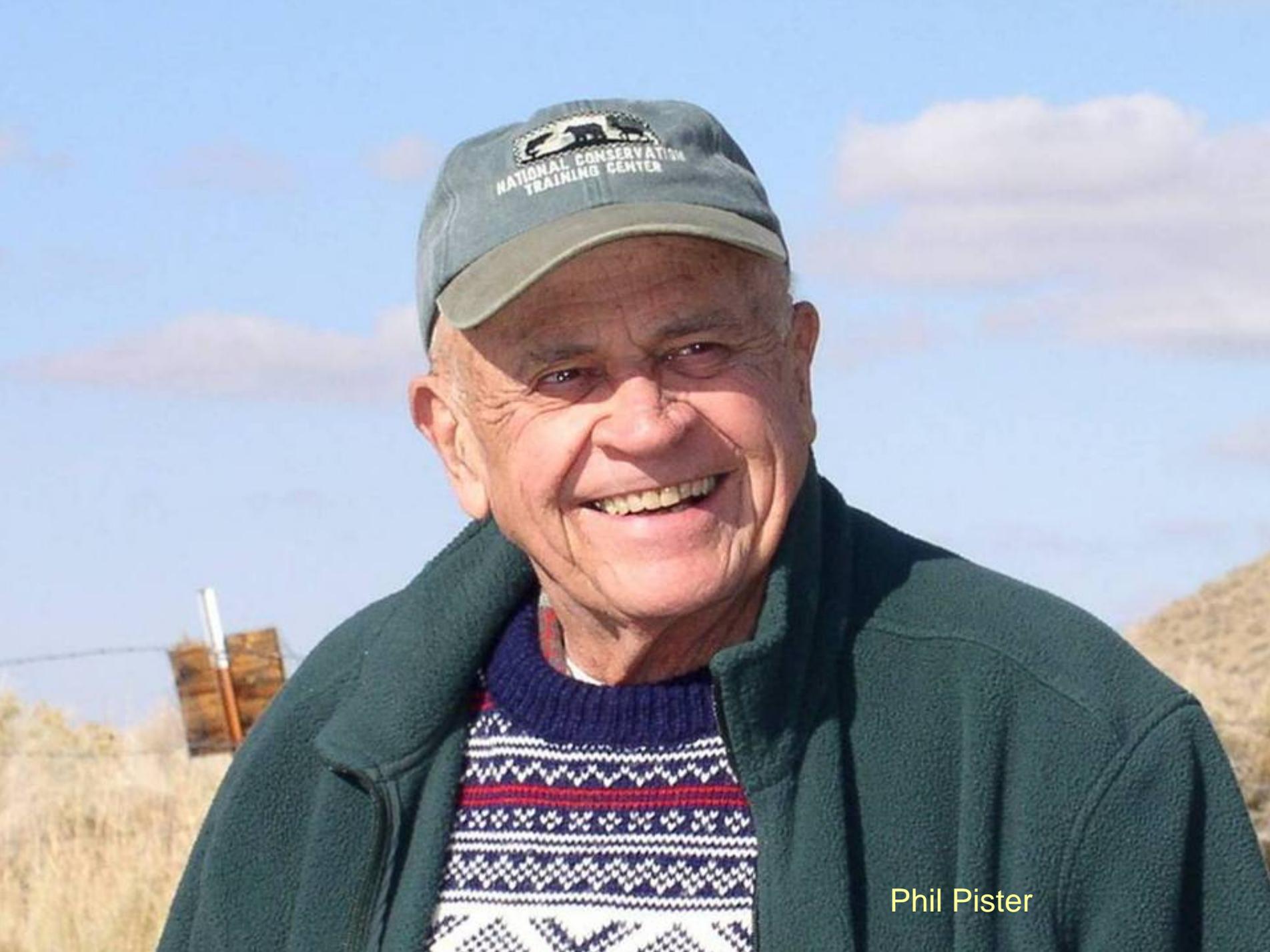


A photograph of a person in a small, light-colored inflatable boat on a calm body of water. The water reflects the surrounding landscape, which includes tall palm trees and dense reeds. The sky is clear and blue. The text 'Natural History and Management of Mohave Tui Chub' is overlaid in yellow at the bottom of the image.

Natural History and Management of Mohave Tui Chub

Steve Parmenter, CDFG

August 15, 2007



Phil Pister



Genomic Variation Lab

- People
- Projects
- Protocols
- Publications
- Links
- Lab Meeting

The Genomic Variation Laboratory (GVL) employs a wide range of molecular genetic techniques to address questions in the conservation genetics of threatened and endangered wildlife, fisheries management, and aquaculture. Much of our work is done in collaboration with government agencies and organizations without the ability to conduct their own genetic analyses. For more information or inquiries about potential collaborations, please contact:

Dr. Bernie May
UC Davis



Current research includes: population structure of native California species; genetic diversity of introduced non-native and threatened species; genetic contribution of sturgeon; population structure of Sacramento perch and splittail; population structure of endangered Shasta crayfish; reproduction of lion-paw scallops; elucidating species of invasive jellyfish; and determining genes conferring resistance to whirling disease in trout.

Past research has included assessing dispersal among yellow-bellied marmots; population structure of endangered lake sturgeon in the Great Lakes; examining the distribution of genetic diversity within Kearney's bluestar; evaluating subspecific status of Northern goshawks; elucidating the



Contact Us:
Department of Animal Science
UC Davis
One Shields Ave.

