

The future of the fishes of the Colorado River and it's tributaries

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Colorado River Basin

“Our nation’s most
endangered river” (2013)



Colorado River Basin

4 federally listed
(ESA) endangered,
endemic fishes



Humpback Chub
Gila cypha



Bonytail
Gila elegans

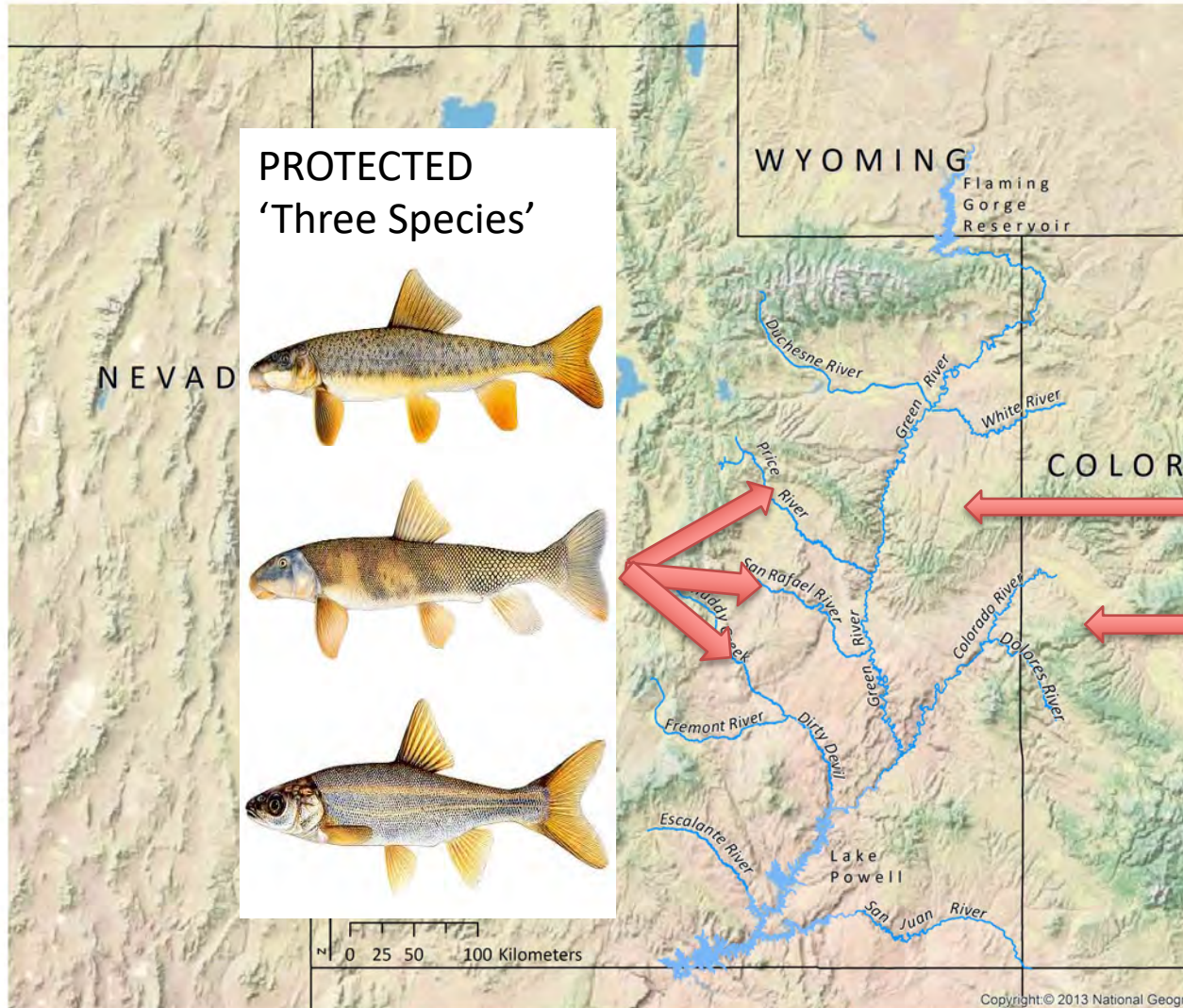


Colorado Pikeminnow
Ptychocheilus lucius



Razorback Sucker
Xyrauchen texanus

Native Fishes of the CRB



PROTECTED 'Three Species'



4 ENDANGERED Fishes of the Colorado River



Humpback Chub
Gila cypha



Bonytail
Gila elegans



Colorado Pikeminnow
Ptychocheilus lucius



Razorback Sucker
Xyrauchen texanus

Colorado River Basin



- Body morphology
- Wide physical tolerance
- Longevity
- Fecundity
- Life-history expression
- Movement
- Opportunistic feeders
- Depauperate



Future?

History: A natural landscape (fish-scape)



- diverse
- heterogeneous,
- varies in space
- it varies in time

Dynamic



Monsoon desert flood



Connected



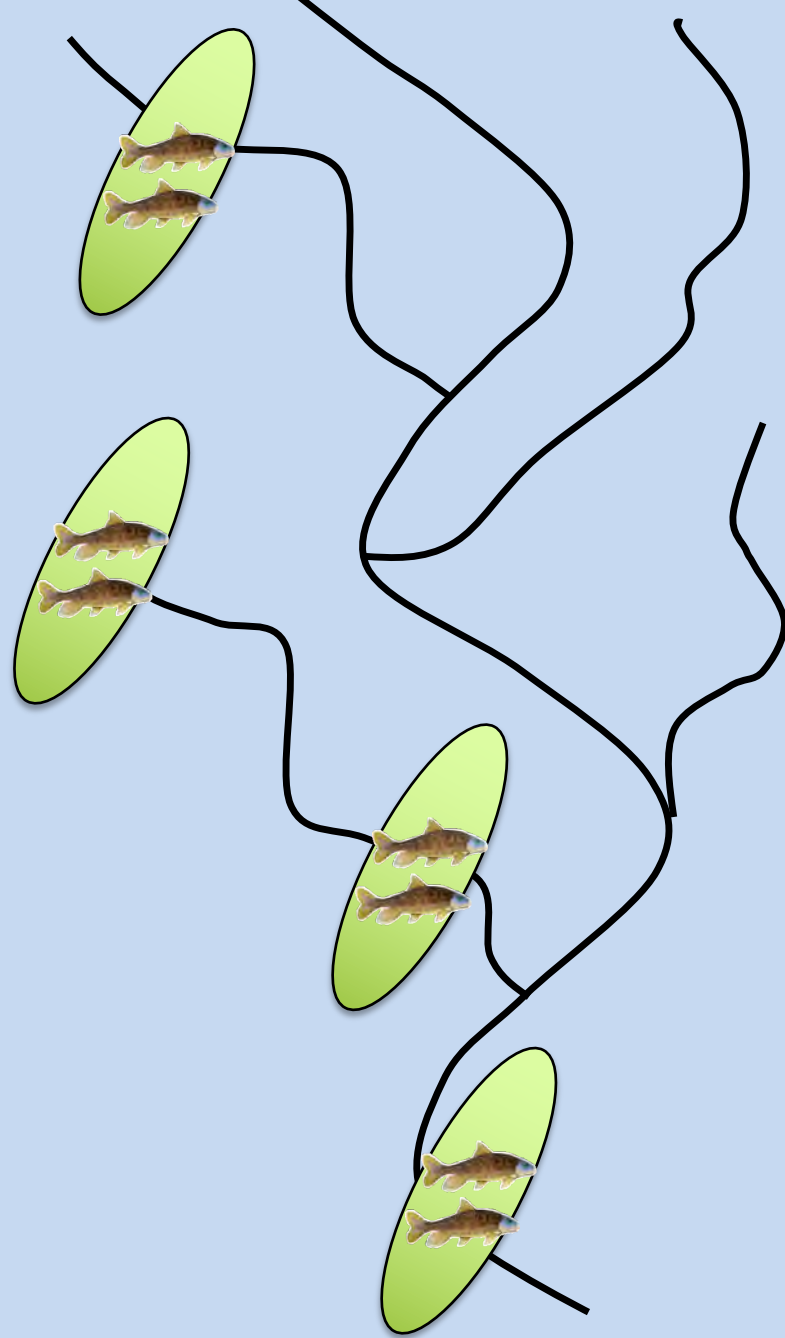
- Complementary habitat types
- Movement among patchily distributed resources
- Re-colonization after local extinction
- *Genes to individuals to meta-populations*



