Impact of repatriation on genetic variation in the Lake Mohave population of razorback sucker

Thomas E. Dowling
Paul C. Marsh
Thomas F. Turner
Melody J. Saltzgiver
Deborah Adams

ASU SCHOOL OF Life Sciences
ARIZONA STATE UNIVERSITY

Museum of Southwestern Biology

MARSH & ASSOCIATES
A legacy of conservation
NATIVE FISH LAB

Objective

Use molecular markers (microsatellites, mtDNA) to monitor impact of management on genetic diversity

Sampling

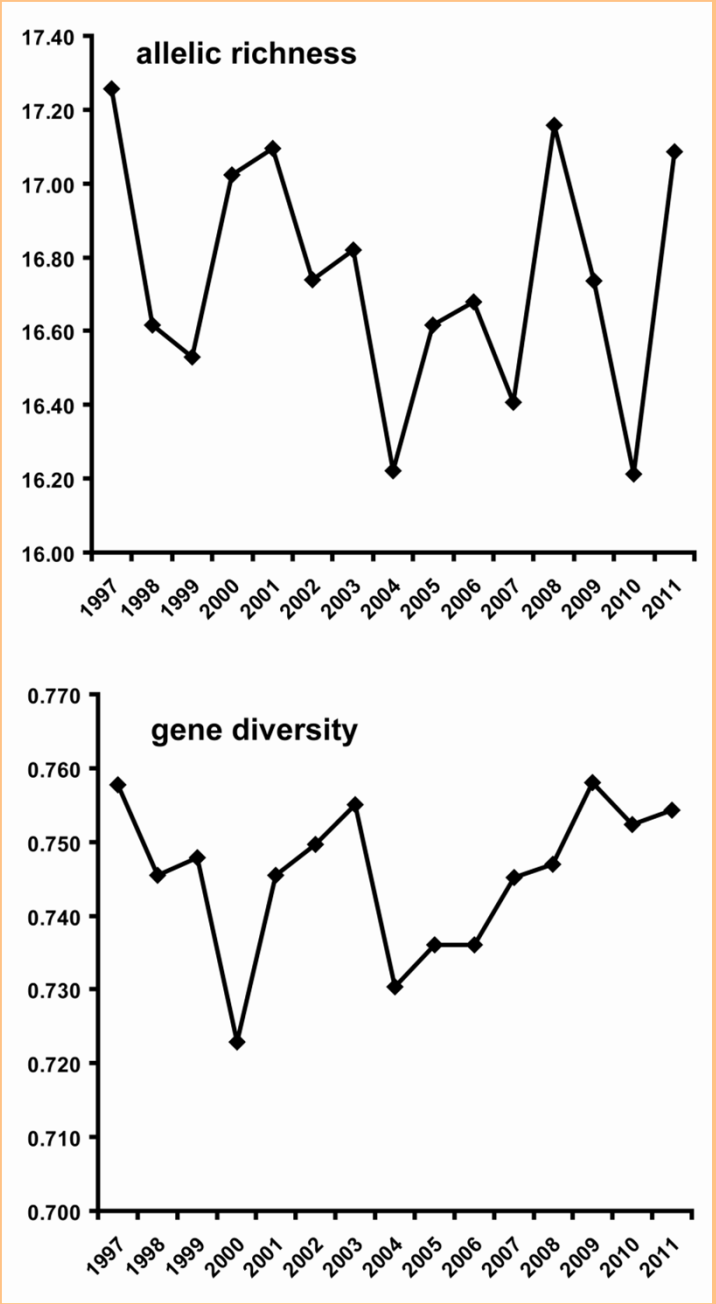
- **15 years worth of data!!!**
- **Larvae (1997-2011)**
  - **259 collections, 6347 individuals**
- **Adults**
  - **303 wild fish**
  - **922 repatriates (stocked 1992 – 2011)**

Statistics

- **Allelic Richness:** **The number of alleles per locus corrected for sample size**
- **Gene Diversity:** **A measure of genetic variation in a population (expected frequency of heterozygous individuals)**

