The Role of Translocations and Invasive Species Suppression in the Conservation of Native Fishes in Grand Canyon

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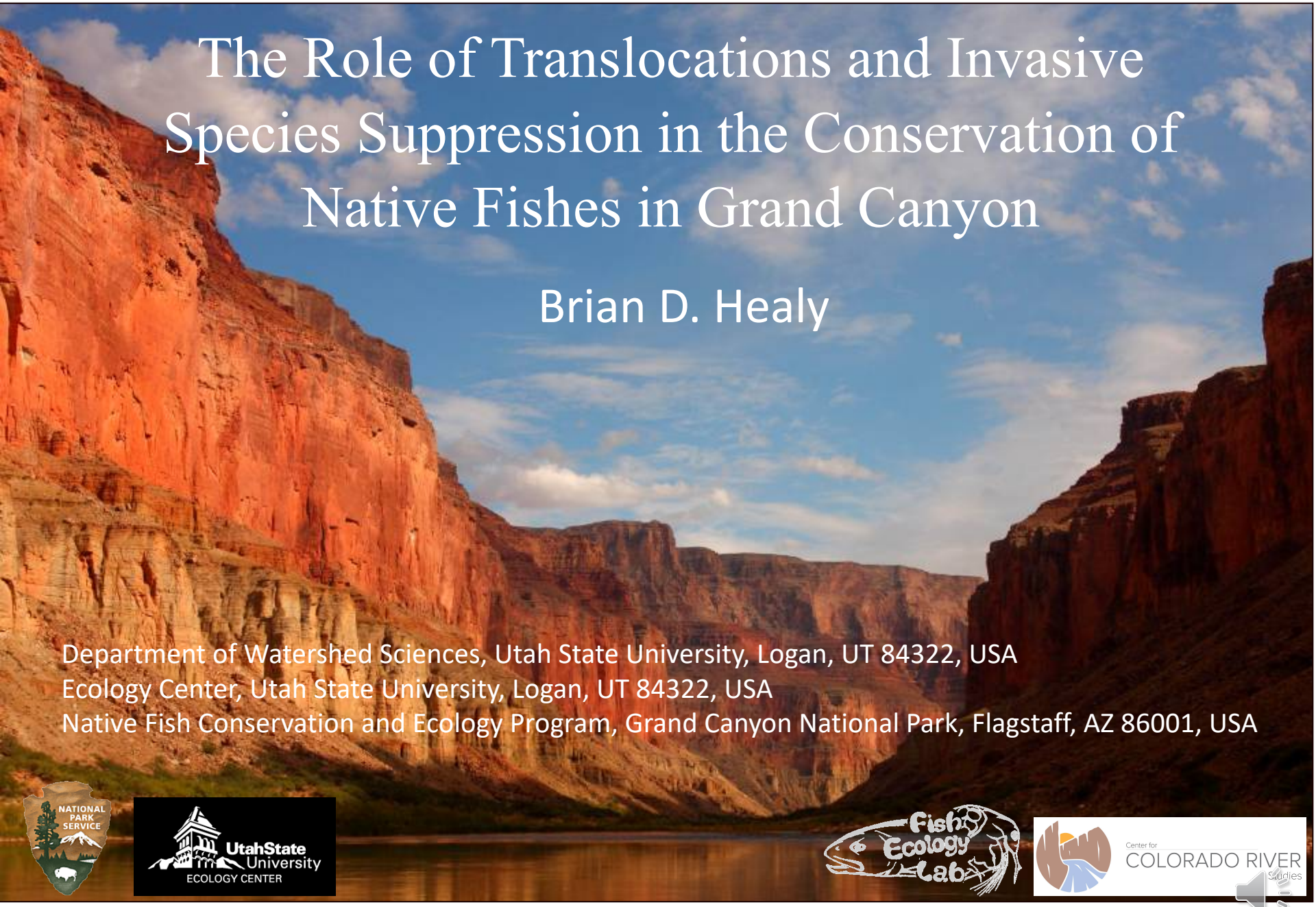


Acknowledgments

Funded or supported by:

- Reclamation
- National Park Service
- Grand Canyon Conservancy
- Arthur L. & Elaine V. Johnson Foundation
- Center for Colorado River Studies – Utah State
- US Geological Survey, Utah Cooperative Fish and Wildlife Unit (In Kind)
- Utah State University-Ecology Center/Watershed Sciences
- Arizona Game and Fish Department

Thank you to many volunteers and technicians!

Collaborators

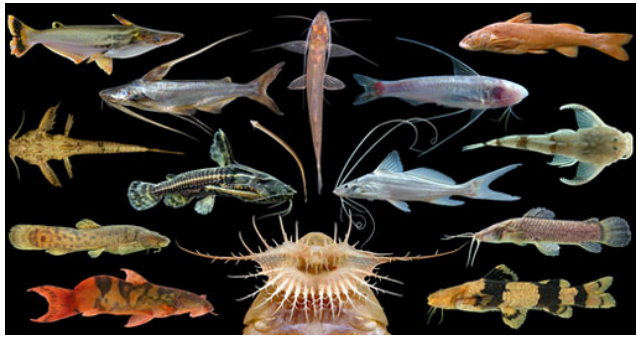
- National Park Service
  - Emily Omana Smith, Robert Schelly, Rebecca Koller, Melissa Trammell, Nic Medley, Clay Nelson, Sarah Haas, Jan Balsom, Santiago Garcia
- Reclamation:
  - Mark McKinstry, Marianne Crawford, Dave Speas, Rich Valdez (SWCA)
- US Fish and Wildlife Service
  - Kirk Young, Randy Van Haverbeke, Manual Ulibarri, Dennis Stone, Mike Pillow, Pam Sponholtz
- US Geological Survey – Grand Canyon Monitoring and Research Center
  - Charles Yackulic, David Ward, Mike Yard
- Utah State University
  - Phaedra Budy, Peter Mackinnon, Mary Conner, Jack Schmidt
- US Geological Survey, Utah Cooperative Fish and Wildlife Unit (In Kind)
  - Phaedra Budy
- University of Missouri
  - Craig Paukert, John Spurgeon, Dan Whiting
- University of Florida
  - William Pine
- Arizona Game and Fish Department

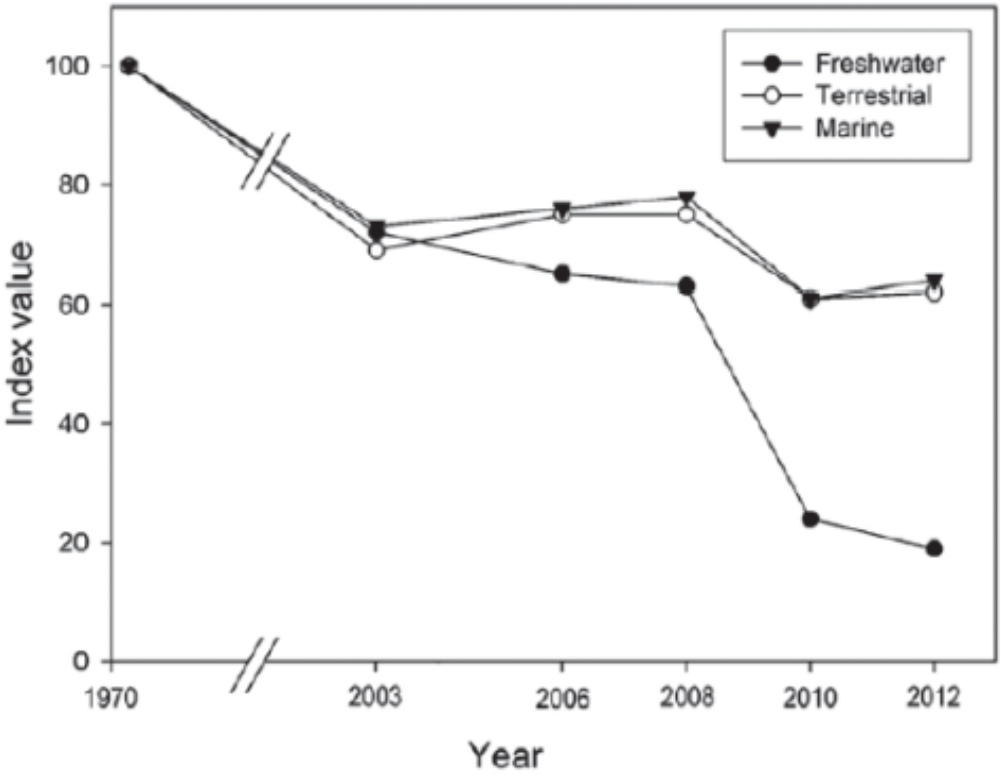
Outline

- Challenges to effectively conserve native fishes in "novel" environments, including in Grand Canyon
- Focus on tributary* - case studies:
  - Invasive trout control to conserve native fishes
  - Translocations of humpback chub
- Discuss "lessons learned" and design considerations

Trends: Freshwater vs. Terrestrial Biodiversity

Freshwaters: 1% of global H_20,
≈ 40-43% of fishes



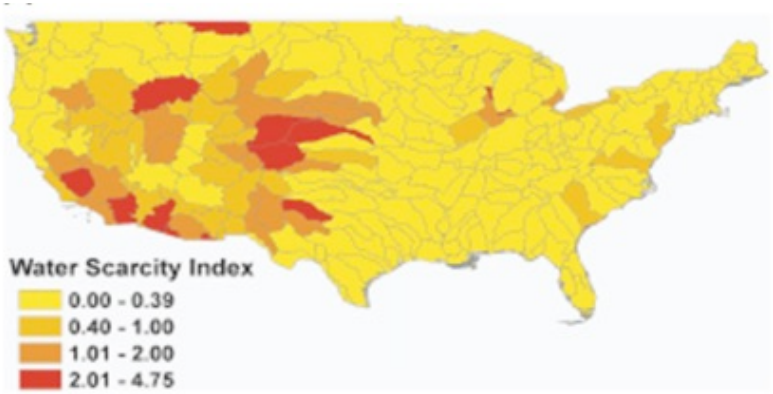


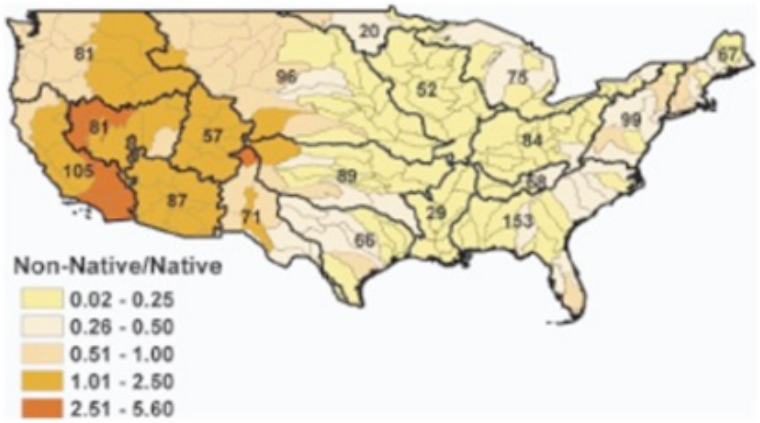
BIOLOGICAL REVIEWS
Cambridge Philosophical Society
Biol. Rev. (2019), **94**, pp. 849–873.
doi: 10.1111/brv.12480

Emerging threats and persistent conservation challenges for freshwater biodiversity

Andrea J. Reid[1*], Andrew K. Carlson[2], Irena F. Creed[3], Erika J. Eliason[4], Peter A. Gell[5], Pieter T. J. Johnson[6], Karen A. Kidd[7], Tyson J. MacCormack[8], Julian D. Olden[9], Steve J. Ormerod[10], John P. Smol[11], William W. Taylor[2], Klement Tockner[12,†], Jesse C. Vermaire[13], David Dudgeon[14] and Steven J. Cooke[1,13]