Robust Metapopulation Structure



Time 1



Robust Metapopulation Structure



Time 2



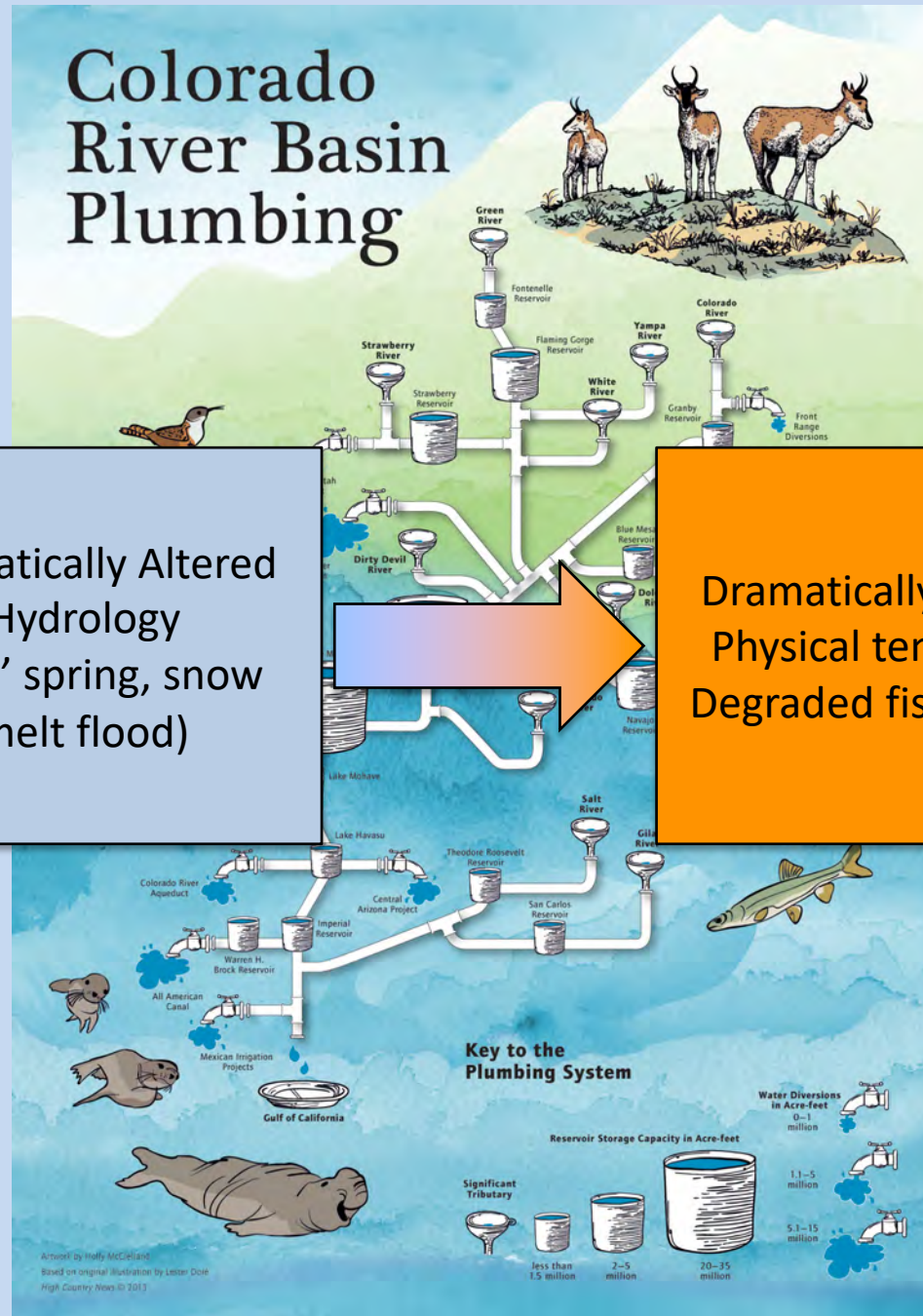
Contemporary Fishscape



Brian Healy/NPS Photo

?

Colorado River Basin Plumbing

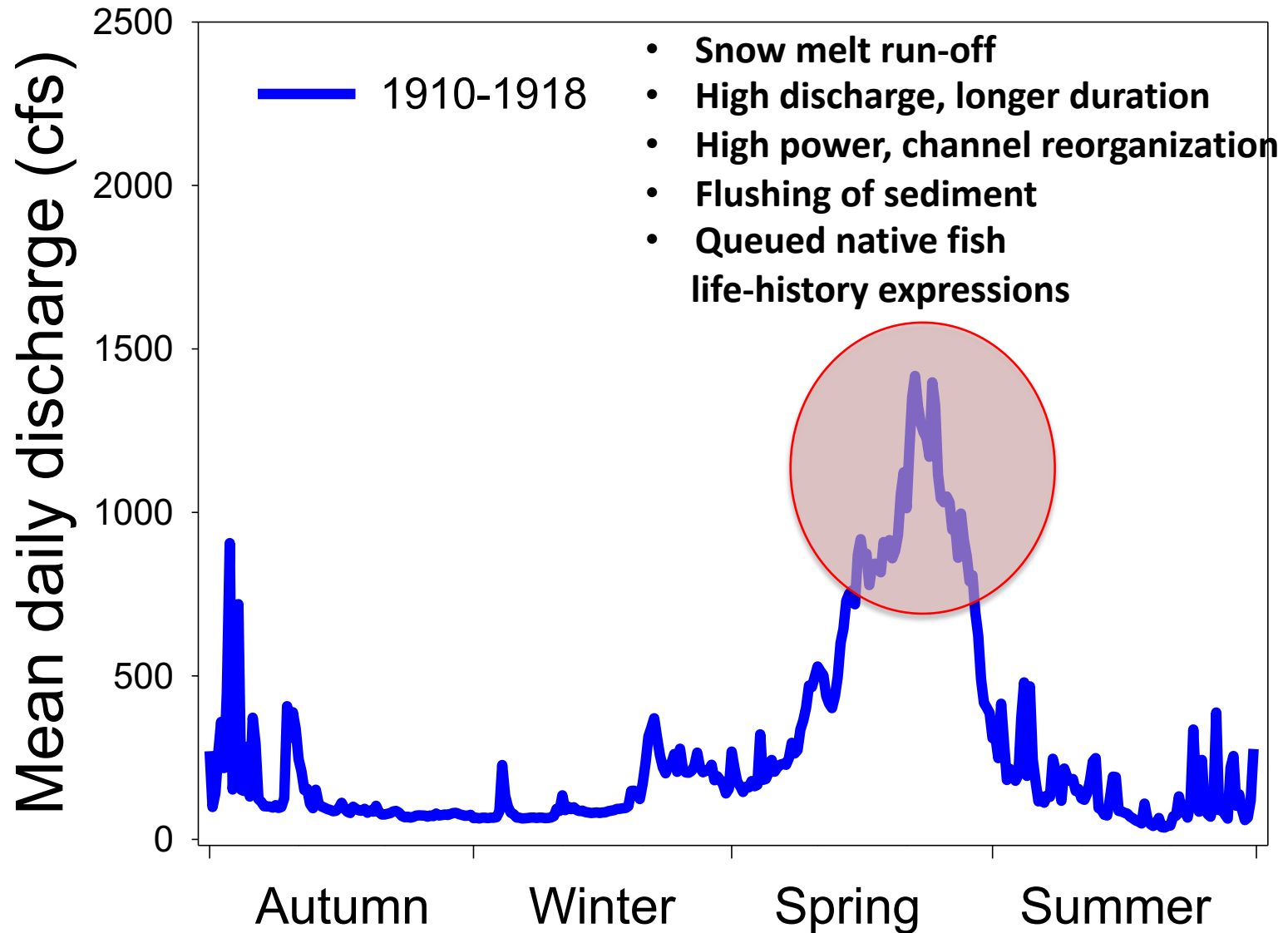


Dramatically Altered Hydrology ('lost' spring, snow melt flood)

