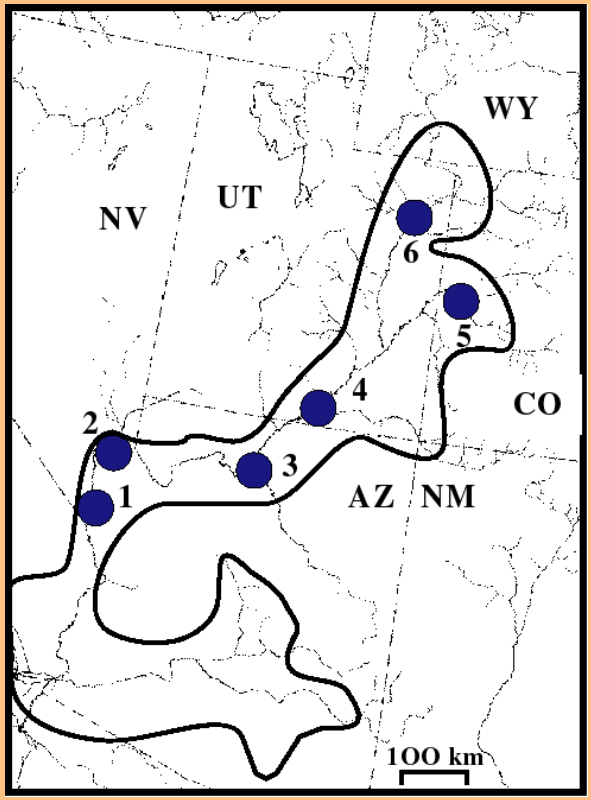
Status of razorback sucker in Lakes Mohave and Mead: A conservation genetic perspective

Thomas E. Dowling
Paul C. Marsh
Thomas F. Turner
Brian Kesner

Funded by:

Background

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



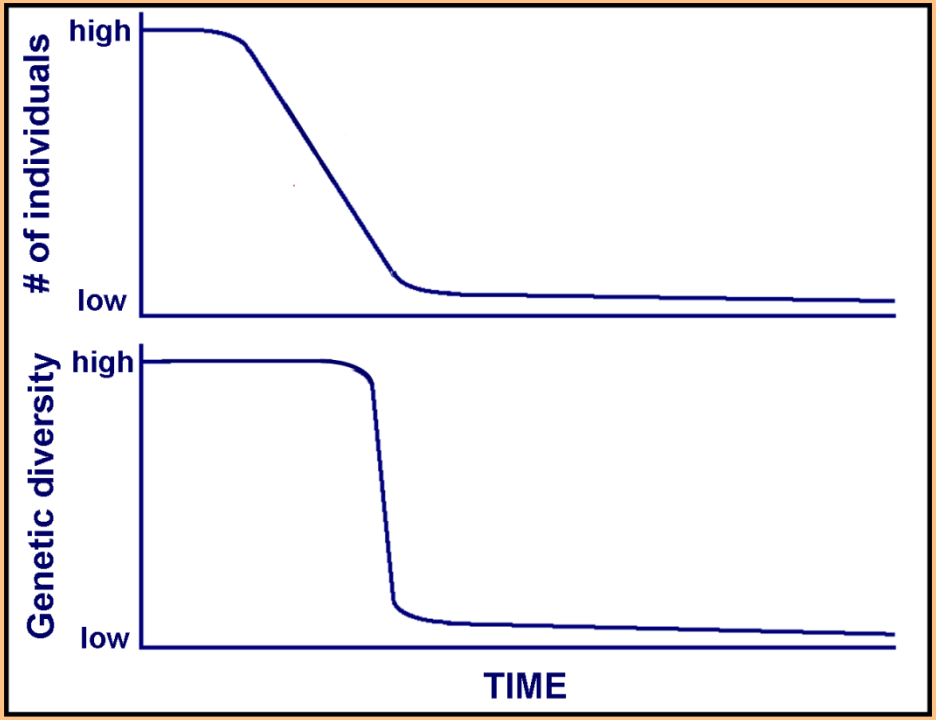
History of population declines

- **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

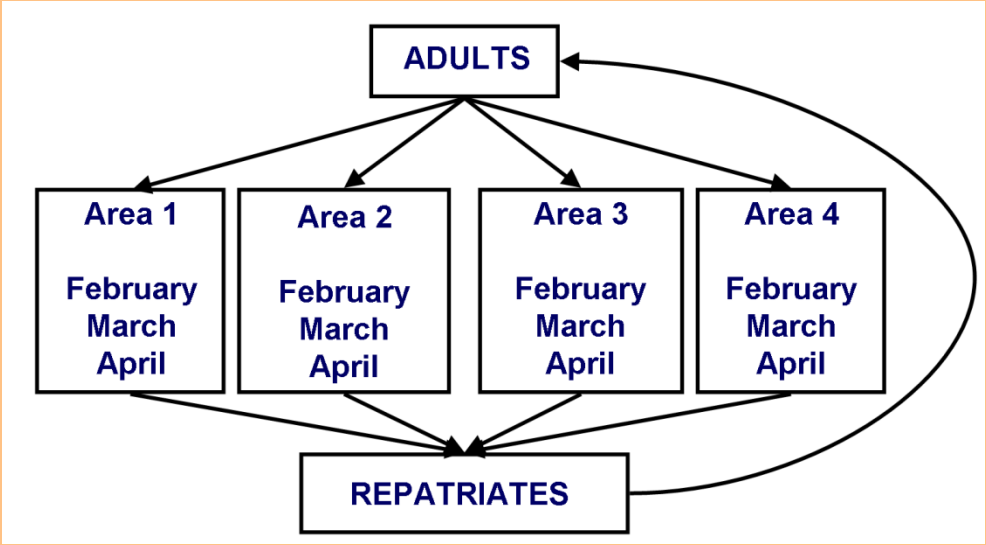


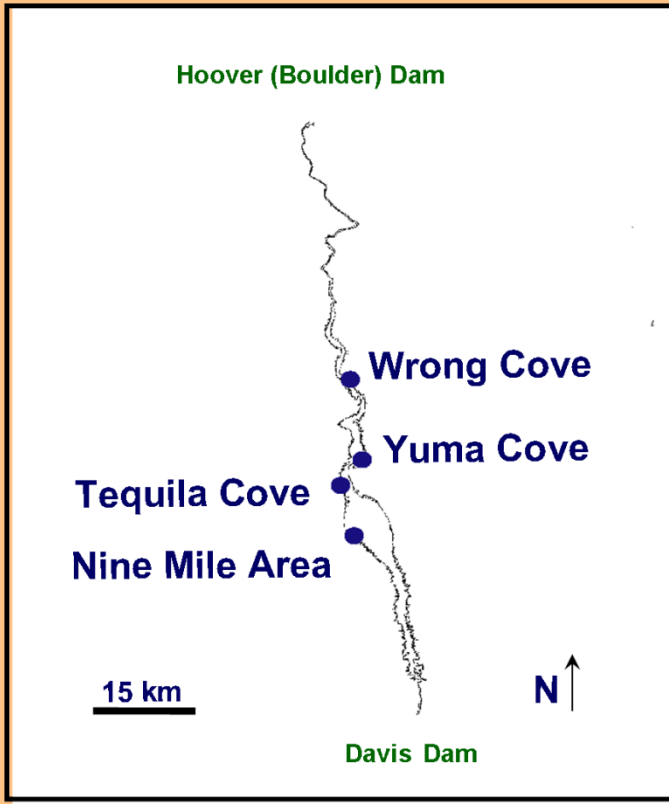
Objective

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

Lake Mohave
Conservation plan

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



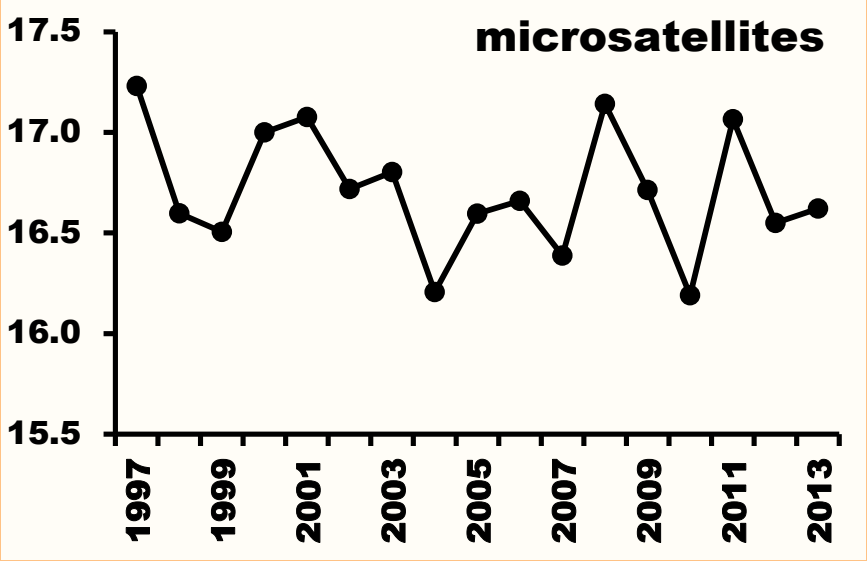