Conservation constraints





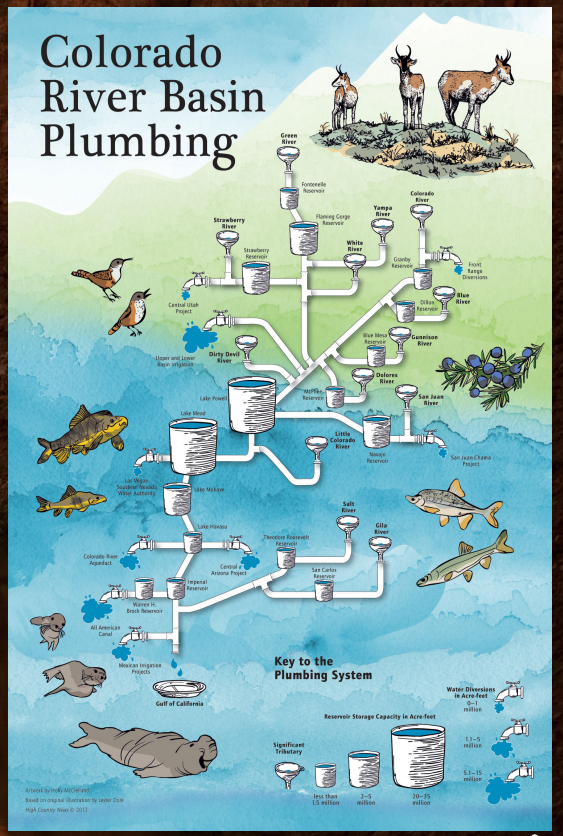
Sabo et al. 2010 –PNAS, *Reclaiming freshwater…Cadillac desert*


Colorado River: “America’s most endangered river”

Colorado River: “America’s most endangered river”

Extensive water development:

- 15 large mainstem dams:
- Reservoirs store 7x mean annual flow!
- 100’s of water diversions



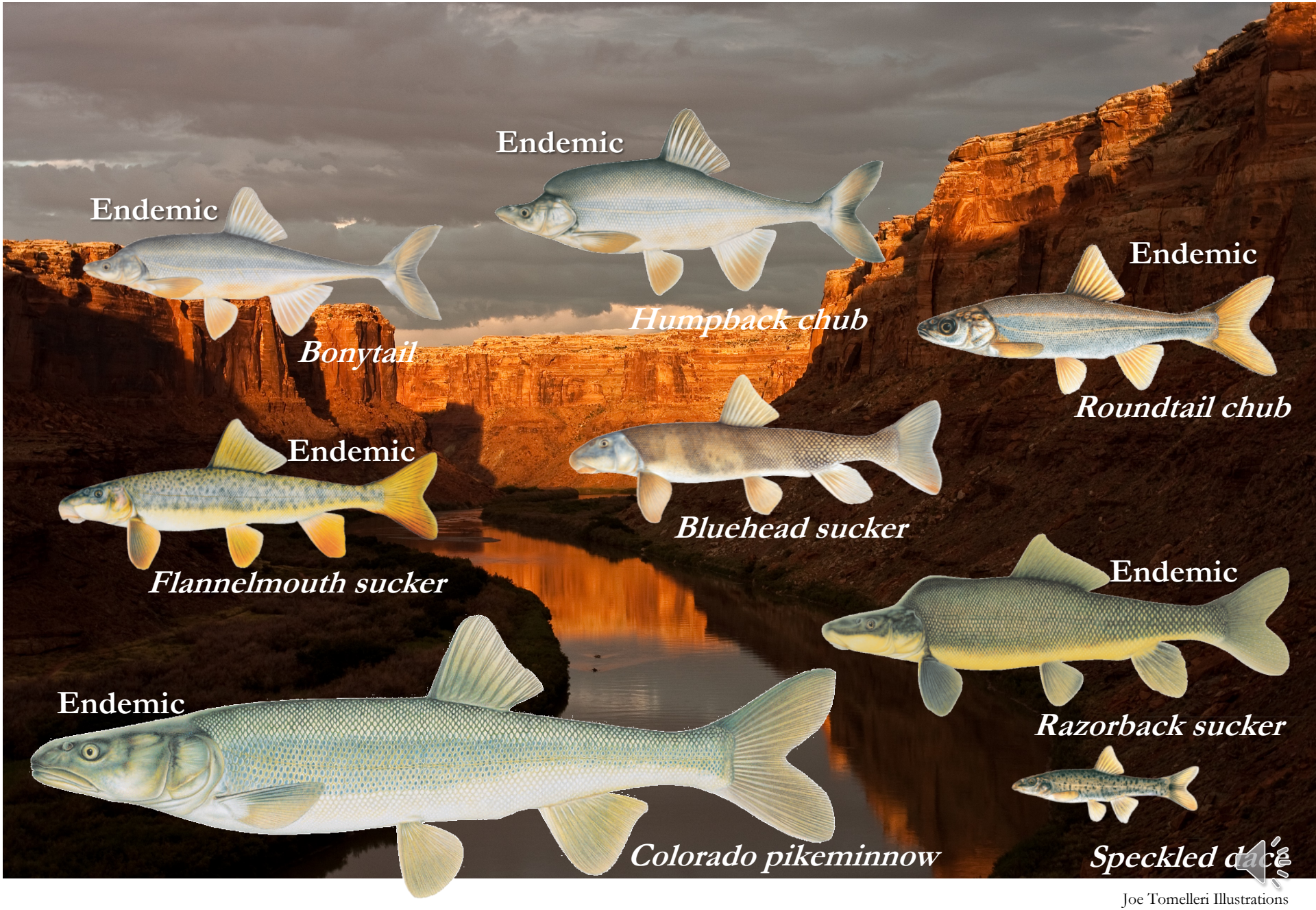
High Country News

Colorado River: “America’s most endangered river”

Photo by Tom Chart

Joe Tomelleri Illustrations

75% are Endemic



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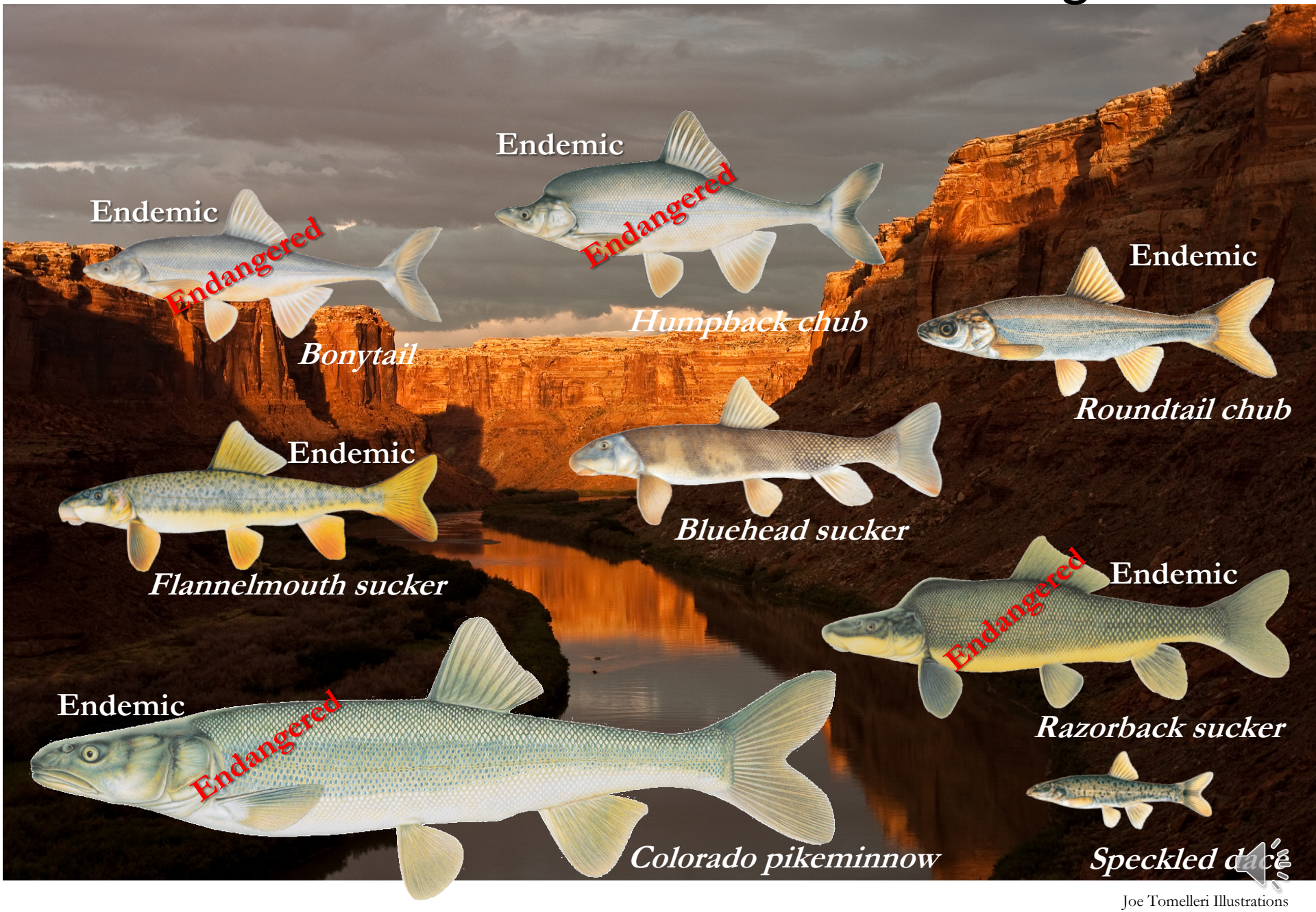
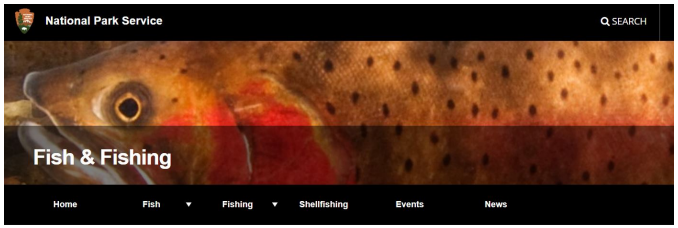
50% are Endangered



Joe Tomelleri Illustrations

Colorado River – National Parks

- Potentially significant role in conservation



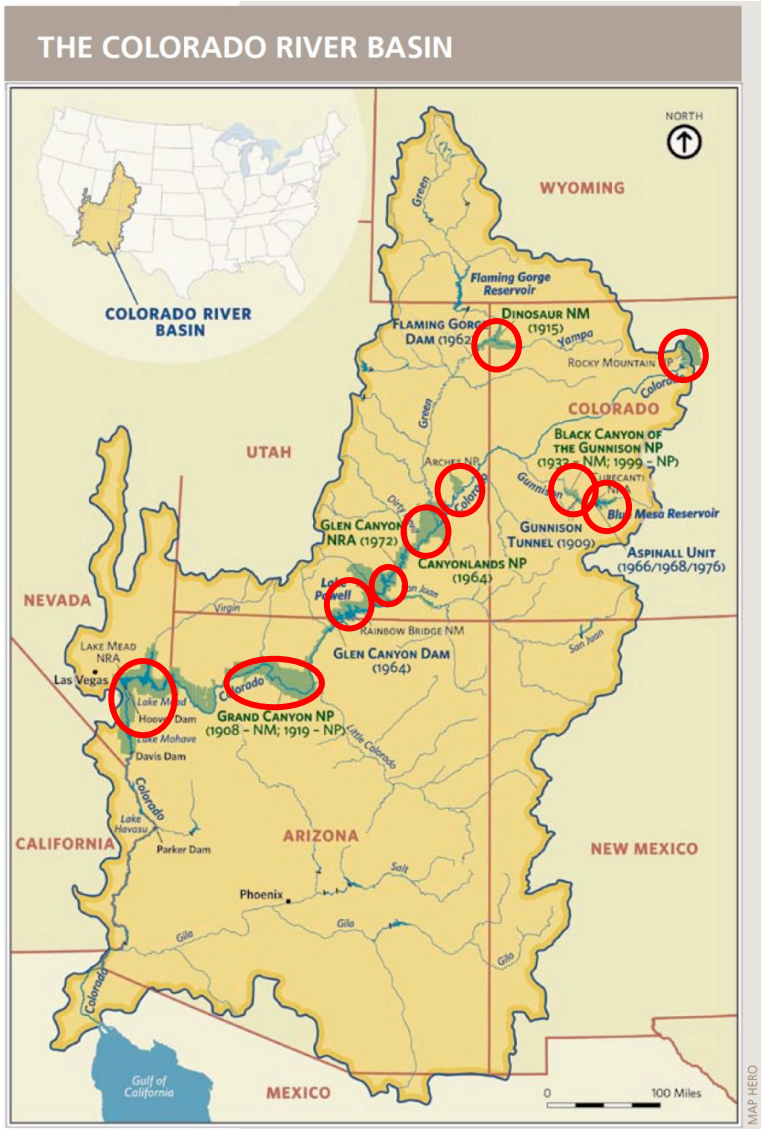
NPS.gov / Home / Fish / Fish Conservation / Benefits of Native Fish

Benefits of Native Fish

The Razorback Sucker is an endangered, native fish species of the Colorado River.