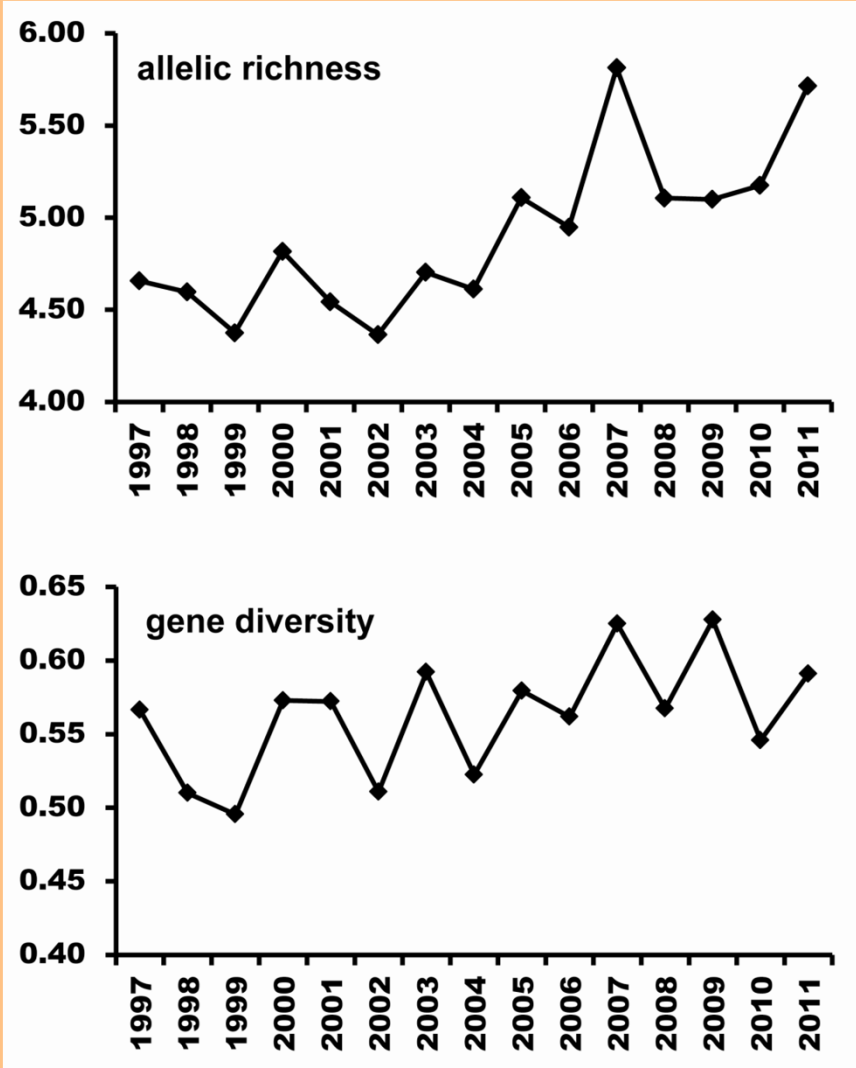
Microsatellite DNA variation within larval samples over time

- **Nuclear DNA variation is being maintained by this sampling strategy**
- **Allelic richness**
  - **r = 0.007, P = 0.914**
- **Gene diversity**
  - **r = 0.007, P = 0.918**