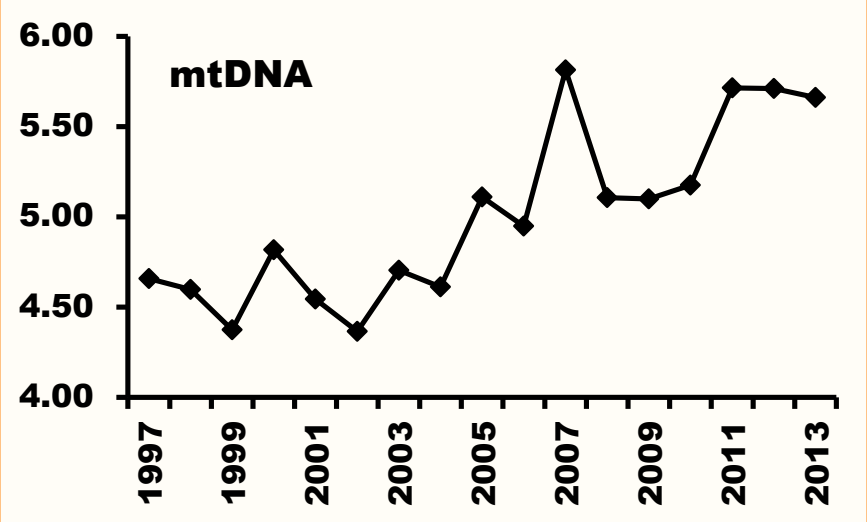
Sampling

- 17 years worth of data!!!
- Larvae (1997-2013)
  - 300 collections, 7388 individuals
  - Temporally and geographically dispersed
- Adults
  - 303 wild fish
  - 1143 repatriates (stocked 1992 – 2013)

Genetic variation within larval samples over time

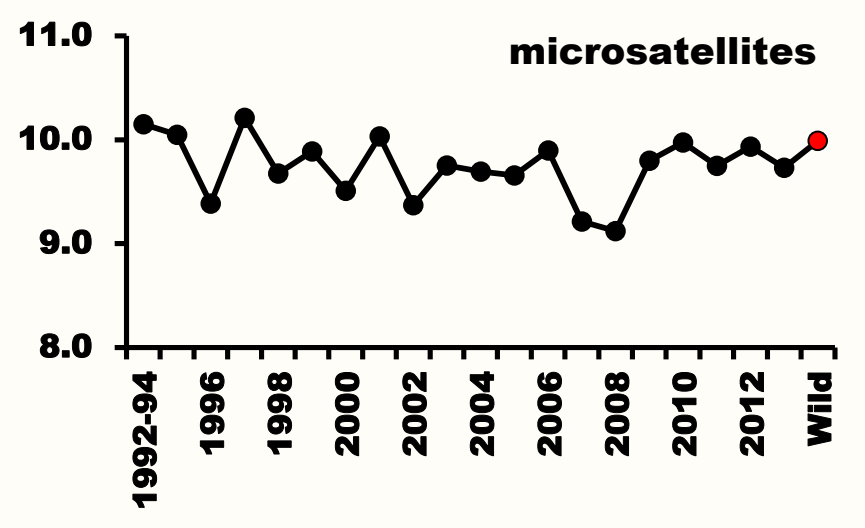
- microsatellites
  - r = 0.257, P = 0.319
- mtDNA
  - r = 0.837, P < 0.001
- Allelic richness is being maintained or increased over time