NPS Photo

Colorado River – National Parks



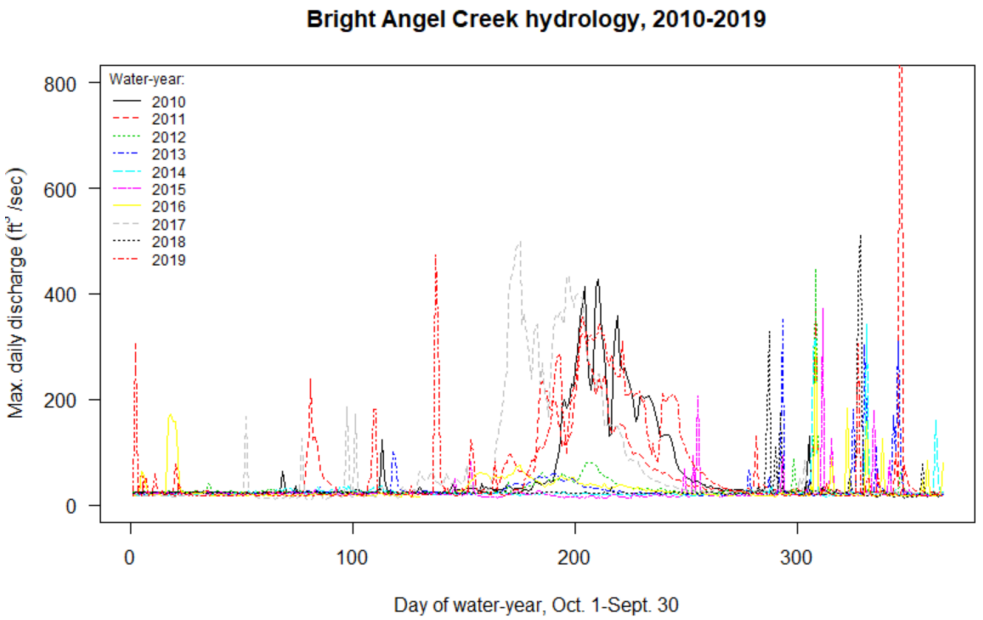
- Potentially significant role in conservation
- 9 NPS units along Colorado River
- Mandate to conserve resources over recreation
  - Organic Act, enabling legislation

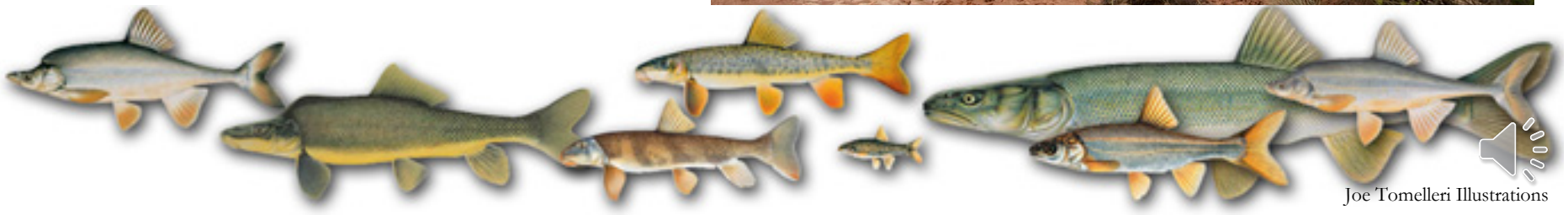
Grand Canyon

Our Challenge:

Colorado River fishes

- Evolved in disturbance-prone environments
- Seasonally-warm thermal regime
- Life history strategies-
  - Long-lived
  - High fecundity
  - Migratory
  - Unique morphology

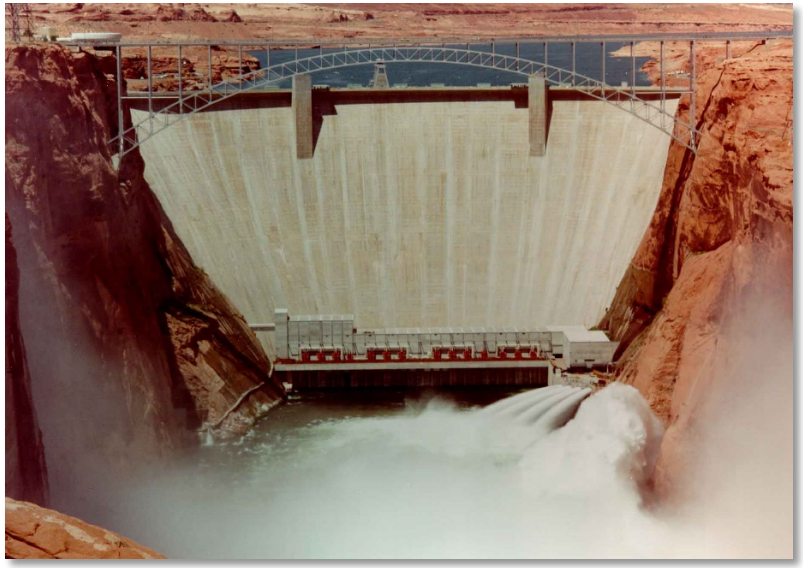




Joe Tomelleri Illustrations

Novel habitats – post “disturbance”

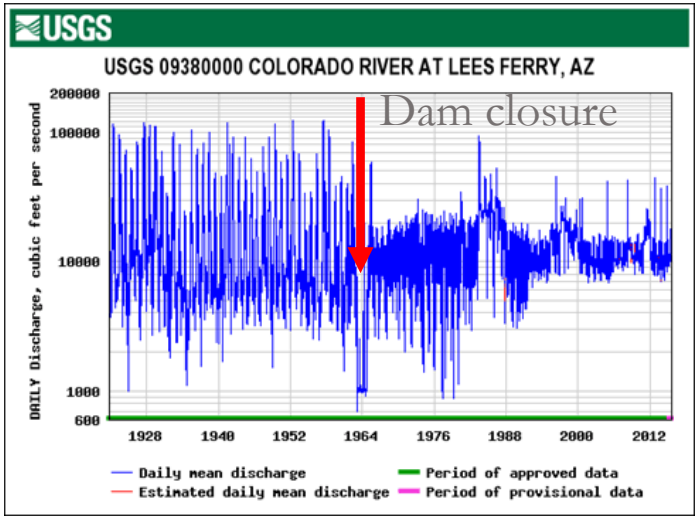
- Damming & diversions
- “Stable” and predictable
- Favors fishes evolved in stable environments



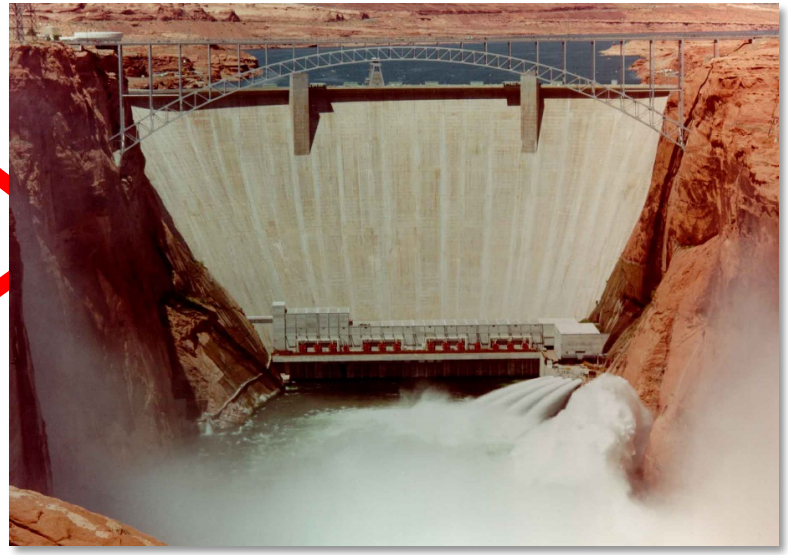
Novel habitats – post “disturbance”

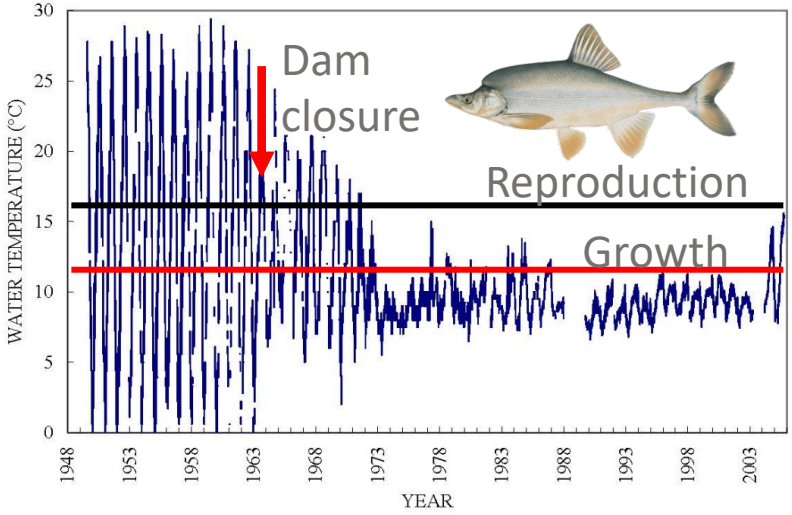
- Damming & diversions
- “Stable” and predictable
- Favors fishes evolved in stable environments (e.g., salmonids)

