Razorback sucker,
Rio Grande silvery minnow,
and considerations on the supplementation of wild populations

Evan W. Carson

Bay-Delta FWO, USFWS

Why supplementation?

- Steep decline, ‘tipping’ point
- All else has failed

Razorback sucker & Rio Grande silvery minnow

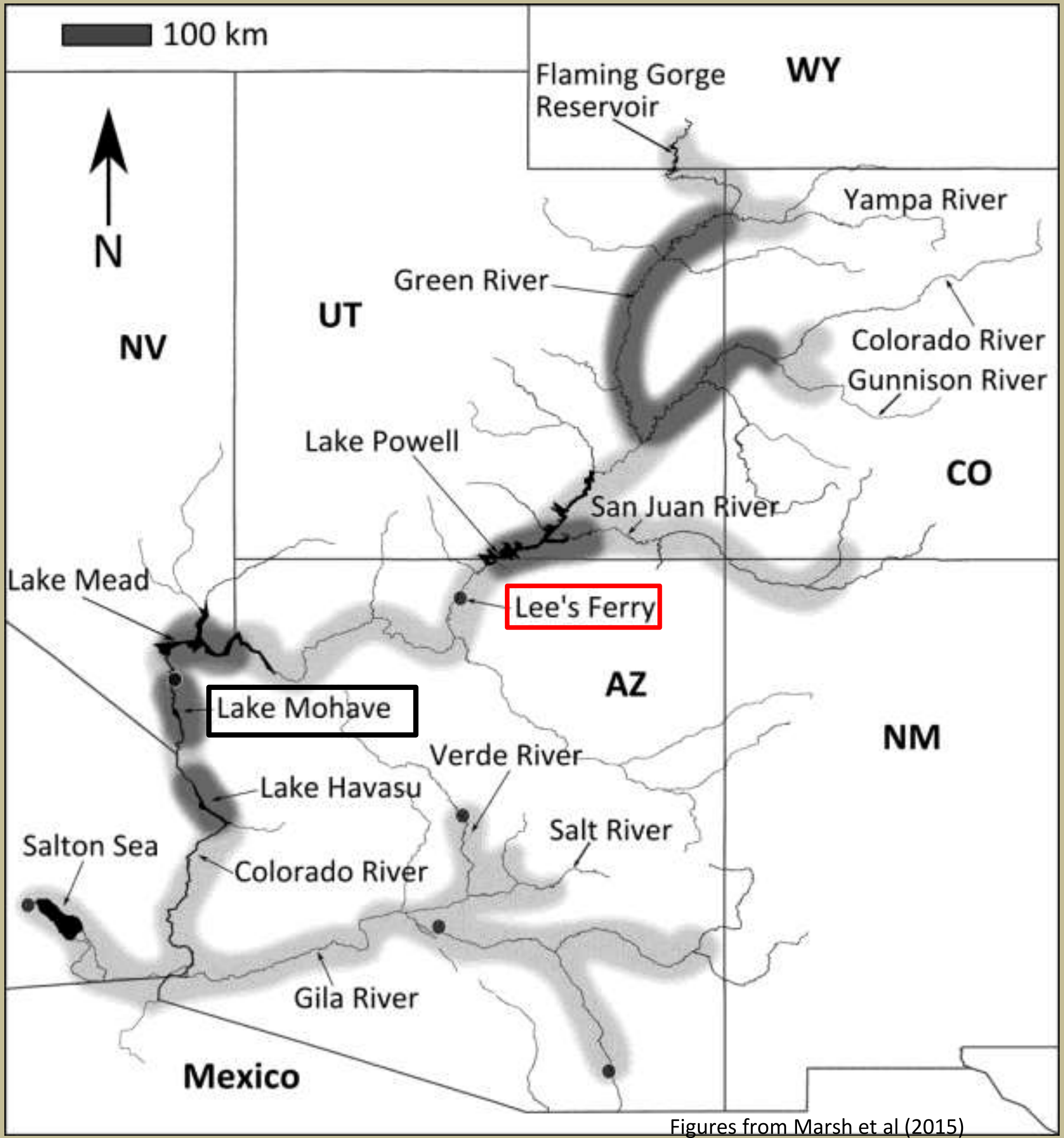
Razorback sucker *Xyrauchen texanus*

Rio Grande silvery minnow *Hybognathus amarus*

- Large-bodied
- Long-lived
- Overlapping generations
- Large, stable (historically)
- Predation, nutrients and other effects of dams

- Small-bodied
- Short-lived
- ~ Discrete generations
- Boom-bust
- Dewatering and fragmentation of habitat

Razorback sucker



Figures from Marsh et al (2015)