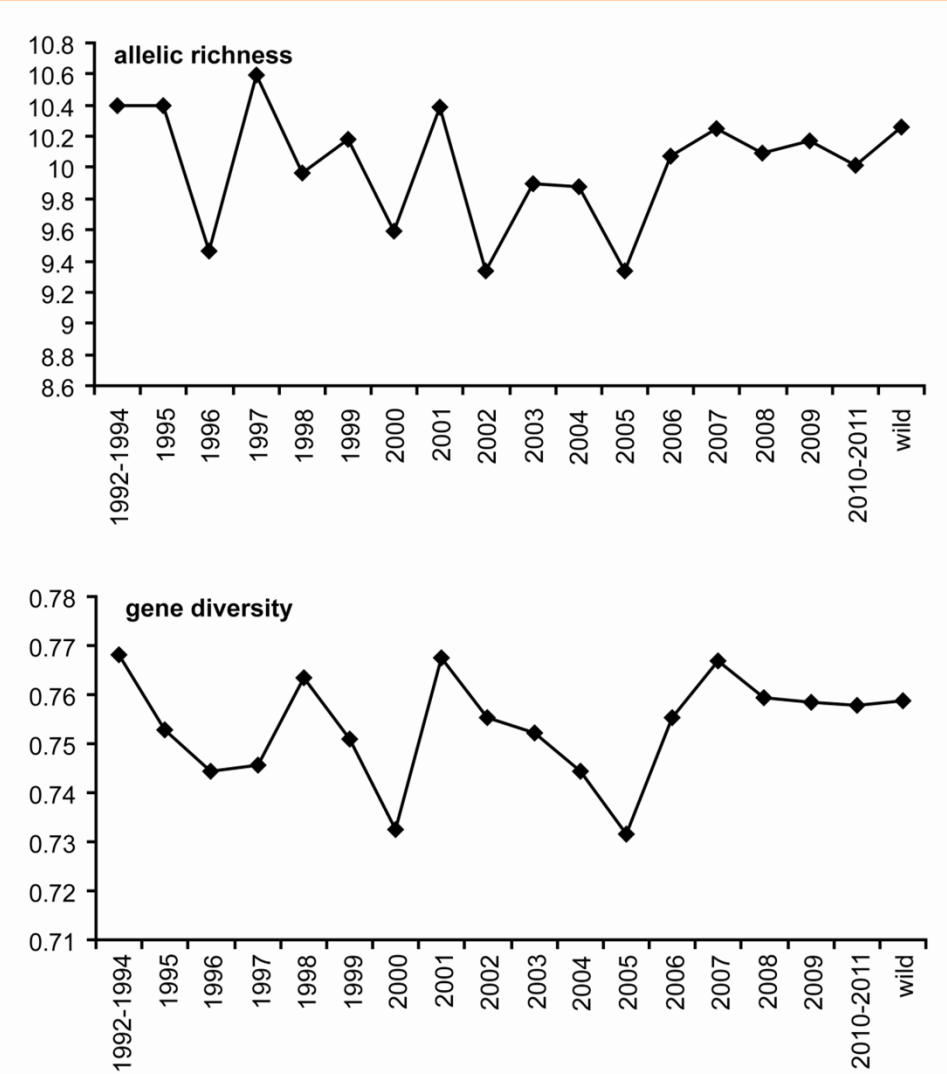
mtDNA variation within larval samples over time

- **mtDNA variation is actually being increased by this sampling strategy!**
- **Allelic richness**
  - **r = 0.212, P = 0.001**
- **Gene diversity**
  - **r = 0.119, P = 0.064**