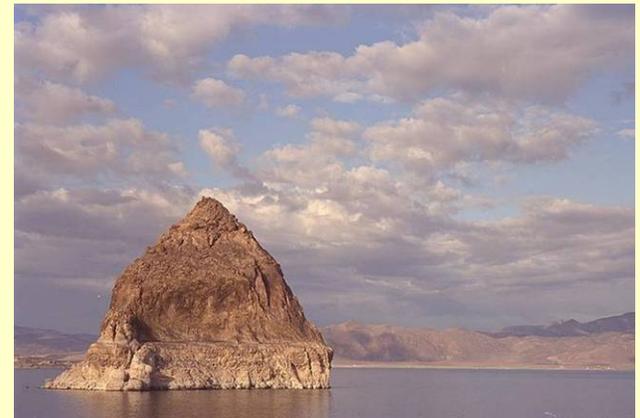
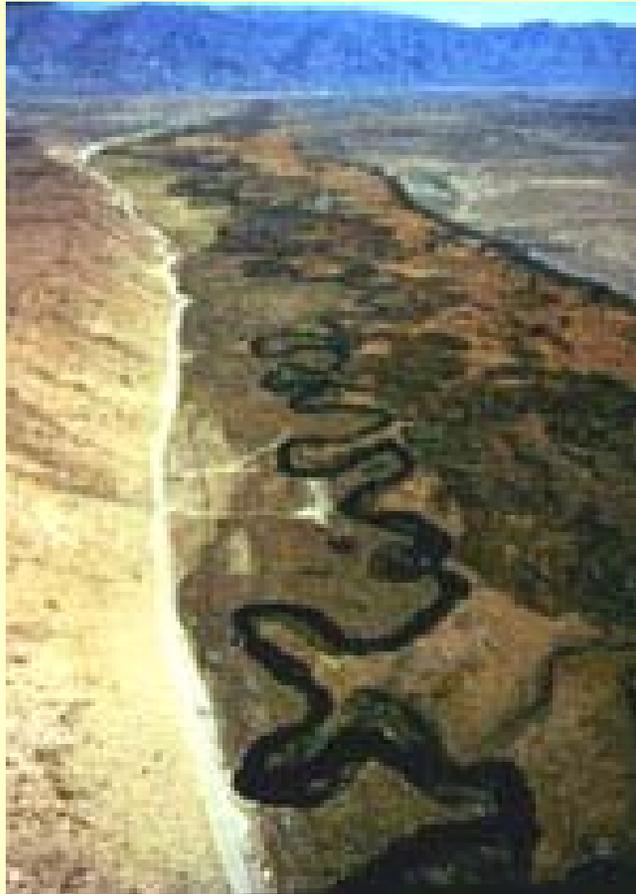


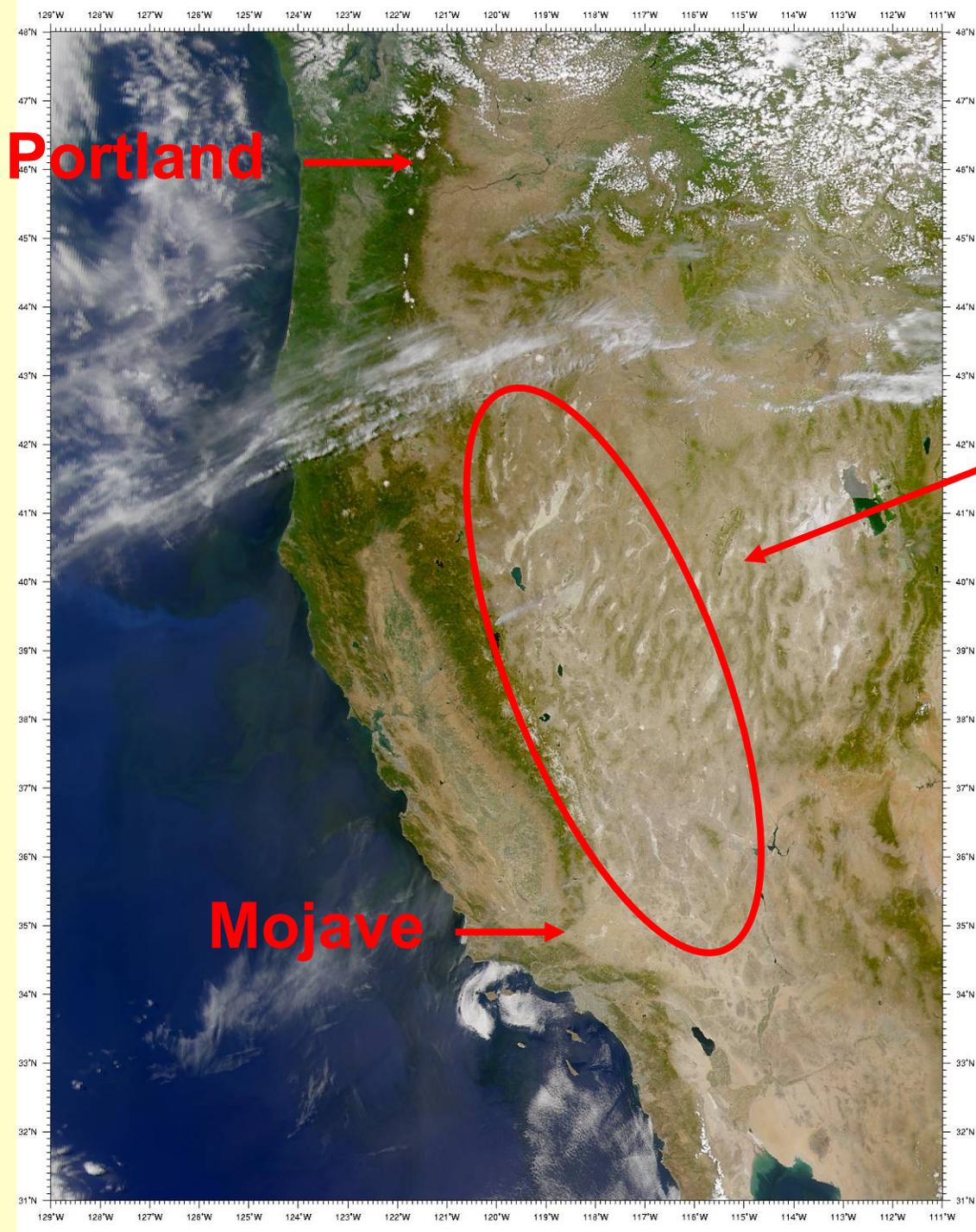
Dr. Yongjiu Chen



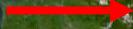
tui chubs in general

- *Siphateles bicolor*
- western Great Basin minnow
- omnivorous, schooling, fecund
- long-lived
- broad physiological tolerance
- many are **endangered**