Rio Grande silvery minnow

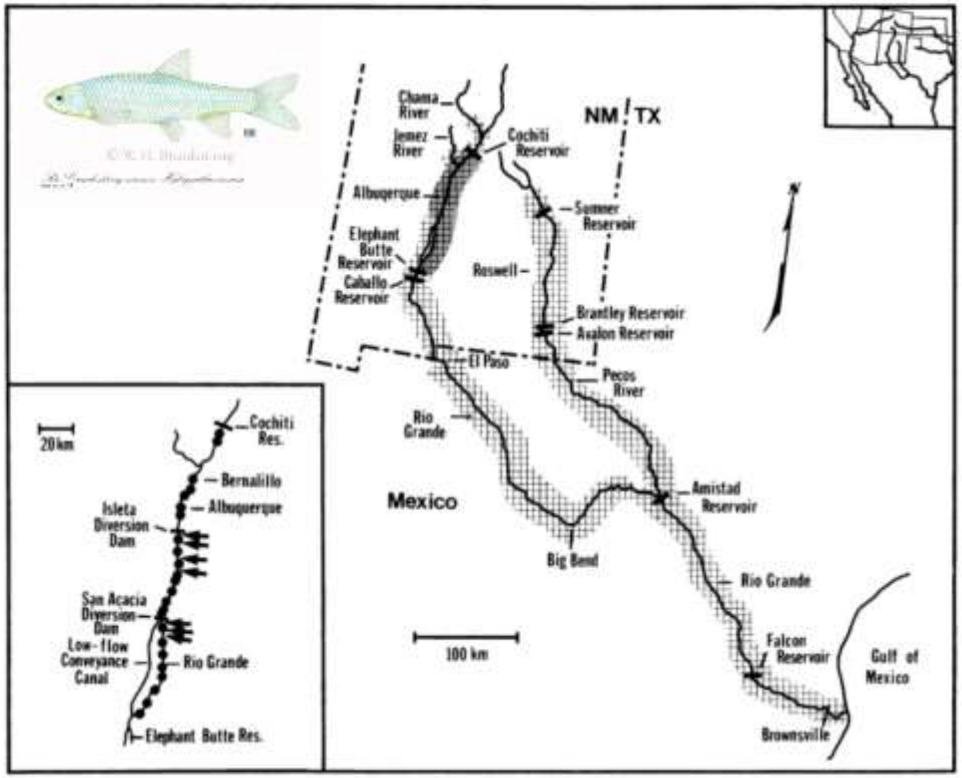


FIG. 1—Distribution of *Hybognathus amarus* in the Rio Grande basin. Cross-hatching indicates historic occurrence, and stippling represents distribution during 1986 to 1989. Inset of the middle Rio Grande, New Mexico, shows collection localities of *H. amarus* during 1986 to 1989; arrows indicate sites where >100 were collected.

Bestgen and Platania (1991)

Macrhrybopsis aestivalis
(extirpated, Rio Grande)

Rio Grande silvery minnow
Hybognathus amarus
(extirpated, Pecos River)

Notropis jemezanus
(extirpated, Rio Grande)

Notropis stramineus

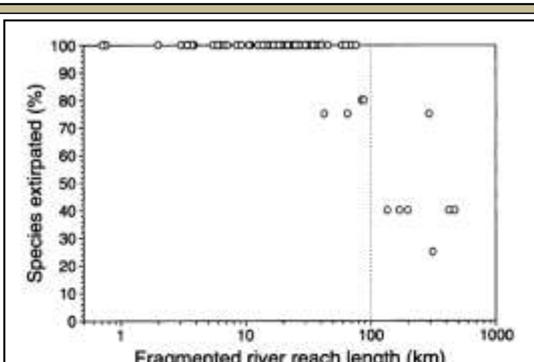
Notropis simus simus
(extirpated, Rio Grande)

Notropis simus pecosensis

Notropis orca (extinct)

Notropis amabilis
(extirpated, Pecos River)

Chad Thomas
http://txstate.fishesoftexas.org



Ecological Applications, 17(7), 2007, pp. 2074–2086

FLOW REGULATION AND FRAGMENTATION IMPERIL PELAGIC-SPAWNING RIVERINE FISHES

ROBERT K. DUDLEY[1] AND STEVEN P. PLATANIA

American Southwest Ichthyological Researchers, LLC, 800 Encino Place NE, Albuquerque, New Mexico 87102-2606 USA, and Division of Fishes, Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico 87131-1091 USA