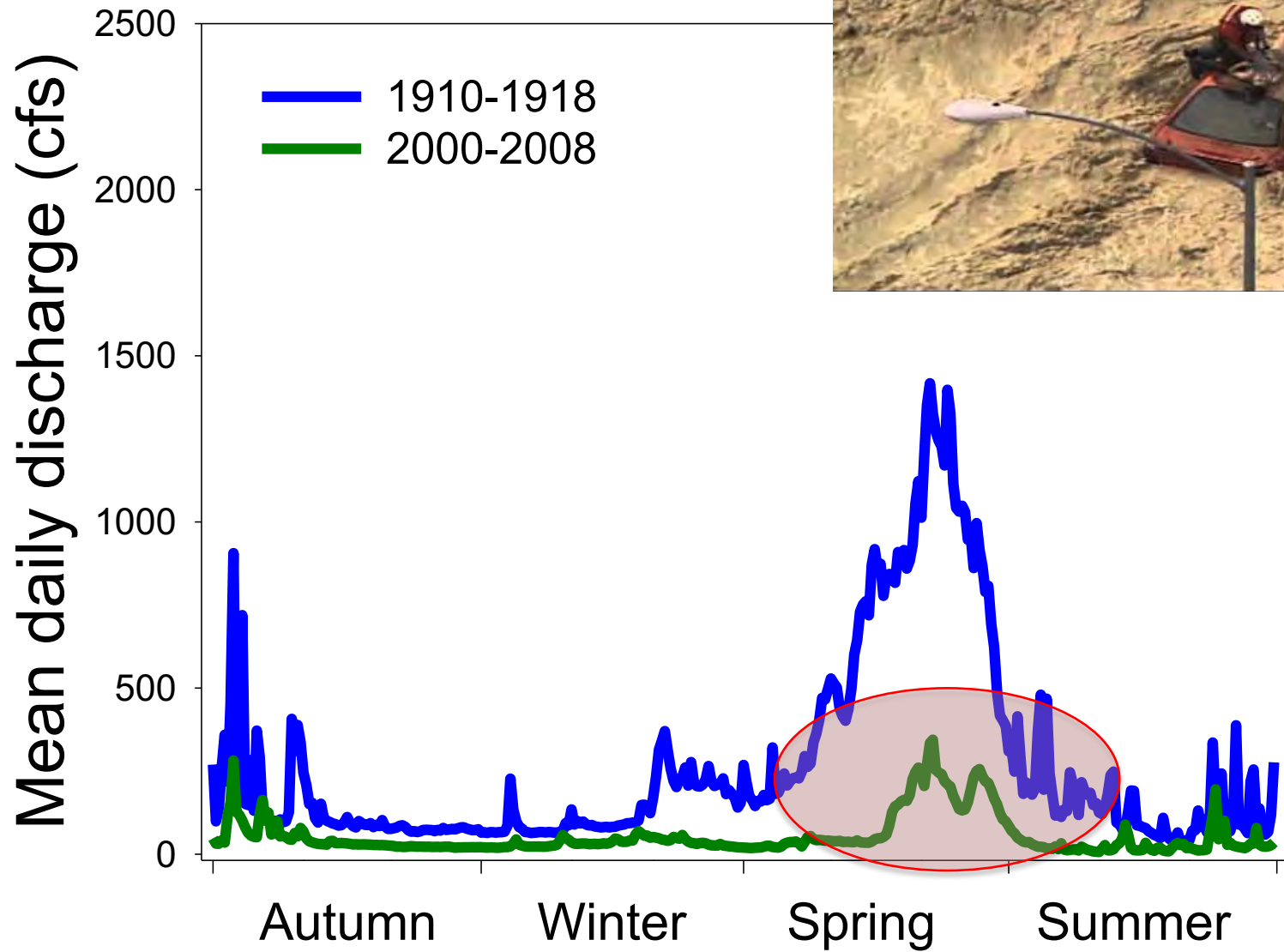
Dramatically Altered Physical template = Degraded fish habitat

Artwork by Holly McClelland
Based on original illustration by Lester Cole
High Country News © 2013

