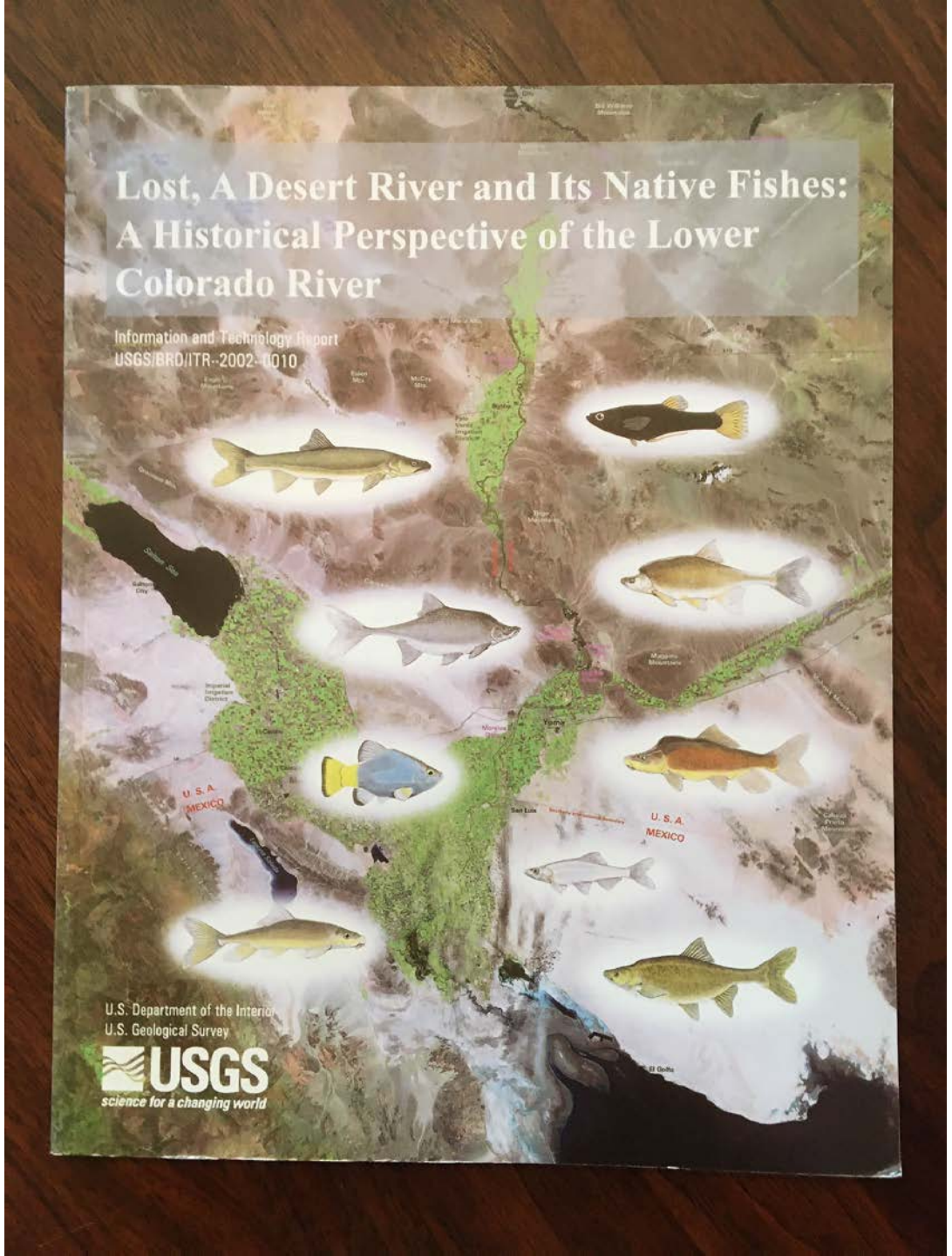


Lost, A Desert River and Its Native Fishes:

A Historical Perspective of the Lower Colorado River

By Gordon Mueller and Paul Marsh

Revisited & Expanded

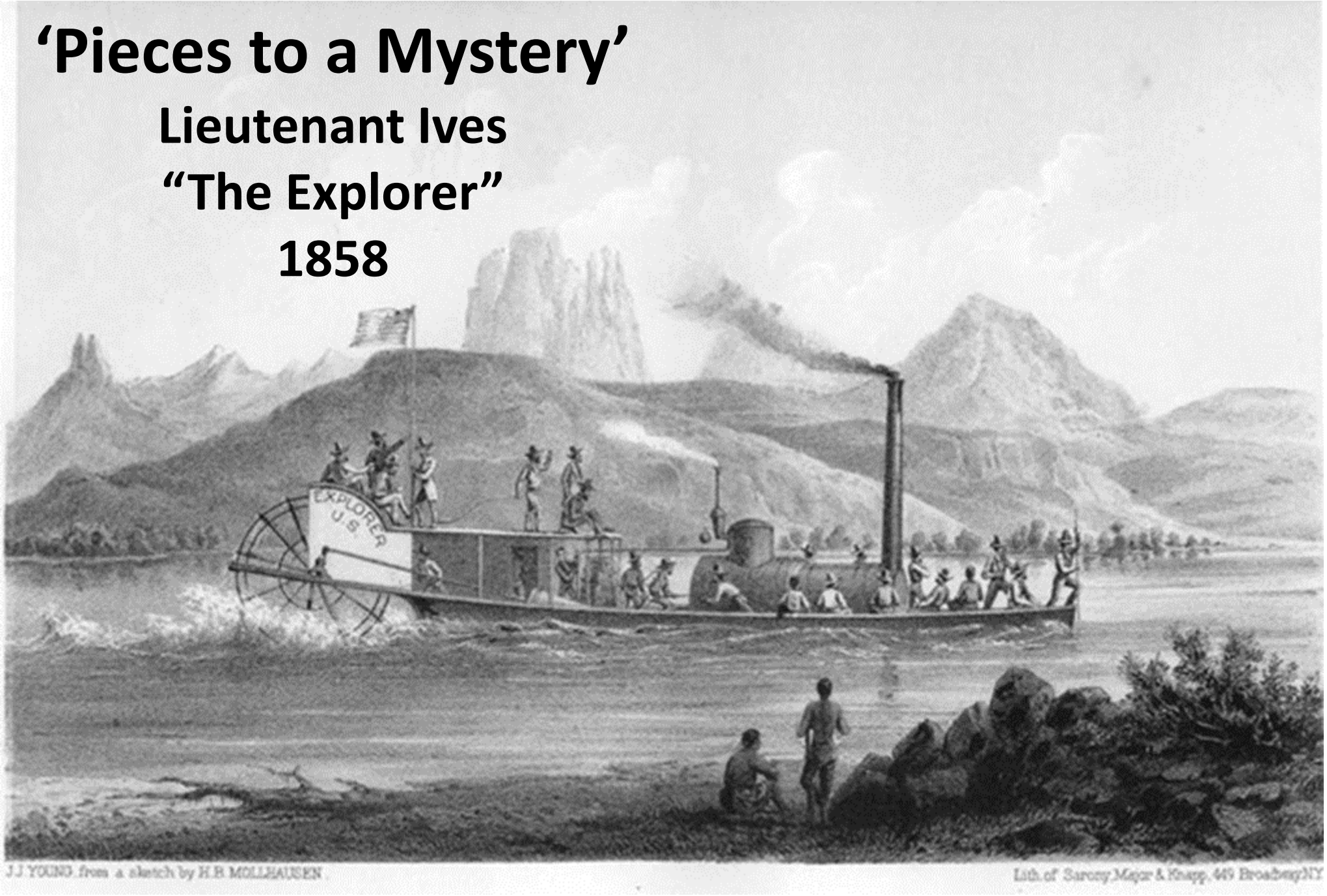
By Gordon Mueller, USGS Retired

Delta and Colorado River Channel, Mexico

What WAS the Lower Colorado River Like?

‘Pieces to a Mystery’

Lieutenant Ives
“The Explorer”
1858



Transition of the Fish Community:

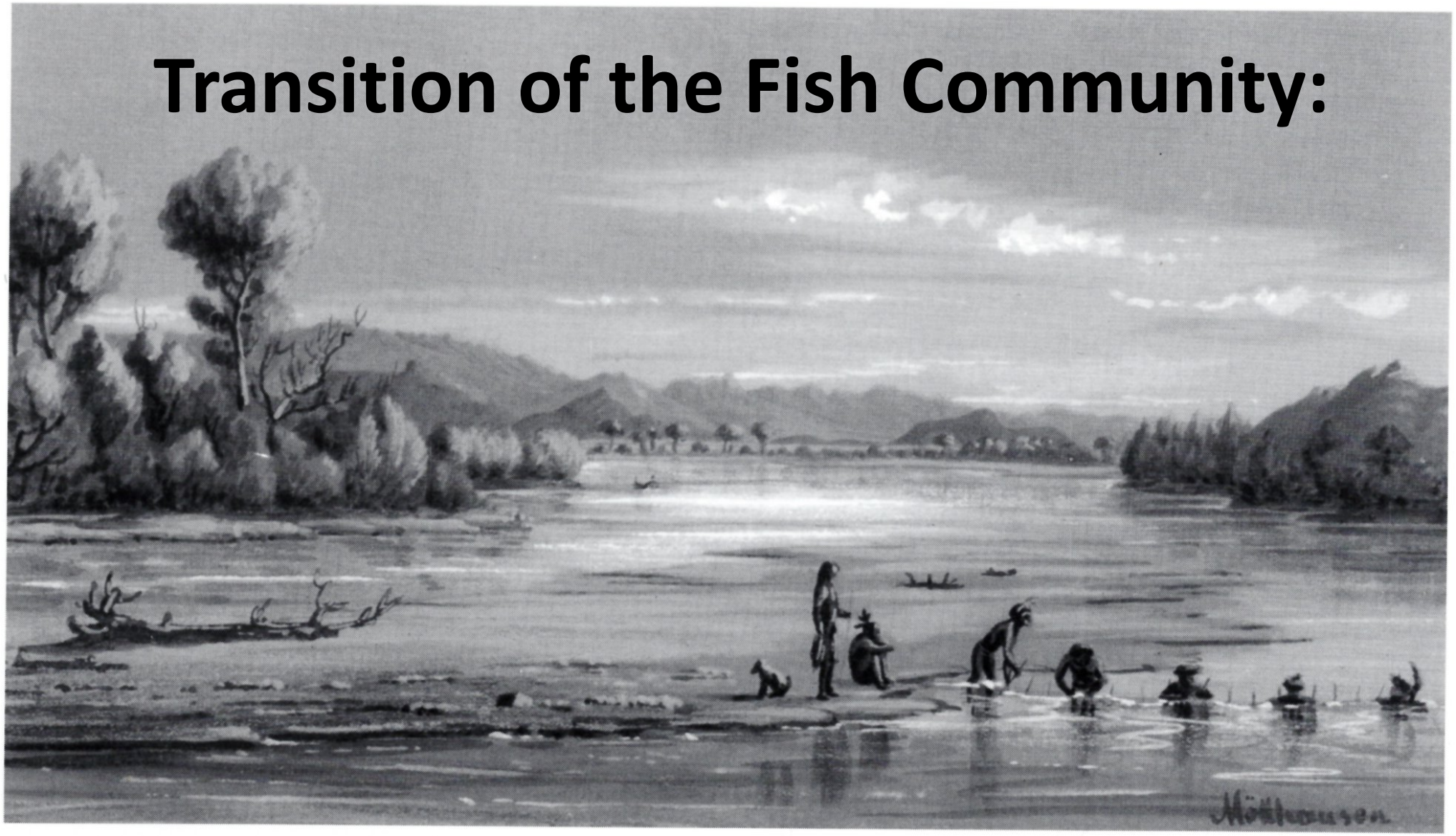
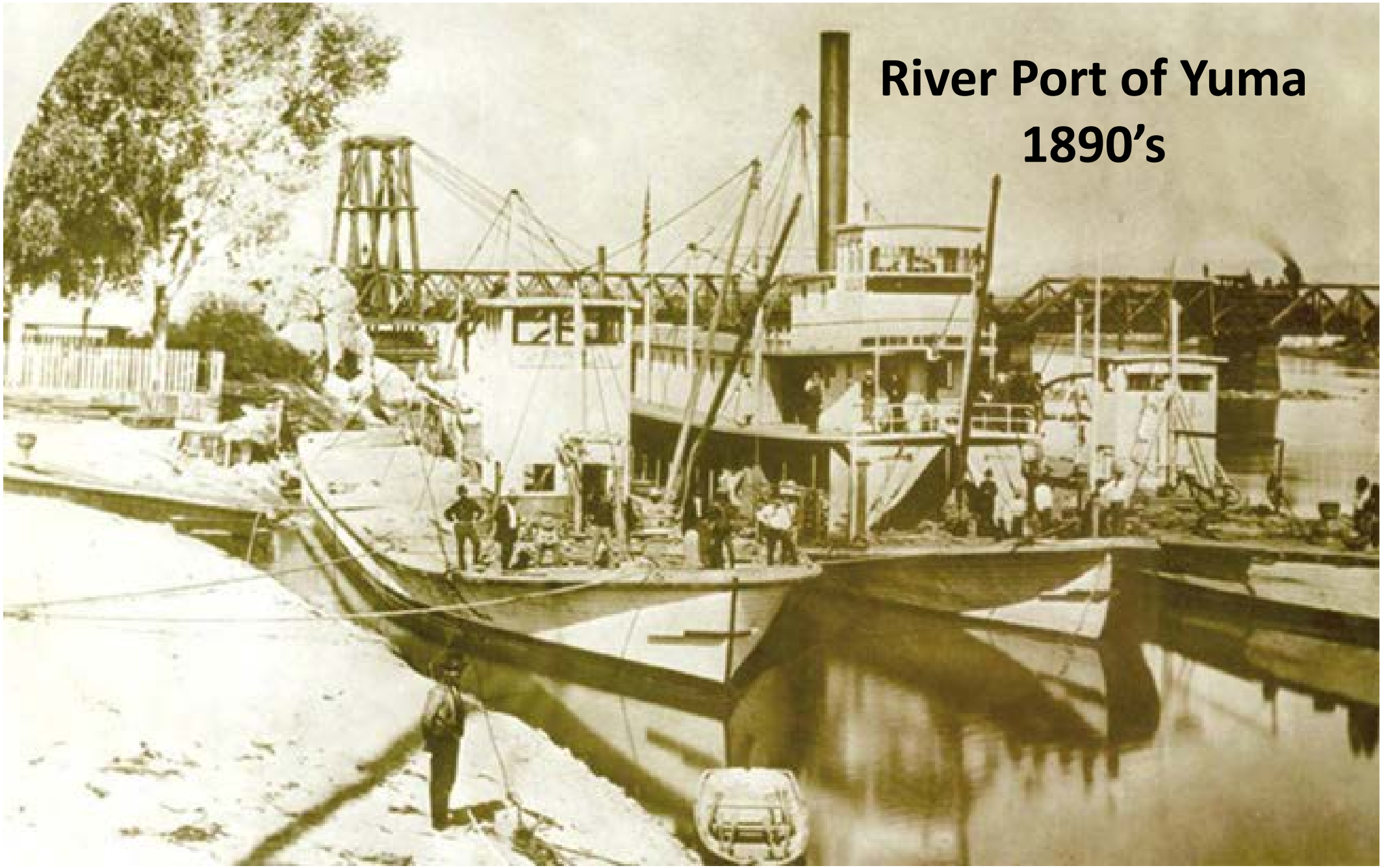
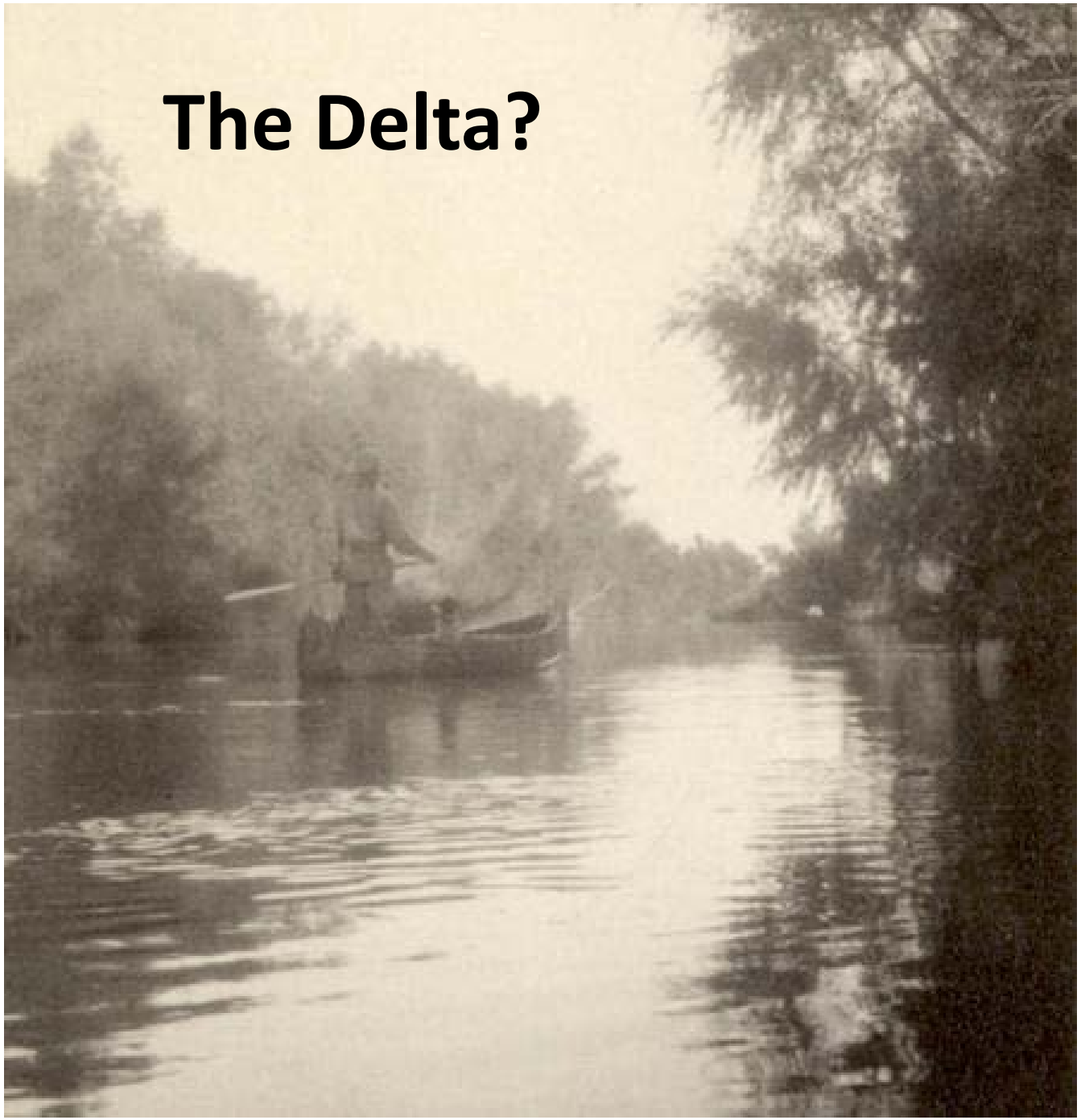


Fig. 3. Henrich Balduin Möllhausen. Cottonwood Valley, water color and gouache on paper, 1858, 1988.1.33. Courtesy of the Amon Carter Museum, Fort Worth, Texas.


River Port of Yuma
1890's

A “Ringbolt Anchor” used to help riverboats winch themselves over rapids

Fig. 15. Map showing steamboat landings on the Colorado River between 1860 and 1870. Courtesy of R.E. Lingenfelter (1978).