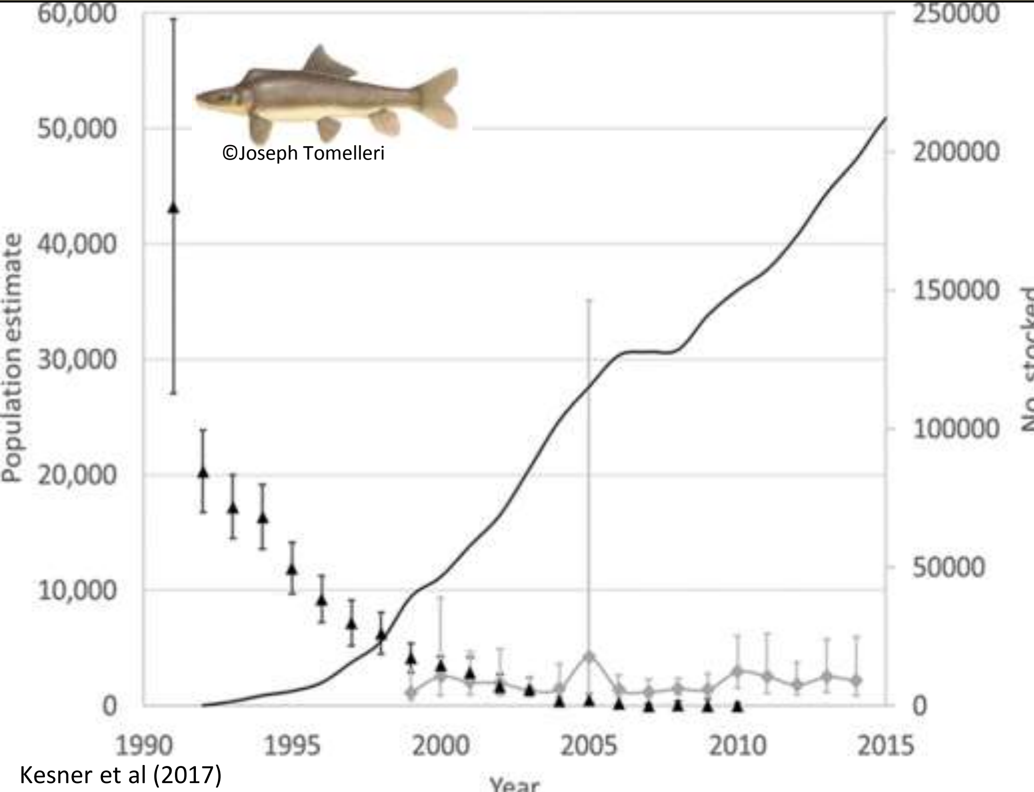
Repatriation and supplementation

Razorback sucker

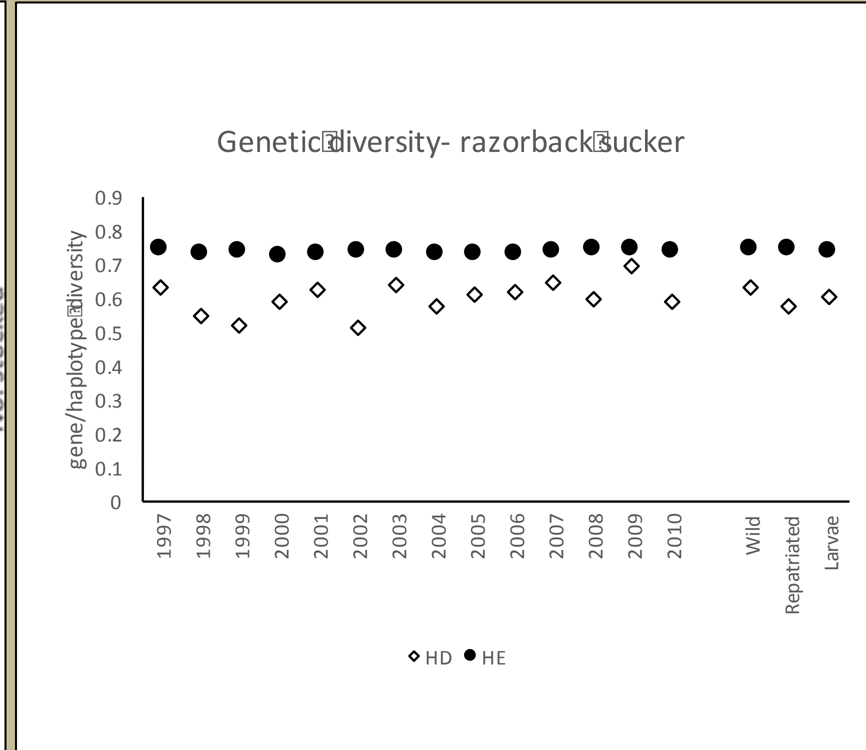
- Separate programs
  - Upper Colorado
    - Hatchery-origin
  - Lower Colorado
    - Repatriation
    - Production in wild
    - Capture wild larvae
    - Hatchery & off-channel
- Multispecies conservation plan
- Genetic & population monitoring
- Applied and basic research

Rio Grande silvery minnow

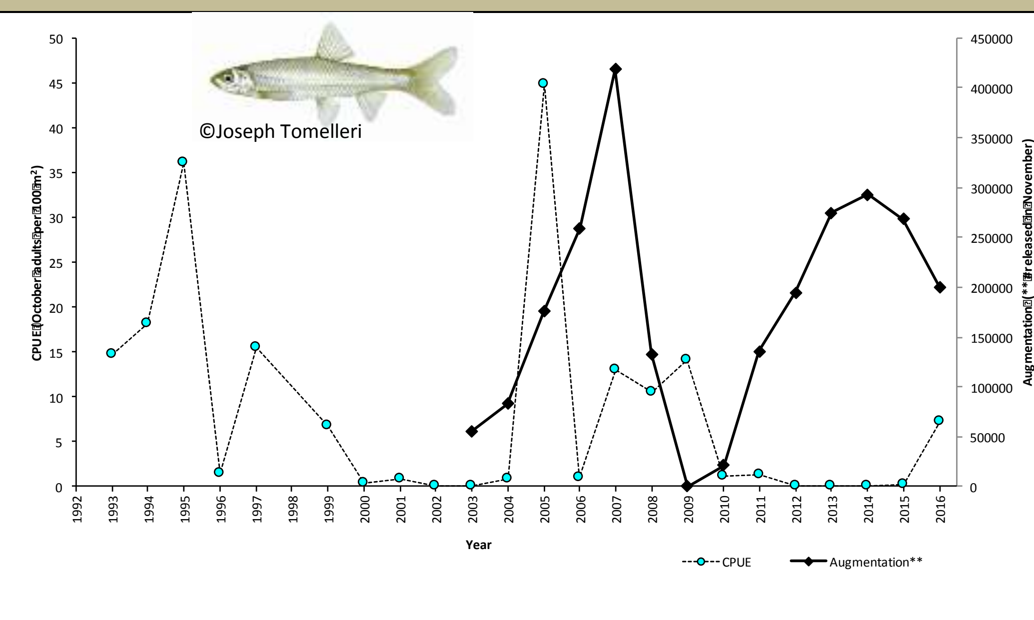
- Hatchery-origin supplementation
  - Wild caught eggs (WCEs)
  - Captive propagation
  - Group spawn
- Multiple facilities
  - **Federal**
  - State
  - Municipal
- Single species management plan
- Genetic & population monitoring
- Applied and basic research

