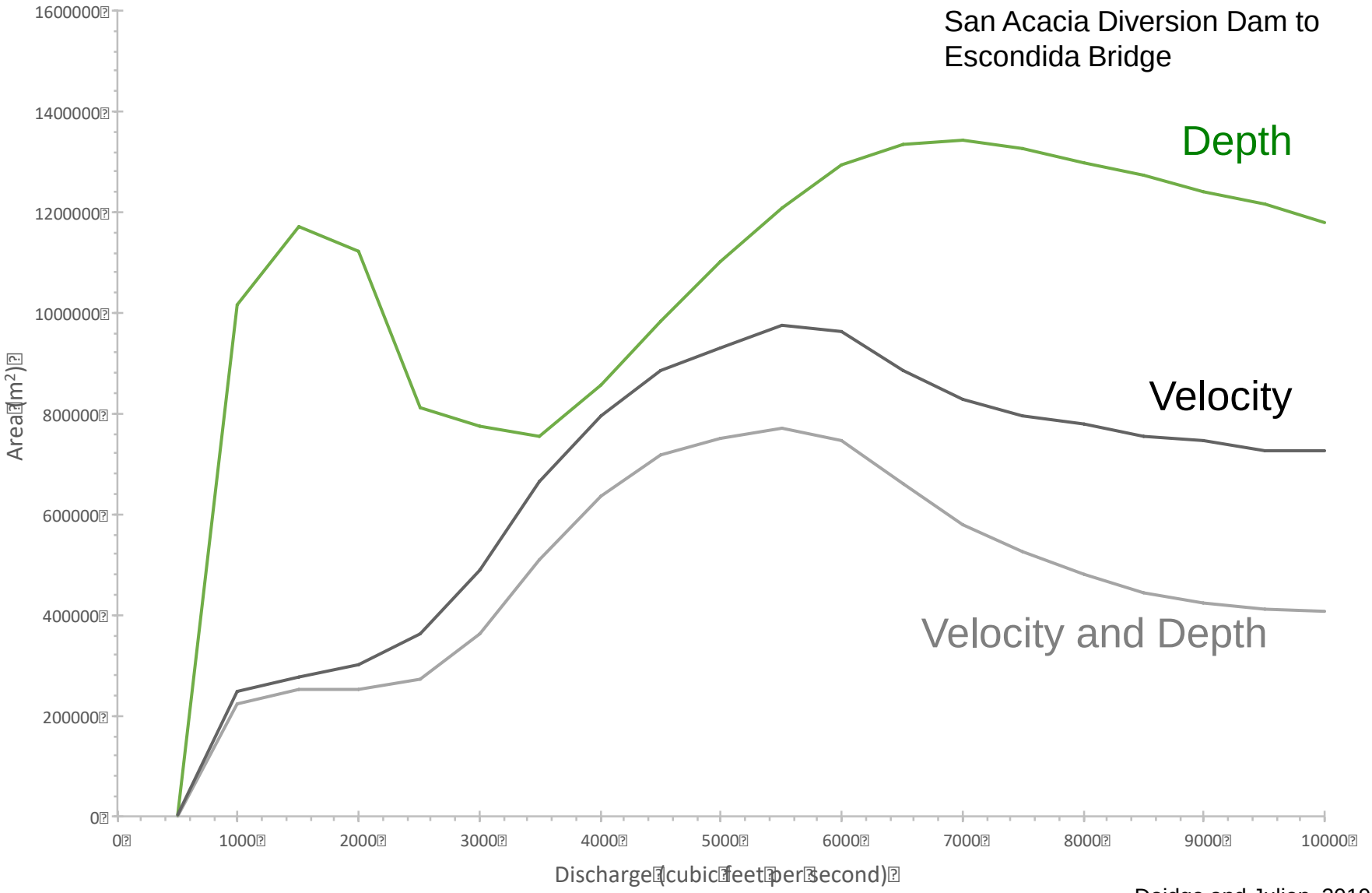
