Status of razorback sucker in Lakes Mohave and Mead: A conservation genetic perspective

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Marsh & Associates Native Fish Lab — A legacy of conservation

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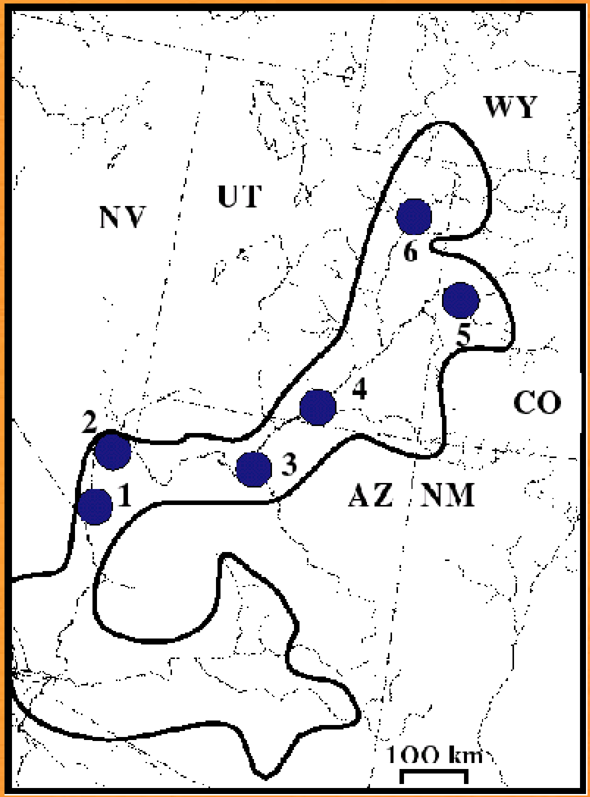
Background

- Endemic to Colorado River system
  - Formerly very abundant in main channels throughout the drainage
- Most abundant in Lake Mohave
  - Highest genetic diversity
  - Serves as a refuge
- Lake Mead
  - Evidence for recruitment

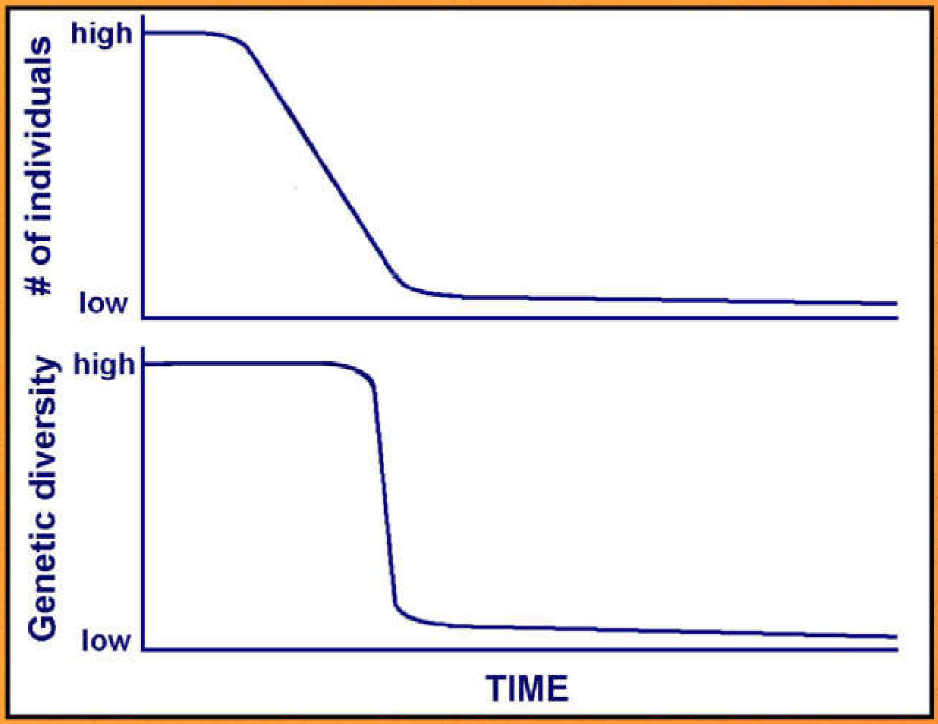


History of population declines

- Reservoirs fill
  - Populations expand
- Introduction of non-native species
  - Failure to recruit
  - Populations senesce and disappear
  - Demise hastened by large predators

Impact on genetic diversity

- **Genetic diversity decreases with population size**
  - **Can have negative effects on health of population (e.g., inbreeding depression)**
  - **Can be used to monitor population size**



Objective

- **Use molecular markers (microsatellites, mtDNA) to monitor levels of genetic diversity in Lakes Mohave and Mead**

Lake Mead

- Essentially extirpated in the 1970s
- Re-appeared in late 1980s – early 1990s
  - Unlike other locations subadults have been found
- Goal
  - Assess patterns of genetic variation