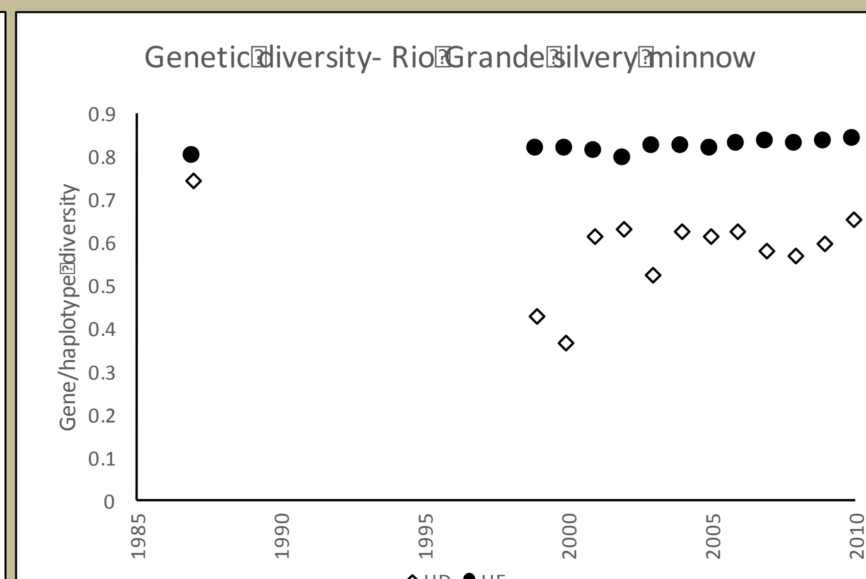


Kesner et al (2017)



Carson et al (2016)





Osborne et al (2012)

Yet, recovery elusive

- Neither is headed to recovery
- Both remain at high risk of extinction
- Despite supplementation
- Why?

Not for lack of effort

Decline of the Razorback Sucker in Lake Mohave, Colorado River, Arizona and Nevada

Paul C. Marsh,* Carol A. Pacey, and Brian R. Kesner
Arizona State University, School of Life Sciences, Tempe, Arizona 85287-4501, USA

[Article]

Stocking of Endangered Razorback Suckers in the Lower Colorado River Basin over Three Decades: 1974–2004

Jason D. Schooley* and Paul C. Marsh
School of Life Sciences, Arizona State University, Post Office Box 874501, Tempe, Arizona 85287-4501, USA

NOTE

Use of Molecular Techniques to Confirm Nonnative Fish Predation on Razorback Sucker Larvae in Lake Mohave, Arizona and Nevada

Chase A. Ehlo*[1]
Marsh and Associates LLC, 5016 South Ash Avenue, Suite 108, Tempe, Arizona 85282, USA
Melody J. Saltzgiver[2] and Thomas E. Dowling
Department of Biological Sciences, Wayne State University, 5047 Gullen Mall, Detroit, Michigan 48202, USA
Paul C. Marsh
Marsh and Associates LLC, 5016 South Ash Avenue, Suite 108, Tempe, Arizona 85282, USA; and School of Life Sciences, Arizona State University, Post Office Box 874501, Tempe, Arizona 85287, USA
Brian R. Kesner
Marsh and Associates LLC, 5016 South Ash Avenue, Suite 108, Tempe, Arizona 85282, USA

Evolutionary Applications

ORIGINAL ARTICLE

Time-series analysis reveals genetic responses to intensive management of razorback sucker (*Xyrauchen texanus*)

Thomas E. Dowling,[1] Thomas F. Turner,[2] Evan W. Carson,[2] Melody J. Saltzgiver,[1,†] Deborah Adams,[3] Brian Kesner[4] and Paul C. Marsh[1,4]

[Article]

Repatriation as a Management Strategy to Conserve a Critically Imperiled Fish Species

Paul C. Marsh,* Brian R. Kesner, and Carol A. Pacey
School of Life Sciences, Arizona State University, Post Office Box 874501, Tempe, Arizona 85287-4501, USA

A Conservation Plan for Native Fishes of the Lower Colorado River

W. L. Minckley, Paul C. Marsh, James E. Deacon, Thomas E. Dowling, Philip W. Hedrick, William J. Matthews, and Gordon Mueller

Journal of Heredity Advance Access published June 8, 2016

American Genetic Association

Brief Communication

Brief Communication

Retention of Ancestral Genetic Variation Across Life-Stages of an Endangered, Long-Lived Iteroparous Fish