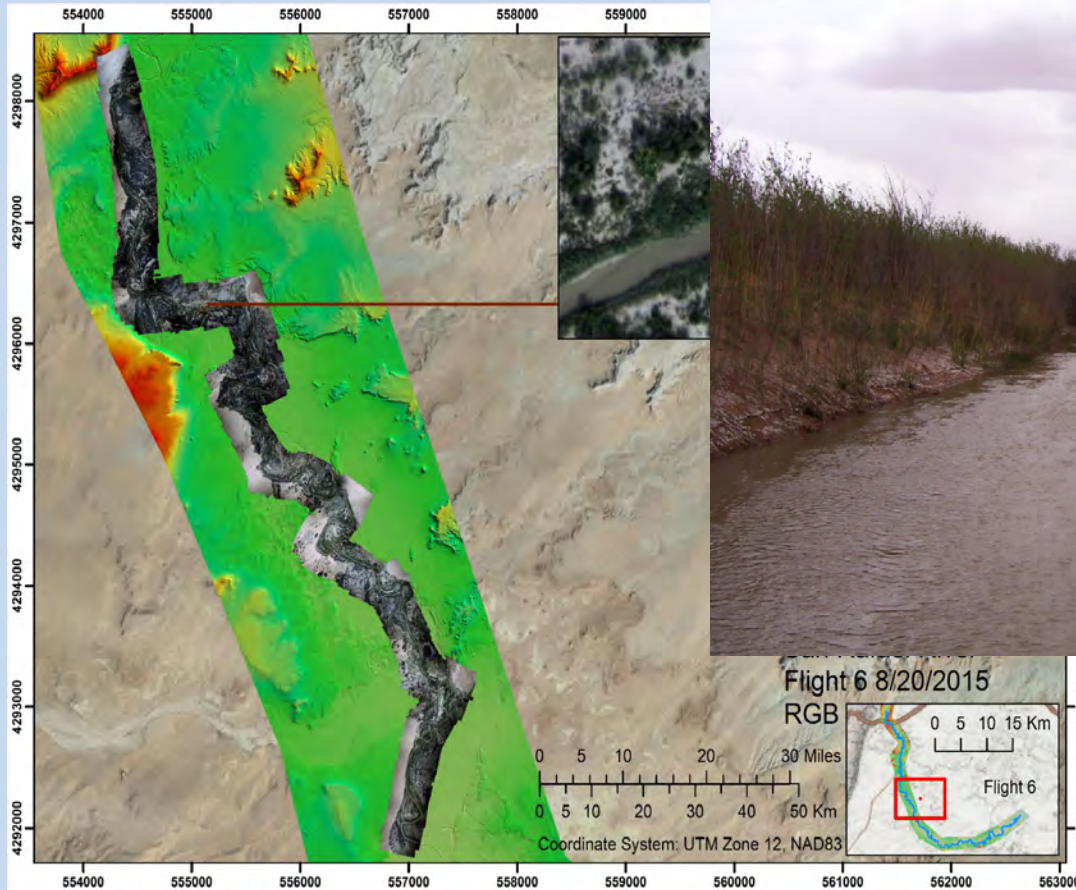
Historical Flow Regime



Not Dynamic



Not heterogeneous



*Simplified, homogenous
“run” habitat (lower river)*

Not connected at
large scale





3D9.1BF18D15CD

pikeminnow

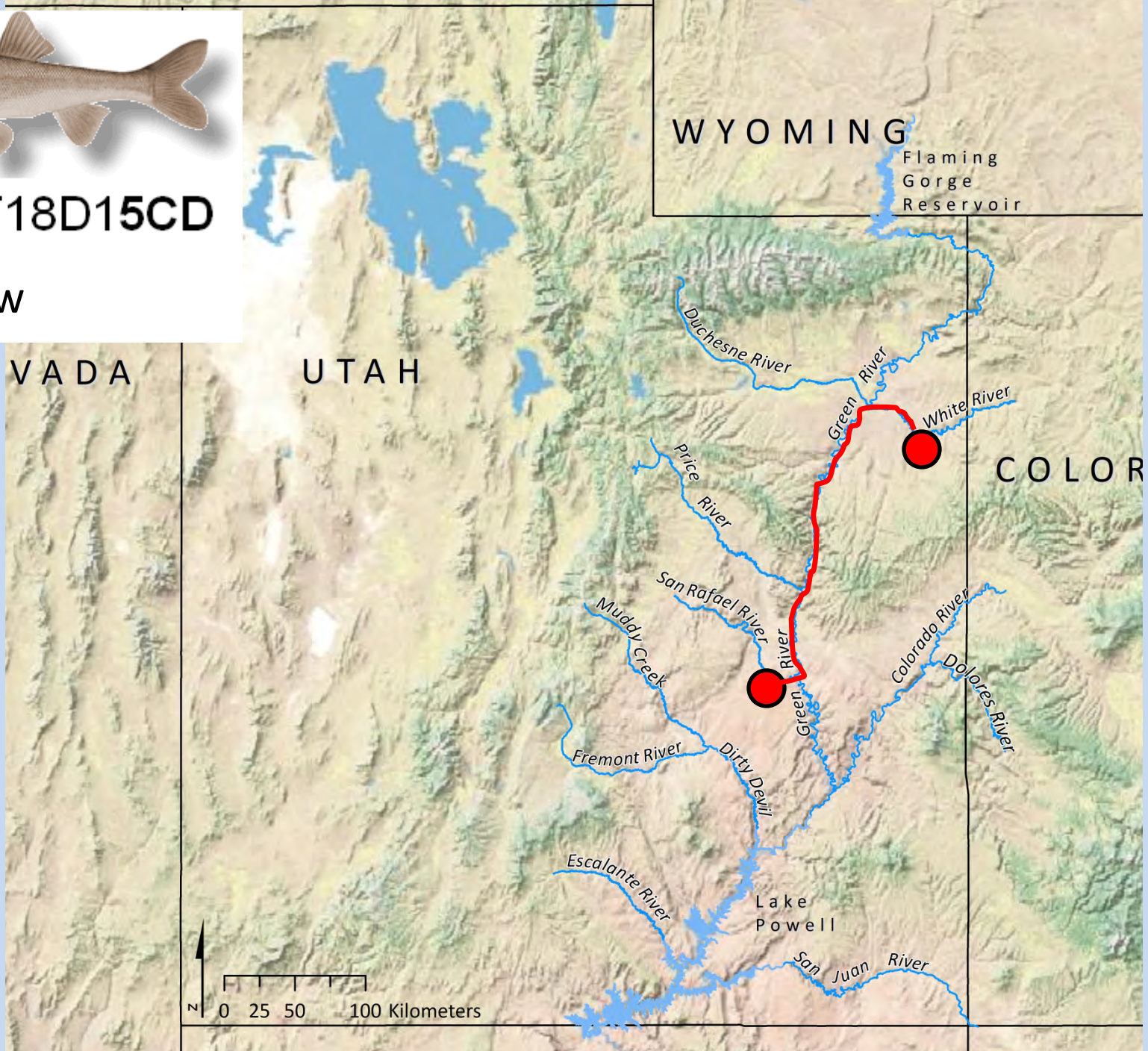
Tagged in
White River
in 2007





3D9.1BF18D15CD

pikeminnow



VADA

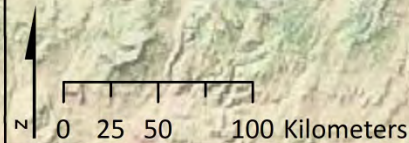
UTAH

WYOMING

Flaming
Gorge
Reservoir

COLORADO

Travelled 282
km from June
to July
“sampled” 2
tributaries



Not connected at small scale



Hatt's Ranch – San Rafael River



~60 km of dry river– San Rafael R



Farnham Diversion – Price River



Non-native, invasive species

- ~40 non-natives fishes introduced
 - ALSO non-native plants, mollusks, invertebrates, & disease
- Competitors
- Predators
- Altered Food Web
 - Flow of energy
- Single biggest threat?
- Synergistics!
- May be better adapted to altered physical template
- Never be completely eliminated
- Not a big threat when recovery planning was first underway



Photo by Tom Chart

Contemporary Fishscape/Ecosystem

A photograph of a large concrete dam in a desert canyon. The dam is a massive structure with multiple spillways. In the background, a tall metal transmission tower stands against a clear blue sky. The surrounding landscape is arid, with reddish-brown rock formations and sparse vegetation. The foreground shows the dark water of the reservoir behind the dam.

- **Completely altered flow and sediment regime**
- **Homogenous and degraded habitat**
- **Fragmented at landscape and local levels**
 - Intermittent drying
- **Lentic (lake) habitat in what was Lotic (riverine)**
- **Climate is getting warmer and drier**
- **Wildfires are increasing**
- **Non-native, invasive fishes are ubiquitous**
- **Non-native, invasive fishes often have the advantage given above**

Future? Novel Ecosystem

Anthropogenic biomes tell a completely different story, one of “human systems, with natural ecosystems embedded within them”. This is no minor change in the story we tell our children and each other. Yet it is necessary for sustainable management of the biosphere in the 21st century.

Ellis and Ramankutty 2008

- Lack natural analogs
- The historical state is largely unachievable
- Physical and biological processes do not obey laws of nature

Novel Ecosystems may require Novel Solutions



- Embrace opportunity
- Targeted management
- Prioritizing efforts

An aerial photograph of a river system. A large, winding reservoir or lake is the central feature, surrounded by a mix of green agricultural fields and brown, eroded soil. The river flows through the landscape, with various channels and tributaries. The overall scene depicts a complex water management system in a semi-arid region.

Accept Ecosystem as Novel Embrace Opportunity: 3 case studies/scenarios

- 1) Contemporary Connectivity: Lake Powell/
San Juan Razorback Sucker
- 2) Water management across years. Planned
releases and mini-floods in tributaries
- 3) Targeted non-native removal and
translocations in tributaries