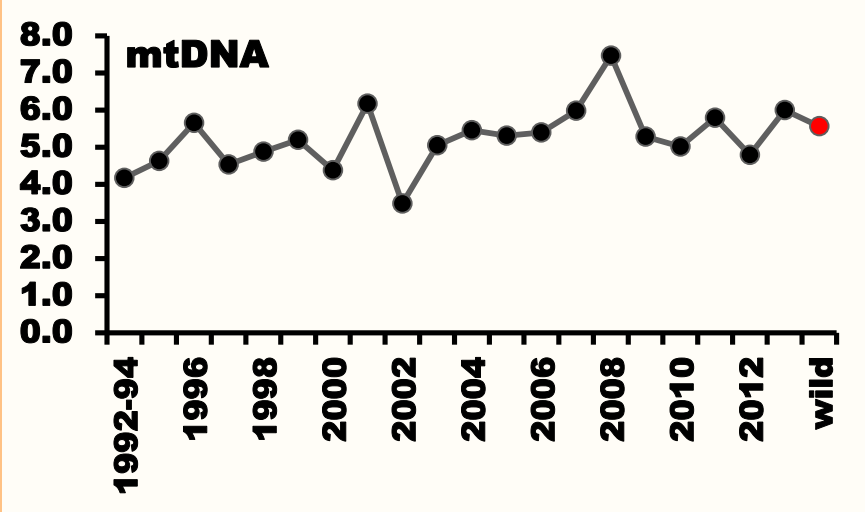




Genetic variation within repatriates over time

- microsatellites
  - r = 0.224, P = 0.342
- mtDNA
  - r = 0.439, P = 0.053
- Allelic richness is being maintained or increased over time





Distribution of mtDNA variation among larvae, adults, and repatriates

SOURCE	
Among samples within groups	F_{ST} = 0.003
Among samples within life stages	F_{SC} = 0.004
Among life stages	F_{CT} = -0.001

No differences among larvae, repatriates, and adults!

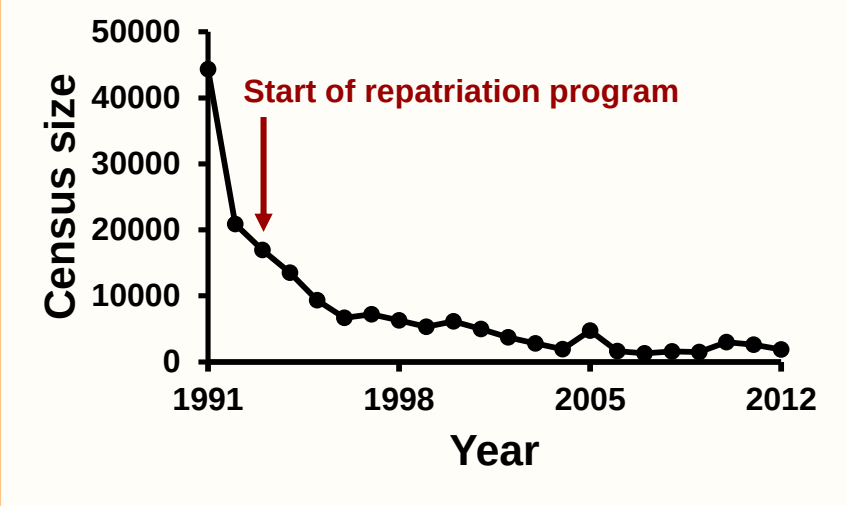
Conclusions: Lake Mohave

- 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**

We still have a problem!!!

- These estimates are from the basin
- Stocking has established a significant population in the riverine stretch above the basin
- Because of limited movement, riverine fish contribute little to reproduction
- As it stands, this may be a wasted resource

  – How do we incorporate these fish into the reproductive population?

Lake Mead

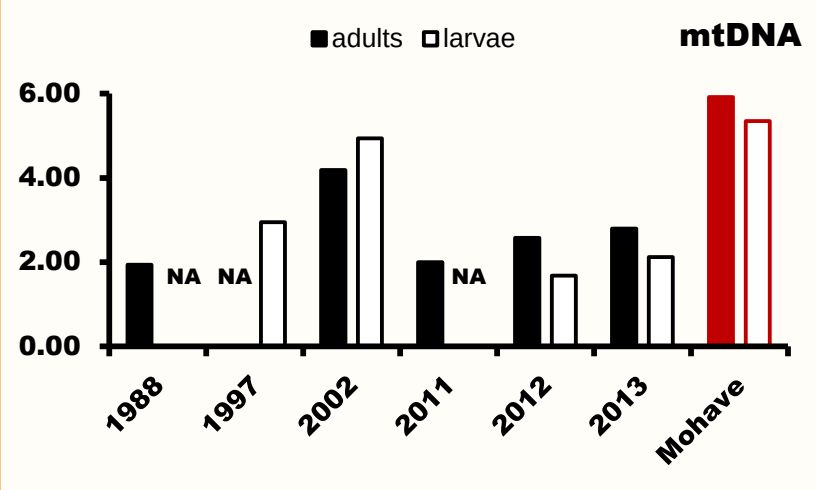
- Essentially extirpated in the 1970s
- Re-appeared in late 1980s – early 1990s
  - Unlike other locations subadults have been found
- Goal
  - Assess patterns of genetic variation