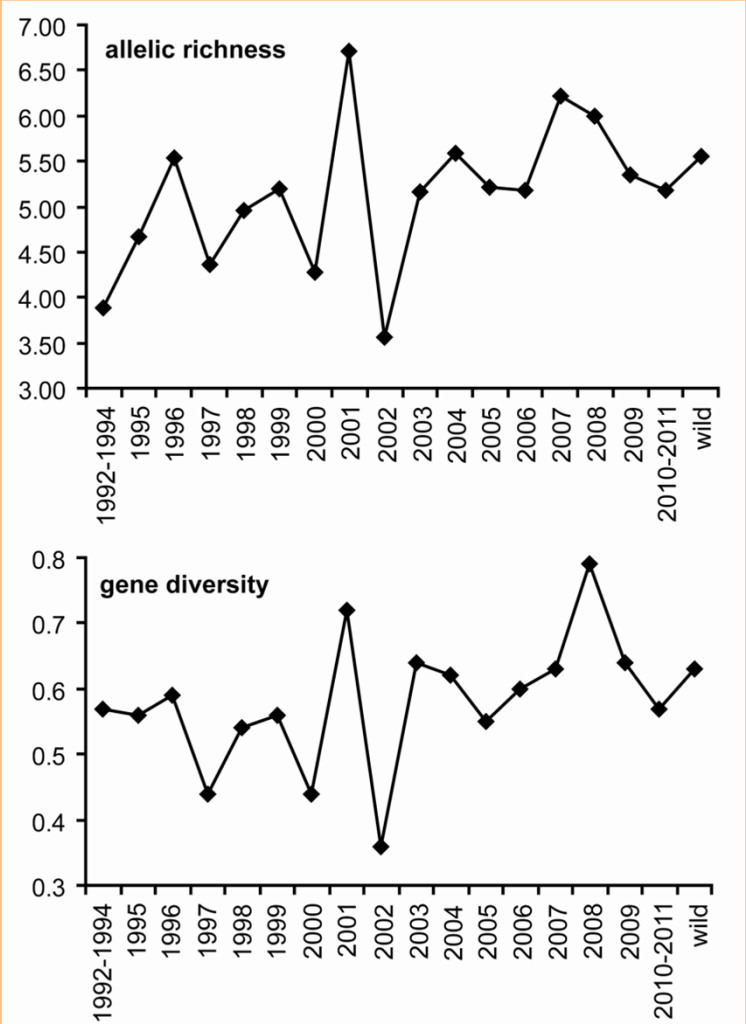
Microsatellite variation within repatriate samples over time

- **Nuclear DNA variation is being maintained by this sampling strategy**
- **Allelic richness**
  - **r = 0.005, P = 0.935**
- **Gene diversity**
  - **r = 0.005, P = 0.938**



mtDNA variation within repatriate samples over time

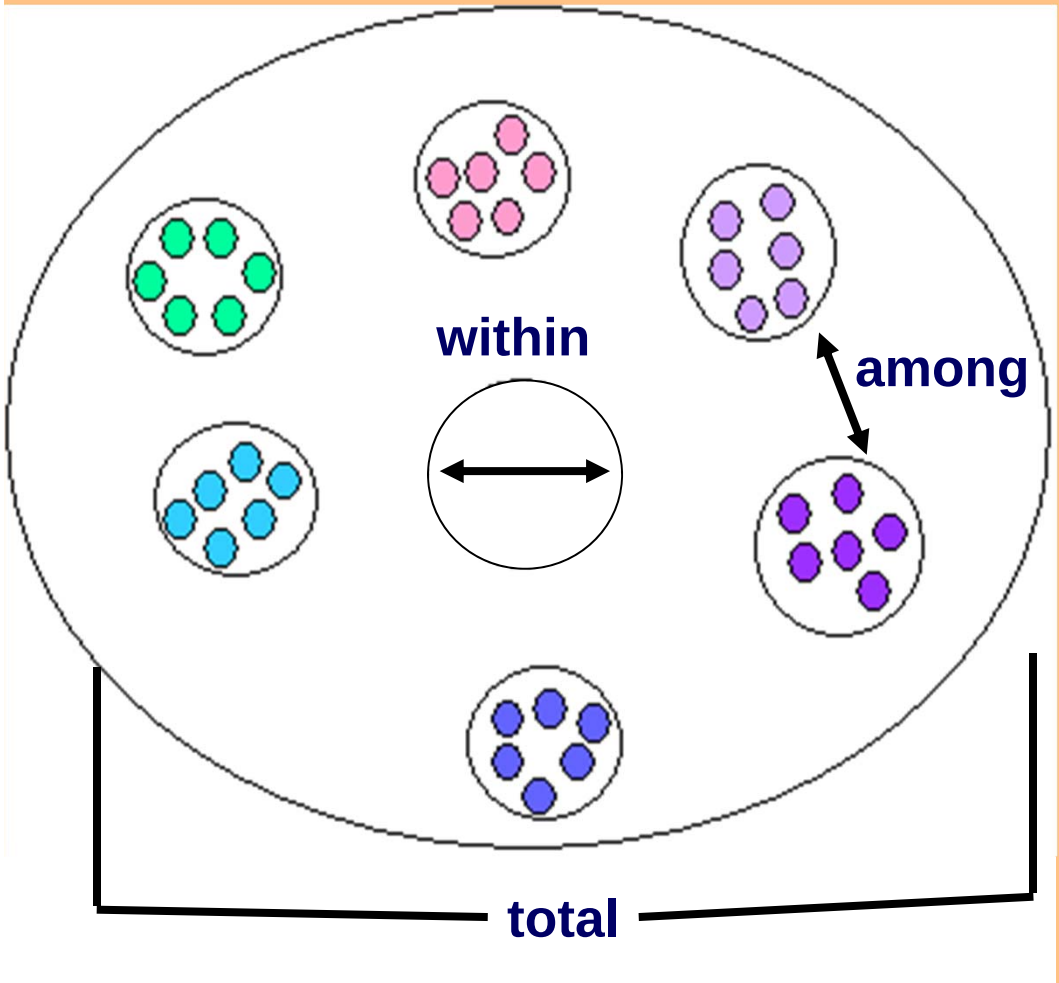
- **mtDNA variation is actually being increased by this sampling strategy!**
- **Allelic richness**
  - **r = 0.449, P = 0.071**
- **Gene diversity**
  - **r = 0.397, P = 0.124**