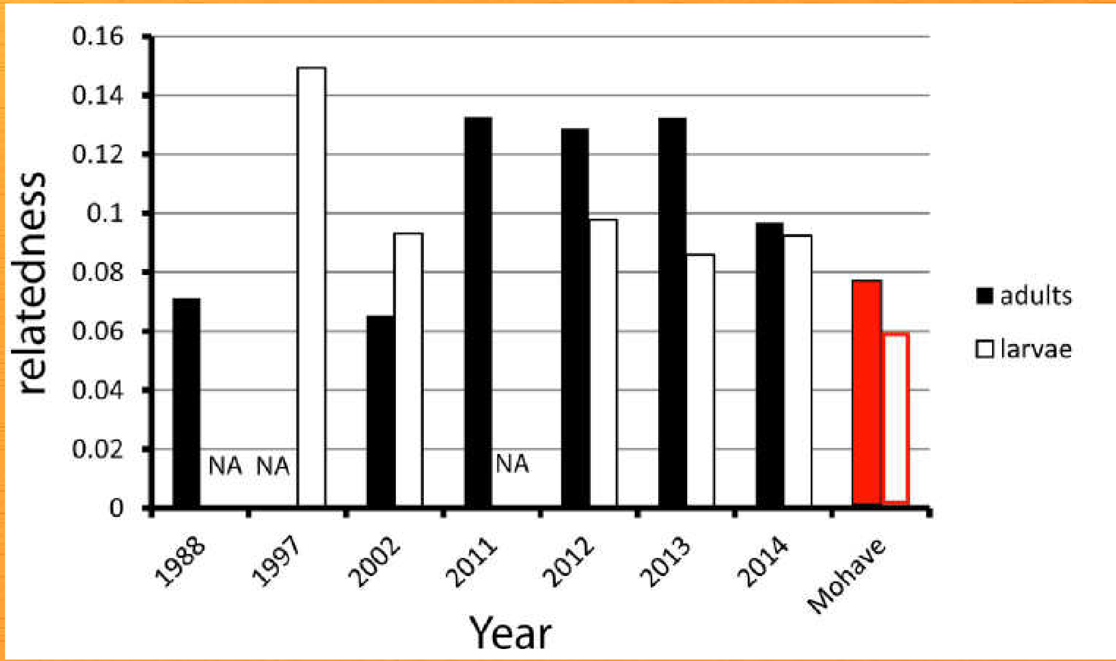
What's happening in Lake Mead?

		Sample Size	
Sample ID	Year	Adults	Larvae
FMS	2013	25	
Mohave	2000/2011	50	120
Mead - unknown	early 90s	15	
	2013	2	
	2014	6	
Colorado River Inlet	2011	4	
	2012	16	
	2013	3	
	2014	7	8
Echo Bay	1997		25
	2002	11	30
	2011	8	
	2012	45	25
	2013	6	7
	2014	14	10
Las Vegas Bay	2002	18	27
	2012		25
	2013	3	40
	2014	8	23
Overton Arm	2011	3	
	2013	38	30
	2014	32	10

- Change in sampling
  - Hiatus between 2002 and 2011
  - Additional locations after 2011

Relatedness

- Higher than original measure from Lake Mead and Lake Mohave
- Reduced in 2014 (relative to 2011-13)