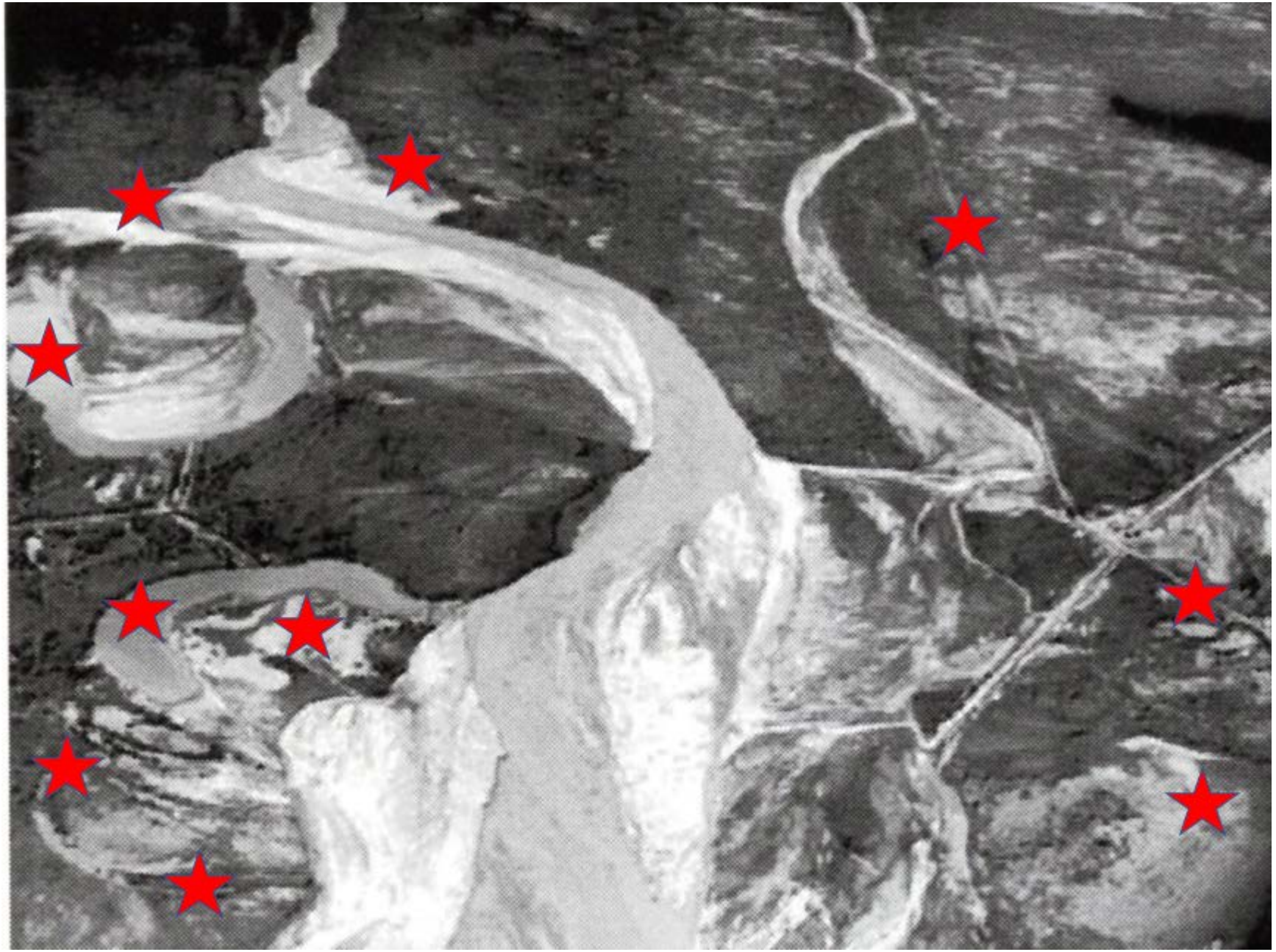


Paddling the delta in 1922, naturalist Aldo Leopold was entranced by the flourishing world beyond the tip of his canoe. “Verdant walls of mesquite and willow . . . a hundred green lagoons,” he wrote. “The river was everywhere and nowhere.”

The Delta was Immense

Colorado Delta
August 15, 1933
Summer Flows

The Delta was their critical habitat; the nucleus of their population; it was where populations could *RECOVER to repopulate the river*.
W.L. Minckley



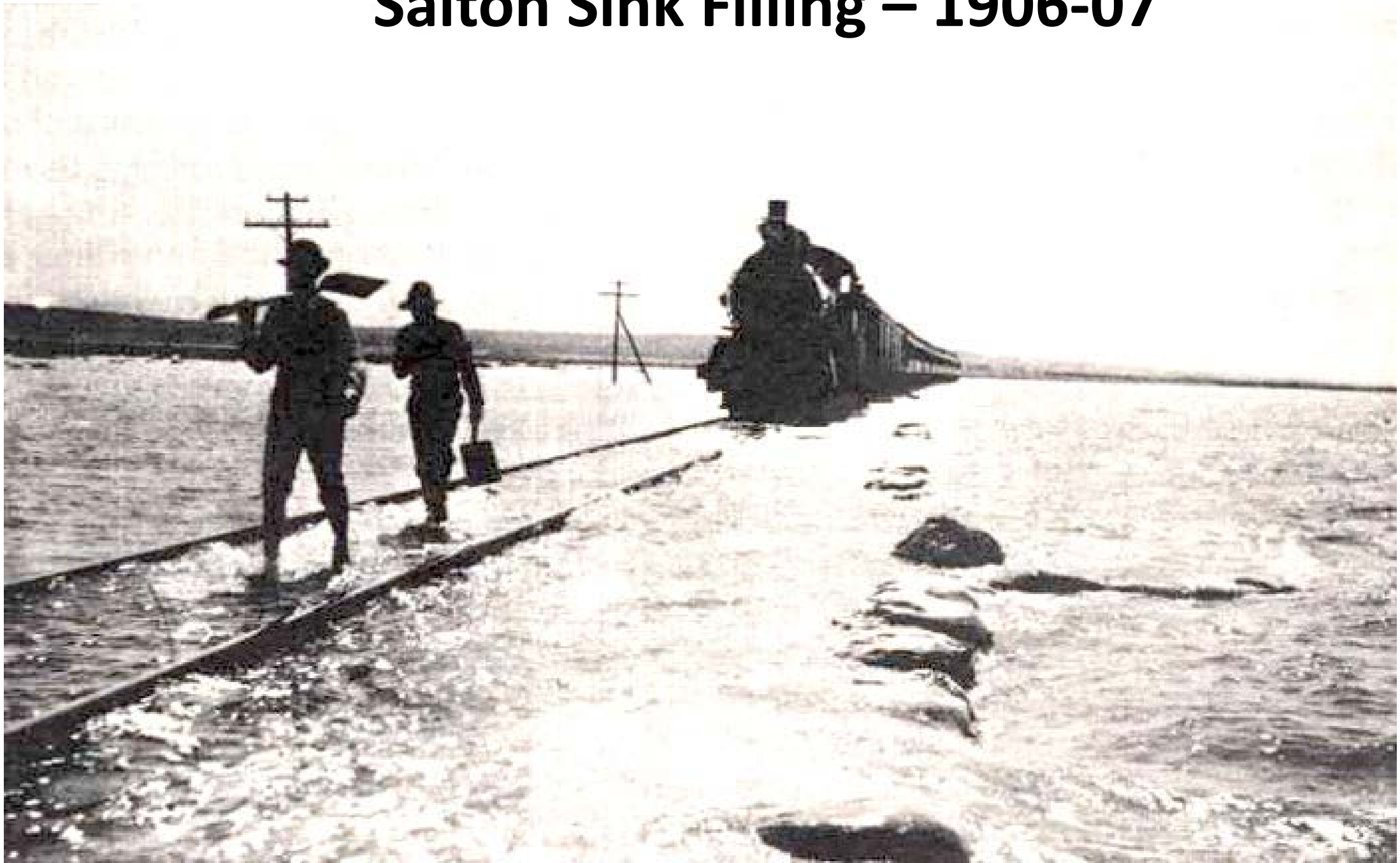
1906-07 Colorado River's Cut to Salton Sea

Newly created "New River"

Where Colorado cut through

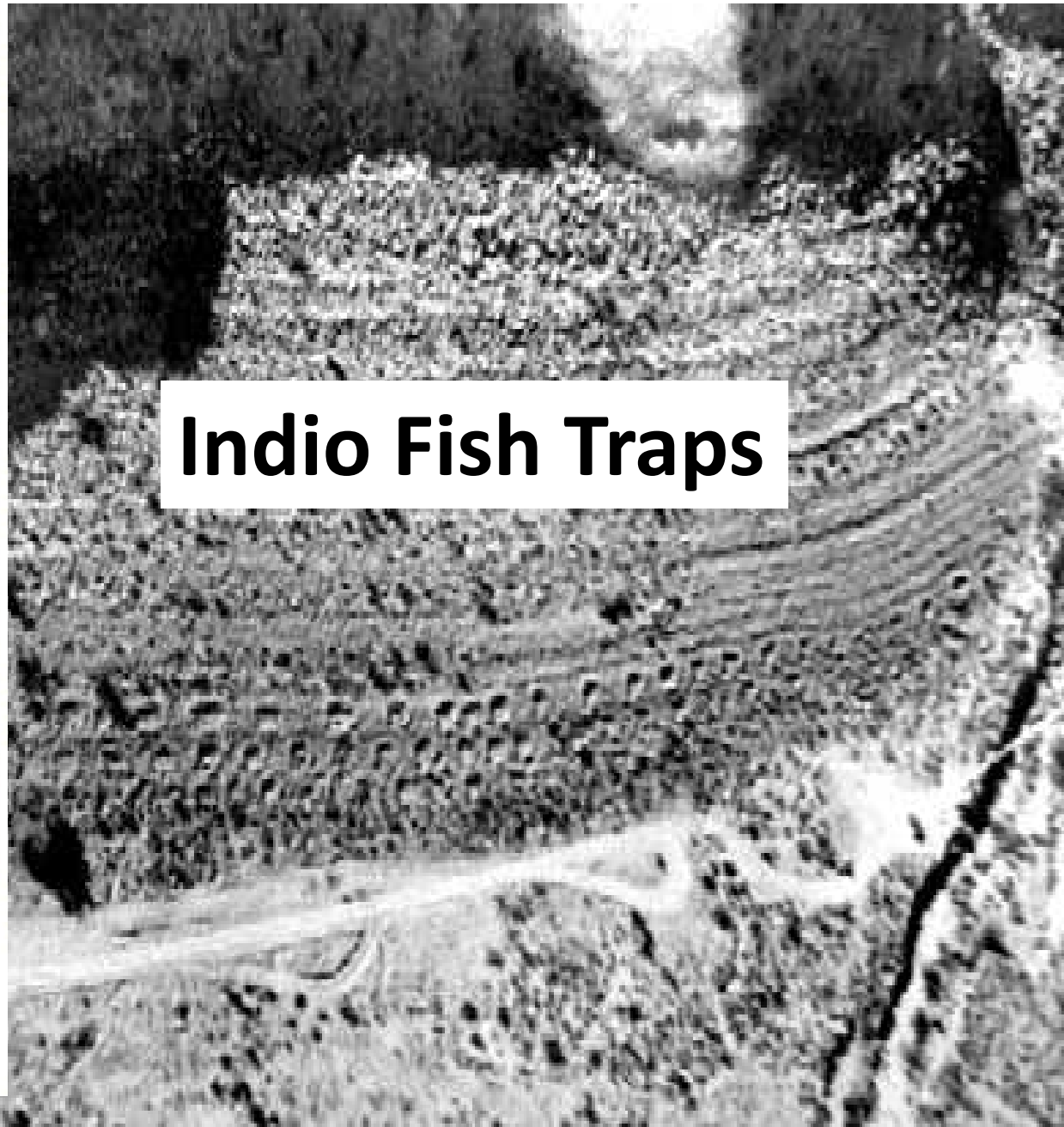
Salton Sink Salt Mining

Salton Sink Filling – 1906-07



Colorado River's Largest Ephemeral Backwater

Fig. 8. Photograph of an ancient rock fish trap located near the Salton Sea, California. Photo courtesy of Eric White, Bureau of Reclamation.