Transmission of variation from larvae to repatriates?

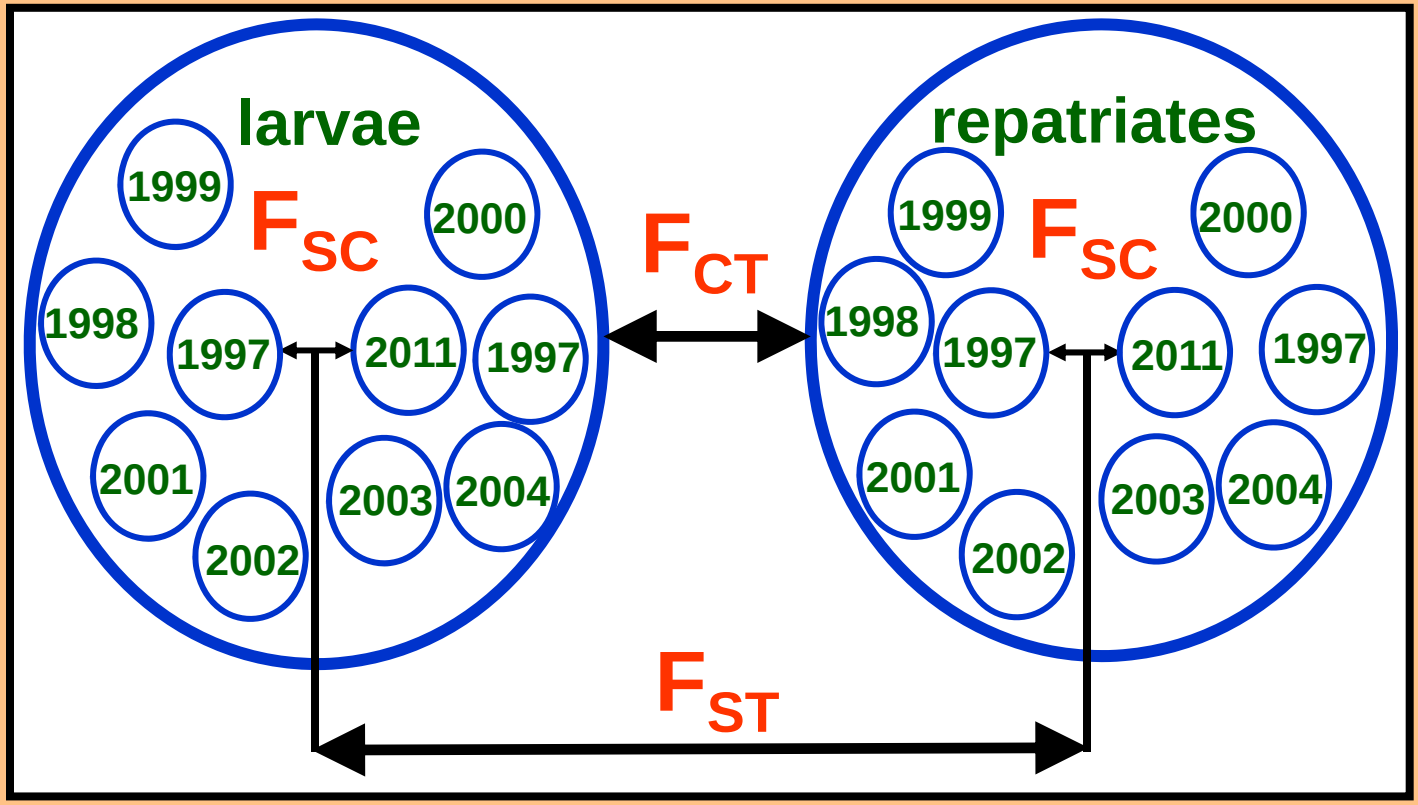
- **Look for differences in allele frequencies among life history stages**
- **Use F-statistics**