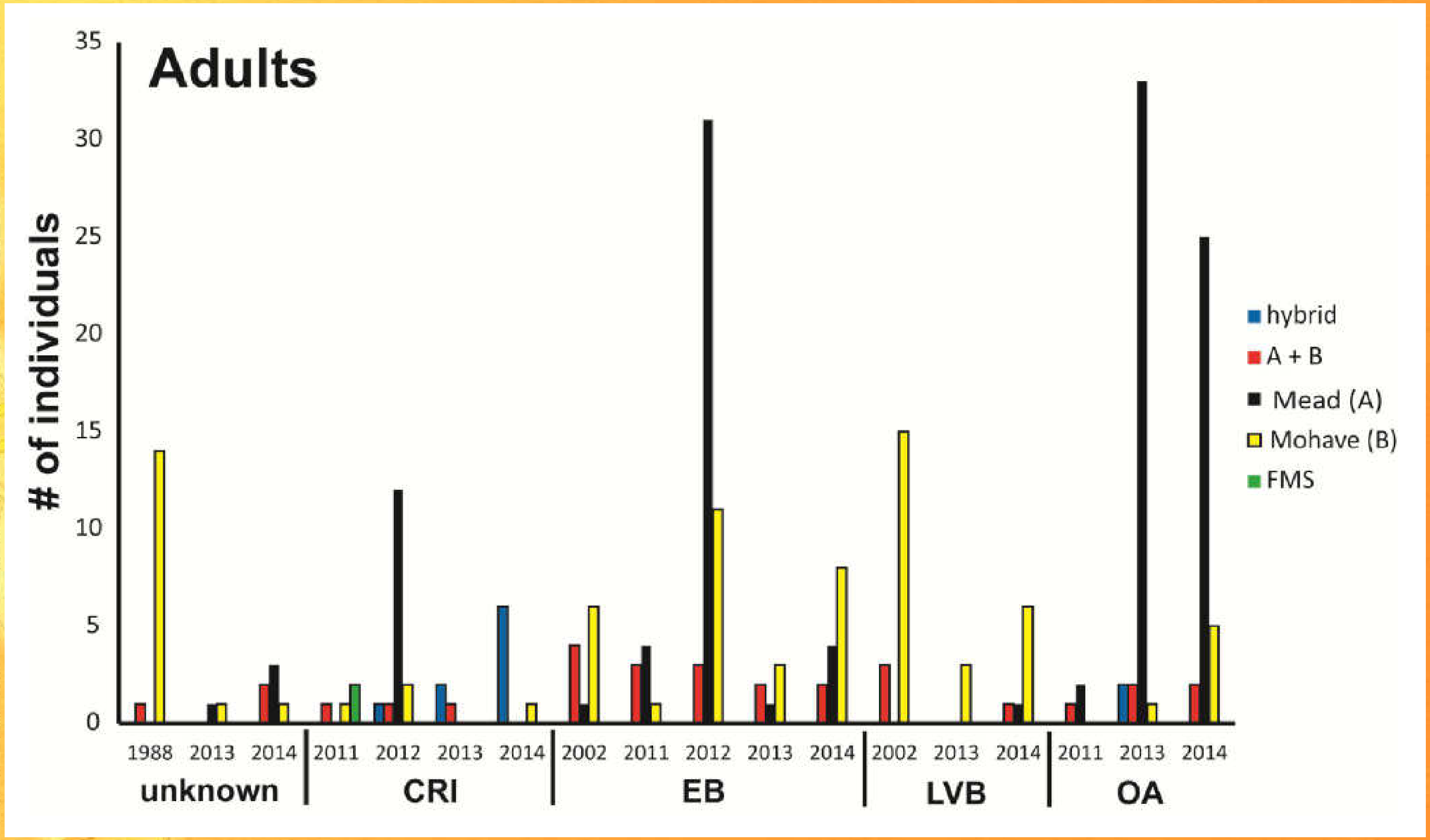


What about variation among populations?

Assignment testing

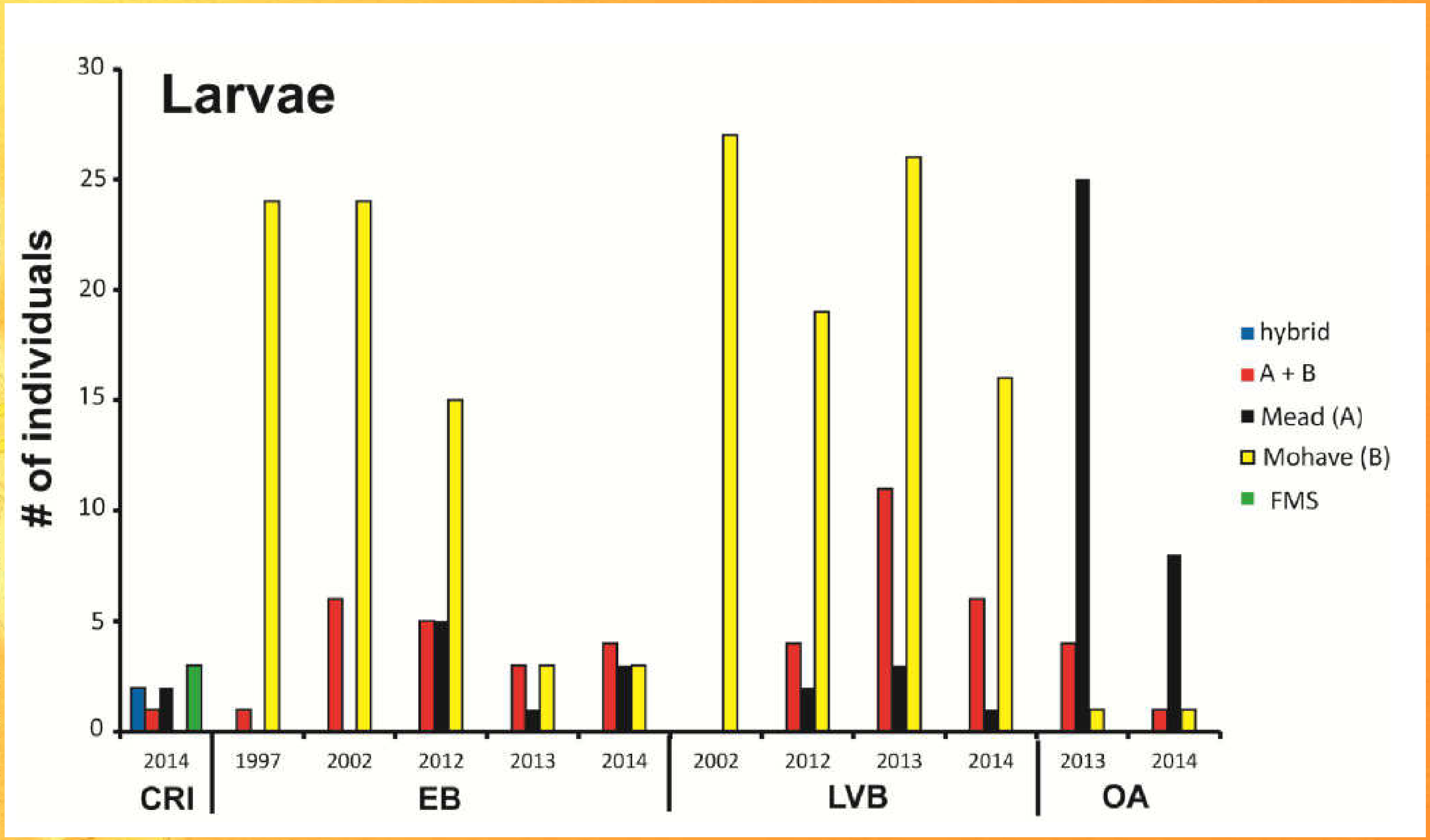
- Identified three forms
  - Flannelmouth
  - Mead specific form
  - Broadly distributed form (including Mohave)