Portland



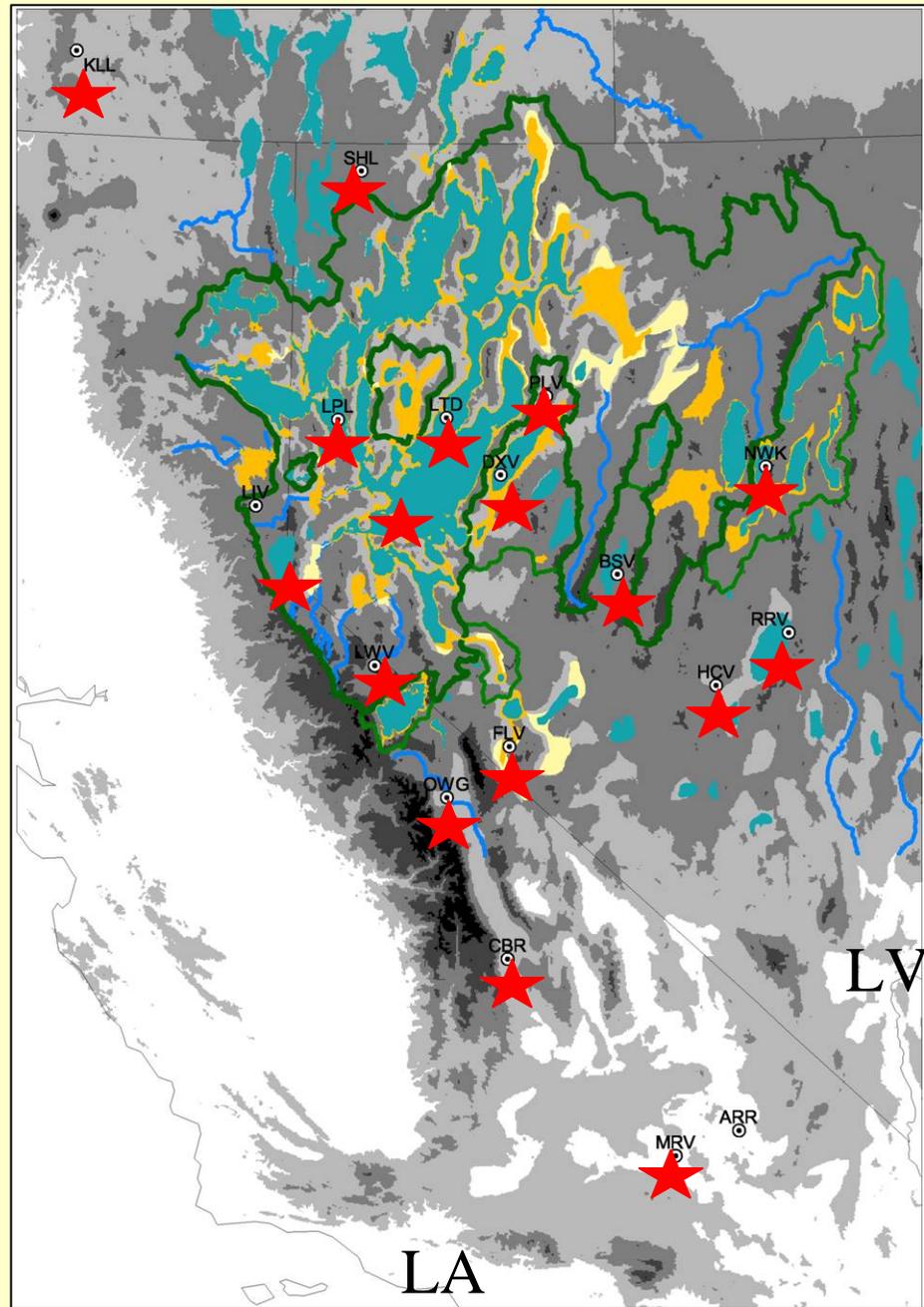
Mojave



tui chubs



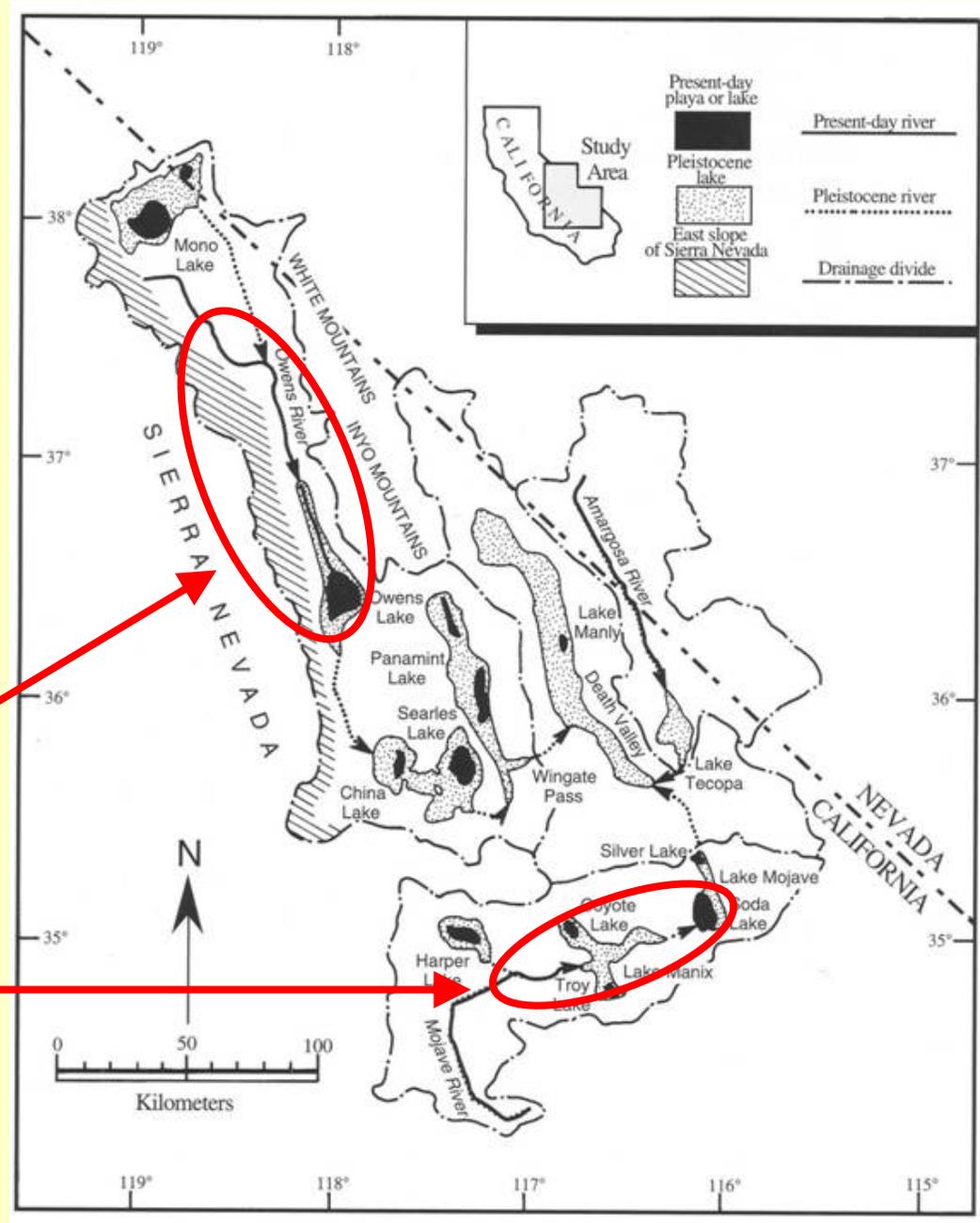
Great Basin: Quaternary cradle of tui chub evolution