1) Contemporary Connectivity: Lake Powell/ San Juan Razorback Sucker



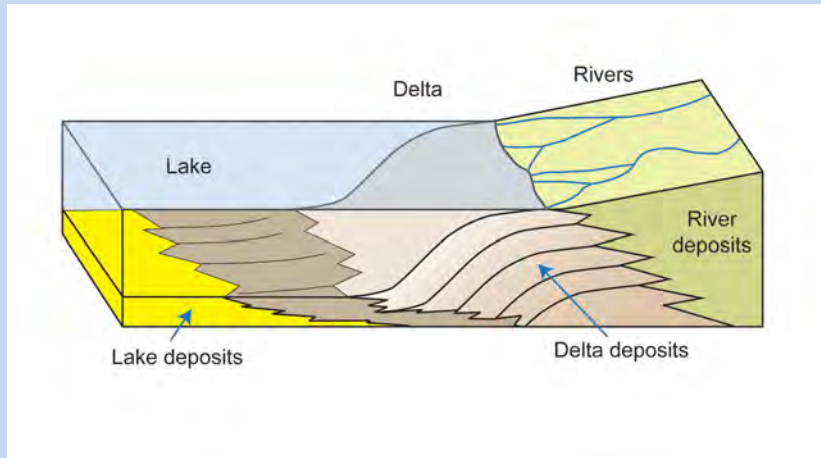
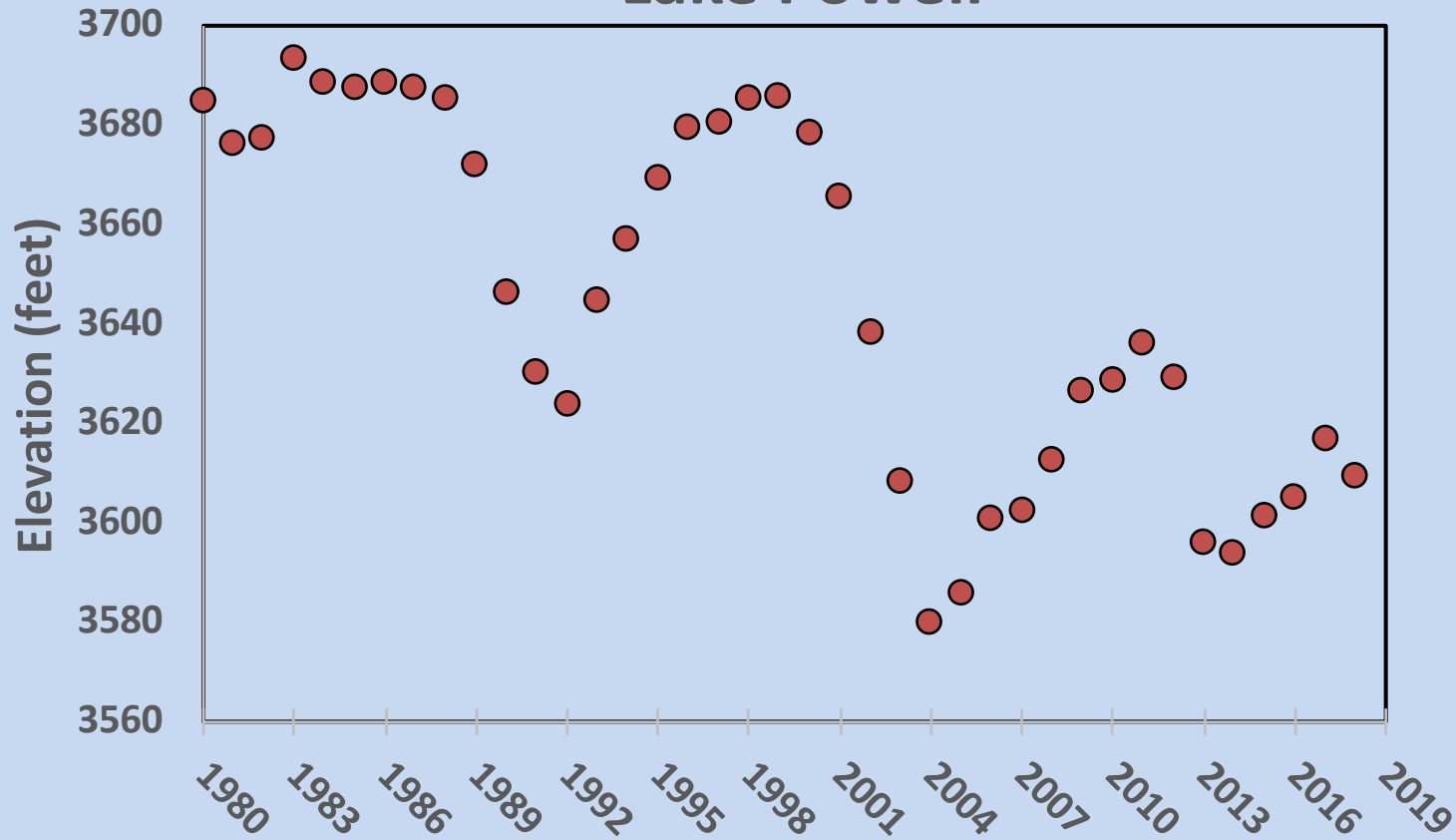
- Arose ~5 million years ago...
- Up to 1 meter, 40 years
- Listed under ESA
- Sustained largely through stocking from hatcheries
- Loss of complimentary habitats
- Predation of juveniles by non-natives



- “New” population
- Reproducing in the wild
- Reaching large size
- Likely Highly Fecund
- “Unusual”, “not typical”, “not riverine enough”?



Lake Powell



Zach Ahrens
USU MS candidate



Piute Farms Waterfall

- More than 1000 endangered RZB trying to ascend and presumably spawn
- 10-15 year old fish
 - ~as many 50,000 eggs



Mark McKinstry

600 mile voyage



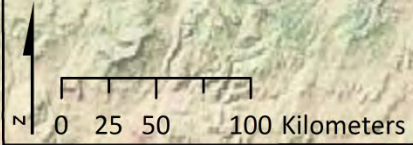
WYOMING

Flaming
Gorge
Reservoir

VADA

UTAH

COLOR



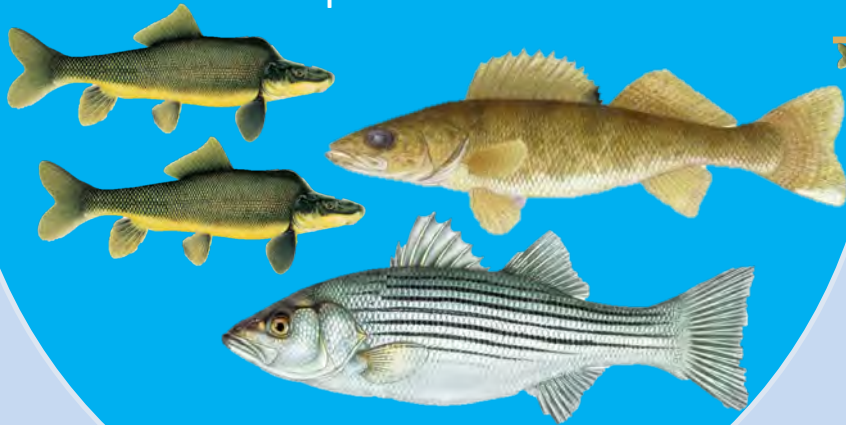
Lake
Powell

San Juan River

Management paradox?

San Juan River:
Spawning grounds for RZB
Relatively few non-native,
invasive fishes
Refuge for young natives

Lake Powell:
Novel habitat RZB (“atypical”?)
More than 1/3 of SJ population
Full of invasive non-native
sport fishes

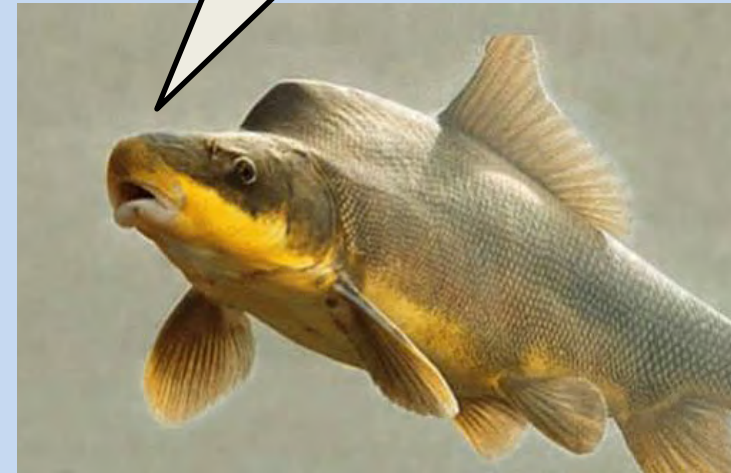


Novel environment
Novel population of endangered fish
Novel feature

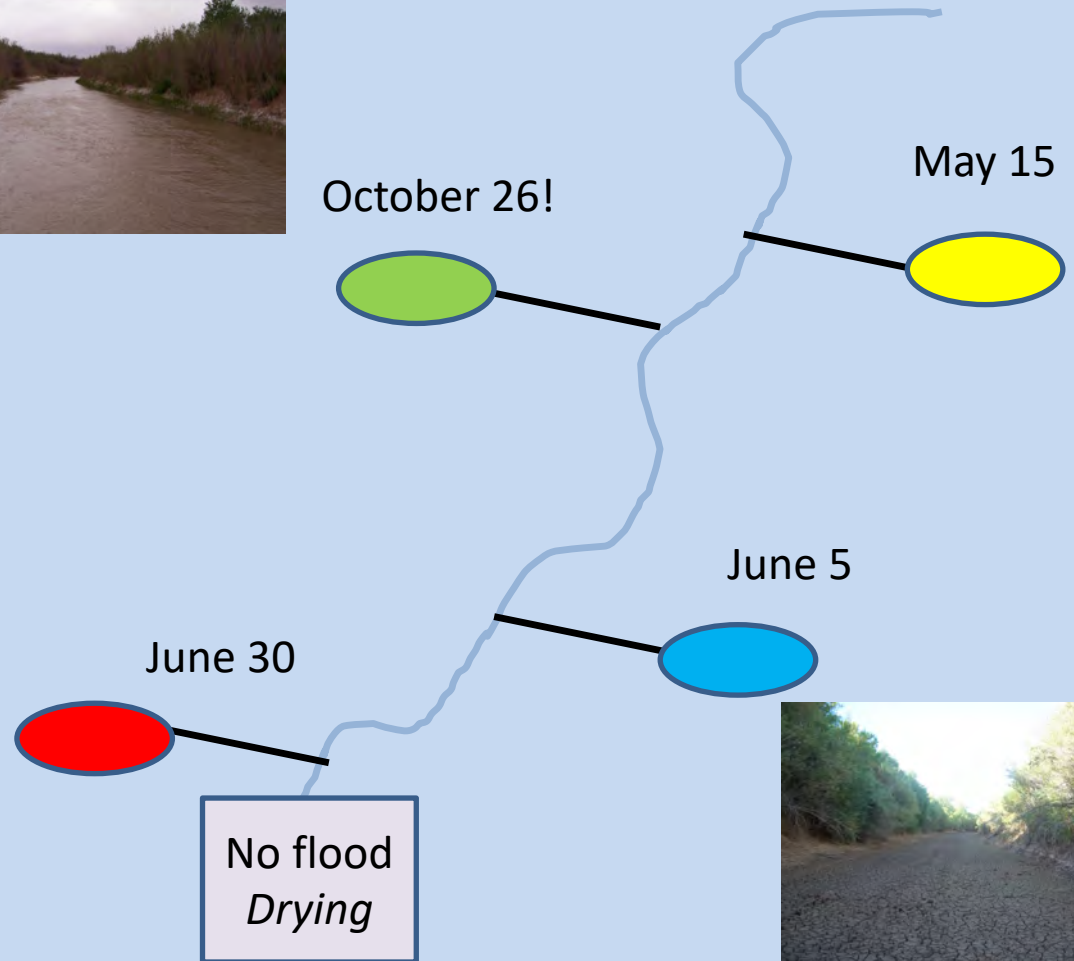
1) Contemporary Connectivity: Lake Powell/ San Juan Razorback Sucker