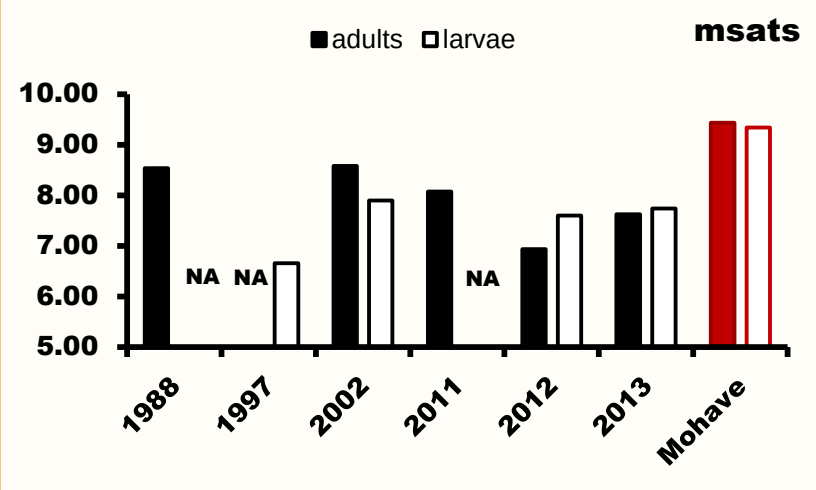
What's happening in Lake Mead?

Year	Adults (# samples)	Larvae (# samples)
Lake Mead		
1988	15	0
1997	0	25
2002	29 (2)	57 (2)
2011	15	0
2012	61	50 (2)
2013	52	77 (4)
Lake Mohave	50	120
Flannemouth	25	0

Diversity

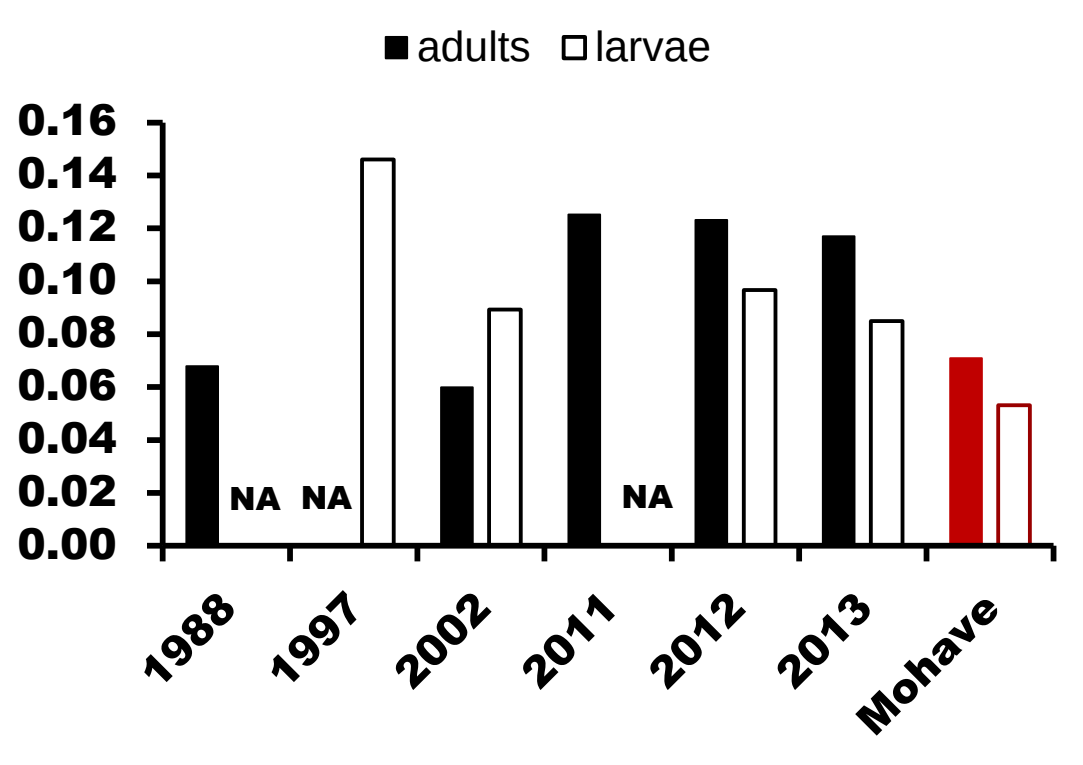
- Lower diversity than Lake Mohave
  - mtDNA reduction greater than microsatellites
- Within Lake Mead, lower diversity in more recent samples (2011-13)