**Tui chubs
access
Owens/Death
Valley system
from the north,
≥ 760,000 b.p.(?)**

Owens tui chub

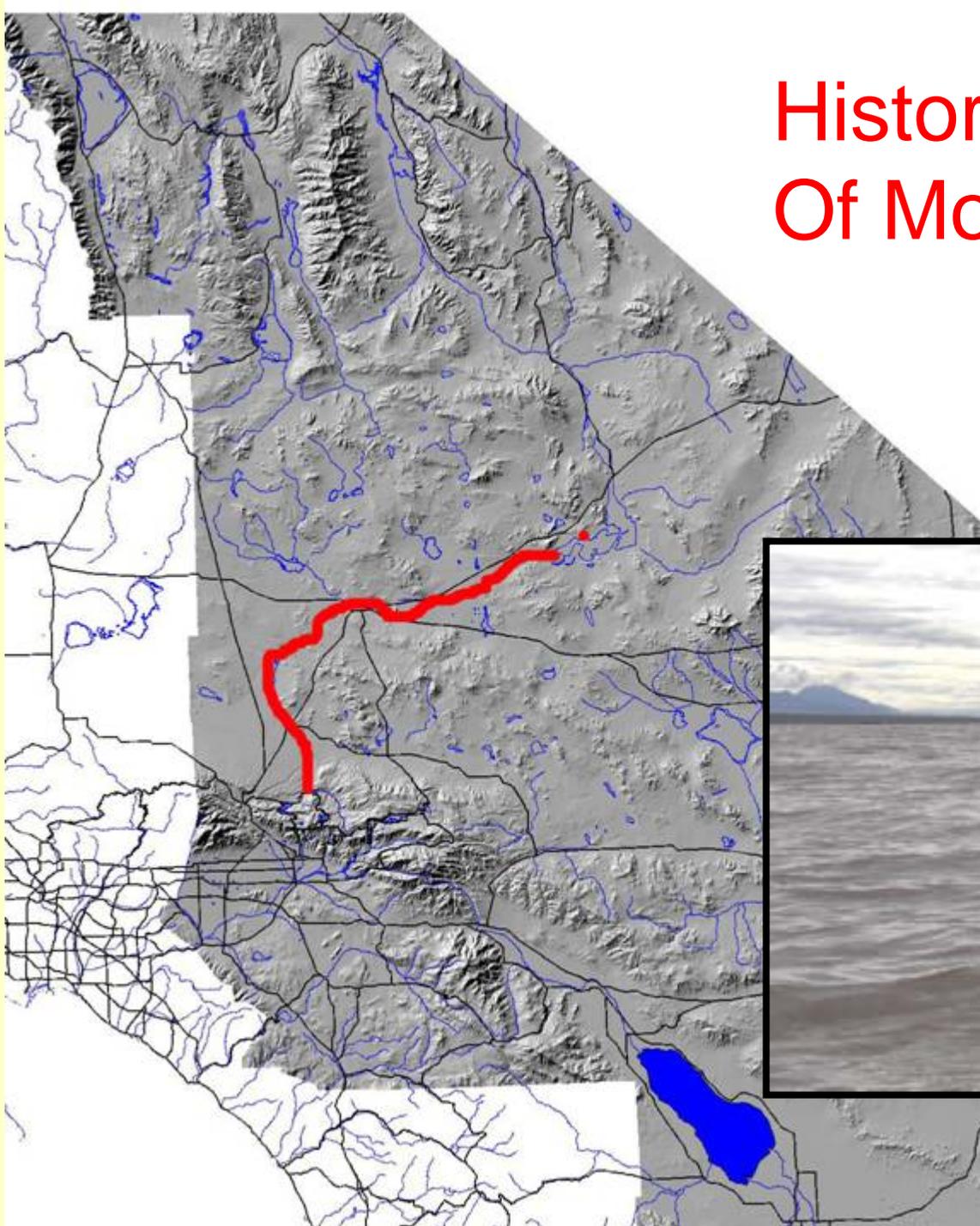
Mohave tui chub





- **Only native fish in Mojave River (extirpated)**
- **Endangered 1971**
- **One relict population “MC Spring”**
- **3 successful transplants**

Historic Distribution Of Mohave tui chub



MASS HYBRIDIZATION BETWEEN TWO
GENERA OF CYPRINID FISHES IN
THE MOHAVE DESERT,
CALIFORNIA

CARL L. HUBBS AND ROBERT R. MILLER





FIG. 1. *Gila orcuttii*

FIG. 2. Hybrid

FIG. 3. *Siphateles mohavensis*

All scales are of adults



FIG. 4. Lowest pool of Deep Creek, photographed by Laura C. Hubbs on September 1, 1934, when the entire fish population was removed and preserved for the analysis of the natural hybrids