Further Upstream

From one extreme to another

Fig. 12. Gila River flooding around 1900. Courtesy of the Bureau of Reclamation, Boulder City, Nevada.

High Water Line (1874) was over 2 miles wide.

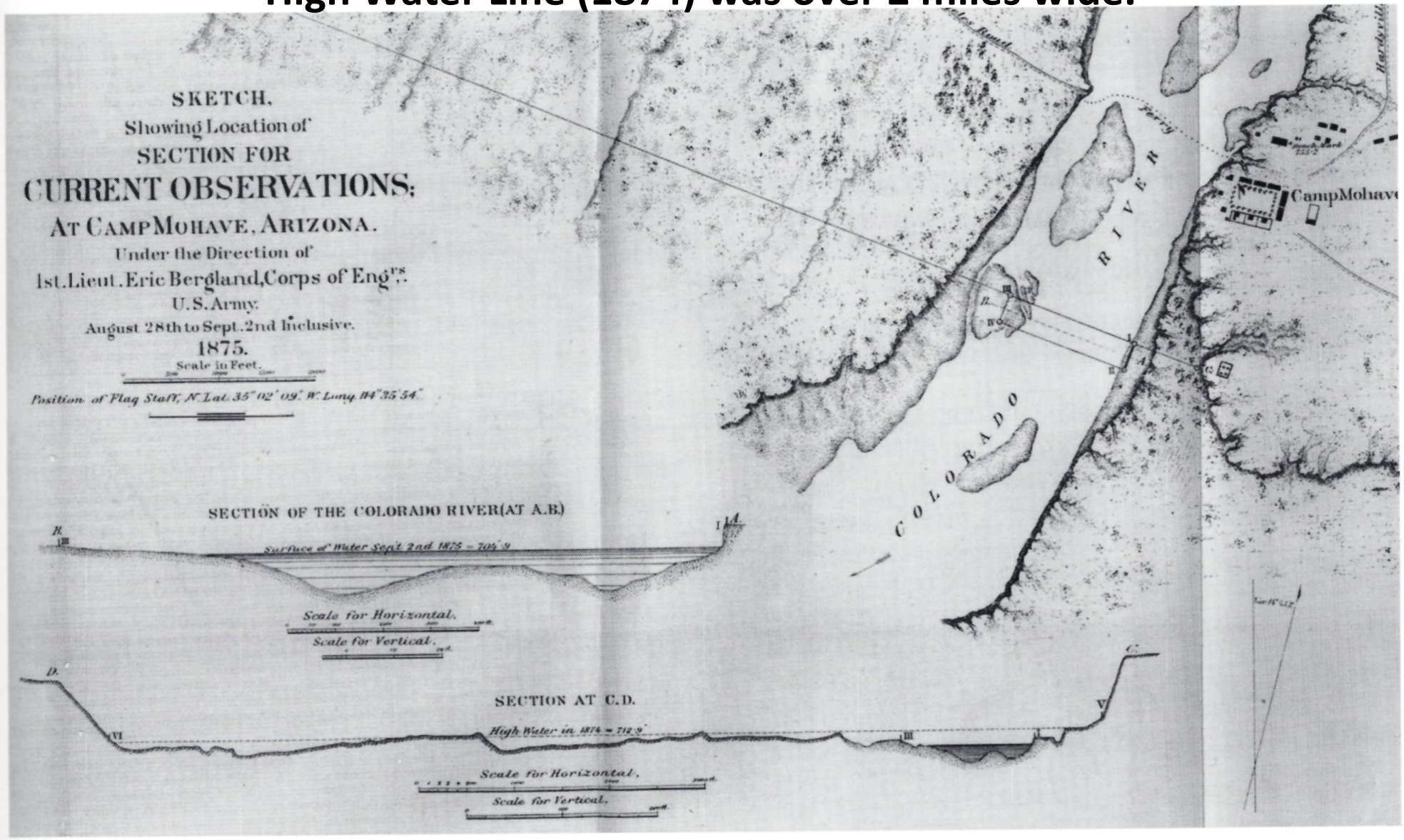


Fig. 9. Survey map of the Colorado River near Fort Mohave, Arizona Territory, drawn by First Lieutenant Eric Bergland, Corps of Engineers (Wheeler, 1876).

Wheeler Expedition 1875

Bullhead City Today

Kolb floated the river during the winter of 1912. Exiting the Iceberg Canyon he wrote: "The river seemed to be growing smaller as we got out in the open country. Like all Western rivers, when unprotected by canyon, it is sinking in the sand. Sandbars impeded our progress at such places at the mouth of the (Las Vegas) wash where we had to drag our boat."

Canyon Reaches

Imagine Canyon Scour: @ 80,000, 150,000 or 400,000 cfs

Lava Falls @ 40,000

Europeans Leave Their Mark
Department of Commerce
National Fish Hatchery System
Carp, Catfish, Bullheads, American Shad – 1880s

Physical Impacts Begin - Laguna Dam 1909

Upstream Migratory Route Severed

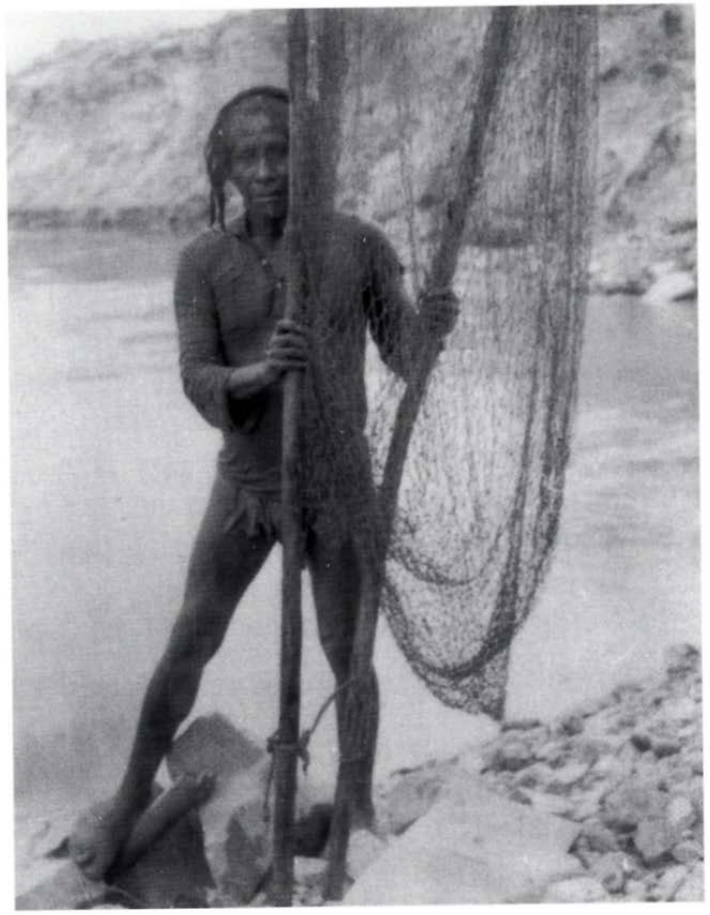
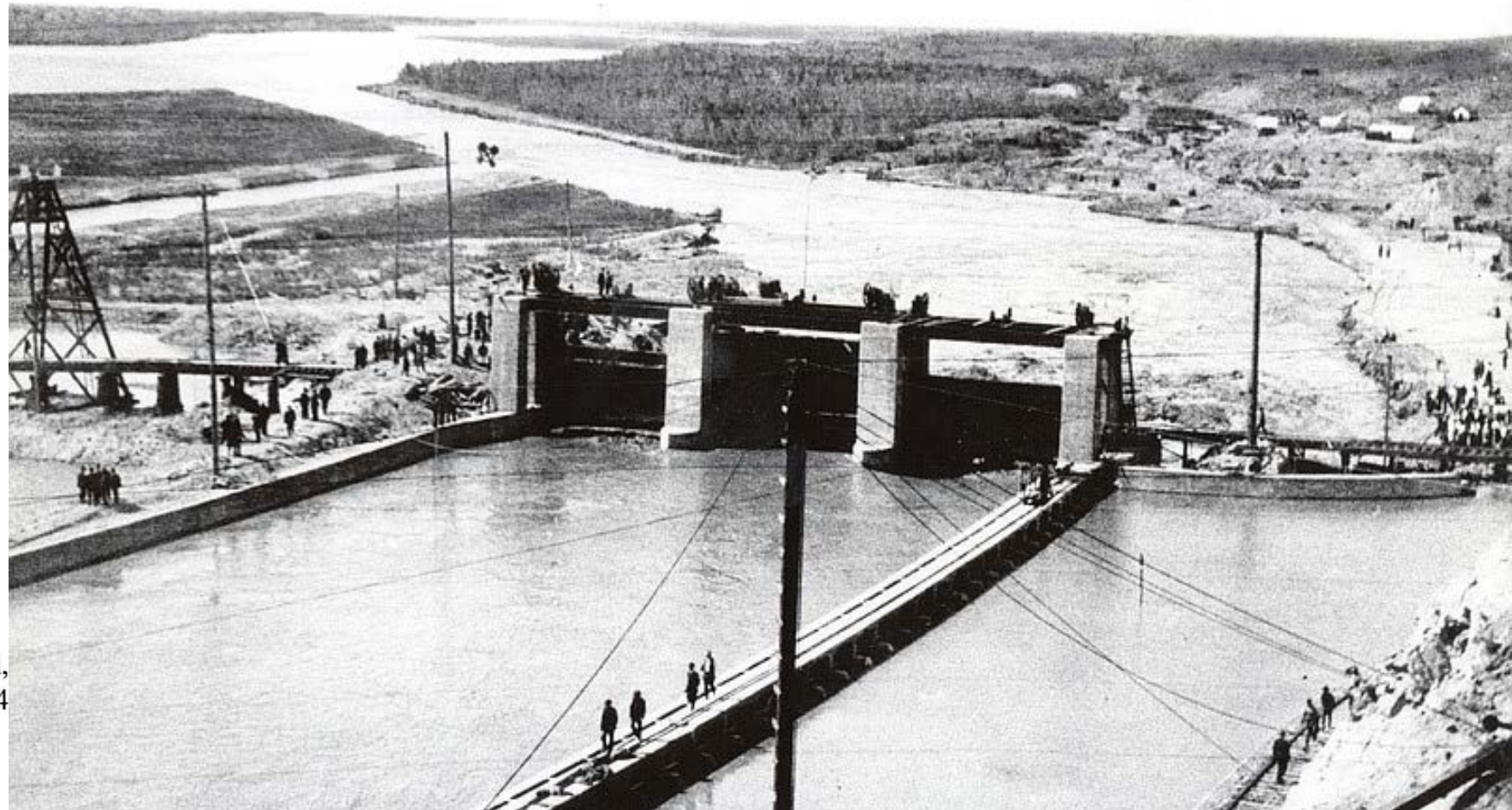
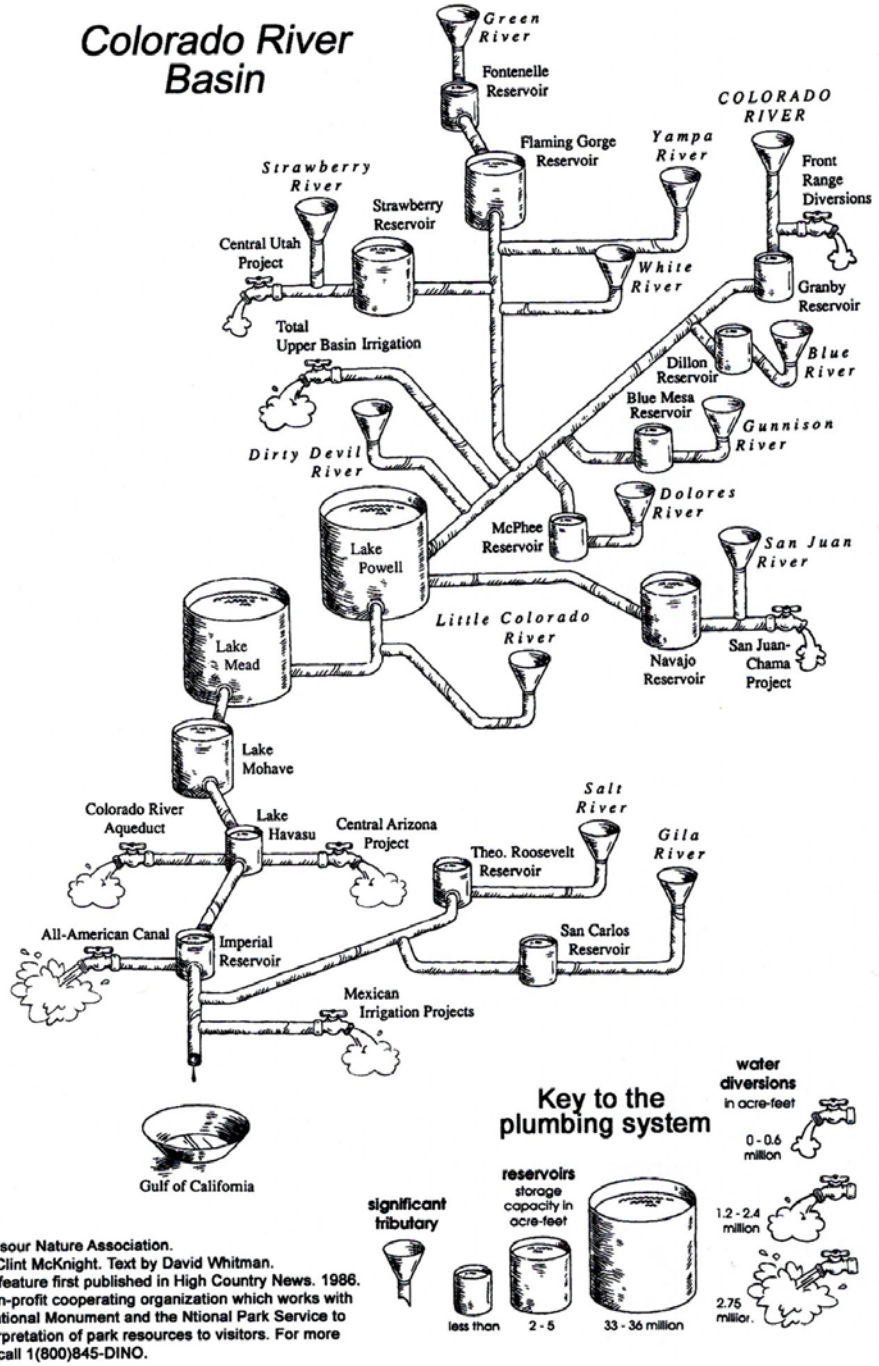