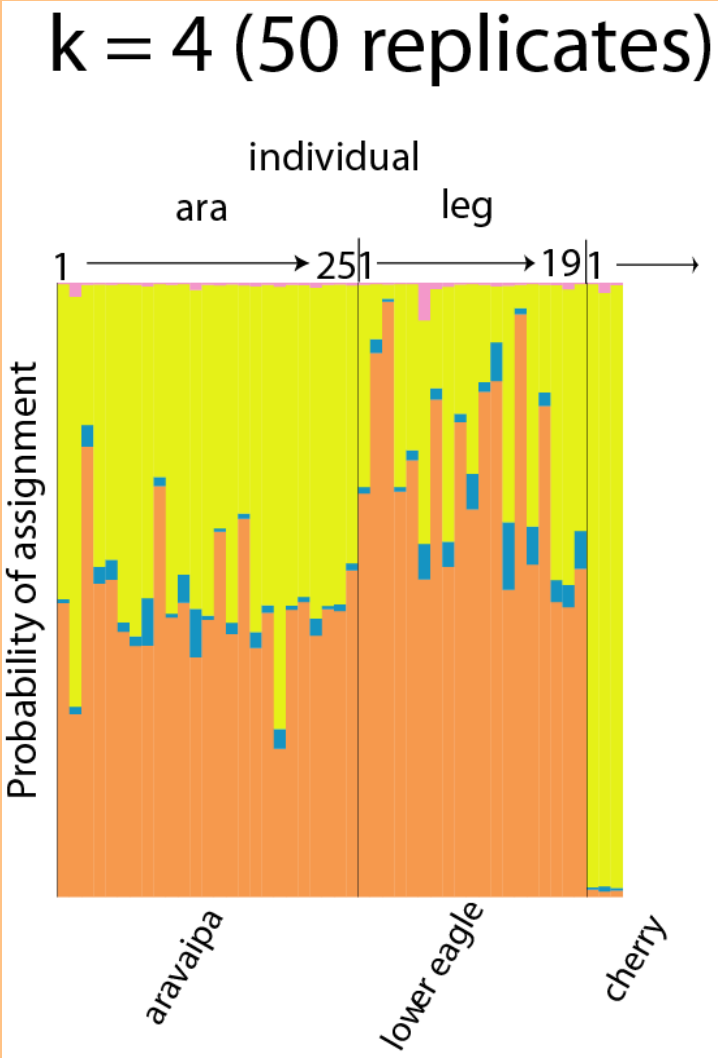
Relatedness

- **Reduced diversity can be due to increased relatedness**
- **Increased in Lake Mead in more recent samples (2011-13)**