Evan W. Carson, Thomas F. Turner, Melody J. Saltzgiver, Deborah Adams, Brian R. Kesner, Paul C. Marsh, Tyler J. Pilger, and Thomas E. Dowling

Proceedings of the Royal Society B

Life history and environmental variation interact to determine effective population to census size ratio

Thomas F. Turner*, Megan J. Osborne, Gregory R. Moyer[†], Melissa A. Benavides and Dominique Alò
Department of Biology, and Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM 87131-0001, USA

Contents lists available at ScienceDirect
Fish & Shellfish Immunology
journal homepage: www.elsevier.com/locate/fsi

Isolation and characterization of major histocompatibility class IIβ genes in an endangered North American cyprinid fish, the Rio Grande silvery minnow (*Hybognathus amarus*)

Megan J. Osborne*, Thomas F. Turner

Reproductive Strategies and Egg Types of Seven Rio Grande Basin Cyprinids

Steven P. Platania and Christopher S. Altenbach

[Article]

Swimming Performance and Fishway Model Passage Success of Rio Grande Silvery Minnow

Kevin R. Bestgen*
Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, Colorado 80523, USA
Brent Mefford
Water Resources Research Laboratory, U.S. Bureau of Reclamation, Denver Federal Center, Denver, Colorado 80225-0007, USA
Jay M. Bundy, Cameron D. Walford, and Robert I. Compton
Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins, Colorado 80523, USA

Taylor & Francis

Genetic Effects of Hatchery Propagation and Rearing in the Endangered Rio Grande Silvery Minnow, *Hybognathus amarus*

MEGAN J. OSBORNE, MELISSA A. BENAVIDES, DOMINIQUE ALÒ, AND THOMAS F. TURNER
Department of Biology and Museum of Southwestern Biology, University of New Mexico, Albuquerque New Mexico, USA

Evolutionary Applications www.evolutionaryapplications.org

ORIGINAL ARTICLE

Genetic monitoring and complex population dynamics: insights from a 12-year study of the Rio Grande silvery minnow

Megan J. Osborne, Evan W. Carson and Thomas F. Turner
Department of Biology and Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico, USA

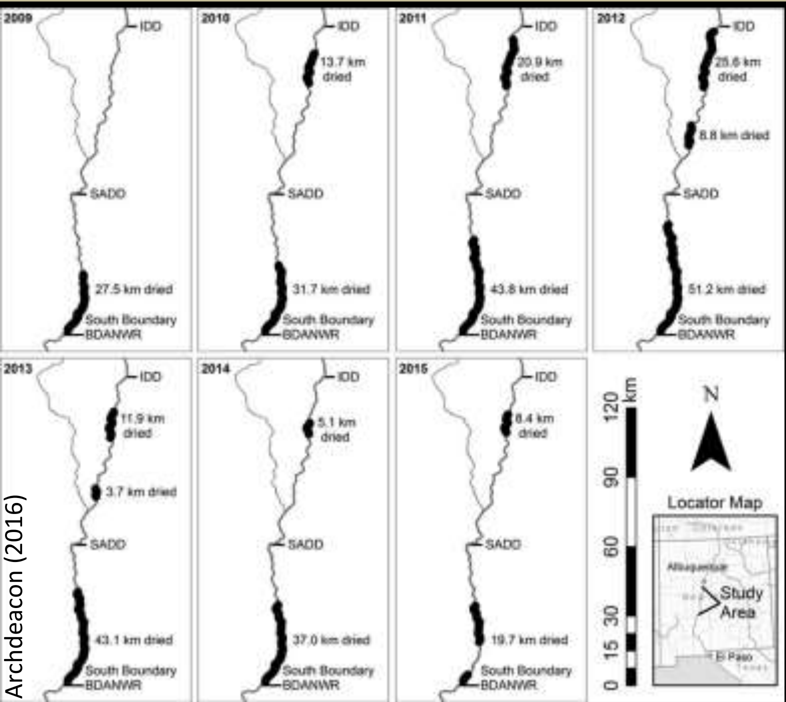
ARTICLE

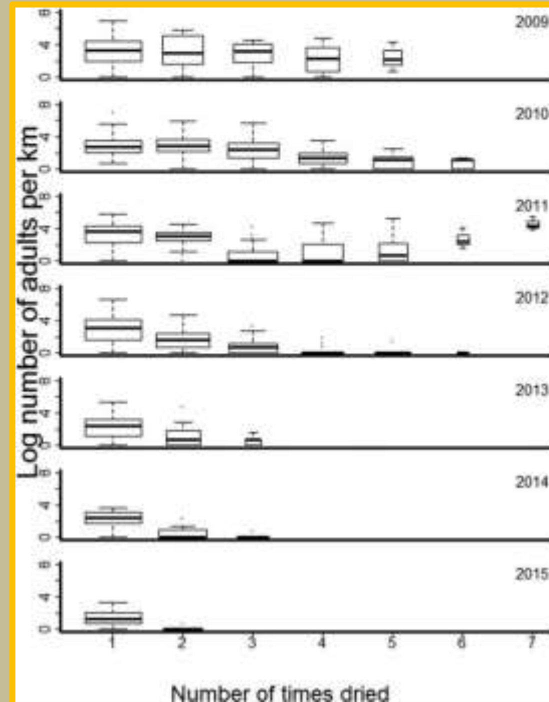
Reduction in Spring Flow Threatens Rio Grande Silvery Minnow: Trends in Abundance during River Intermittency