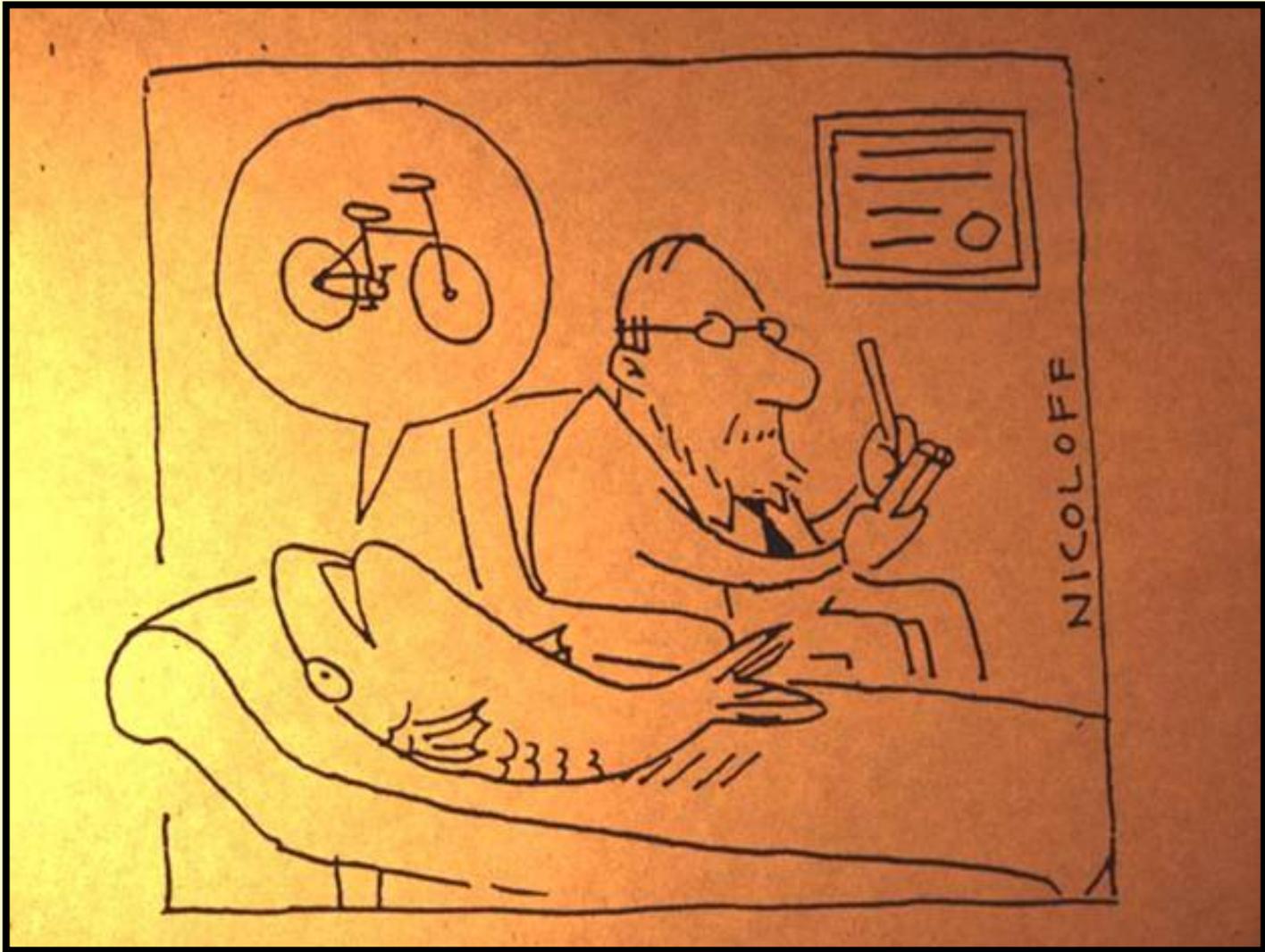
PHYSIOLOGICAL RESPONSES OF A NATIVE AND AN INTRODUCED DESERT FISH TO ENVIRONMENTAL STRESSORS¹

DANIEL T. CASTLEBERRY AND JOSEPH J. CECH, JR.
*Department of Wildlife and Fisheries Biology, University of California,
Davis, California 95616 USA*

Fish species	Number of times pinned first*	Fish sizes ($\bar{X} \pm 2 \text{ SE}$)†	
		Mass (g)	Standard length (mm)
Mojave tui chub	12	4.0 \pm 0.7	61 \pm 4
Arroyo chub	3	4.2 \pm 0.7	61 \pm 4

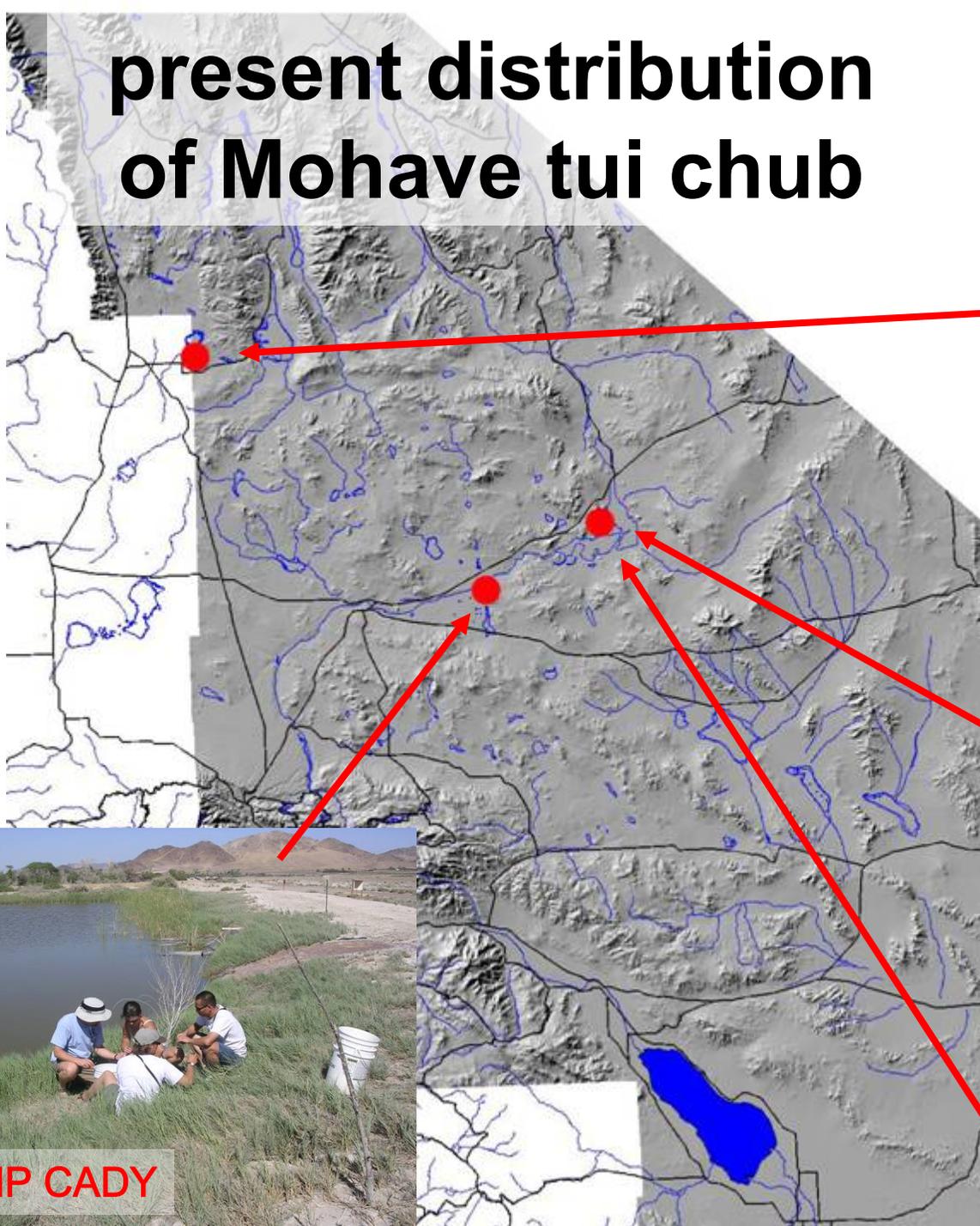
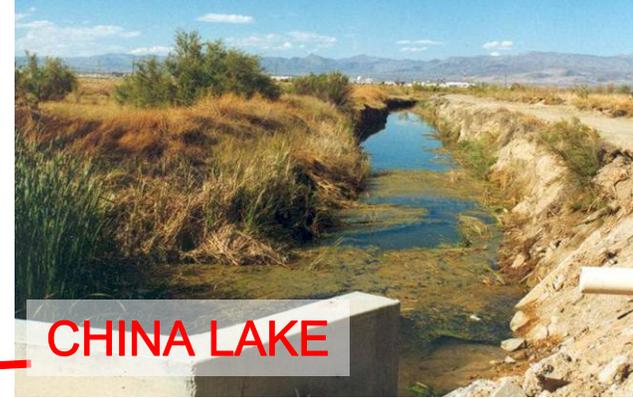
* The two species' scores were significantly different from equal ($P < .05$, sign test).