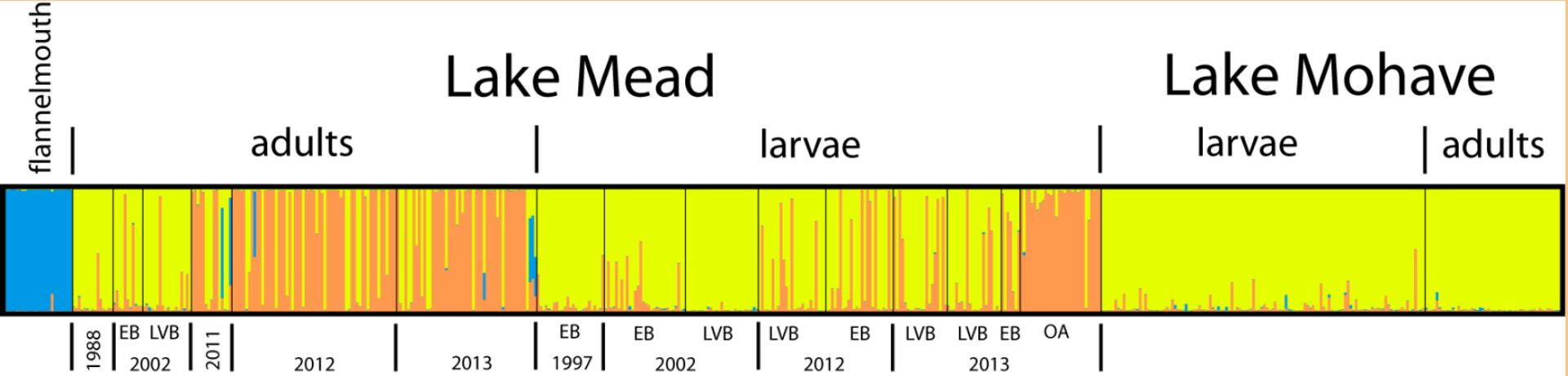
What about variation among populations?

Assignment testing: interpretation



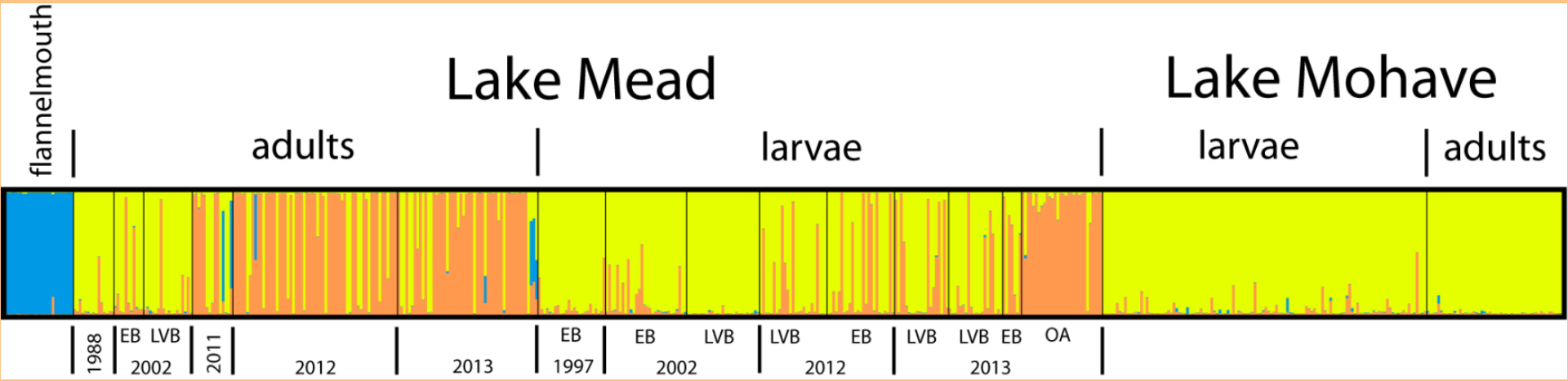
- **Color = group identifier**
- **Columns = individuals**
- **Height = probability of assignment to specific groups**

Flannelmouth-razorback sucker hybrids



- **Only found in adults**
- **More frequent in recent samples (2011-13)**
  - $X^2 = 71.6$, 6 df, $P < 0.05$
- **Most common in the Colorado River inflow**
  - $X^2 = 22.6$, 6 df, $P < 0.05$

Population structure



- **Two groups of razorbacks**
  - **Lake Mohave (yellow)**
  - **Lake Mead (orange)**
- **Lake Mead group increased in frequency over time (especially in adults)**
  - $X^2 = 64.1$, 4 df, $P < 0.05$

Conclusions

Lake Mead

- Diversity becoming more reduced in Lake Mead
  - Variation a subset of that found in Lake Mohave
  - Reduction has led to increased relatedness
- Lake Mead diverging from Lake Mohave
  - Impact of drift?
  - As exemplified by flannelmouth-razorback hybrids, increased influx from Grand Canyon?
- In addition to temporal samples, better geographic sampling is needed