F-statistics



- Subpopulations (S) are made up of individuals (I)
- Can examine several components affecting random mating
  - between individuals within subpopulations (IS)
  - among individuals relative to the total population (IT)
  - among subpopulations (ST)

Partitioning among sample variation (F_{ST})



F_{ST} = divergence among all life stages

F_{SC} = divergence among temporal samples within life stages

F_{CT} = divergence among regions corrected for temporal variation within life stages

Distribution of mtDNA variation among larvae, adults, and repatriates

SOURCE	
Among groups	F_{ST} = 0.003
Among samples within groups	F_{SC} = 0.004
Among larvae, repatriates, and adults	F_{CT} = -0.001

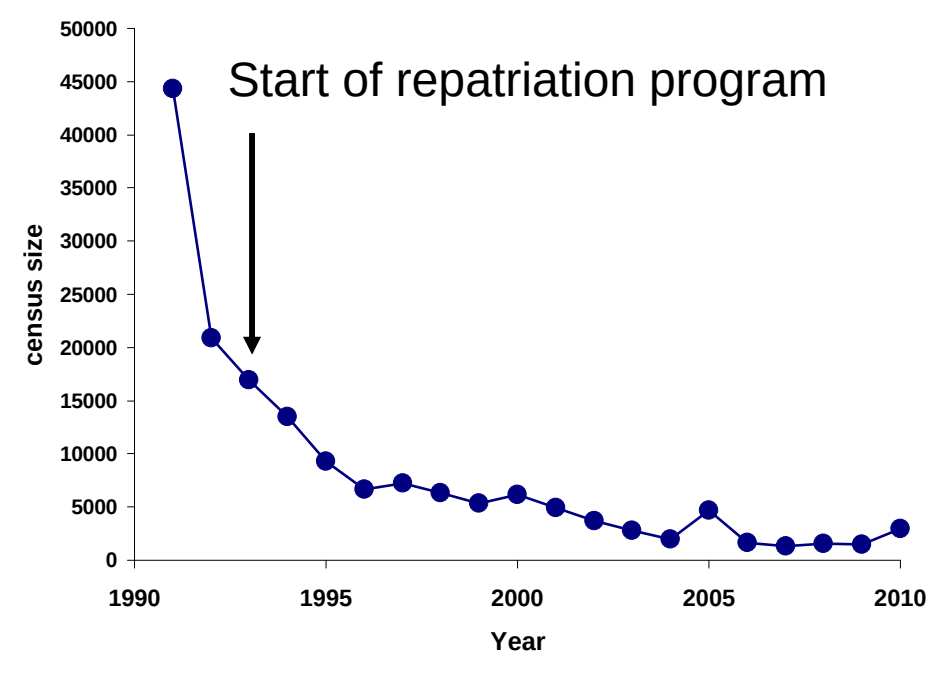
No differences among larvae, repatriates, and adults!