Q. So, what do these fishes need in life?

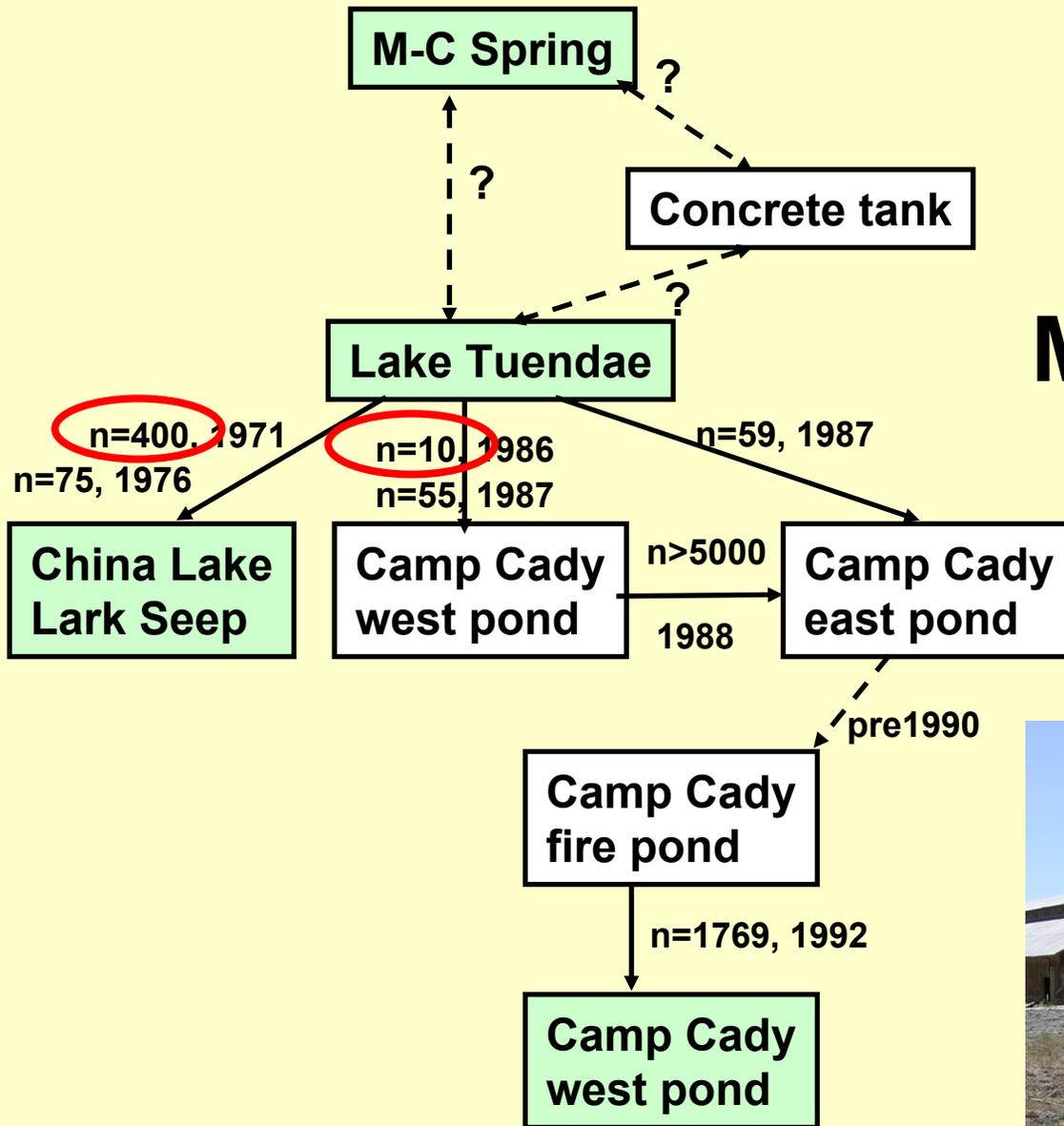


A. Isolation....and water!

present distribution of Mohave tui chub



Transplant history of Mohave tui chub



Importance of Genetic Variation

- Fitness declines with inbreeding
- Persistence of species depends in part upon fitness
- Maintaining evolutionary potential allows adaptation to changed conditions (=remain fit)



Example: Florida Panther

- Declined to 60-70 individuals
- 10 % heterozygosity vs. ~45% in western US
- Cowlicks, kinked tails and low fertility
- 5 females introduced from Texas
- 25 F1 offspring lack mutant phenotypes and appear more robust
- Population tripled in size





Example: Devils Hole

- An exposed aquifer surface in SW Nevada, with an endemic fish.
- World's smallest range for a vertebrate.
- 1973 Landmark Supreme Court decision limited groundwater extraction & affirmed ESA.
- Unexplained population decline from 400 to 80 in 6 year period ending 2006.
- Spring 2007 population is 24.