Fig. 65. Native American netting fish in the Imperial Canal, August 16, 1907. National Archives Photo 115-JAJ-324 Imp. National Archives, Washington, D.C.

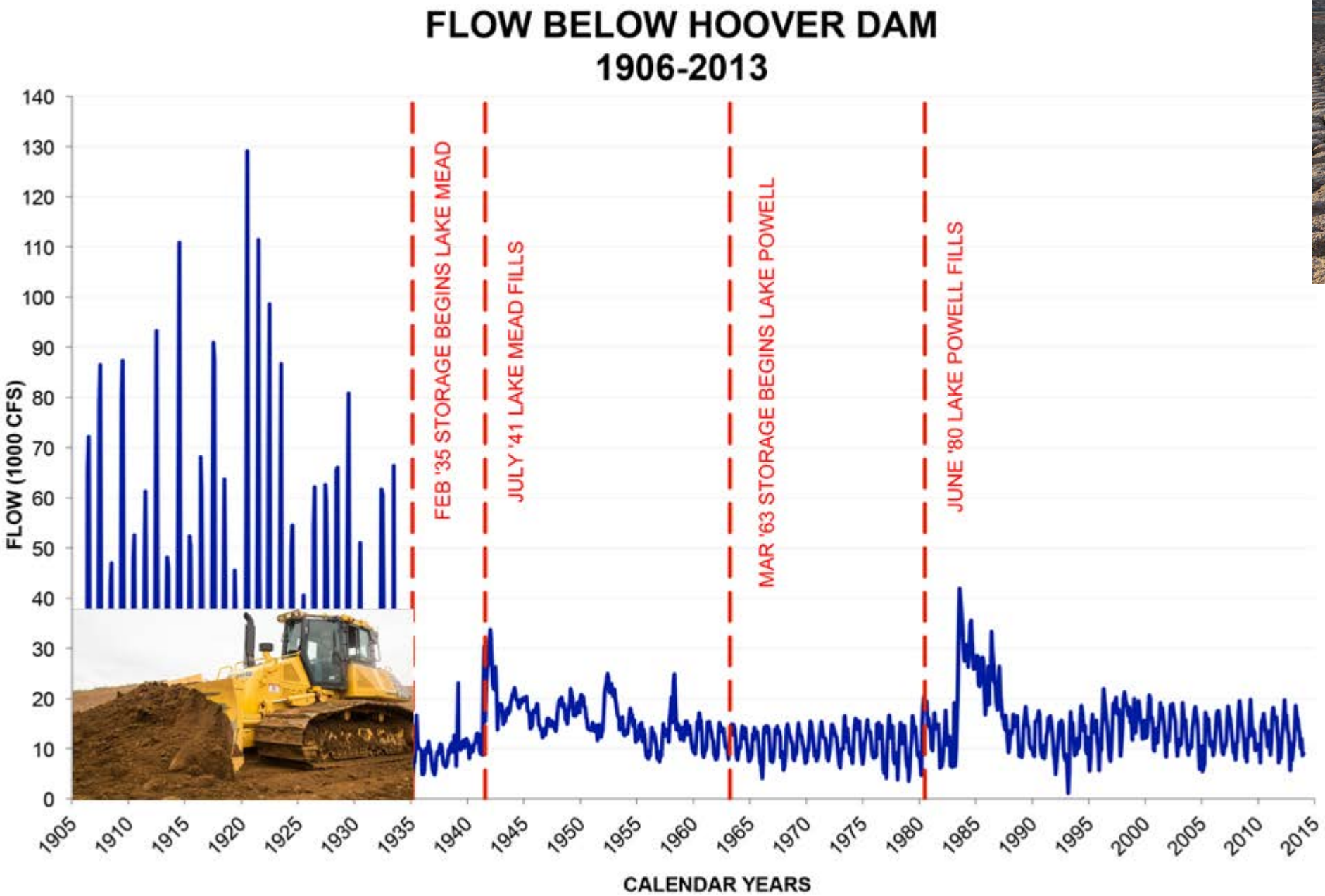


Competition for WATER

Who's Top Dog In the Basin?
WE ARE!



Maintenance Flows Gone!

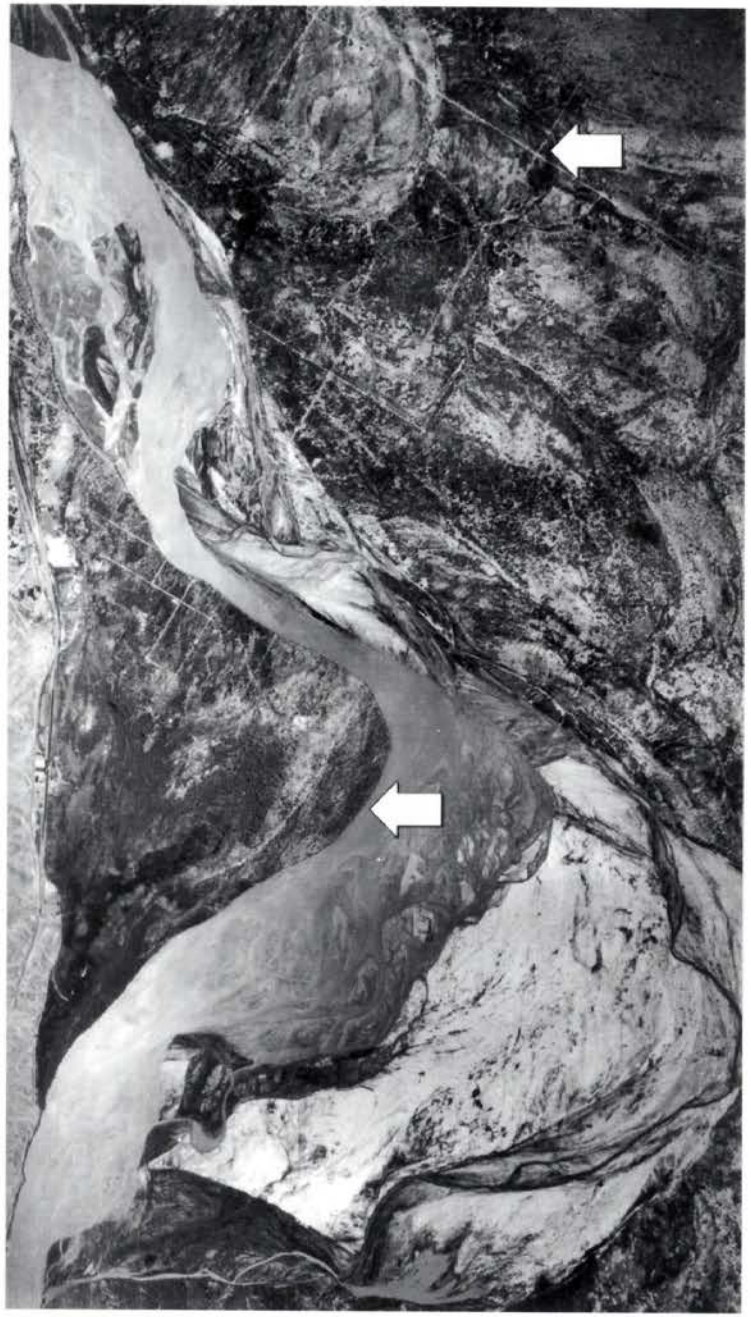


Mechanical Dredging & Levees

Flood Prevention
Water Delivery

Hundreds,
Thousands,
Tens of Thousands
Of Nursery Acres

Lost!