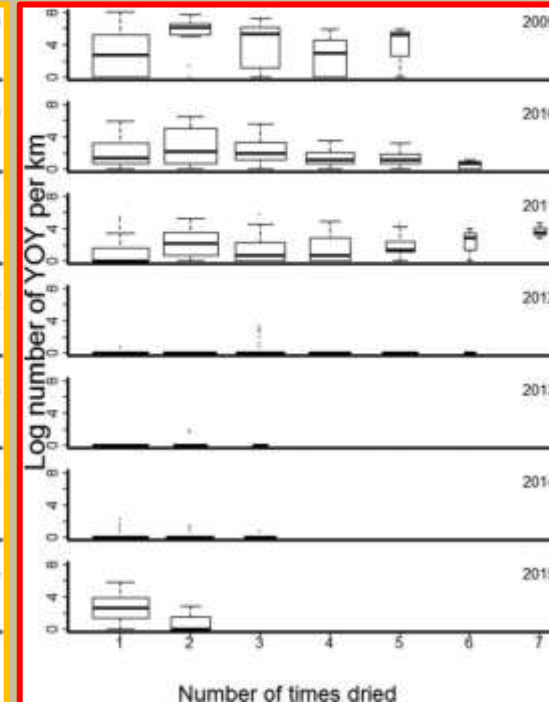
Thomas P. Archdeacon*
U.S. Fish and Wildlife Service, New Mexico Fish and Wildlife Conservation Office, 300 Commons Avenue Northeast, Albuquerque, New Mexico 87109, USA

Common threads

- Habitat
- Threats
- Propagation and supplementation


Archdeacon (2016)
2009
2010
2011
2012
2013
2014
2015
IDD
SADD
27.5 km dried
13.7 km dried
31.7 km dried
20.9 km dried
43.8 km dried
25.6 km dried
8.8 km dried
51.2 km dried
11.9 km dried
3.7 km dried
43.1 km dried
5.1 km dried
37.0 km dried
8.4 km dried
19.7 km dried
South Boundary BDANWR
0 15 30 60 90 120 km
N
Locator Map
Albuquerque
Study Area
El Paso

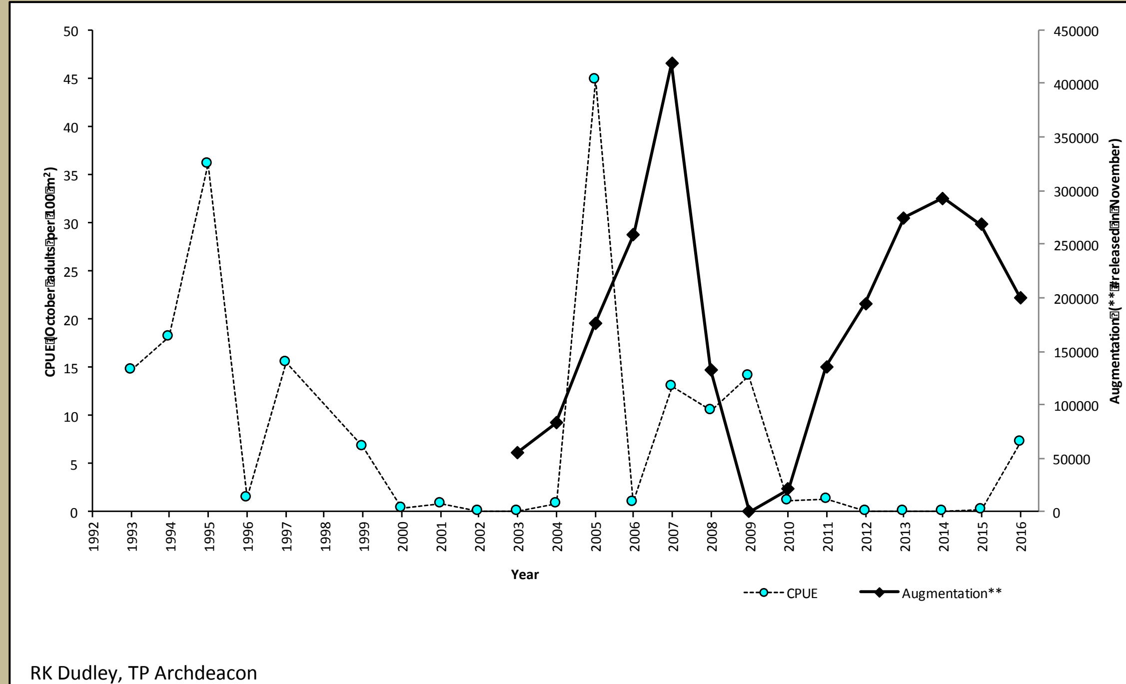

Log number of adults per km
2009
2010
2011
2012
2013
2014
2015
1 2 3 4 5 6 7
Number of times dried


Log number of YOY per km
2009
2010
2011
2012
2013
2014
2015
1 2 3 4 5 6 7
Number of times dried