Photo courtesy of James Deacon

Genetic Questions

- Are Mojave River populations hybrids not?
- How much variation exists within and among MTC populations?



- Are there past or continuing losses of diversity?

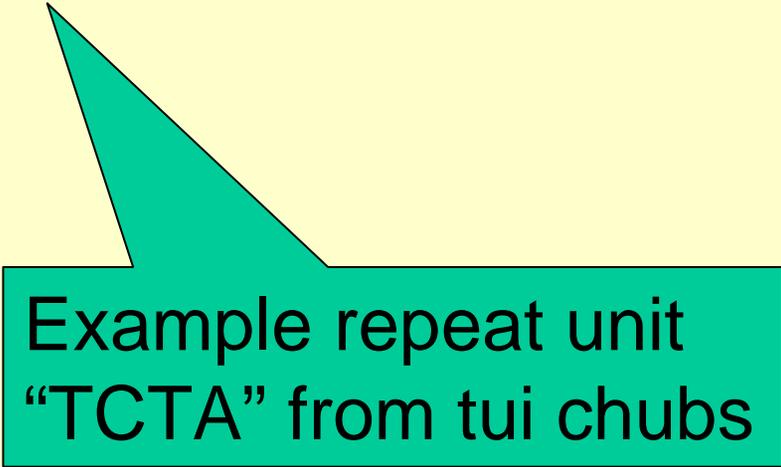
Samples

- Non-destructive fin clips
- PCR Amplification
- 4 refuge MTC populations + river + arroyo
- 48 samples / site



Microsatellites are non-coding loci with a short tandem repeating sequence:

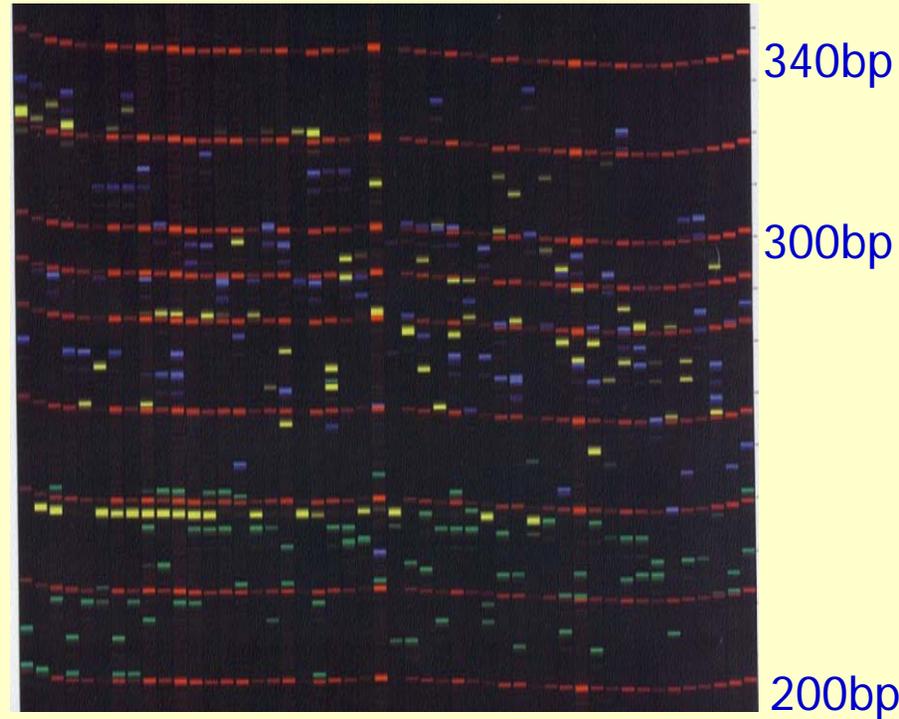
....TCTATCTAT**TCTA**TCTATCTATCTATCTATCTATCTA.....



Example repeat unit
“TCTA” from tui chubs

microsatellite DNA

- Selectively neutral / rapid evolution
- Bi-parentally inherited
- Co-dominant
- Variable: 65-90 alleles/taxon, at 6 loci
- Detect subtle variation among populations



Final Report

Title: Genetic Purity and Subspecific Status
of the Mohave Tui Chub

Submitted by: Bernie May (Director), Jeff Rodzen and Jeremy Agresti
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Submitted to: Department of the Navy
Engineering Field Activity-WEST
Naval Facilities Engineering Command
900 Commodore Drive
San Bruno, CA 94066-2402

Letter of Agreement: N68711-97-LT-70025

Duration: June 19, 1997 to September 30, 1997

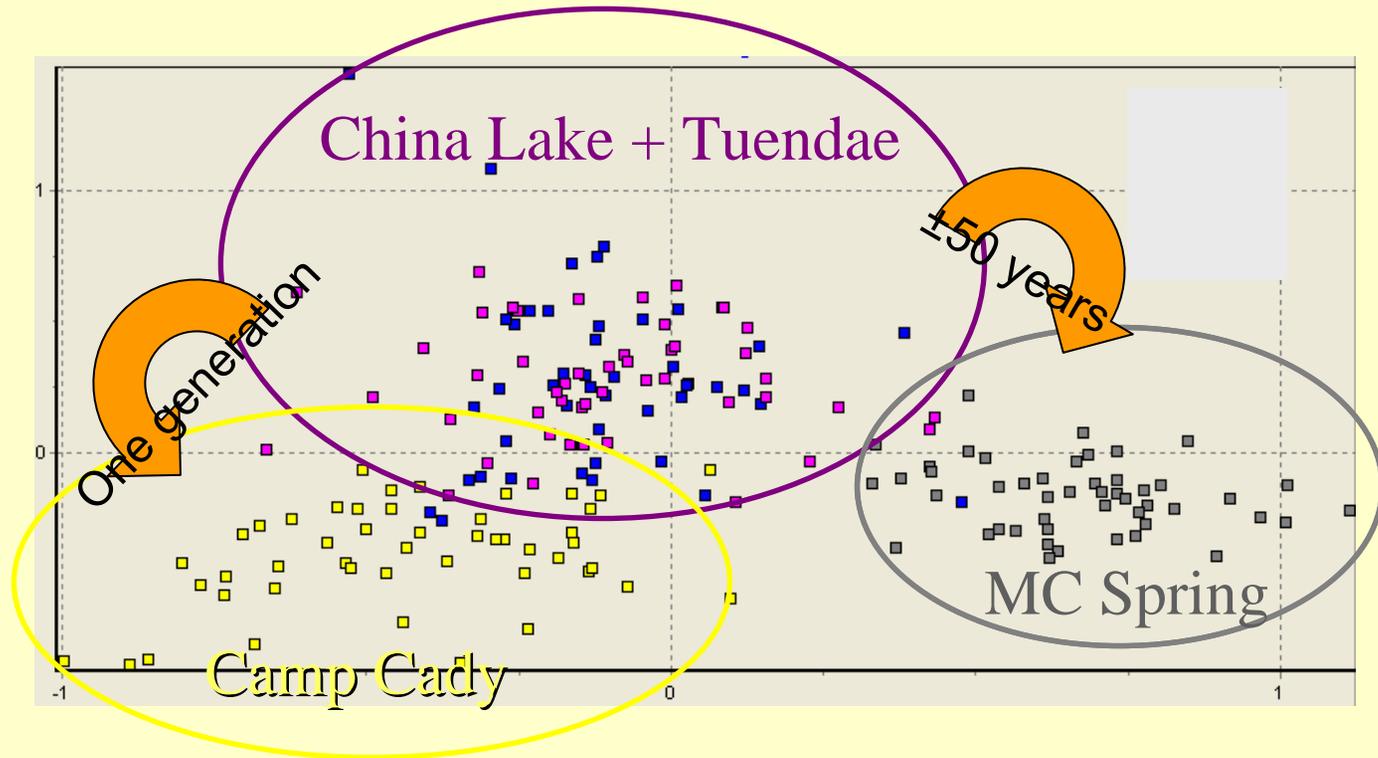
HYBRIDS?