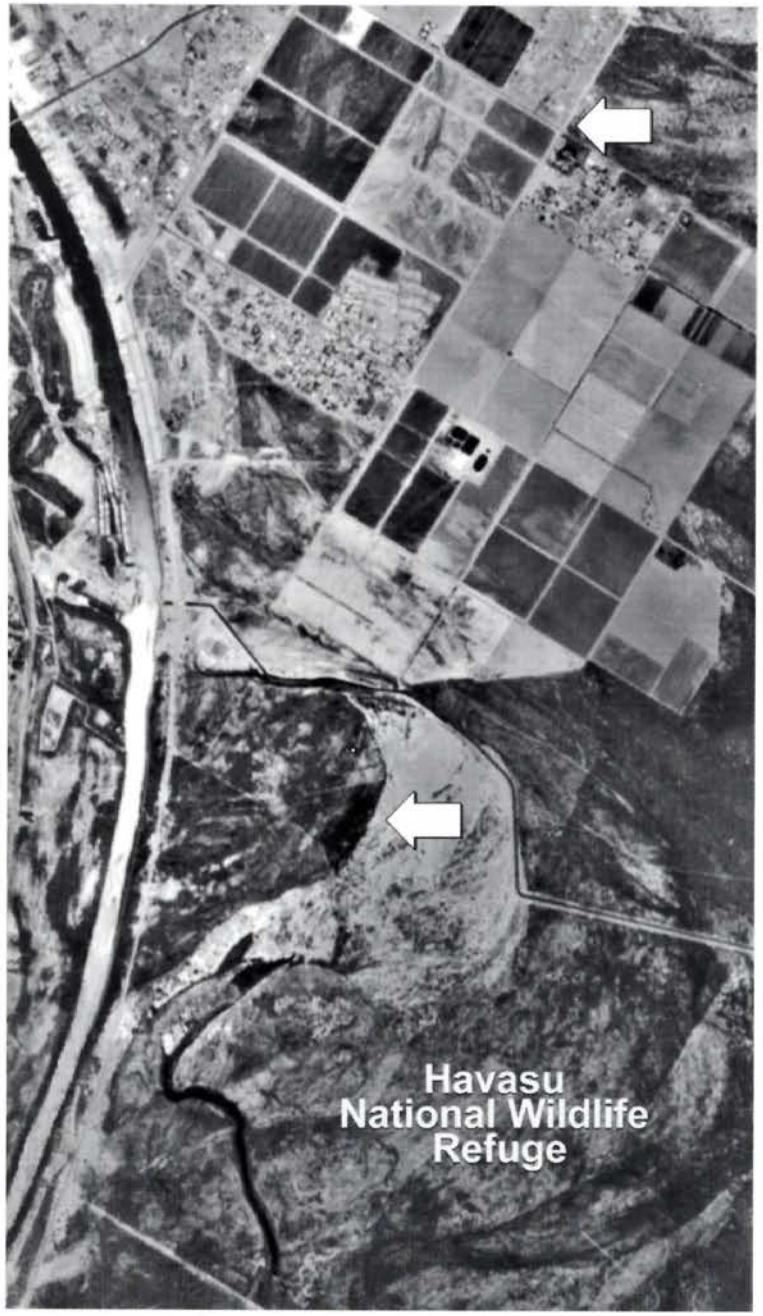


Fig. 33. Aerial photographs of the Colorado River channel just downstream of Needles, California taken in 1938 and 2000. 1938 photograph courtesy of the Bureau of Reclamation, Boulder City, Nevada.

Vegetative Channelization = Loss of high magnitude floods, associated river scour and invasive plants.

Fig. 67. Cowboy posed with a Colorado pikeminnow on a cane pole. Courtesy of the Arizona Collection, Arizona State University Libraries.

Fig. 68. National Park Service Junior Naturalist Bert Long, holding a 25 1/2 inch-long Colorado pikeminnow taken from Lake Mead on April 22, 1940. Courtesy of the National Park Service, Lake Mead National Recreation Area.

Fig. 69. Photograph entitled "Netting carp in Lake Mead." The fish are mostly large razorback suckers, NAU.PH.96.4.175.34. Courtesy of the Cline Library, Northern Arizona University, Flagstaff.

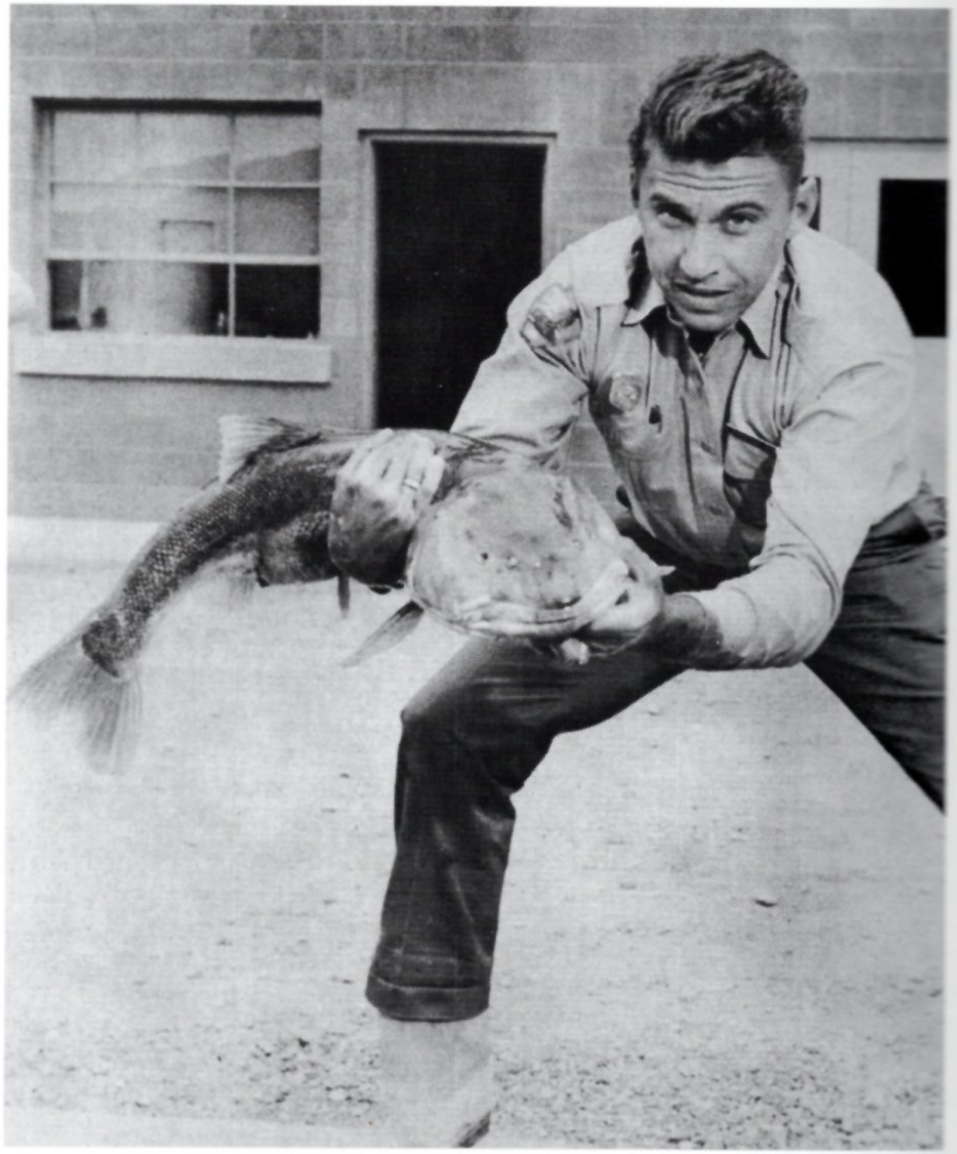


Fig. 72. Last Colorado pikeminnow captured in Lake Mohave, November 13, 1962. Courtesy of Jim Sleznick.

Fig. 70. A day's catch of largemouth bass from Lake Mead (1947), NAU.PH.96.4.175.32. Photograph courtesy of the Cline Library, University of Northern Arizona, Flagstaff.

Table 6. Chronology of fish introductions or capture in the Lower Colorado River Basin to 1975.

Species	Location	Source[a]	Year
Common carp	Lower River	C	1881
American shad	Needles, California	S	1884
Channel catfish	Lower River	S	1892
Yellow bullhead	Lower River	S	1899
Cutthroat trout, Rainbow trout	Lower River	S	Pre-1900
Black bullhead	Lower River	C	1904
Brown bullhead	Topock	C	1910
Brook trout	Grand Canyon	S	1920
Mosquitofish	Nevada	C	1922
Brown trout	Grand Canyon	S	1924
White crappie	Lower River	C	1934
Black crappie, Largemouth bass	Lower River	S	1935
Bluegill, Green sunfish	Lake Mead	S	1937
Smallmouth bass	Lower River	C	1940's
Goldfish	Lower River	B	1944
Fathead minnow	Grand Canyon	B	1950's
Banded cichlid	Lake Mead	C	1950's
Guppy, Mexican tetra, Sailfin molly, Shortfin molly, Green swordtail, Southern platyfish	Lower River	C	1950
Redside shiner, Leatherside chub, Utah sucker Rio Grande chub, Rio Grande sucker	Lower River	B	1950
Dusky mountain sucker	Lake Mead	B	1950
Sacramento hitch	Lake Havasu	B	1950
Rio Grande killifish, Longjaw mudsucker	Lower River	B	1950
Mottled sculpin	Lake Mead	B	1950
Utah chub	Lake Mohave	B	1951
Redear sunfish	Lower River	C	1951
White River spinedace, Yellow perch	Lower River	B	1951
California killifish	Yuma	B	1951
Golden shiner, Red shiner	Lower River	B	1953
Threadfin shad	Lake Mead	S	1953
Warmouth	Lower River	C	1958
Striped bass	Lower River	S	1959
Blue catfish, Mozambique mouthbrooder	Lower River	S	1960's
Zilli tilapia	Lower River	C	1960's
Flathead catfish	Martinez Lake	S	1962
Sockeye salmon	Lake Mohave	S	1962
White catfish	Lower River	S	1963
White sturgeon	Lake Havasu	S	1967
Coho salmon	Lake Mead	S	1966
Rainbow trout	Lake Mead	S	1969
Walking catfish	Rodgers Spring	C	1970
Walleye	Lake Mead	C	1971
Freshwater eel	Lake Mead	C	1972
Cutthroat trout	Lake Mead	S	1972
Cuttbow trout	Lake Mead	S	1975

[a]S = stocked; C = collected; B = sold as live bait (U.S. Fish and Wildlife Service, 1980).