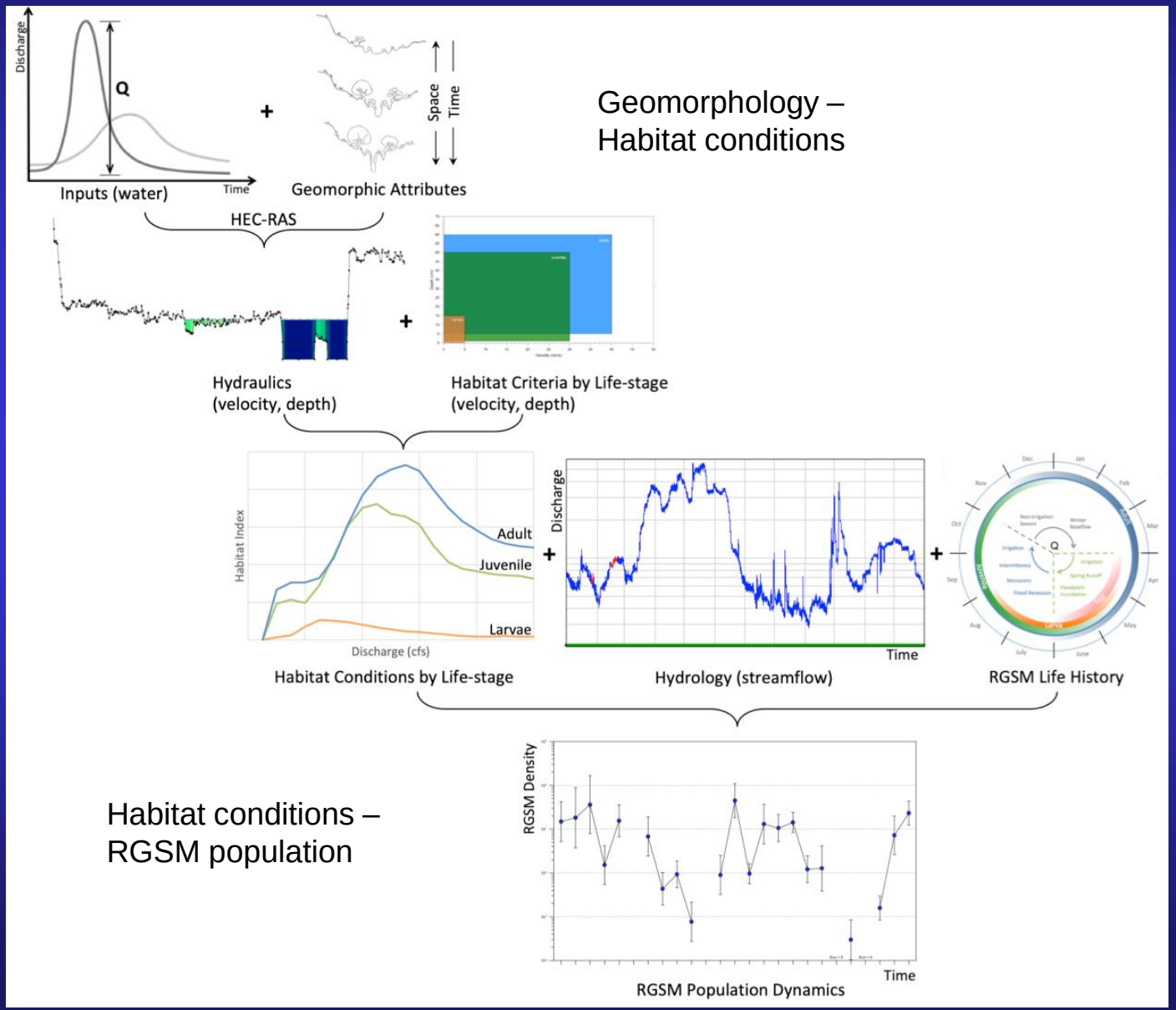