Genetic Diversity

POP	CC	CL	LT	MC
$\sum N_A(\sum N_w)$	41 (0)	62 (6)	57 (4)	34 (1)
$R^{\pm} C.I.$	0.67 ± 0.12	0.93 ± 0.06	0.88 ± 0.09	0.56 ± 0.17
$M^{\pm} C.I.$	0.61 ± 0.12	0.70 ± 0.13	0.64 ± 0.15	0.65 ± 0.15
H_E^{\wedge}	0.54	0.61	0.59	0.41



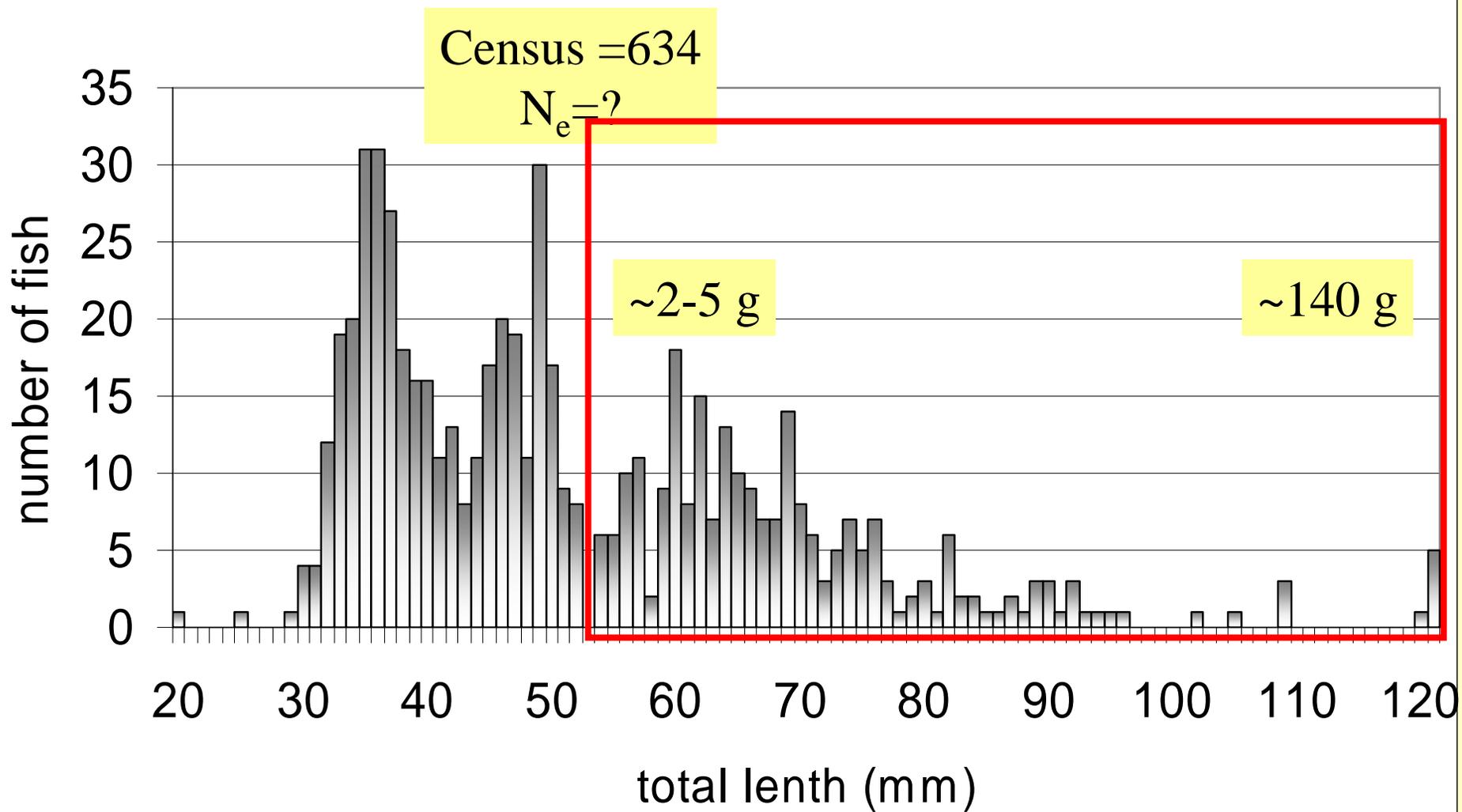
Population divergence



Loss of genetic variation in Mohave tui chub

- Mohave tui chub occur in 4 populations
- 2 populations are robust; 2 are depauperate
- Inbreeding and genetic drift
- Possible “extinction” spiral
- Reversible through managed immigration

Lengths of Mohave Tui Chub, MC Spring, Oct. '05



Recommendations

- Use both Lake Tuendae and China Lake to found additional populations
- Exchange individuals among populations—and monitor.
- Investigate the role of hybridization in species replacement—can these species coexist?