Assignment testing



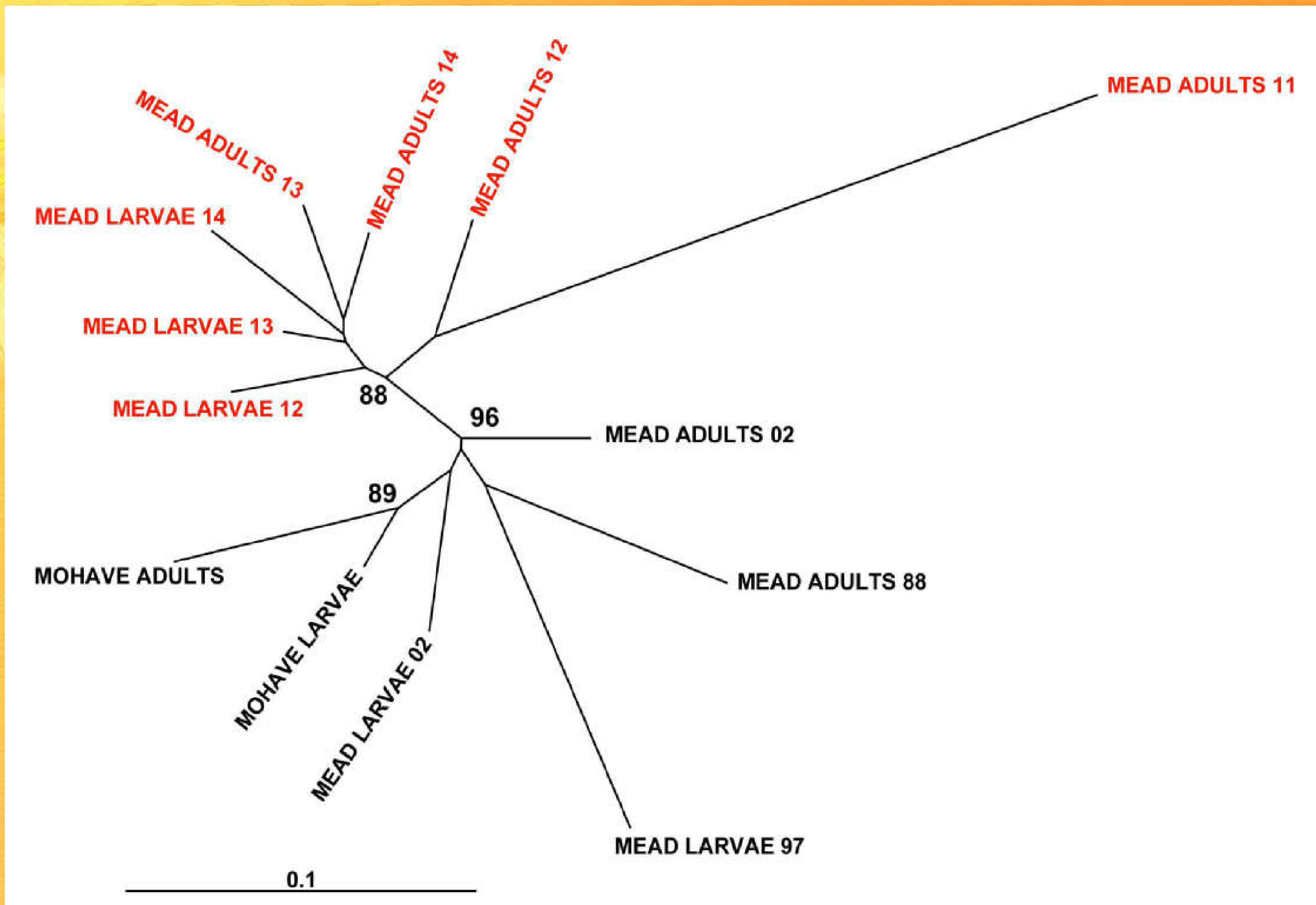
- **Hybrids most common in the CRI**
- **Mead specific form (A) most common in EB and OA**