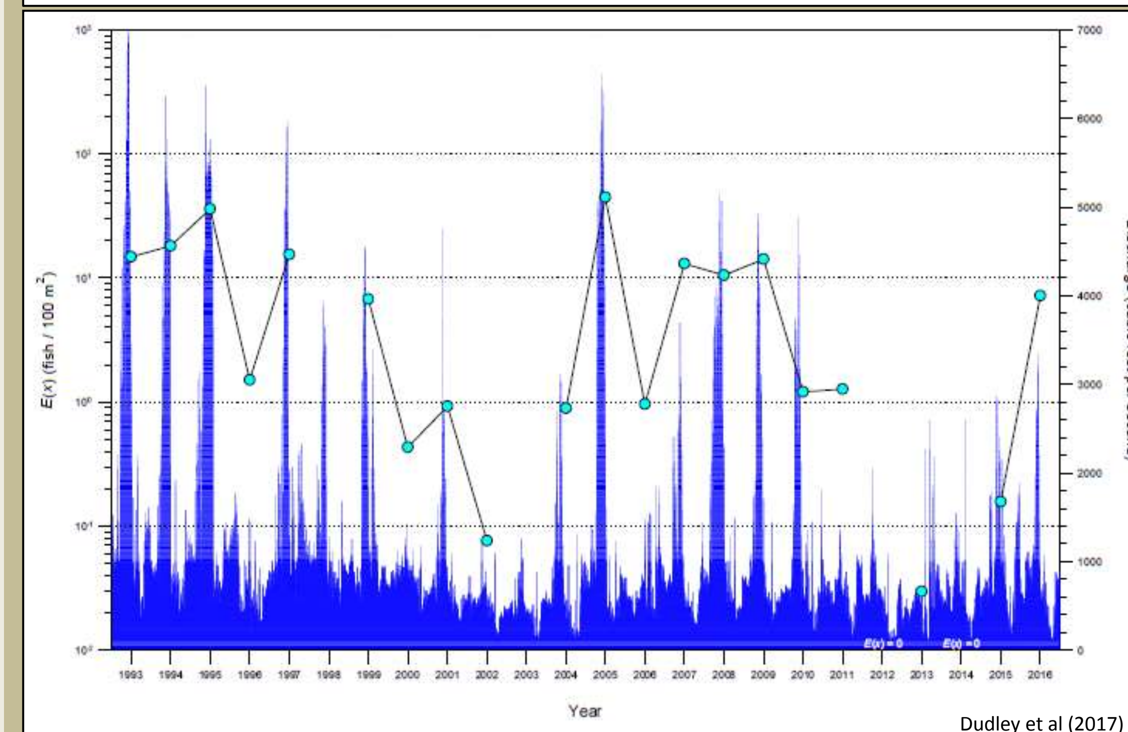

N
Flow
50 m
Archdeacon and Remshardt (2012)
Before repair
After repair
March
April
May
June
July
August
September
Month
Courtesy of MJ Osborne

- Immediacy lost
- Put-take
- Costly and open ended
- Poor estimates of census size
- Augmentation numbers driven by hatchery, not by population status
- Problems with consistency and reliability among hatcheries
- Voluntary agreements with water users fail in critical periods (i.e., drought)
- Binding agreements needed