Study area: Grand Canyon



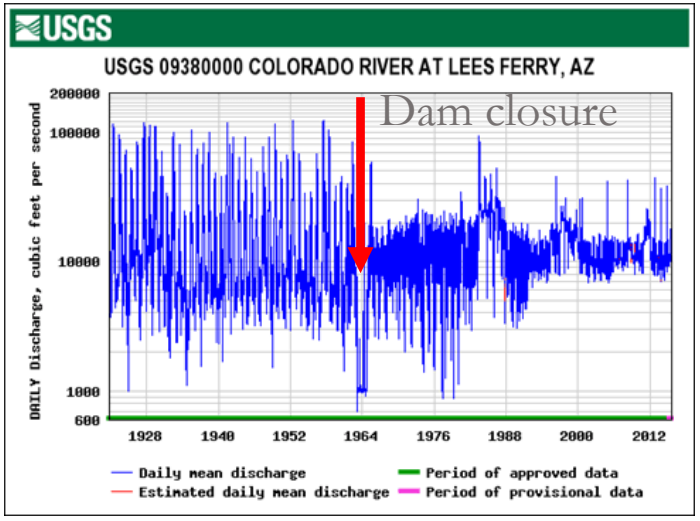
Altered hydrology

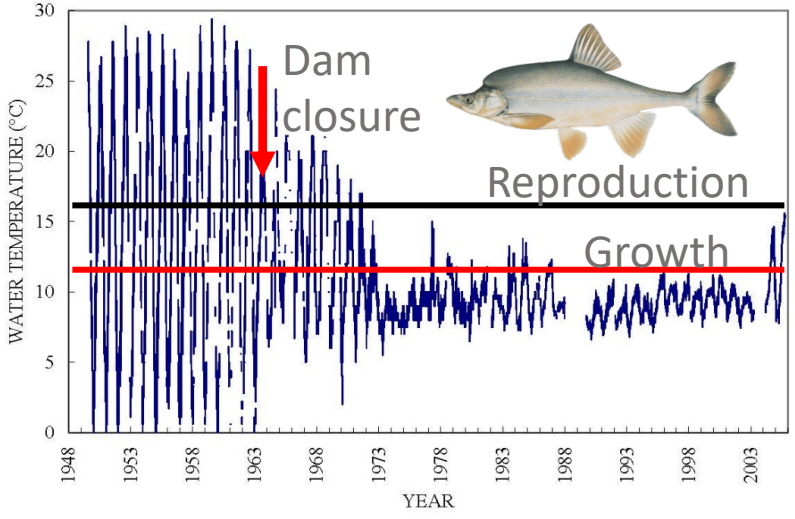




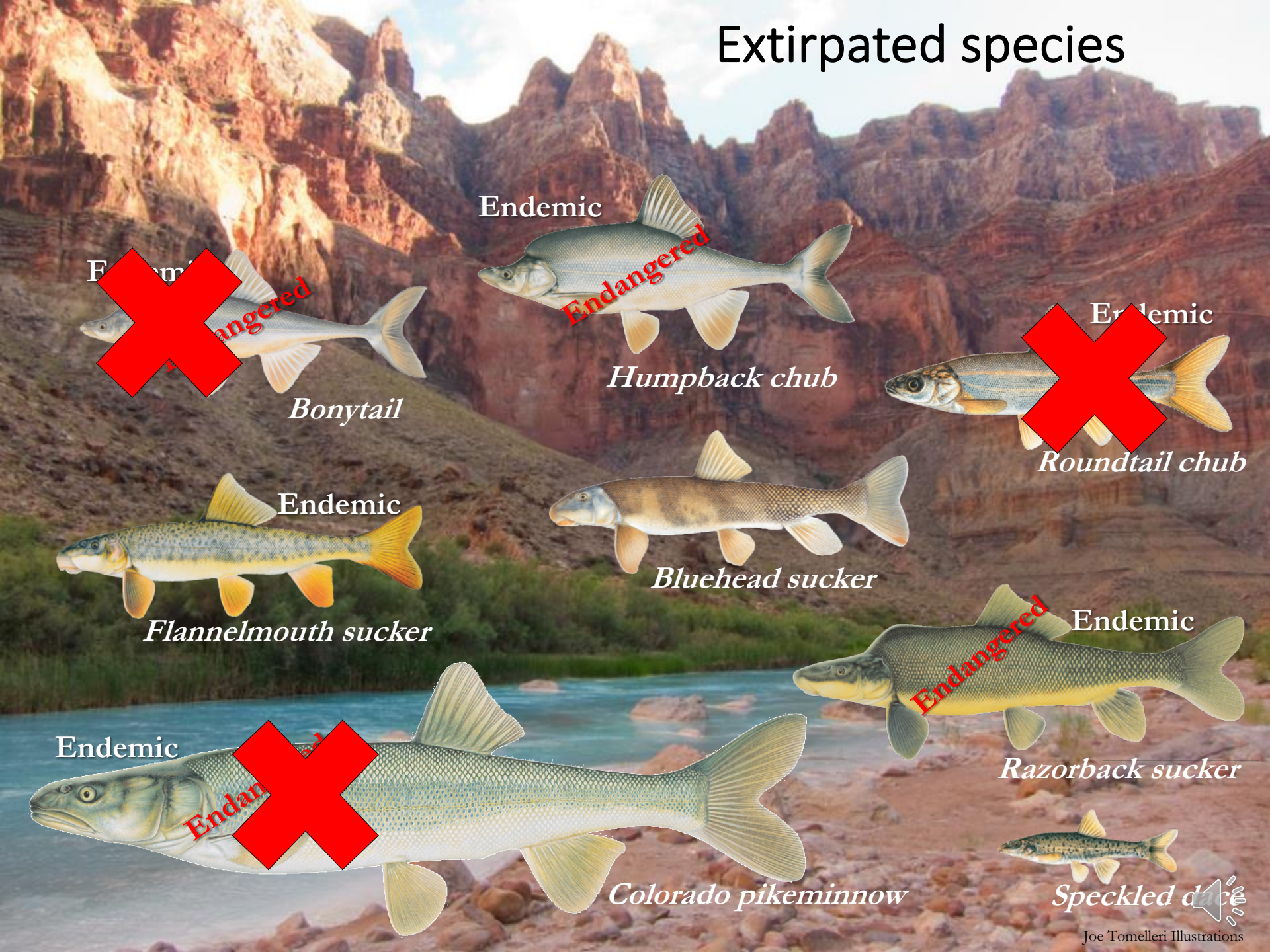
Altered thermal regime

Study area: Grand Canyon



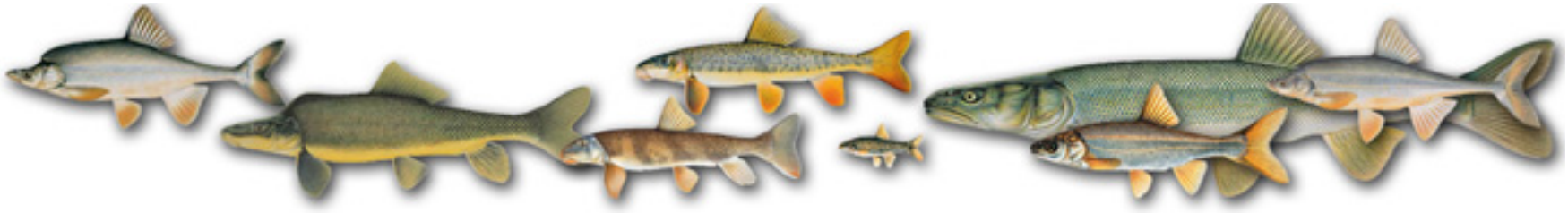


Extirpated species



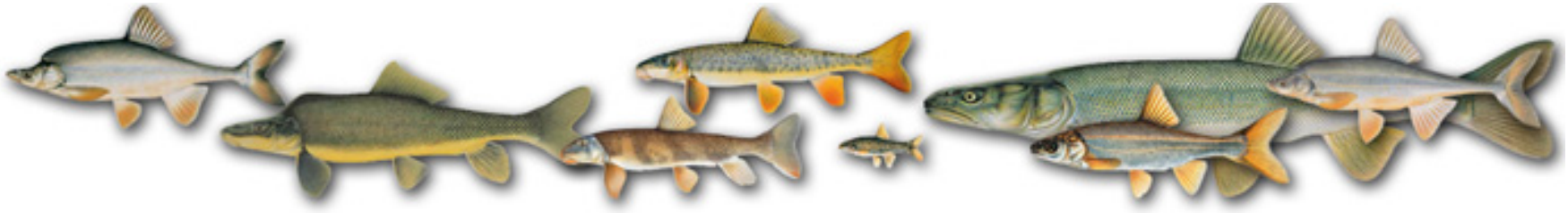
How do we conserve riverine fishes?

Joe Tomelleri Illustrations



How do we conserve riverine fishes?

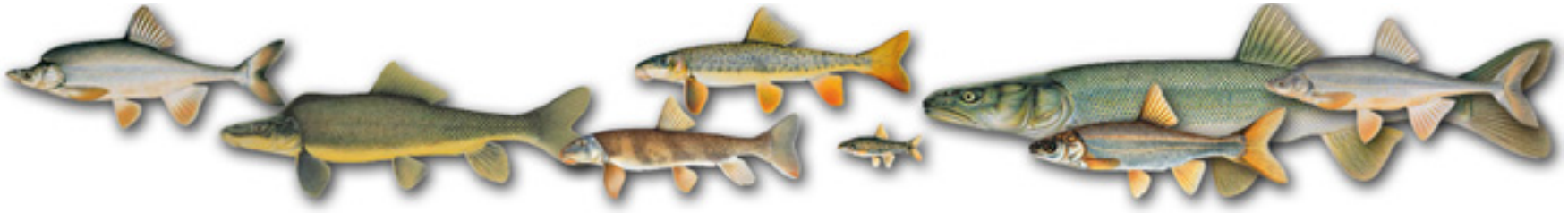
Joe Tomelleri Illustrations



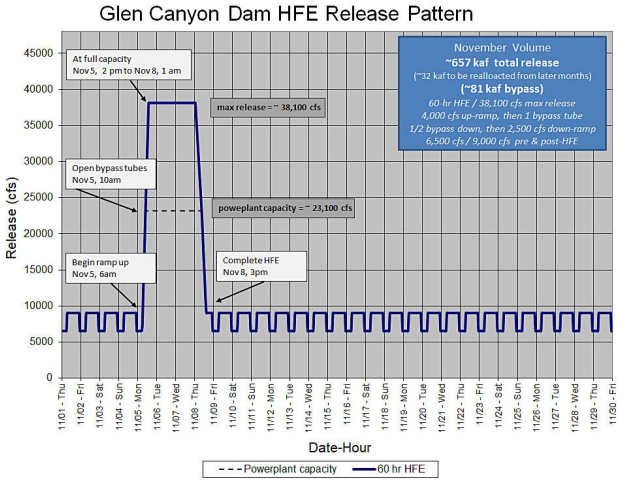
- Restore habitat

How do we conserve riverine fishes?

Joe Tomelleri Illustrations



- Dam management:
  - Outcomes difficult to predict
  - Low summer steady flow cost >$23 million
- Restore habitat



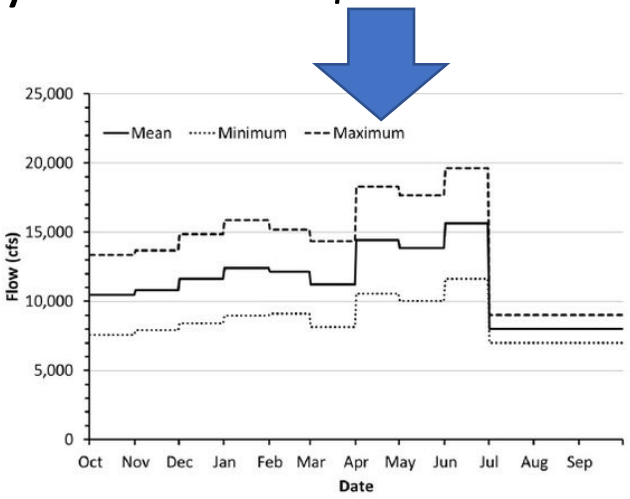


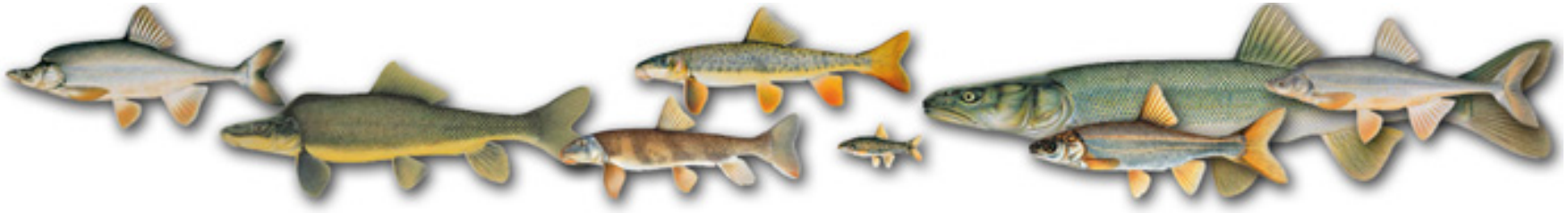
FIGURE 2-22 Mean, Minimum, and Maximum Daily Flows under Triggered Low Summer Flows of Alternative D in an 8.23-maf Year Based on the Values Presented in Table 2-10

Colorado River – stakeholders

Stakeholder	Objective
Federal agency	
U.S Bureau of Reclamation	Water management
National Park Service	Protect/conserve natural and cultural resources
U. S. Fish and Wildlife Service	Endangered species recovery
Bureau of Indian Affairs	Tribal interests
Tribes	
Hualapai	Maintain/protect cultural values
Hopi	Maintain/protect cultural values
Navajo	Maintain/protect cultural values
Pueblo of Zuni	Maintain/protect cultural values
Southern Paiute Consortium	Maintain/protect cultural values
San Juan Paiute	Maintain/protect cultural values
Basin States	
Arizona	Water distribution/rights
California	Water distribution/rights
Colorado	Water distribution/rights
Nevada	Water distribution/rights
New Mexico	Water distribution/rights
Utah	Water distribution/rights
Wyoming	Water distribution/rights
Environmental Groups	
Grand Canyon Wildlands Council	Environmental protection/conservation
American Rivers	Environmental protection/conservation
Recreation Interests	
Grand Canyon River Guides	Commercial and recreational river running
International Federation of Flyfishers/Trout Unlimited	Fishing for invasive trout
	Federal Power Purchasers
Colorado River Energy Distributors	Hydropower
Utah Municipal Power	Hydropower
Other	
Arizona Game and Fish Department	Fishing interests and native fish conservation
Western Area Power - Department of Energy	Hydropower distribution

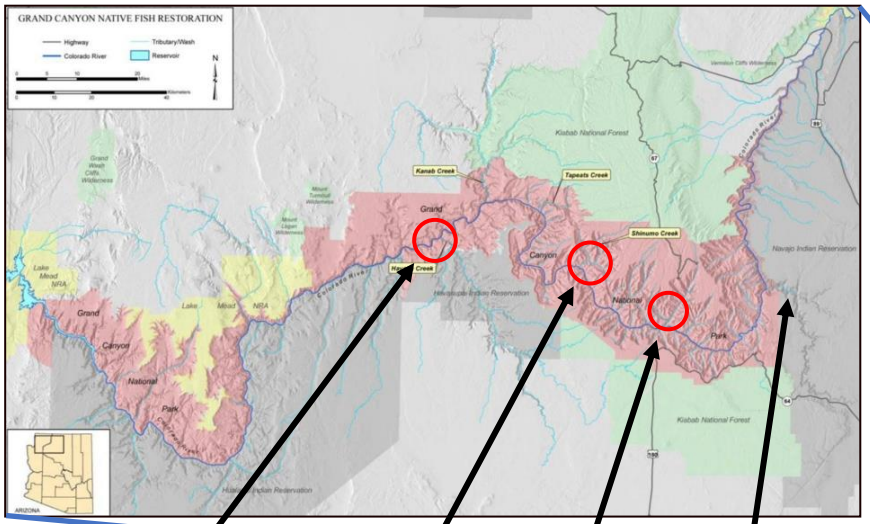
How do we conserve riverine fishes?