Doidge and Julien, 2019

Linkage Report – Conceptual Approach



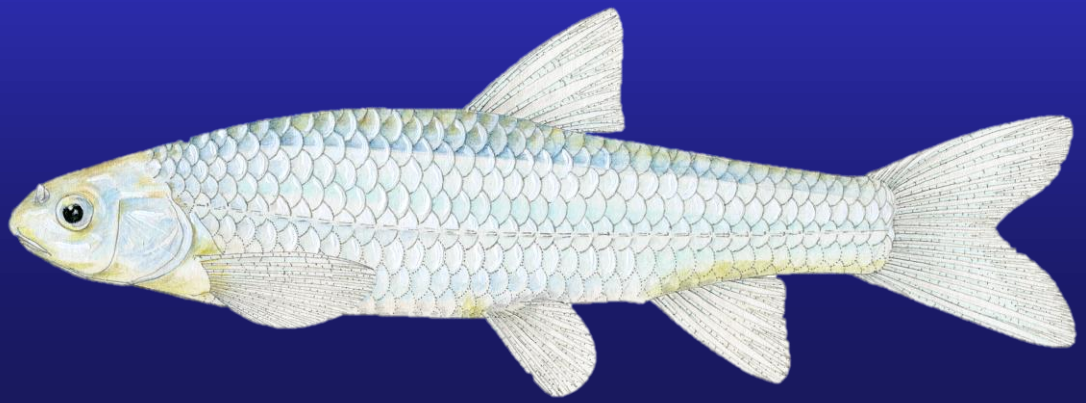
Anticipated Project Outcomes

1. Identify and understand key process-linkages between morpho-dynamics and habitat conditions:
   Floodplain connectivity, instream habitat complexity, geomorphic controls on RGSM habitats

2. Develop integrated channel-habitat evolution model:
   Describe past, present, and future habitat responses to observed fluvial morpho-dynamics in the Middle Rio Grande

3. Provide recommendations for data collection to fill data gaps and improve characterization of key process-linkages

4. Inform river management practices that have potential to create and maintain suitable habitat for RGSM



Discussion

MIDDLE RIO GRANDE ENDANGERED SPECIES COLLABORATIVE PROGRAM

Works Cited

Blythe, T. L., and J. C. Schmidt. 2018. Estimating the natural flow regime of rivers with long-standing development: the northern branch of the Rio Grande. Water Resources Research 54(2):1212–1236.

Doidge, S. and P. Julien. 2019. Middle Rio Grande San Acacia Reach: Morphodynamic processes and Silvery Minnow habitat from San Acacia Diversion Dam to Escondida Bridge. Report to U.S. Bureau of Reclamation, Albuquerque, NM.

Dudley, R. K., S. P. Platania, and G. C. White. 2019. Rio Grande Silvery Minnow population monitoring during 2018. Report to the U.S. Bureau of Reclamation, Albuquerque, New Mexico.

Laforge, K., C. Y. Yang, P. Y. Julien, and S. Doidge. 2019. Rio Puerco Reach: Hydraulic modeling and Silvery Minnow habitat analysis. Report to U.S. Bureau of Reclamation, Albuquerque, NM

Mortensen, J. G., R. K. Dudley, S. P. Platania, T. F. Turner. 2019. Rio Grande Silvery Minnow Biology and Habitat Syntheses. Report to U.S. Bureau of Reclamation, Albuquerque, NM.

Massong, T., P. Tashjian, and P. Makar. 2006. Recent channel incision and floodplain evolution within the Middle Rio Grande, NM. Page Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference. Reno, Nevada.

Rozin, U., and A. P. Schick. 1996. Land use change, conservation measures and stream channel response in the Mediterranean/semiarid transition zone: Nahal Hoga, southern Coastal Plain, Israel. Pages 427–444 Proceedings of the Exeter Symposium. International Association of Hydrological Sciences, Exeter, UK.

Swanson, B. J., G. A. Meyer, and J. E. Coonrod. 2011. Historical channel narrowing along the Rio Grande near Albuquerque, New Mexico in response to peak discharge reductions and engineering: magnitude and uncertainty of change from air photo measurements. Earth Surface Processes and Landforms 36(7): 885–900.

Wohl, E., B. P. Bledsoe, R. B. Jacobson, N. L. Poff, S. L. Rathburn, D. M. Walters, and A. C. Wilcox. 2015. The natural sediment regime in rivers: Broadening the foundation for ecosystem management. BioScience 65(4):358–371.

Yang, C. Y., K. Laforge, P. Y. Julien, and S. Doidge. 2019. Isleta Reach: Hydraulic modeling and Silvery Minnow habitat analysis. Report to U.S. Bureau of Reclamation, Albuquerque, NM.