Assignment testing



- Hybrids found in larvae from CRI in 2014
- Mead RBS most common in OA

Similarity of samples

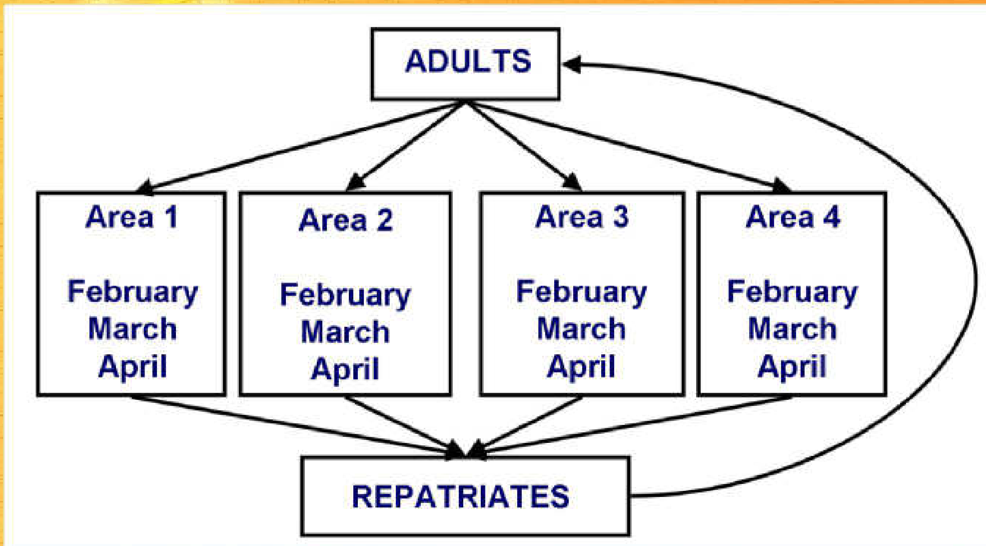


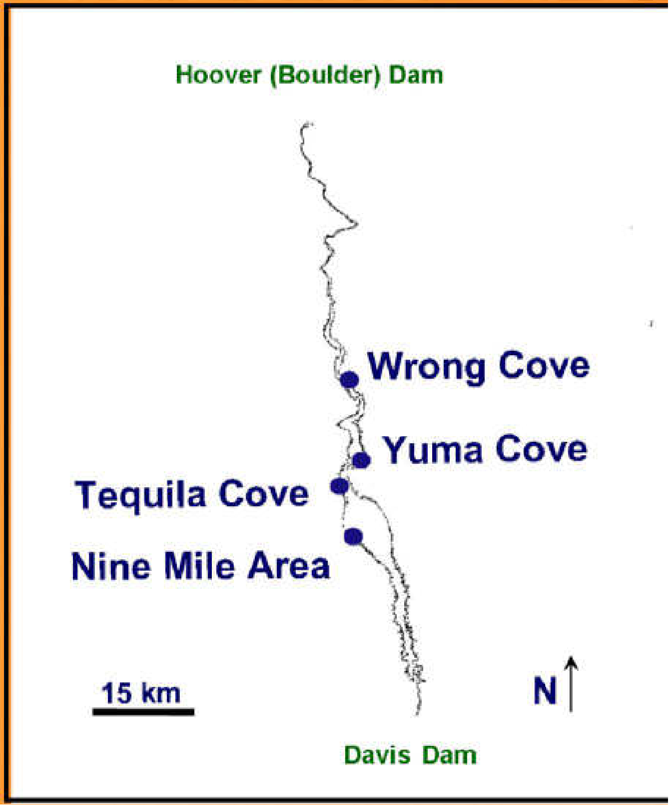
Conclusions
Lake Mead

- RBS in Lake Mead diverging from Lake Mohave
  - Impact of drift due to small population size?
  - As exemplified by flannelmouth-razorback hybrids, increased influx from Grand Canyon?
  - Other geographic effects?
- Because of reduced genetic diversity and change in the population, should augment with Mohave stock to preserve existing Mead variation