Joe Tomelleri Illustrations



- Manipulate populations
- Restore habitat

Study area



Havasu Creek

Shinumo Creek

Bright Angel Creek

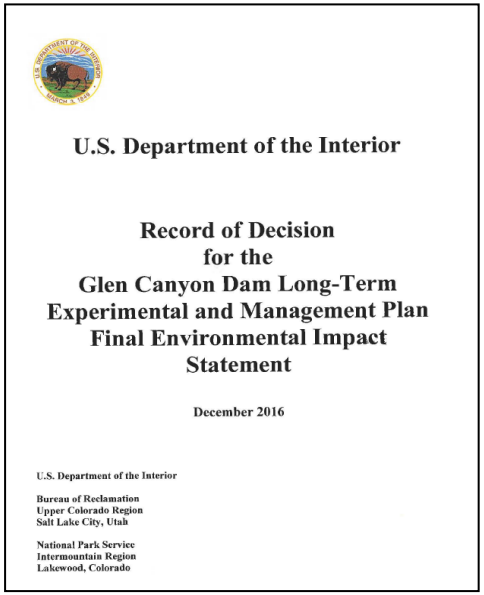
Little Colorado

*Natural flow & thermal regimes

Conservation measures- Humpback chub

- Glen Canyon Dam operations Biological Opinions:
  - Control of nonnative fish (rainbow and brown trout)
  - Translocations to Grand Canyon tributaries

- NPS Comprehensive Fisheries Management Plan (2013)



U.S. Department of the Interior

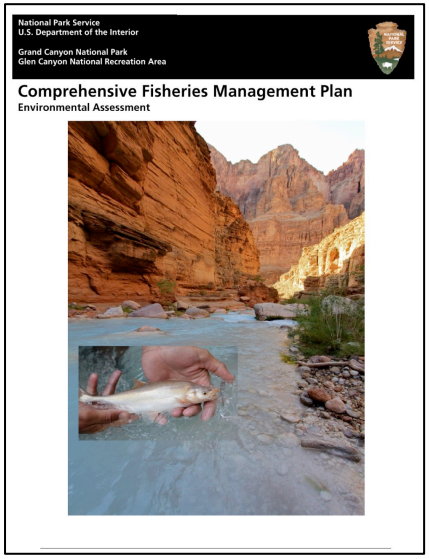
Record of Decision
for the
Glen Canyon Dam Long-Term
Experimental and Management Plan
Final Environmental Impact
Statement

December 2016

U.S. Department of the Interior

Bureau of Reclamation
Upper Colorado Region
Salt Lake City, Utah

National Park Service
Intermountain Region
Lakewood, Colorado



National Park Service
U.S. Department of the Interior

Grand Canyon National Park
Glen Canyon National Recreation Area

Comprehensive Fisheries Management Plan
Environmental Assessment

Case study: Humpback chub translocations

Illustration by Joseph Tomelleri

Humpback chub translocations

- Grand Canyon: largest population
- Little Colorado River – center of the Humpback Chub universe:
  - Sole spawning location =

    Risk of extirpation
- Translocations proposed to:
  - Enhance juvenile recruitment
  - Increase population redundancy

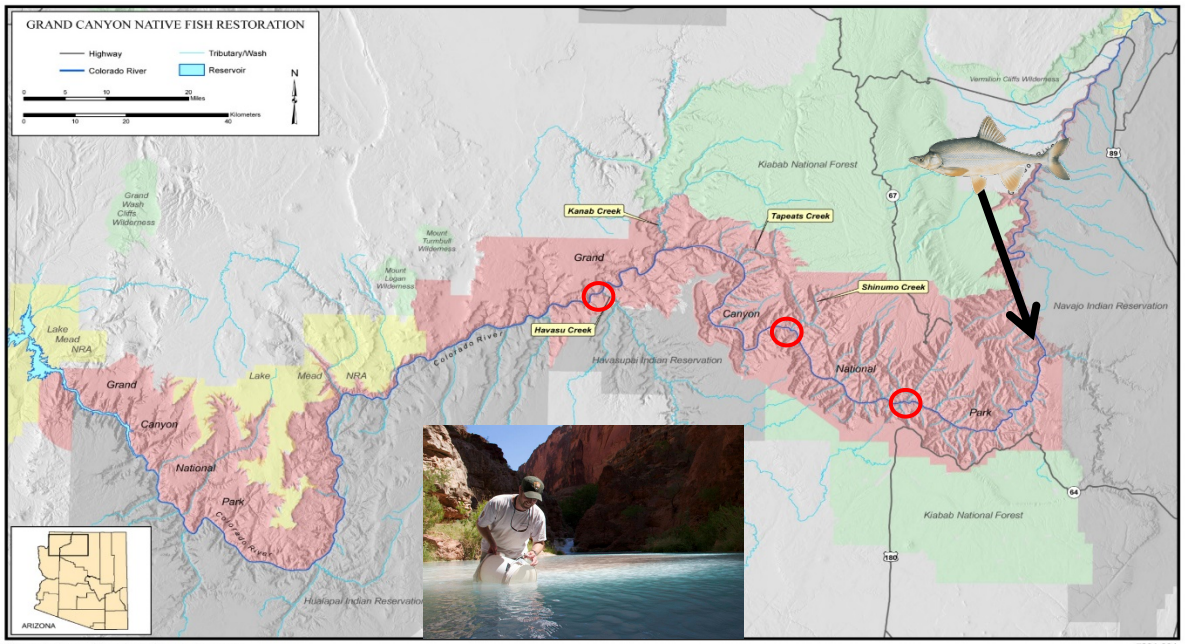


Figure 1. General location of the project area.

7291-091

Translocation – Site Selection

- Valdez et al. 2000:
  - Feasibility study for developing a second spawning population in Grand Canyon
  - Evaluated 8 tributaries (water quality/quantity, habitat, presence of nonnative fishes)

Criteria	*Little Colorado River*	Bright Angel Creek	Shinumo Creek	Havasu* Creek
Water Quantity (cfs)	250	35	9	63
Temperature Range (°C)	2-25	1-24	1-23	9-23
Nonnative Fishes	Numerous (warmwater)	Salmonids (Brown Trout)	Rainbow Trout	Minimal

Translocation sites

- Important differences in habitat among the three tributaries

Joe Tomelleri Illustrations

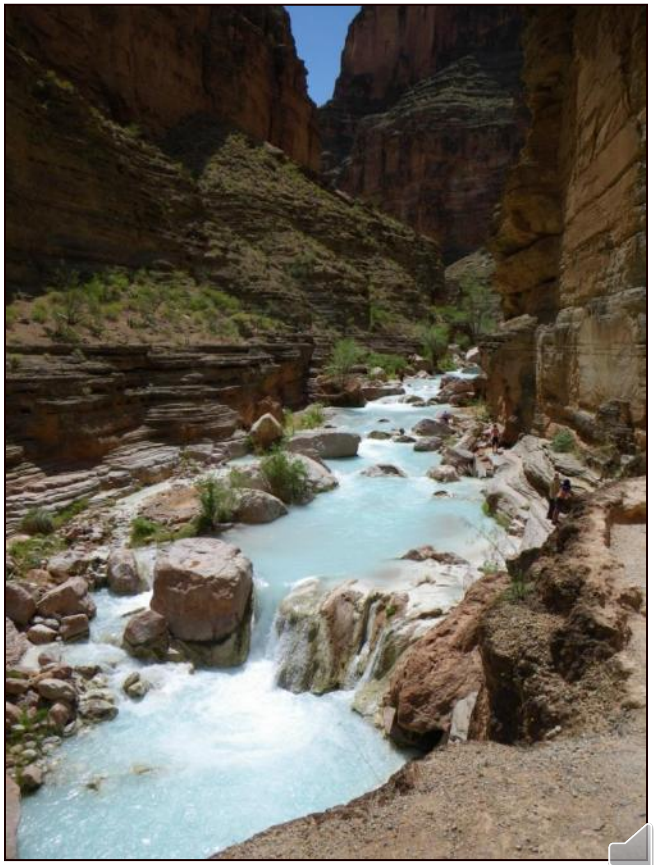
Translocation sites

- Important differences in habitat among the three tributaries – and much smaller than the Little Colorado and and Colorado rivers

Questions about translocations

Will chub remain & survive in the tributaries?

Will chub augment mainstem aggregations?



Little Colorado River Collections

Logistics: hatchery Rearing

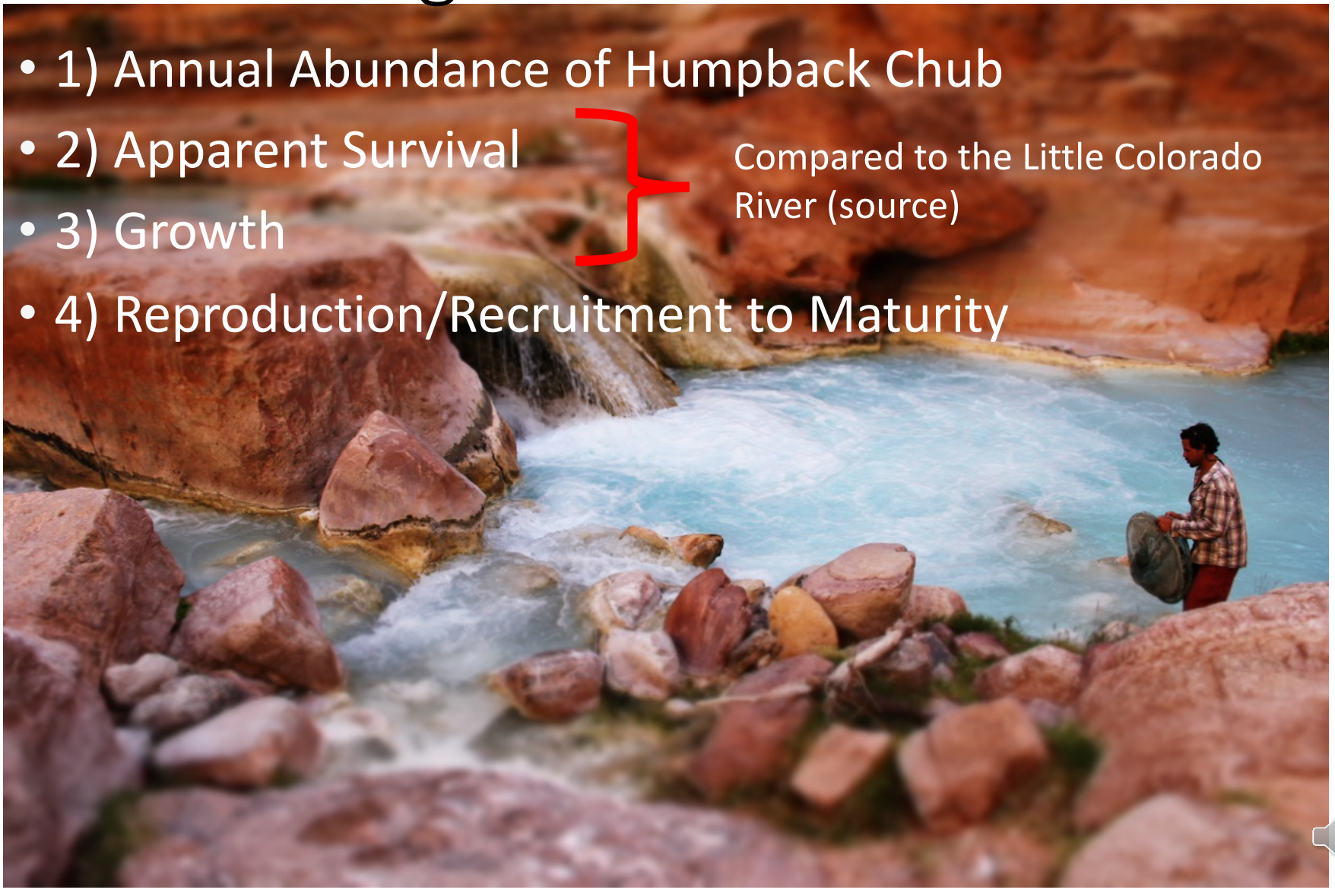
- 8-12 months
- Parasite & disease treatment
- Flow training
- PIT- tagging
- Weight & length measurements

NNF control – Shinumo Creek

- Purpose:
  - Suppress rainbow trout
  - Maximize survival of translocated fish
- Electrofishing and angling
- Smaller scale than Bright Angel
- Effectiveness?