CPUE and augmentation

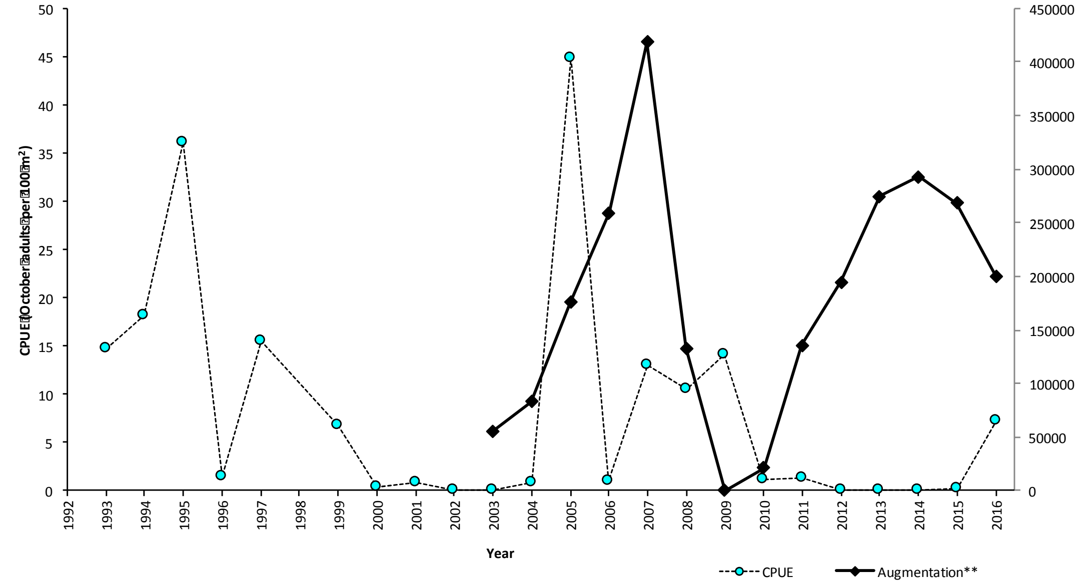


CPUE and discharge



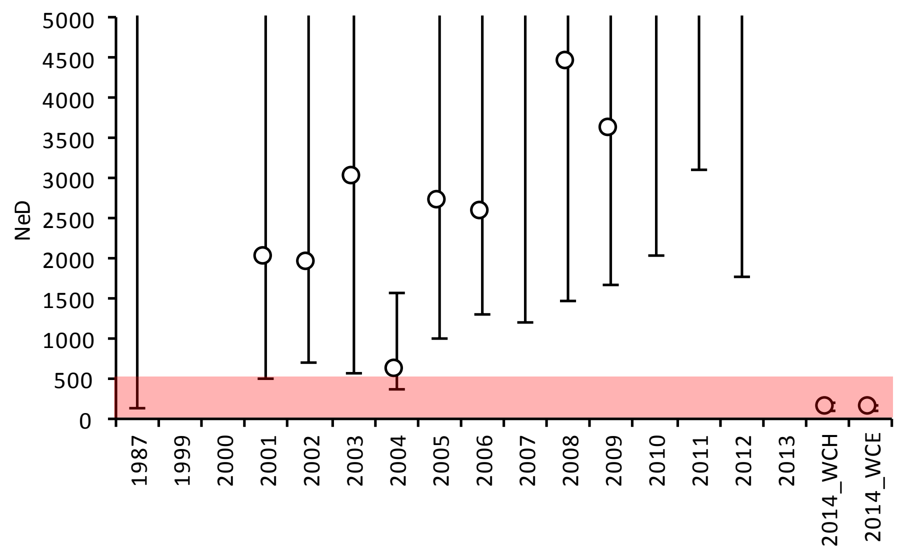
Conservation genetics

- **Confluence of risks**



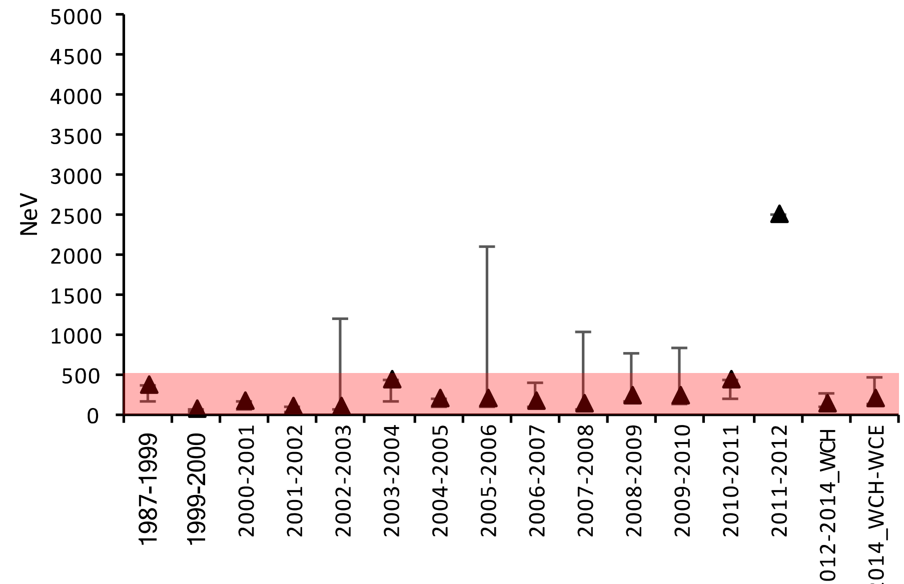
RK Dudley, TP Archdeacon

~ Inbreeding effective size, N_{eD}



Carson et al (2014)

Variance effective size, N_{eV}



Success?

- Neither is extinct

- Neutral genetic variation maintained

- Movement (slowly) in the right direction
  - Fish passage
  - Experiments
    - Spawning success
    - Timing of release
    - For razorback sucker, efforts toward completion of life cycle in wild

If goal is to retain something that is like each species, then this has occurred

But

Habitat	Threats
Without baseline environmental conditions to support these fishes – Supplementation can't bring recovery Need to identify and correct causes of decline – Improve and restore habitat – Identify and manage around vulnerable stages in life cycle – Allow completion of life cycle in the wild	As long as not addressed – No reason to expect supplementation to improve conservation status Need to: – Identify threats – Rank – Manage or eliminate • Includes risks from demographic and genetic causes

Conclusions

Tail wags the dog

- Hatcheries/supplementation programs not responsive to conservation needs

- Experimental approaches would have been useful
  - Vulnerable times in life cycle
  - Performance of ‘wild’ and hatchery fish in wild
- Robust assessment of conservation status
  - Reliable estimates of population size
  - Management informed by conditions in the wild
- Genetics must match biology and ecology of the species
  - Genetic monitoring incorporated into management
  - Reduction of negative effects in wild and hatchery populations
- Accountability and commitment
  - At higher levels
  - Binding agreements, not voluntary ones

Acknowledgements

Thomas Archdeacon
Rob Dudley
Manuel Ulibarri
Chris Hoagstrom
Tom Dowling
Paul Marsh
Mike Schwemm
Doug Markle
Josh Rasmussen
Evan Childress
Laura Paskus
Megan Osborne
Tien-Chieh Hung
Mandi Finger