Lake Mohave
Conservation plan

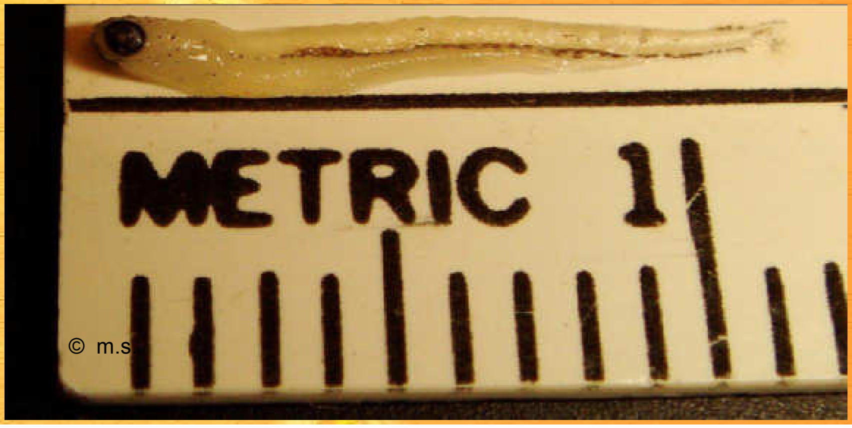
- Initiated in mid-1990's
- Capture naturally produced larvae
  - across regions
  - throughout the spawning season
  - Monitor variation in these samples





Sampling

- 18 years worth of data!!!
- Larvae (1997-2014)
  - 315 collections, 7751 individuals
  - Temporally and geographically dispersed
- Adults
  - 305 wild fish
  - 1277 repatriates (stocked 1992 – 2014)