PIT Tag Antenna System

Monitoring Metrics



- 1) Annual Abundance of Humpback Chub
- 2) Apparent Survival
- 3) Growth
- 4) Reproduction/Recruitment to Maturity

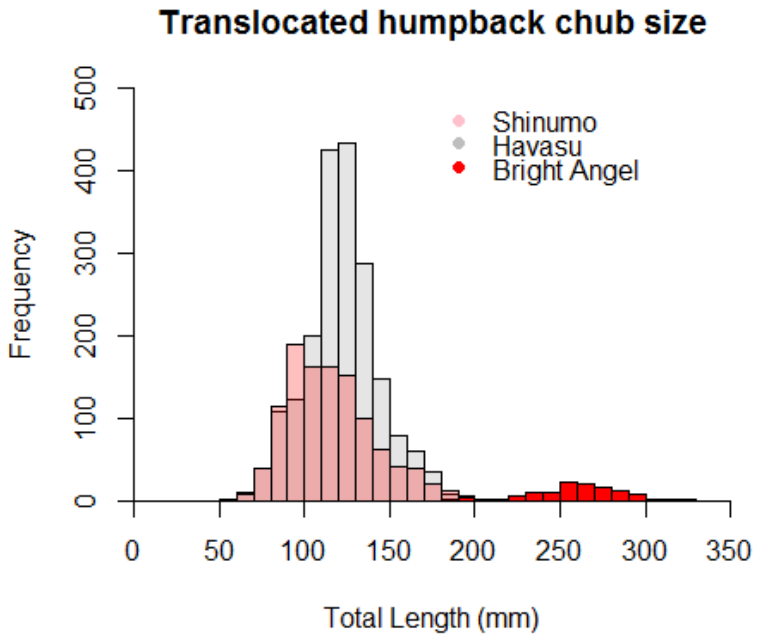
Compared to the Little Colorado River (source)

Methods – Data Analysis

- Mark-recapture sampling – spring and fall:
  - Hoop nets, minnow traps
  - Abundance
  - Seasonal/annual daily growth Rates
  - Preliminary “true survival”
    - Barker model
  - Monitor fish community

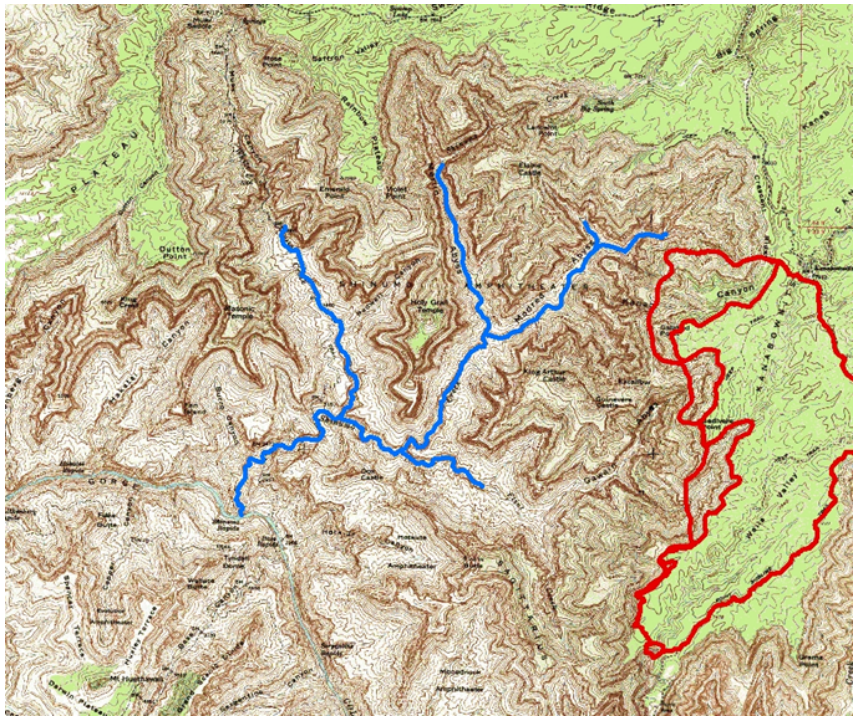
Translocations 2009-2018

Shinumo ~ 1,102 fish, 2009-2013
Havasu ~ 1,956 fish, 2011-2016
Bright Angel ~ 116 fish, 2018



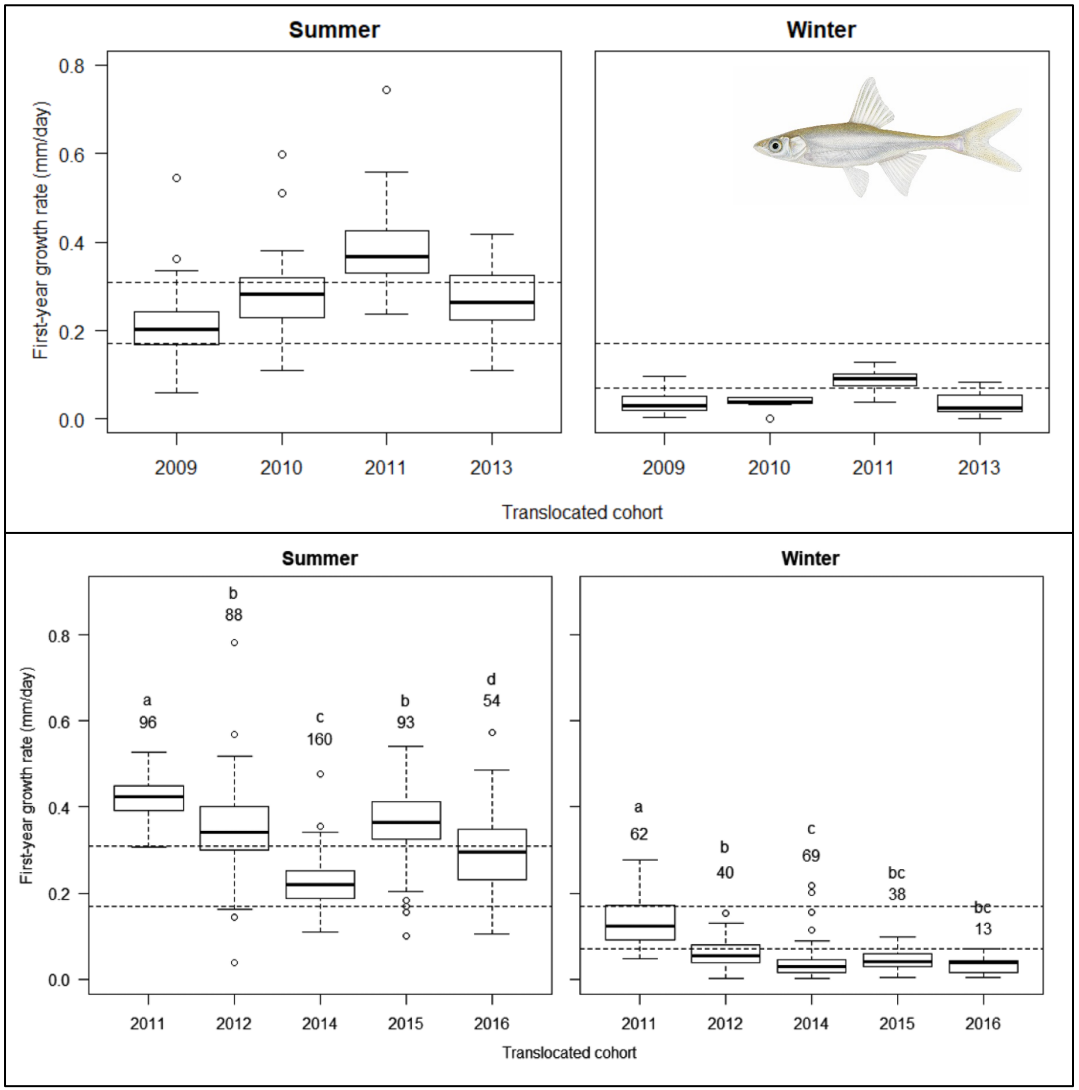
2014 Galahad Fire-Shinumo Creek

- Native fish extirpated



Seasonal growth compared to LCR

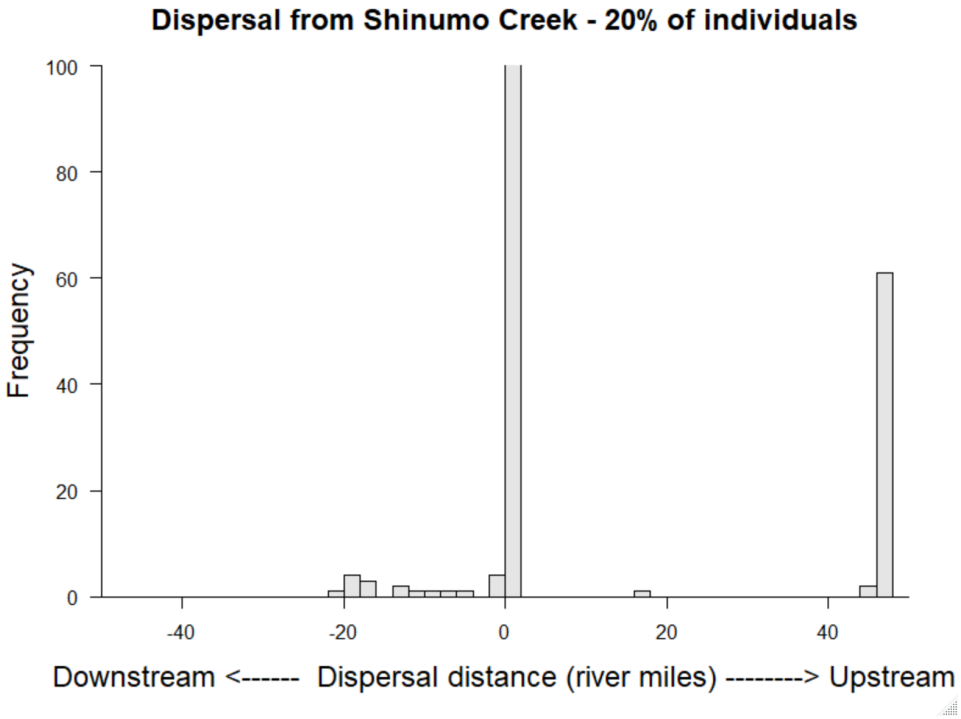
- Shinumo Creek
- Havasu Creek



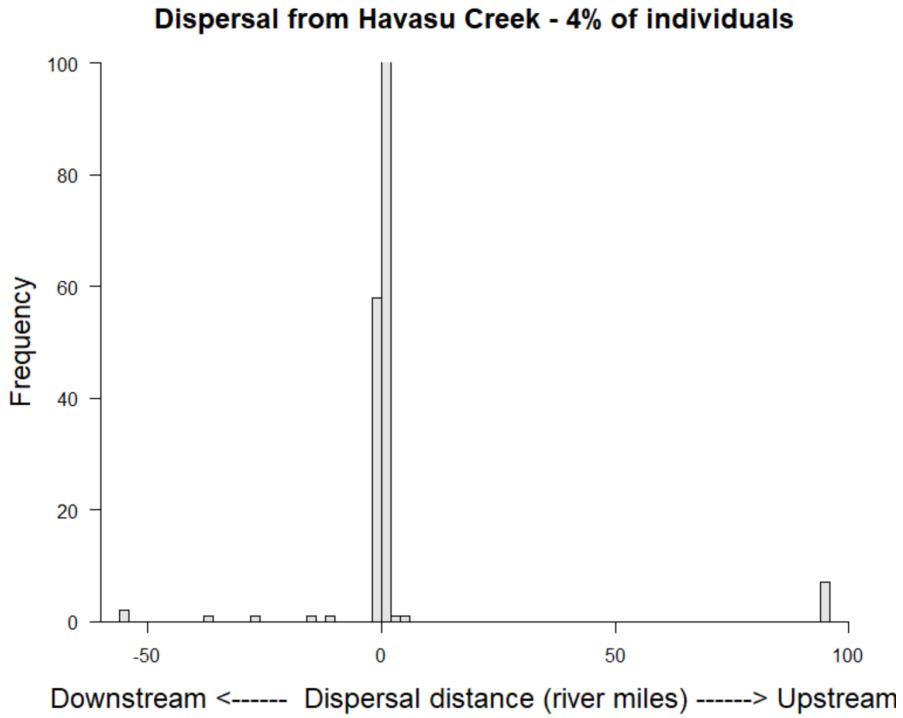
Data- Shinumo: Spurgeon et al. 2015, NPS unpublished data; Havasu: Healy et al. 2019; LCR: Dzul et al. 2016