Conclusions

- **All measures of genetic variation consistent among samples of larvae and repatriates**
- **Variation is being transmitted from larvae to repatriates**
- **Increasing levels of genetic variation over time**

Still have a problem!!!

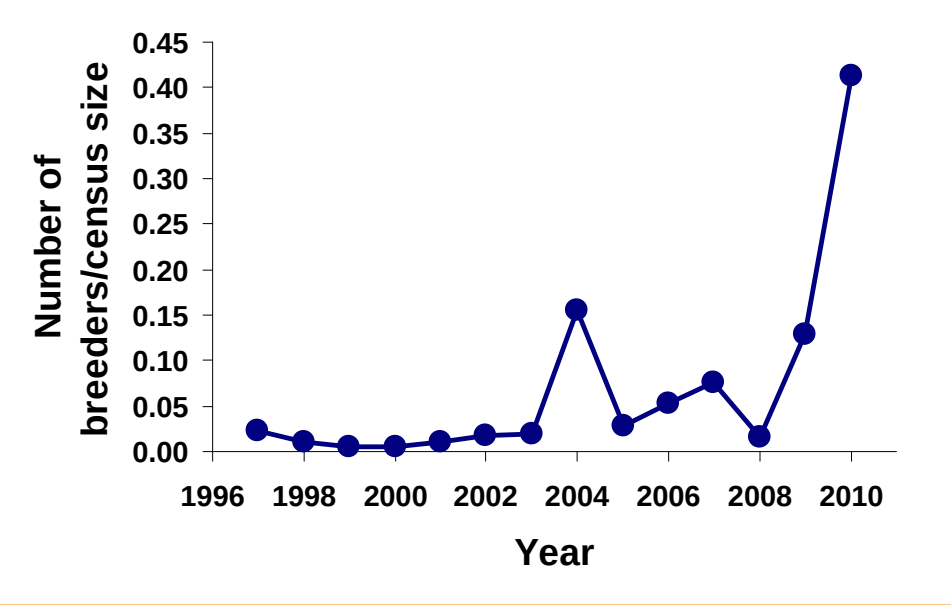
Despite all of our efforts, population size continues to decline



At this point, more than 155,500 young fish have been repatriated, with estimated annual survivorship of ca. 1%

Still have a problem!!!

Genetic variation is increasing because a higher proportion of the population is contributing



- **Problem - ability to maintain genetic variation is constrained by population size**
- **This will lead to a loss of variation, resulting in decreased adaptability and potential issues with inbreeding**

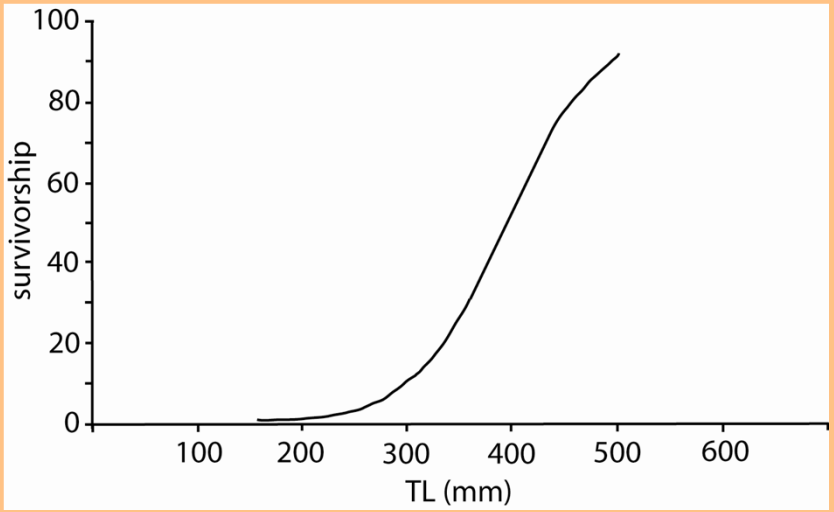
Still have a problem!!!