Genetic variation within larval samples over time

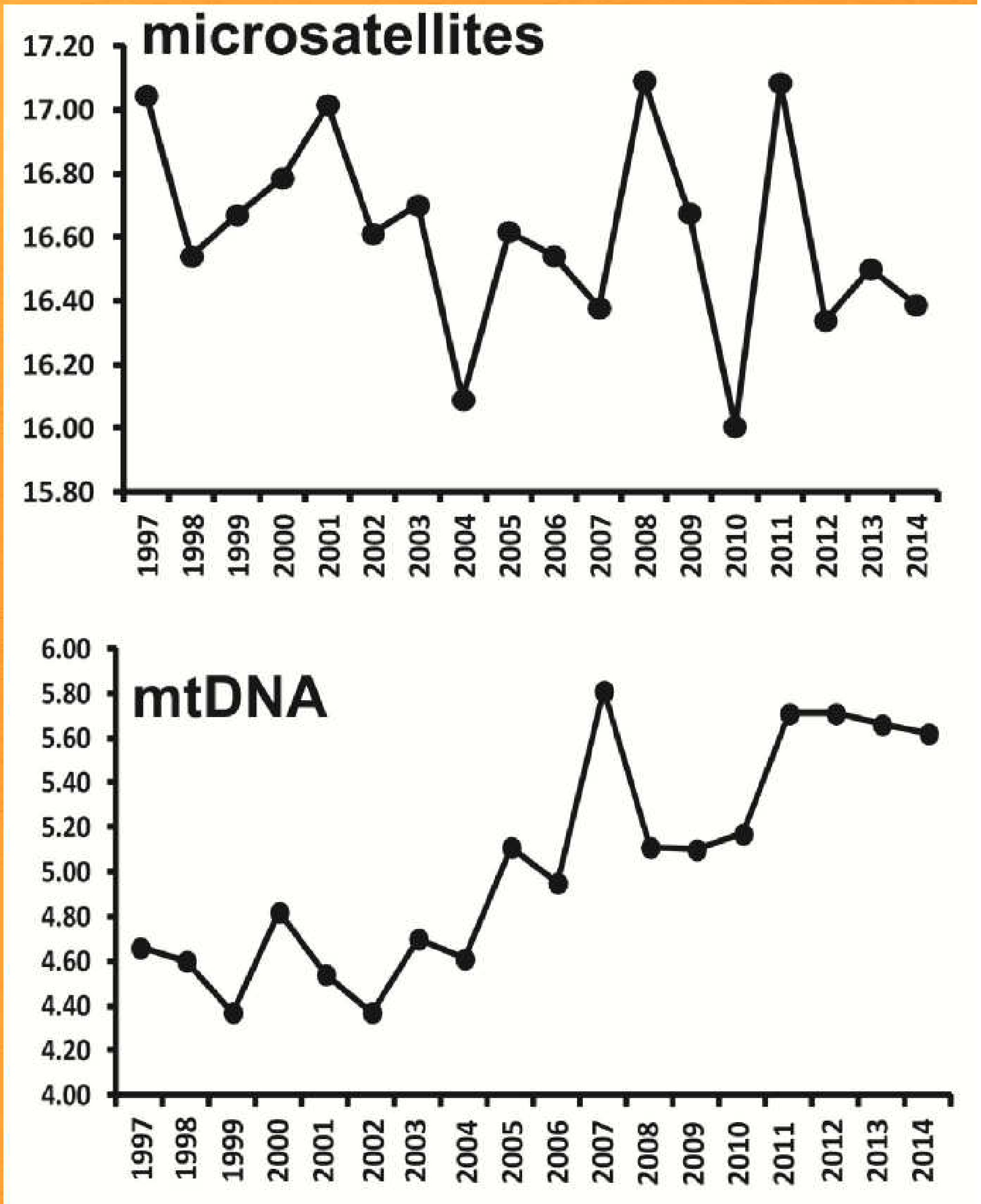
- **microsatellites**

  $R^2 = 0.101$, $P = 0.186$

- **mtDNA**

  $R^2 = 0.724$, $P < 0.001$

- **Allelic richness is being maintained or increased over time**



Genetic variation within repatriates over time (stocking cohorts)

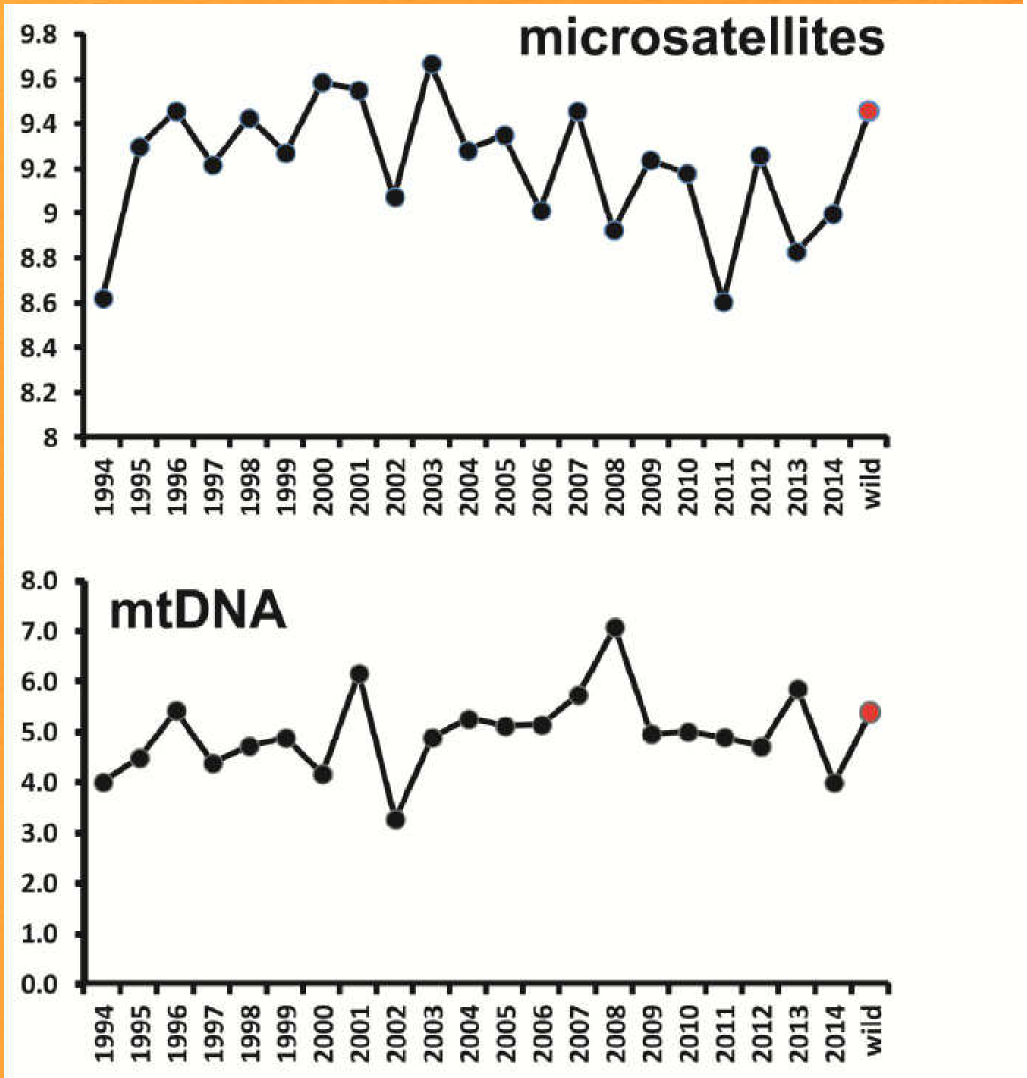
- **microsatellites**

  R^2 = 0.100, P = 0.169

- **mtDNA**

  R^2 = 0.067, P = 0.259

- **Allelic richness is maintained over time**



Distribution of mtDNA variation among larvae, wild adults, and repatriates

SOURCE	
Among samples	$F_{ST} = 0.006$
Among samples within life stages	$F_{SC} = 0.005$
Among larvae, wild adults, repatriates	$F_{CT} = -0.001$