Dispersal of translocated fish

Re-sights or detections outside of Shinumo Creek:

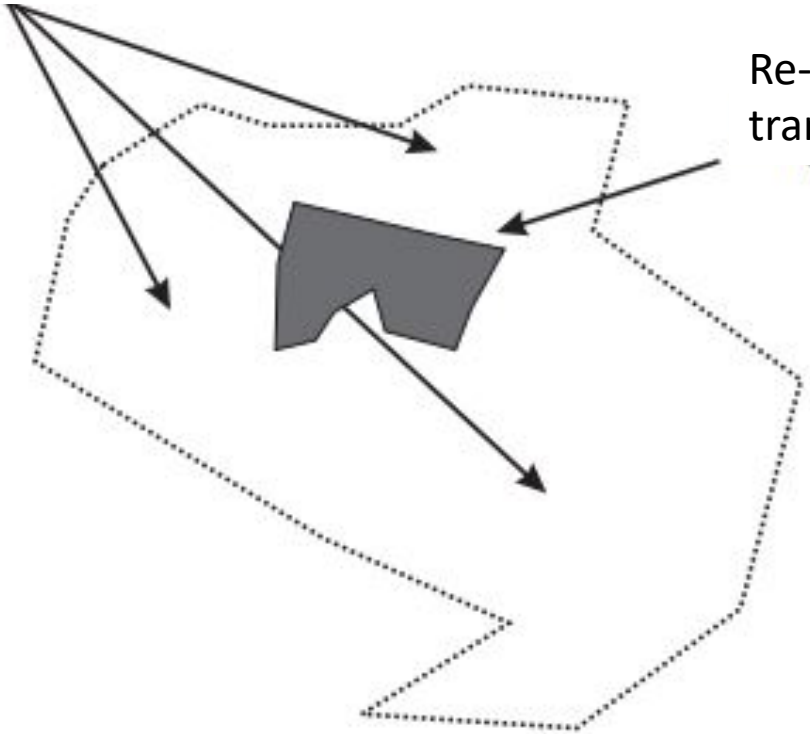


Re-sights or detections outside of Havasu Creek:



Barker model – “true” survival and fidelity

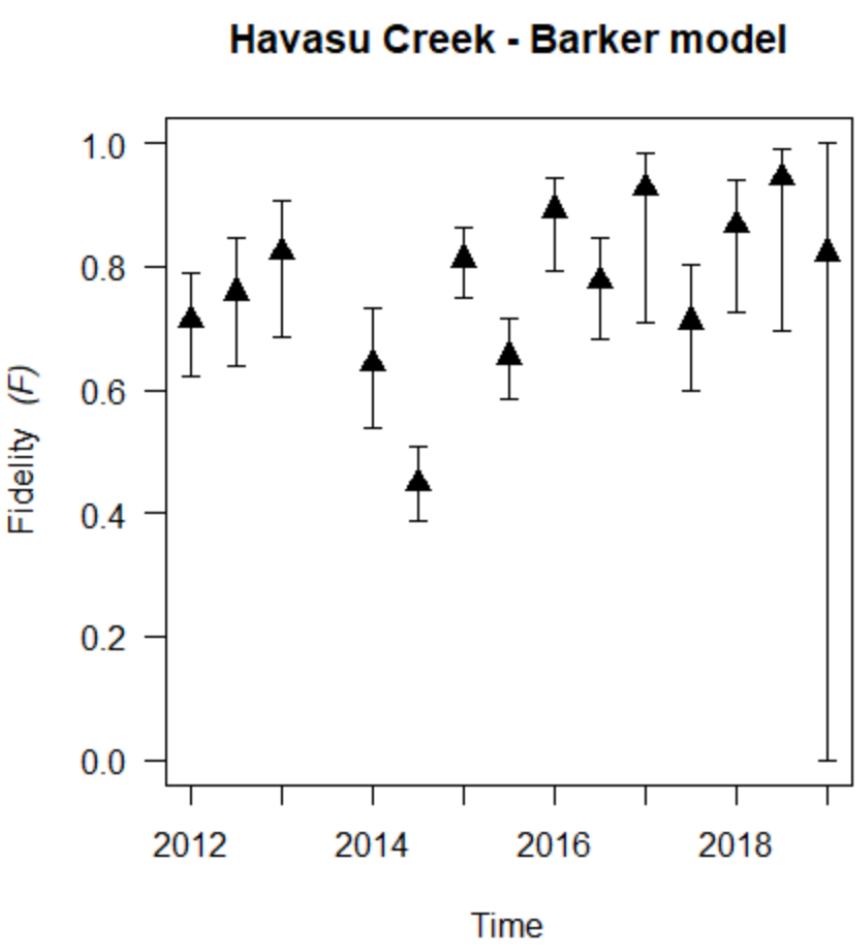
Re-sights outside translocation sites

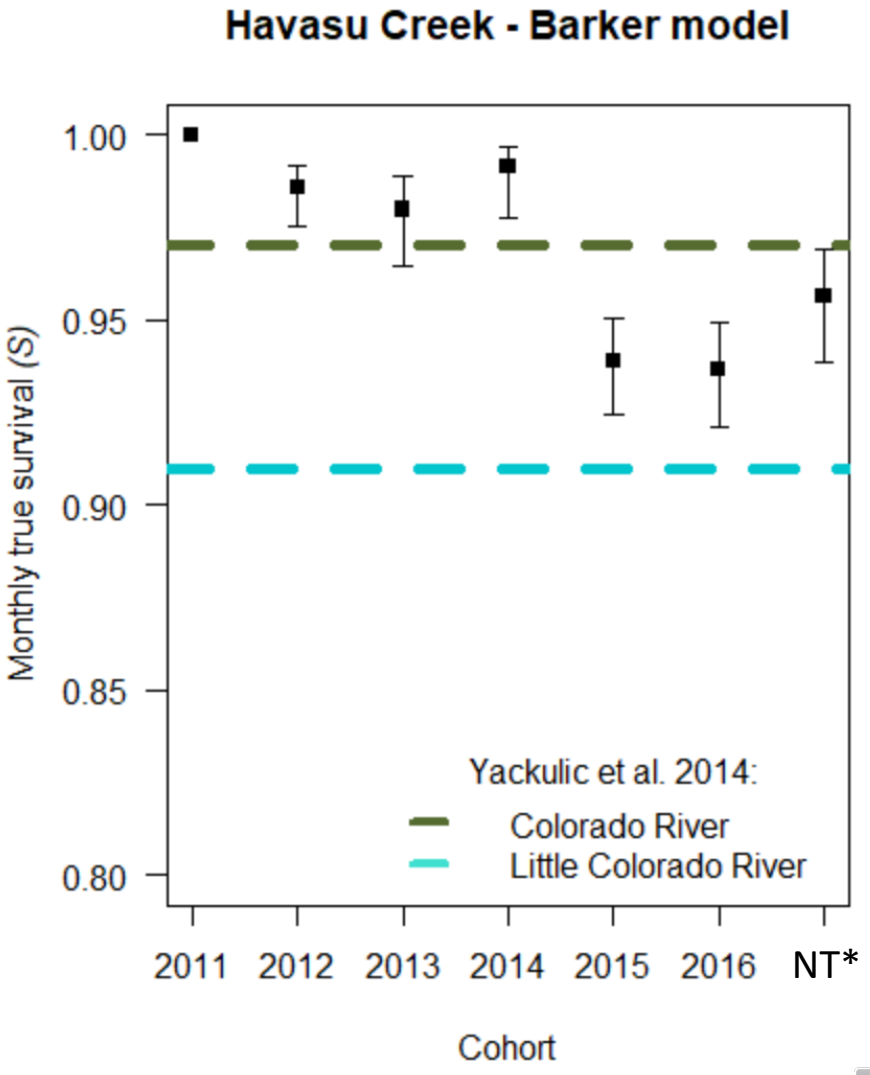


Re-captures at translocation sites

Allows for inclusion of “captures” in the study area, and “re-sights” (live or dead) outside of the study area

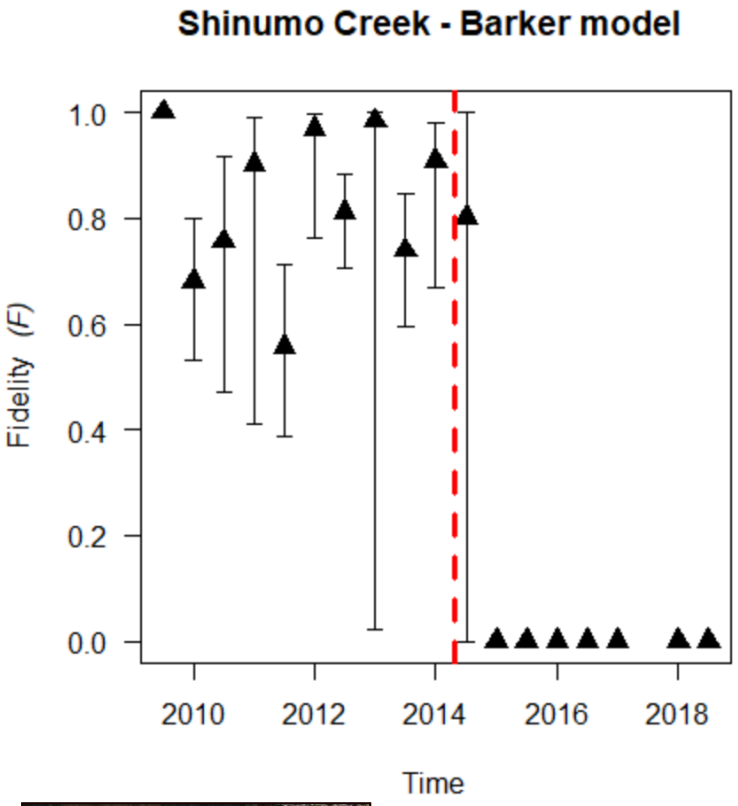
Survival – Havasu Creek vs LCR

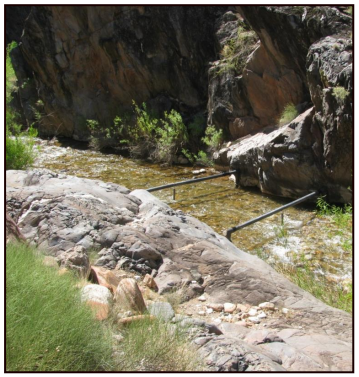




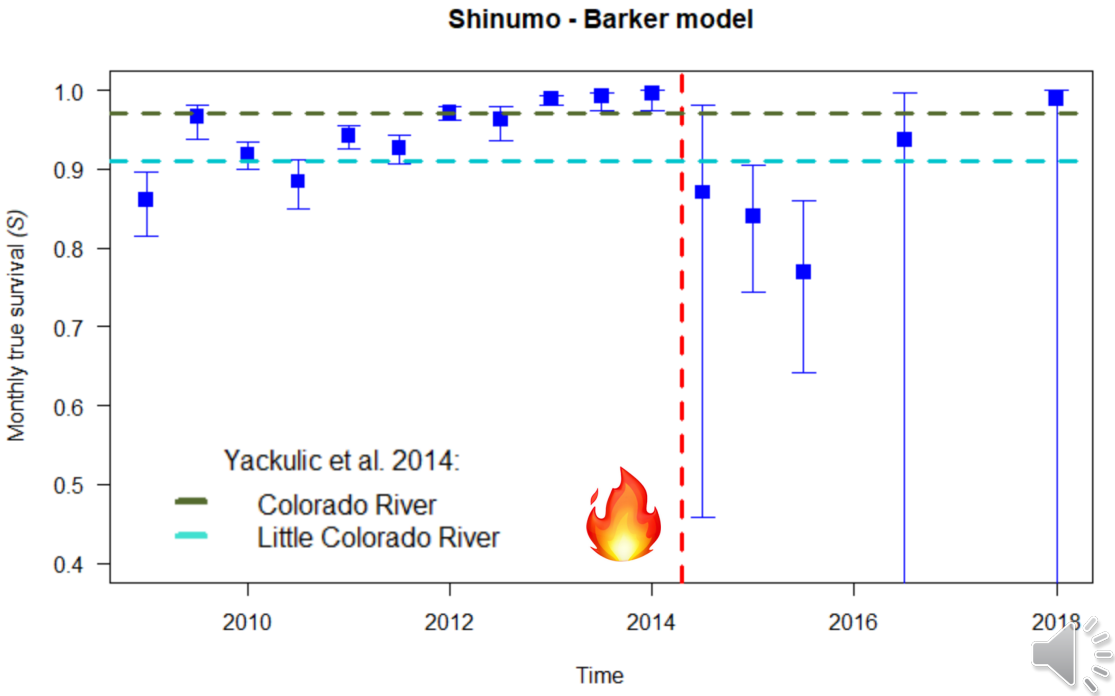
NT*= non-translocated/fish produced *in situ*