“There’s a Whole Lot more to these fish than body and habitat metrics”

Their ability to cope with environmental pressure:

Behavior/ Performance/Survival Skills

‘Replica of a Delta Oxbow Refugium?’

Cibola High Levee Pond

Greater Appreciation of Their Adaptability
Longevity & Spawning Capabilities Reflect a Harsh Environment

Spawning: They are all broadcast spawners, broadcasting their eggs over scoured (or fanned) gravel/cobble. (They could count on river scour.)

Razorback: River flows, backwaters, reservoirs, oxbows, rearing ponds,
Bonytail: Oxbows, reservoirs, **LINED REARING PONDS**, ***'Animal trail'***
Humpback chub: Canyon slack water, **FIBERGLASS TANK**,
Colorado Pikeminnow: River runs.

Spawning Period (including Delta):		**Longevity:**
Razorbacks:	November? – June	50 yrs.
Bonytail:	April? – July	50 yrs.
Humpback chub:	April? – July	30 yrs.
Colorado Pikeminnow:	May?-July	30 yrs.

Why is Genetic Diversity Important?

Genetic diversity serves as the mechanism for populations to **ADAPT** to environmental change, generally through genetic mutation.

Three Types of Environmental Adaptations

- Structural Adaptations. A structural adaptation is a change involving a physical aspect of an organism. ...
- Behavioral Adaptations. A behavioral adaptation is a change affecting the way an organism naturally acts. ...
- Physiological Adaptation. A chemical or bodily function adaptation.

Dorsal ‘Keel’ Structural Adaptation ‘Swallowing Hinderance’ Billabong?

Behavioral and Structural Adaptation

Flamarique, I. Novales; Mueller, G.A.; Cheng, C.L.; Figiel, C.R. (2006). "Communication using eye roll reflective signalling". Proceedings of the Royal Society B: Biological Sciences. ***274*** *(1611): 877–82.*

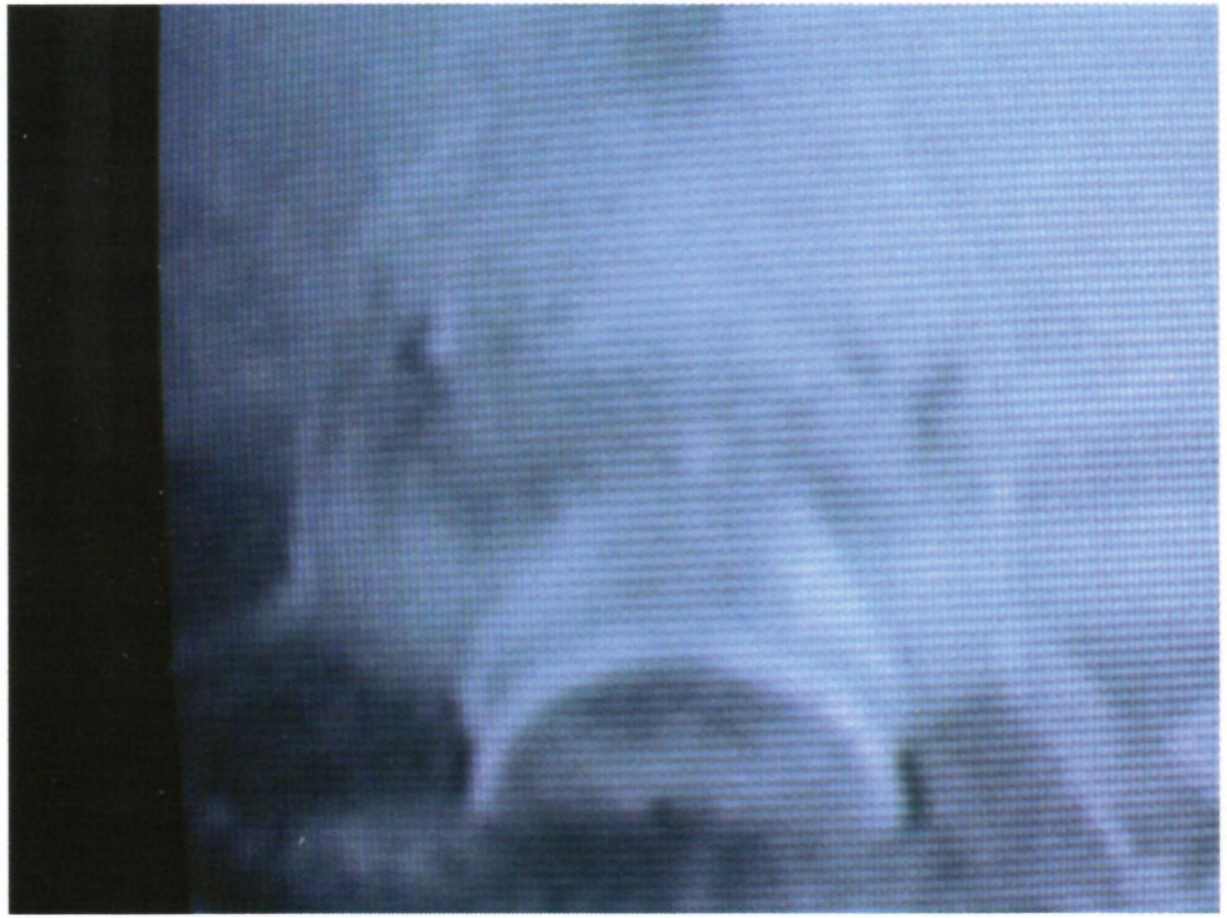


Fig. 53. Photograph showing a spawning razorback sucker resting on the bottom of Cibola High Levee Pond.

Fig. 54. A frame grab of the same fish exhibiting the "blinking" phenomenon, where fish roll their eyes to reveal the highly reflective interlining of the eyes. This behavior is believed to be a spawning or possibly a territorial display.

Behavioral Adaptation (Hereditary)

Fig. 29. Startled bonytail exhibiting a cooperative fright behavior where fish align with their heads toward the center of a tight ball and beat their tails frantically. Hatchery personnel has termed this behavior "scrumming." Photo courtesy of Chester Figiel, 2004, U.S. Fish and Wildlife Service.

Learned Behavior

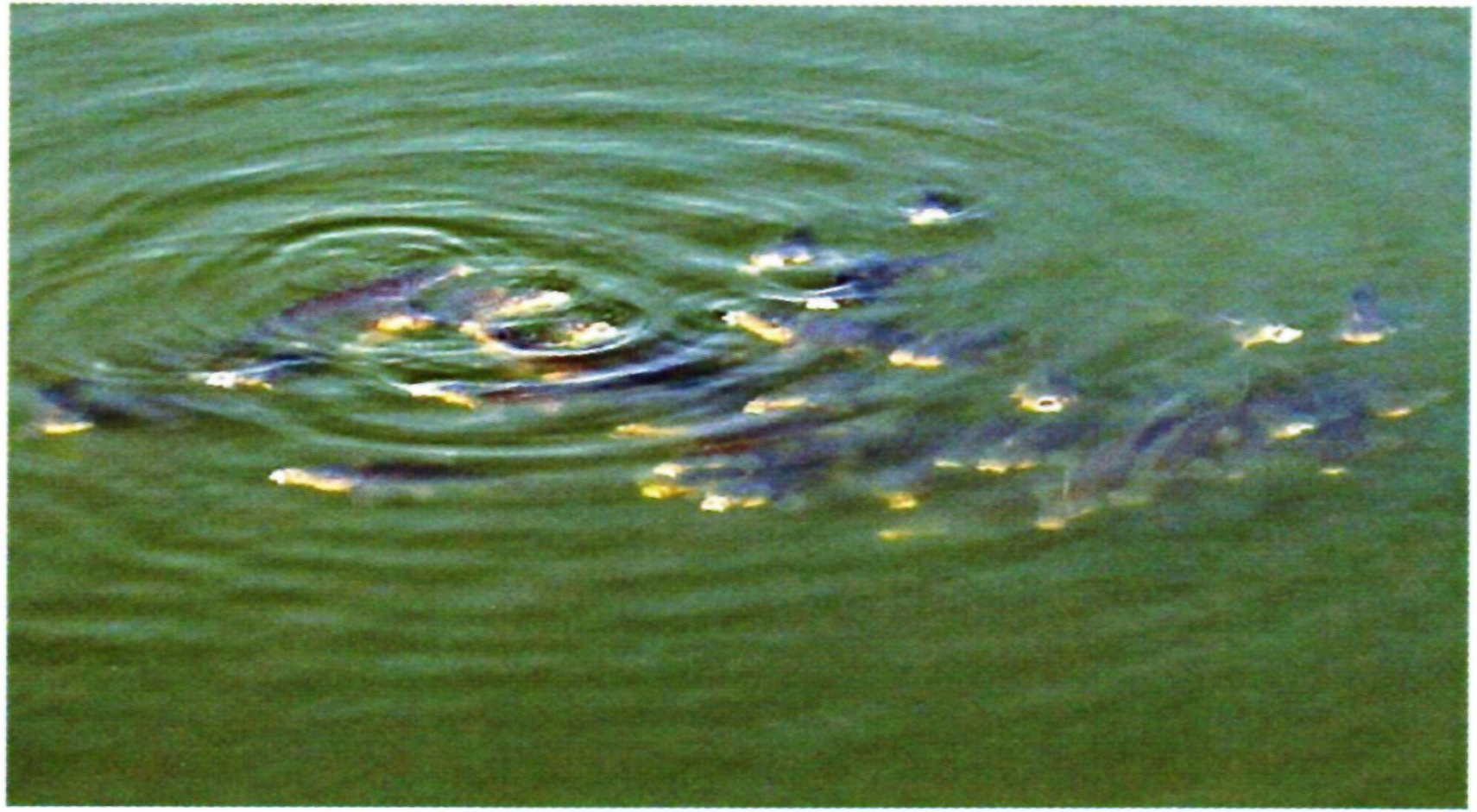


Fig. 36 A school of approximately three dozen adult razorback suckers feeding on zooplankton near the surface of CHLP, Arizona-California. Often schools would contain more than 100 fish that would swim in formation. They appeared to work in unison, forming a "wall of mouths" to herd and feed on zooplankton.