- Accept population for what it is...
 - *“lava poured over the lip of the Grand Canyon would have dammed the river, forming a large lake-JS”*
- Embrace novel opportunity
- Restore ‘selective’ connectivity
 - Selective fish barrier
- Allow RZB go up to spawn
 - Block non-natives
- Cost Benefit Ratio
 - Compare to recovery efforts elsewhere in CRB...\$\$\$
 - Maybe good for other spp., pikeminnow too

I have demonstrated I am a good fish, why not let me go do what I know how to do?



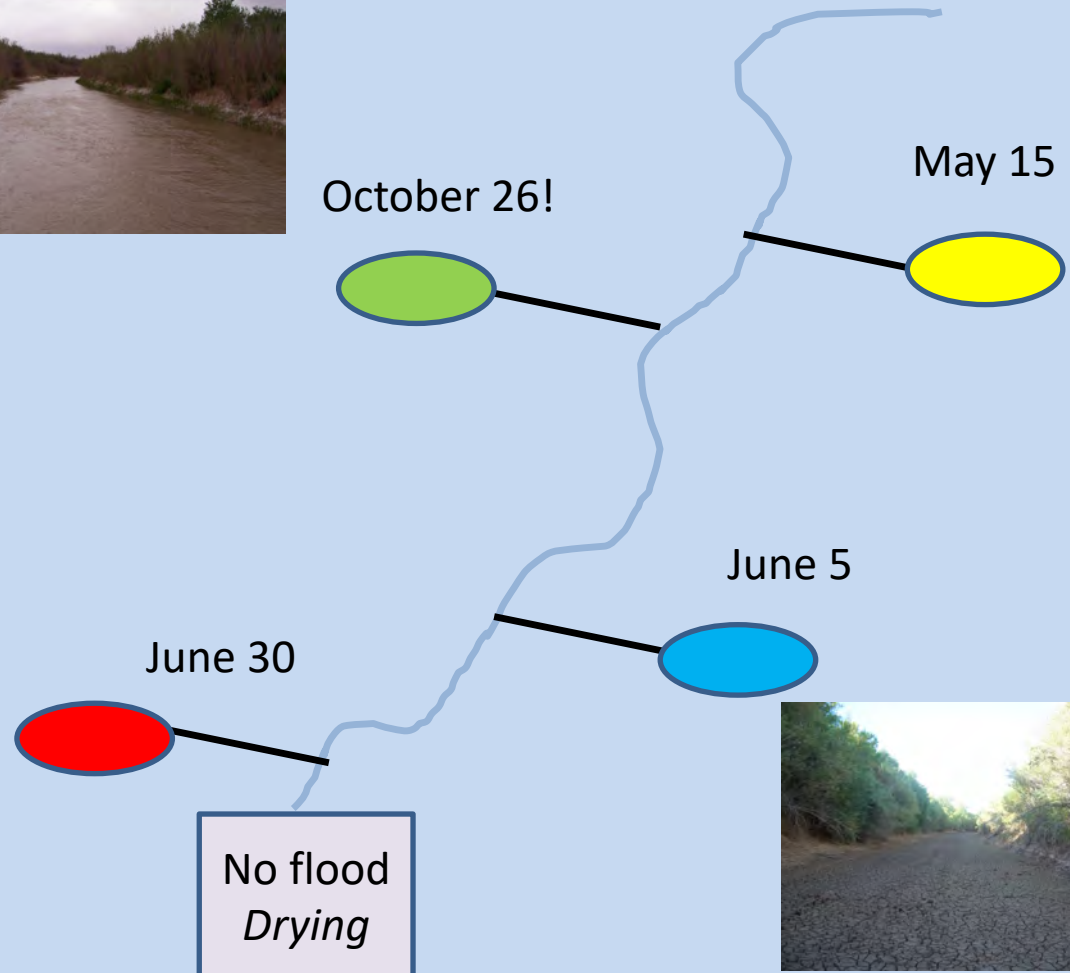
2) Water management across years. Planned releases and mini-floods in tributaries



2) Water management across years. Planned releases and mini-floods in tributaries

Tributaries of the Green and Colorado Rivers:

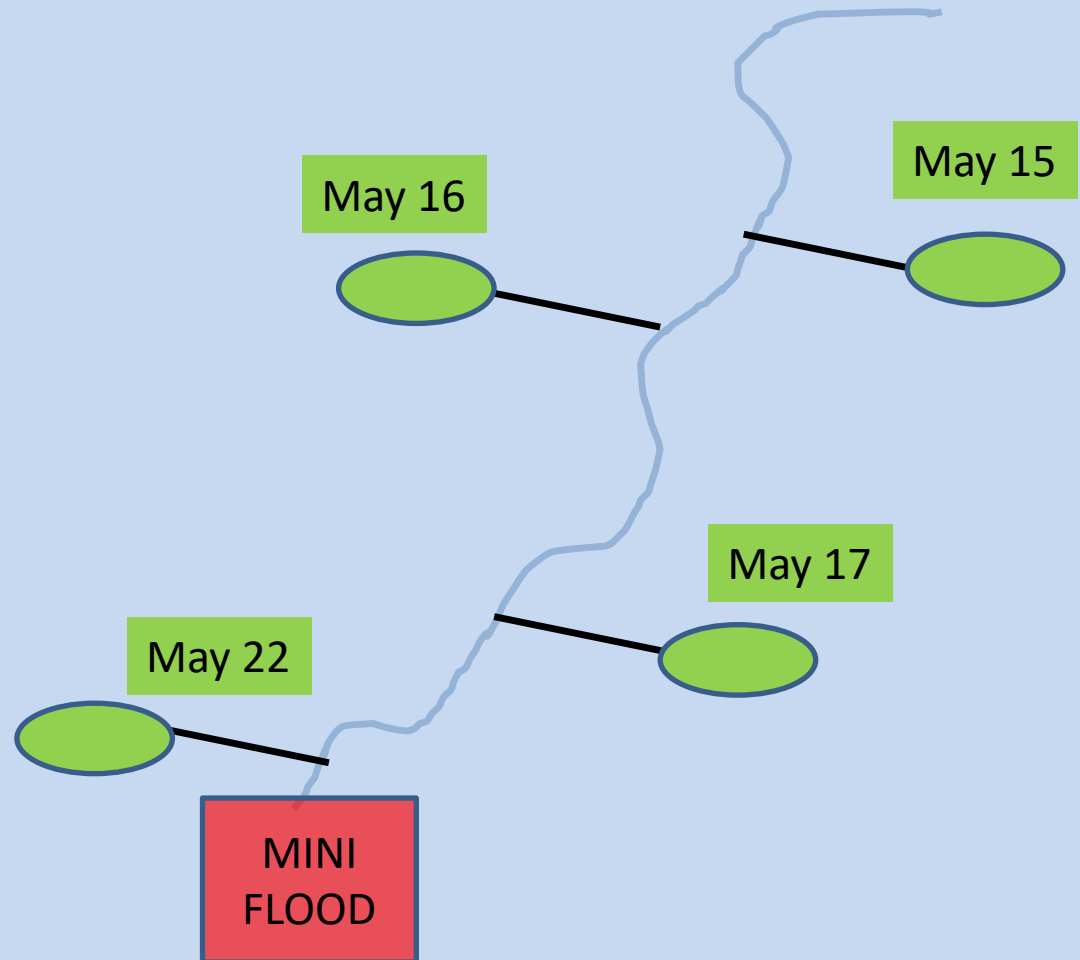
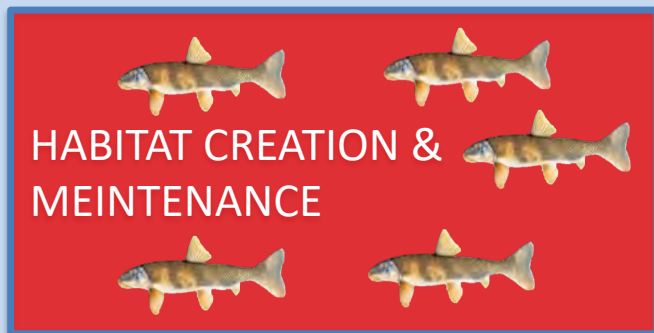
- No flood (no habitat)
- Drying in dry years (fish mortality)
- Larvae and Juveniles = more sensitive to threats and poor habitat
- Good year followed by drying the next year obliterates any contribution of the good year
- Negative feedback loop on willingness of irrigators to cooperate