Survival/fidelity – Shinumo Creek

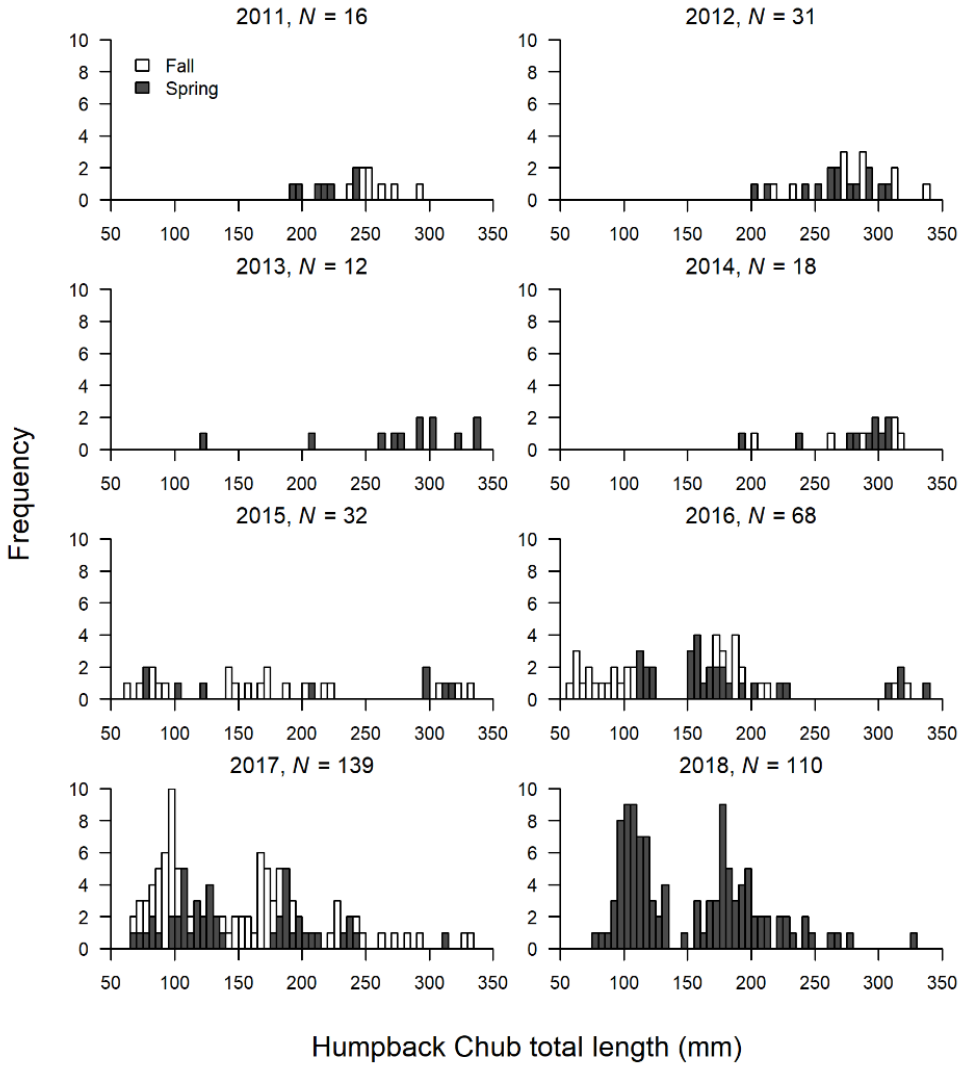




- Fidelity variable, lower than Havasu (zero, post-fire)
- Survival comparable to LCR, pre-fire



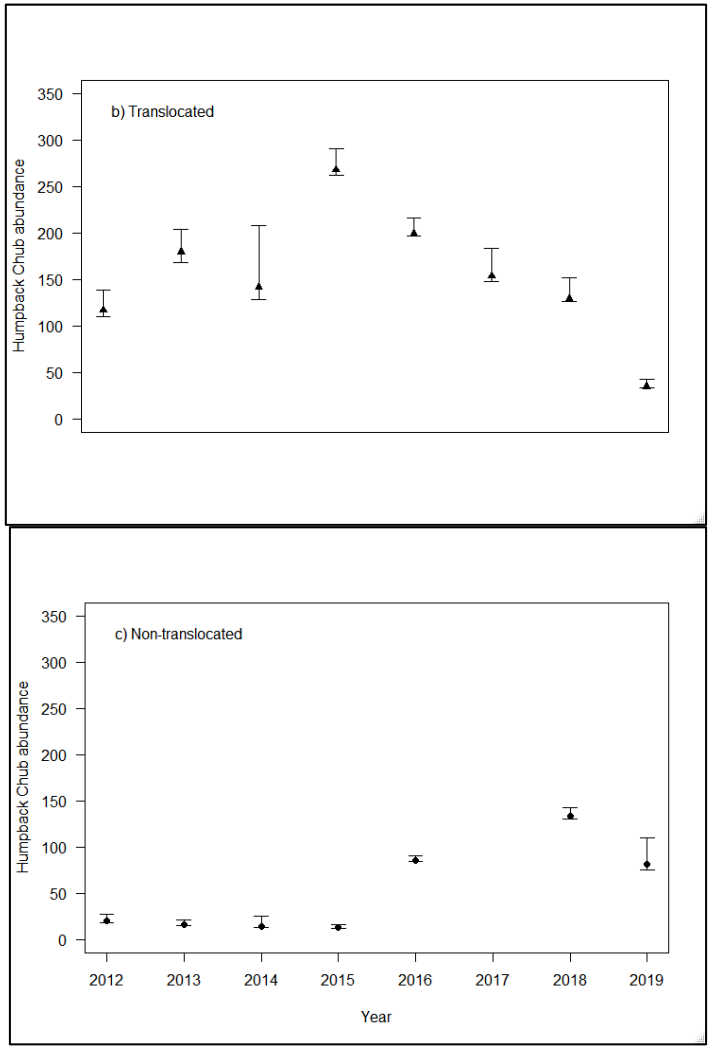
Havasu Creek- Non-translocated HBC



2nd reproducing HBC population in Grand Canyon!

Healy et al. 2020. North American Journal of Fisheries Management 40:278-292

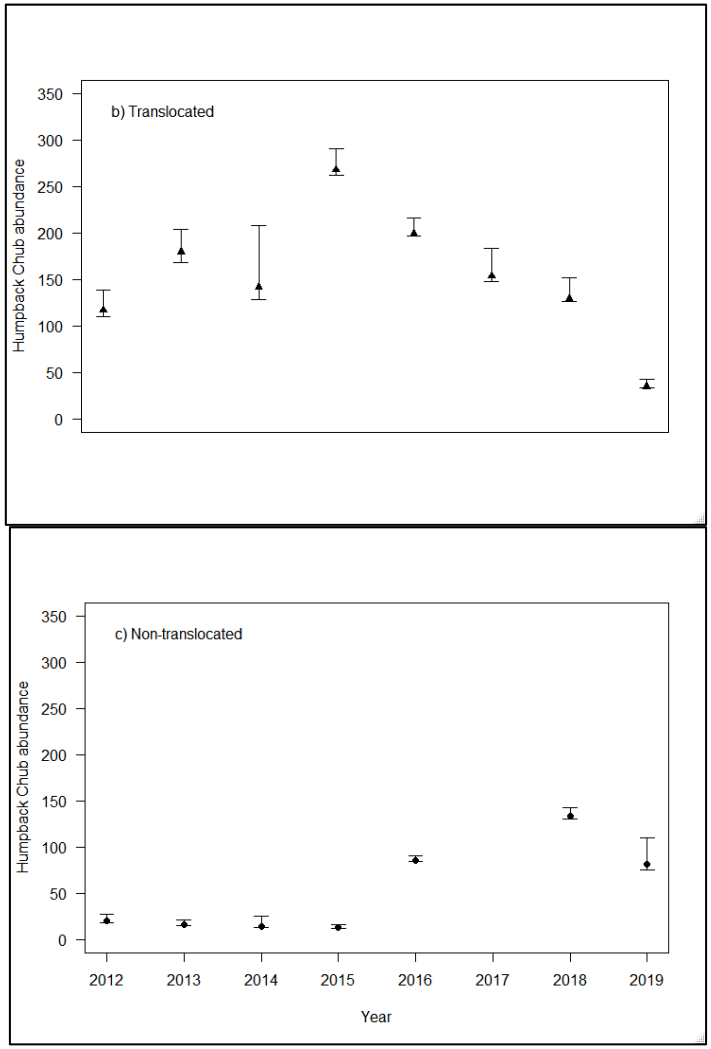
Havasu abundance estimates



- Havasu Creek abundance:
  - Translocated fish declined
  - *New recruits increased*, slight decline in 2019 due to limited recruitment in 2018.

Healy et al. 2020. North American Journal of Fisheries Management 40:278-292

HBC abundance estimates



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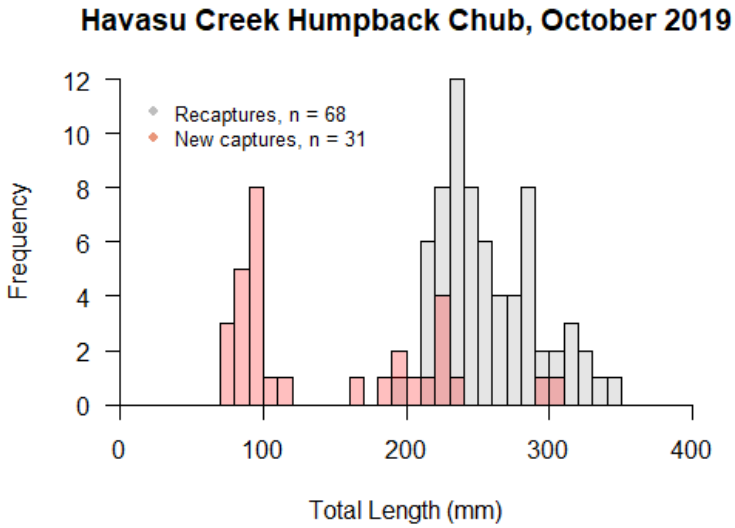

Healy et al. 2020. North American Journal of Fisheries Management 40:278-292

Next steps

- Shinumo Creek:
  - Continue to monitor recovery, trout expansion
  - Planning for possible future trout removal and translocations
- Havasu Creek:
  - Continue monitoring the reproducing population
  - Consider future genetic augmentation
- Bright Angel Creek
  - Continued trout removal
  - Monitoring abundance of native/nonnative fish
  - Translocation #2 in 2020 – 400+ larval fish collected in 2019

Translocations– design considerations

- Habitat assessment – identify translocation sites
  - Less-impaired tributaries may provide opportunities to test actions!
- Minimize impact to the source population – Population viability model (Pine et al. 2013)
- Reduce potential sources of mortality
  - Ideally no non-native fish present (e.g., Havasu)
- Define objectives – establish monitoring metrics ahead of time
- Adequate monitoring to understand conservation value
  - Exploring new ways to analyze data

Conservation Implications

- Tributaries can provide opportunities for “large river fish” conservation
- Successful mechanical suppression of invasive fishes with sustained, widespread effort
- Understanding environmental drivers of native response to predator removal
- Inform conservation under “novel” conditions

Questions?

Joe Tomelleri Illustrations

Arthur L. & Elaine V. Johnson Foundation
National Park Foundation/Albright-Wirth Grant

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