Recessive Gene?

What triggered this one?

Fig. 18. Two large (>40 cm) bonytails. The top fish is the typical coloration of a mature adult. The lower fish is a pigmentation anomaly which was observed only once at CHLP but was also reported at Dexter NFHTC, New Mexico.

Achi Hanyo

Behavioral Differences In the Fish

- Young RZB were totally predator naïve,
  - Predator avoidance is learned,
  - Schooling is essential in that process,
- Not Nocturnal: Active during daylight hours:
- STERILE monoculture makes them curious,
- No experience with cover,
- Trained to be surface feeders,
  - Little or no experience with natural foods,
- Netted ponds delays avian predator experience,
- Domestication = Poor Stocking survival
- SAME ISSUES VOICED IN SALMON RECOVERY

USGS
science for a changing world

Prepared in Cooperation with the U.S. Fish and Wildlife Service,
Willow Beach National Fish Hatchery

Preliminary Testing of the Role of Exercise and Predator Recognition for Bonytail and Razorback Sucker

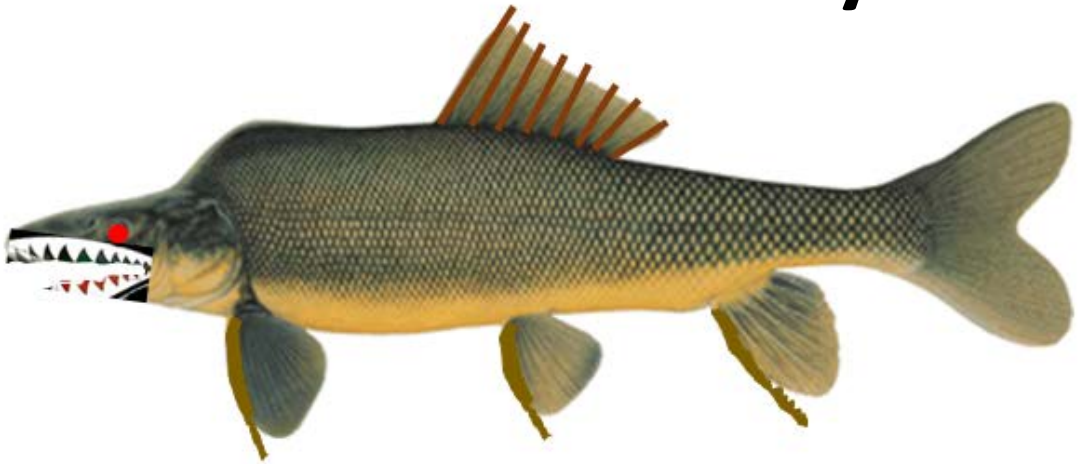
By Gordon A. Mueller and Jeanette Carpenter, U.S. Geological Survey, and Robert Krapfel and Chester Figiel, U.S. Fish and Wildlife Service

Open-File Report 2007–1423

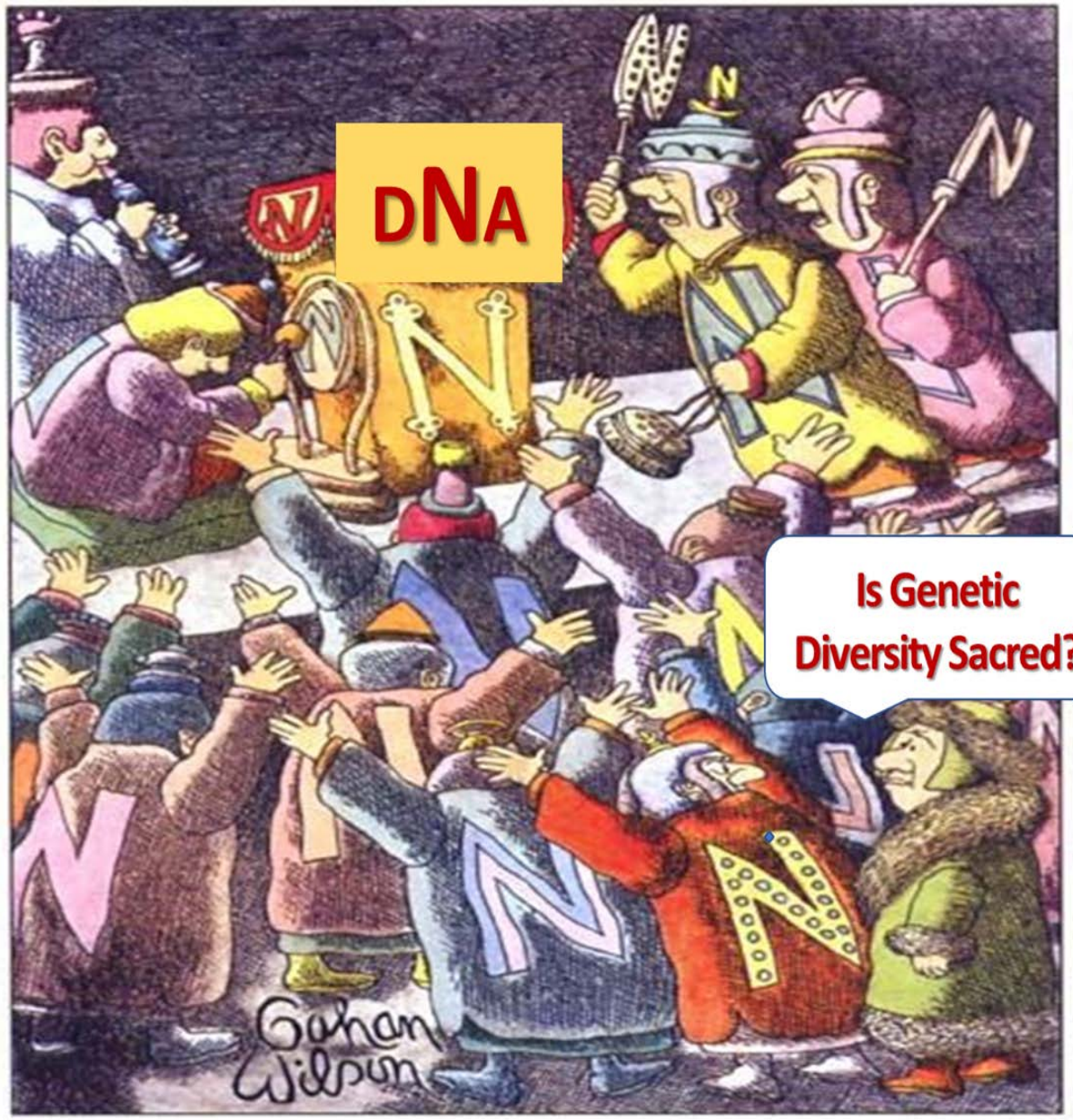
U.S. Department of the Interior
U.S. Geological Survey

Hatchery Variant

Where Are We Today?



Lake Mead Variant



HABITAT OR BEHAVIOR?

Young carp and flannelmouths must hide better!

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, Gordon Mueller

BioScience, Volume 53, Issue 3, March 2003, Pages 219–234,

USGS
science for a changing world

Ecology of Bonytail and Razorback Sucker and the Role of Off-Channel Habitats in Their Recovery

Scientific Investigations Report 2006-5065

U.S. Department of the Interior
U.S. Geological Survey

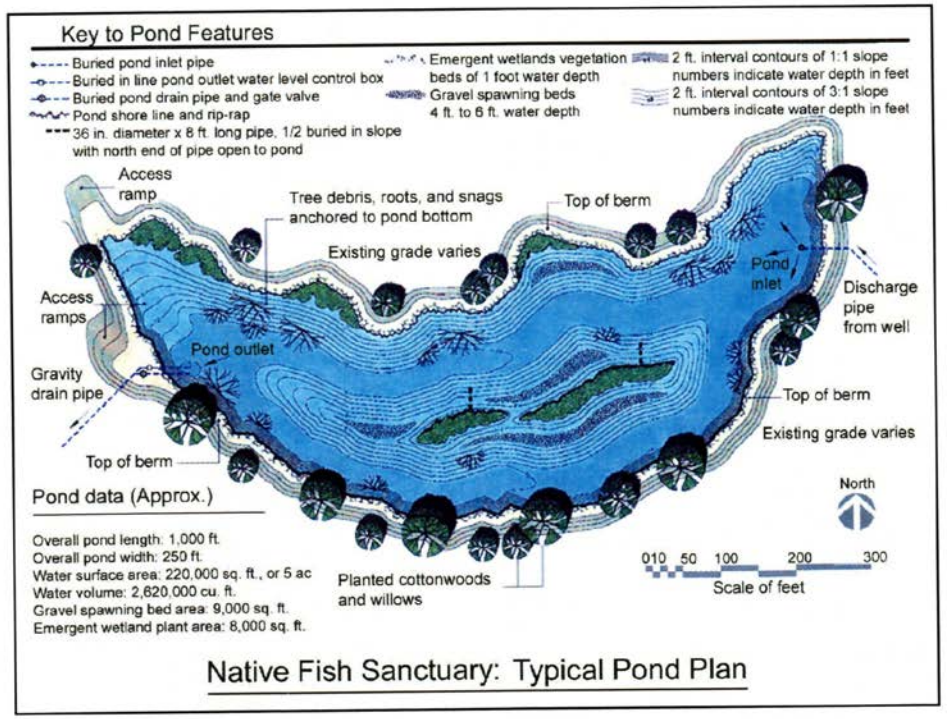
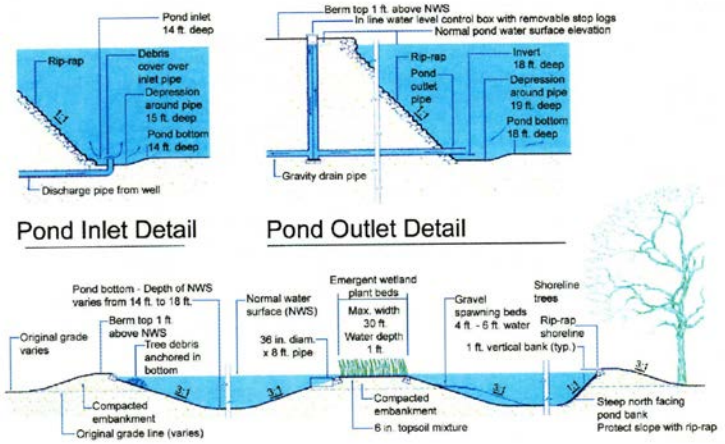


Fig. 82. Landscape illustration (surface, top down) of a native fish sanctuary designed to mimic features found at Cibola High Levee Pond and other natural oxbow habitats. The facility would contain spawning bars, vegetative and brush cover, and submergent, emergent, and riparian vegetation.



The End?