2) Water management across years. Planned releases and mini-floods in tributaries.

Tributaries of the Green and
Colorado Rivers:

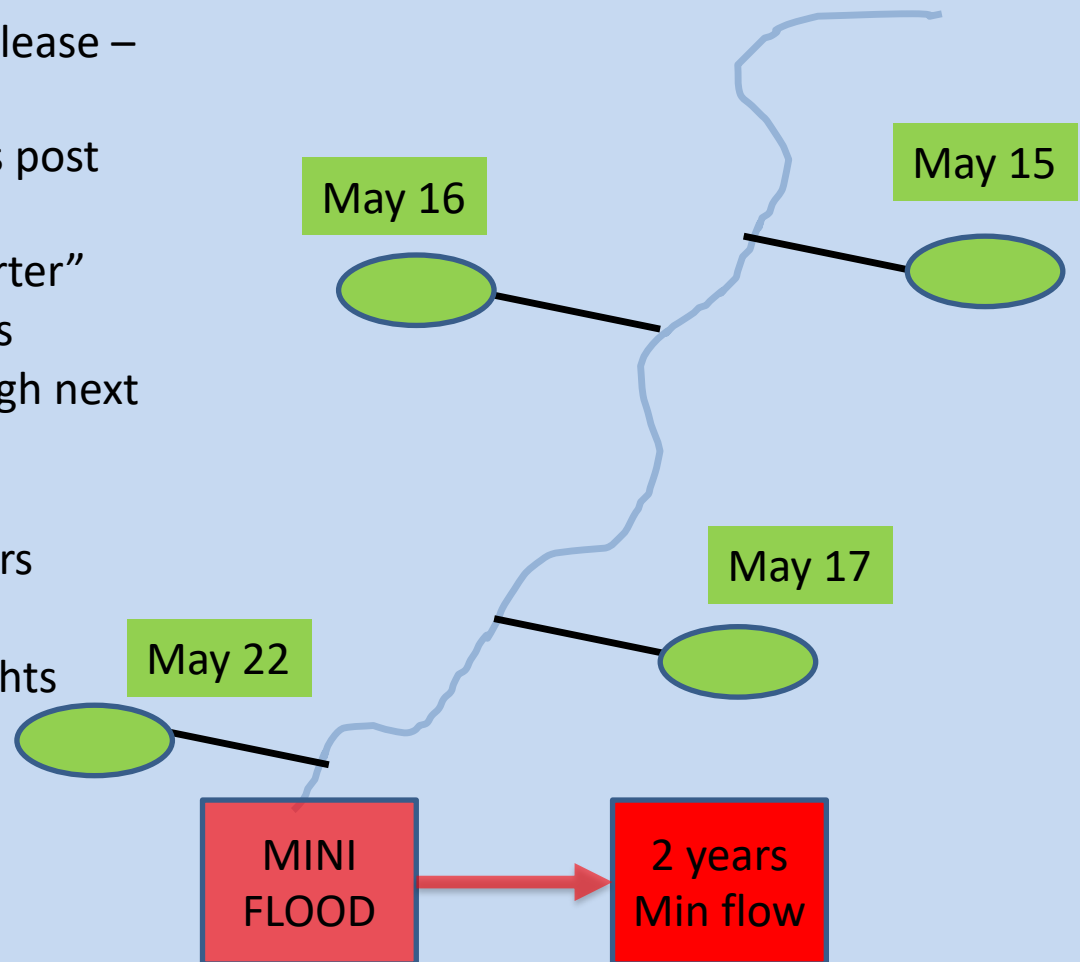
- Wet years: coordinated and
timed 'sequential' hold and
release – mini flood



2) Water management across years. Planned releases and mini-floods in tributaries.

Tributaries of the Green and Colorado Rivers:

- Wet years: ‘sequential’ hold and release – mini flood
- Agree minimum flows for 1-2 years post mini-flood
 - Allows fish to mature to “smarter” and more mobile young adults
- Good year class could trickle through next 10-15 years
- Don’t request water in “other” years
- Generation retiring – buy water rights
- Novel opportunistic approach
- Implications for mainstem?



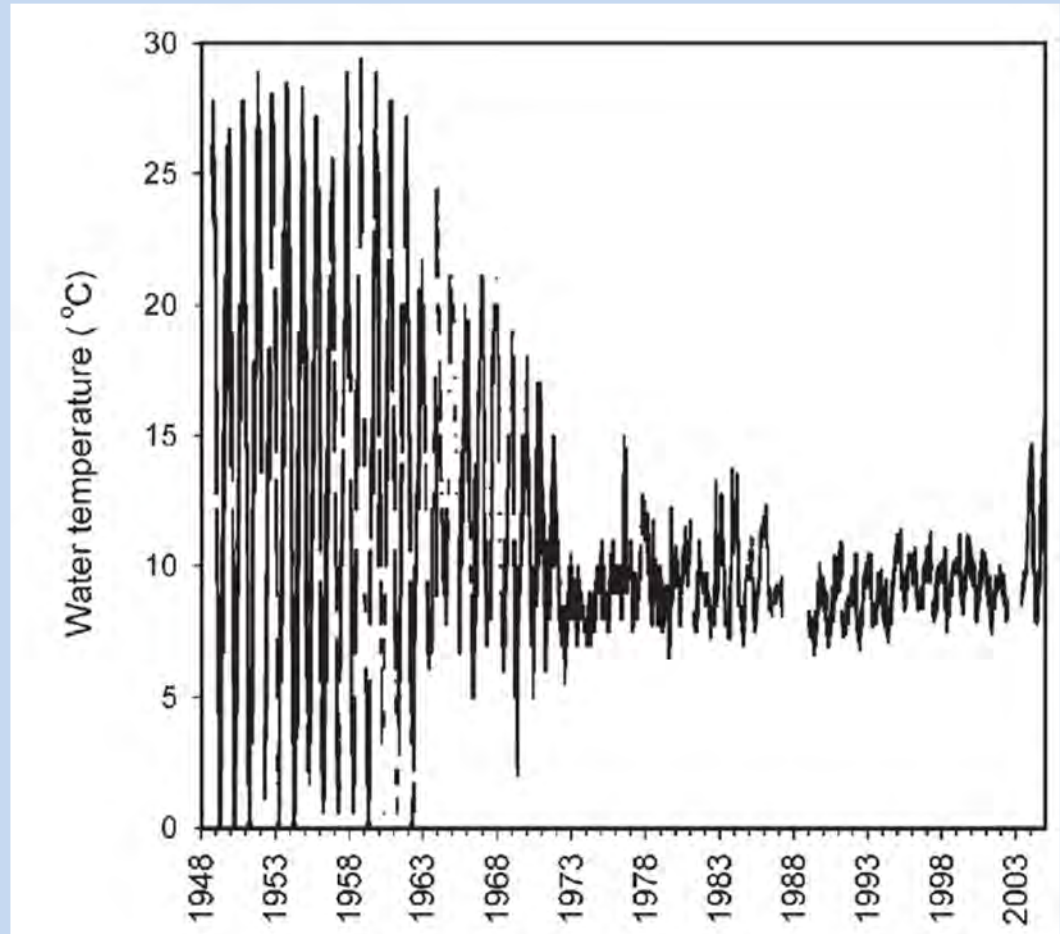
3) Targeted non-native removal and translocations in tributaries