Size matters

Difficult to grow up fish to >400 mm in a timely manner

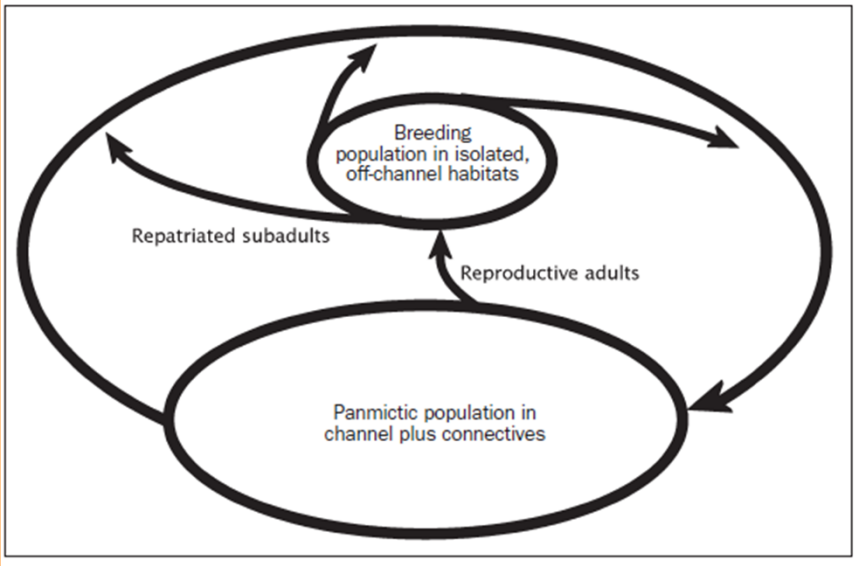
Even so, striped bass are large enough to eat even the largest razorback suckers

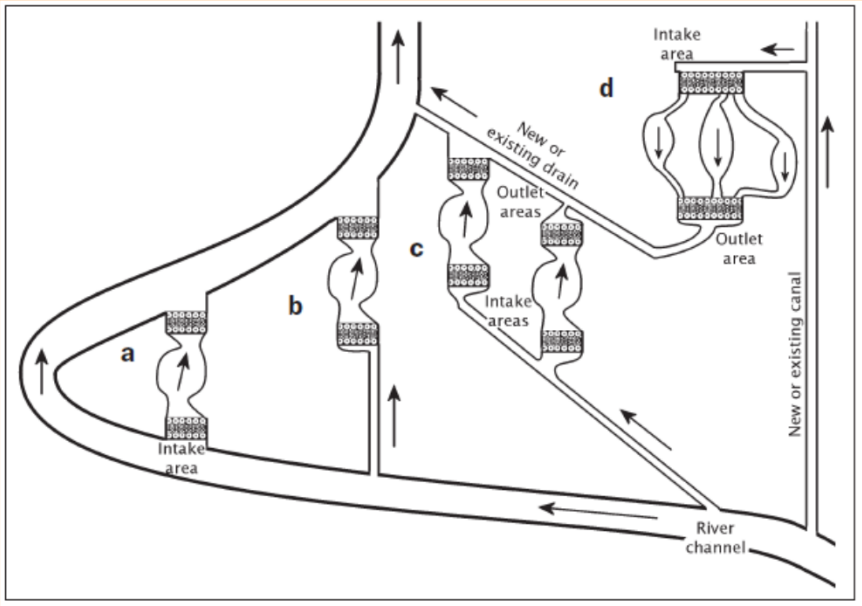
SOLUTION: refuges where can develop appropriately age structured populations



Solution: Off-channel habitats (Minckley et al. 2003)

- **Develop isolated off-channel habitats**
- **Refugia for reproduction**
- **Interchange individuals with main river**





Off-channel habitats

- **Need some basic life history information**
  - **How many individuals do we use in each pond?**
  - **How often do we exchange them?**
  - **How does reproductive success vary across individuals and years?**
- **Demographic and genetic information is essential for design of and informed management of backwater populations**