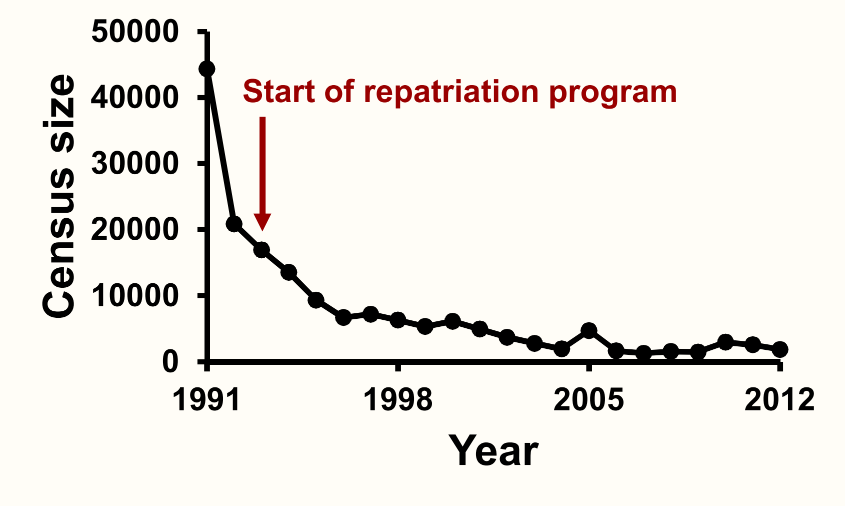
No differences among larvae, repatriates, and wild adults!

Conclusions: Lake Mohave

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

We still have a problem!!!

- Despite all of our efforts, population size continues to be an issue
- 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

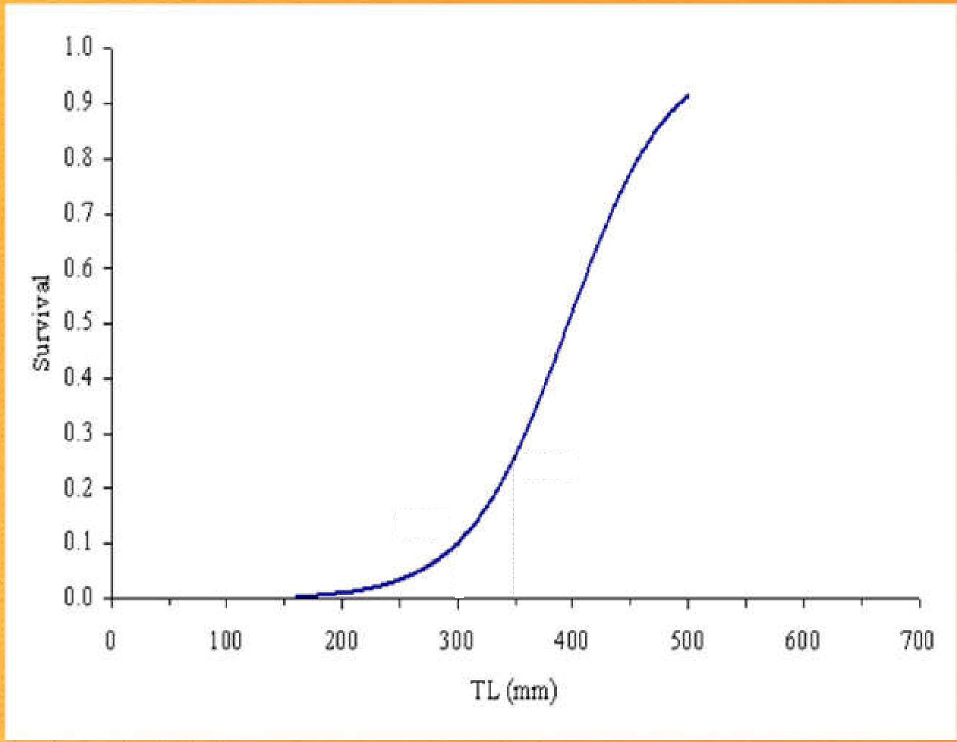
Major Issues
Riverine population

- Stocking has established a population of at least as many fish in the riverine stretch above the basin
- Because of limited movement, riverine fish contribute little to reproduction
- As it stands, this is a wasted resource

- How do we incorporate these fish into the reproductive population?
  - Is this feasible? If not, should stop stocking in the river

Major Issues
Stocking size

- **Size at stocking is critically important**
  - **45 cm fish having a survival rate *an order of magnitude higher* than 35 cm fish**



Major Issues
Stocking size

- **Makes more sense (biologically and economically) to stock larger fish!**
- **Therefore, we need to make a concerted effort to get this done!**