- Western Grand Canyon is now 95% native fishes (*BIO-West, Inc.*)
- **Why?**

B. Healy and many partners

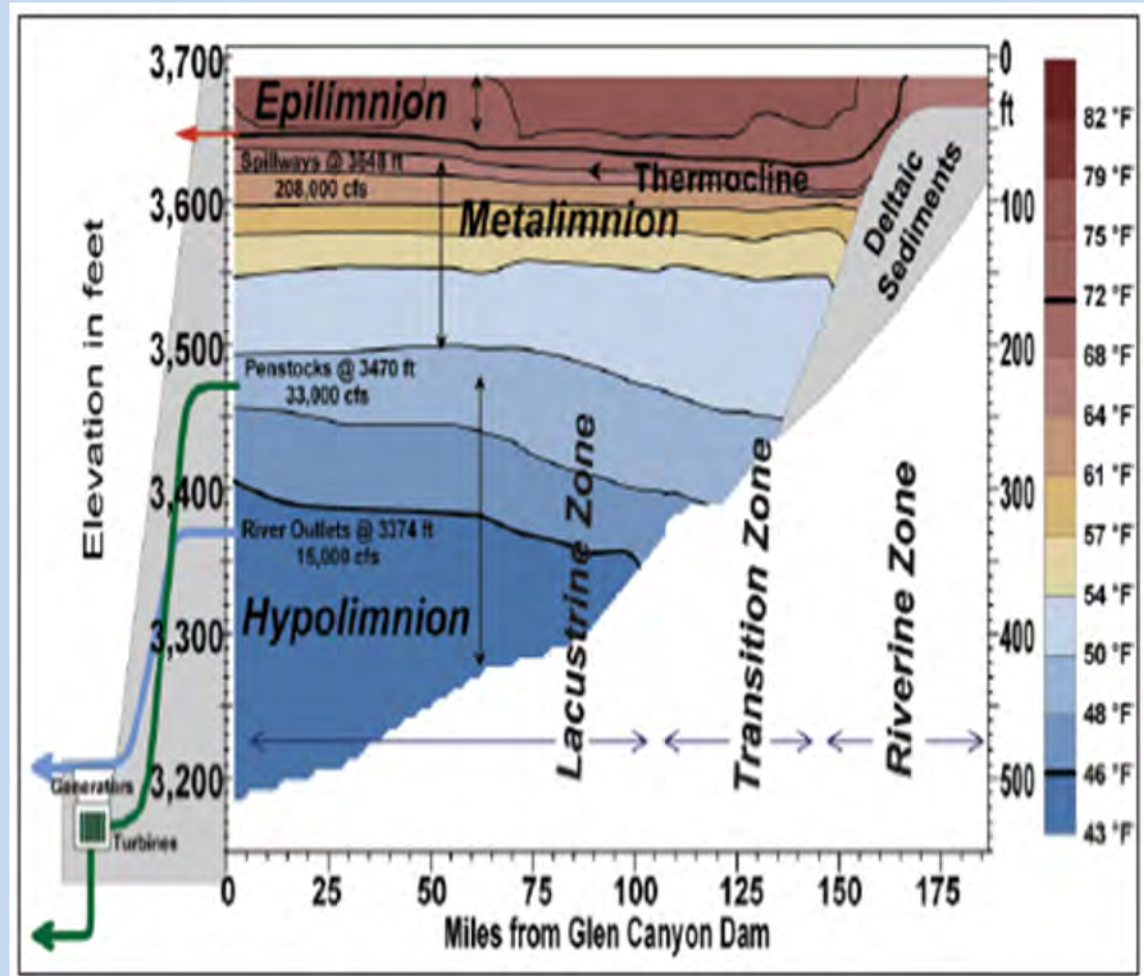
3) Targeted non-native removal and translocations in tributaries

- Western Grand Canyon is now 95% native fishes (*BIO-West, Inc.*)
- **Why?**
- Temps post dam were cold and constant = unsuitable for native fishes



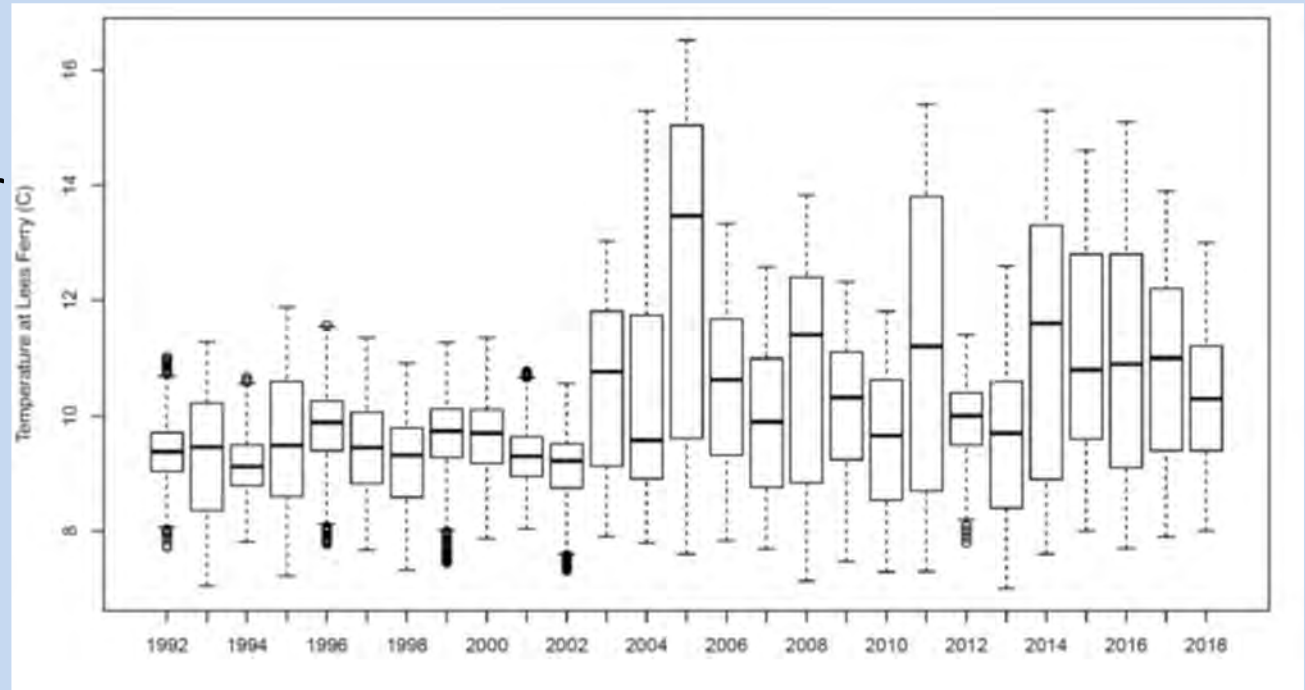
Sometimes nature throws us a bone and “opportunities”

- Grand Canyon is now 95% native fishes
- **Why?**
- Lake Powell low levels
 - water being released comes from “higher” elevations in the reservoir = warmer



Sometimes nature throws us a bone and “management opportunities”

- Grand Canyon is now 95% native fishes
- **Why?**
- Temperatures are now closer to historical temperatures optimal for natives
 - and not suitable for many non-natives



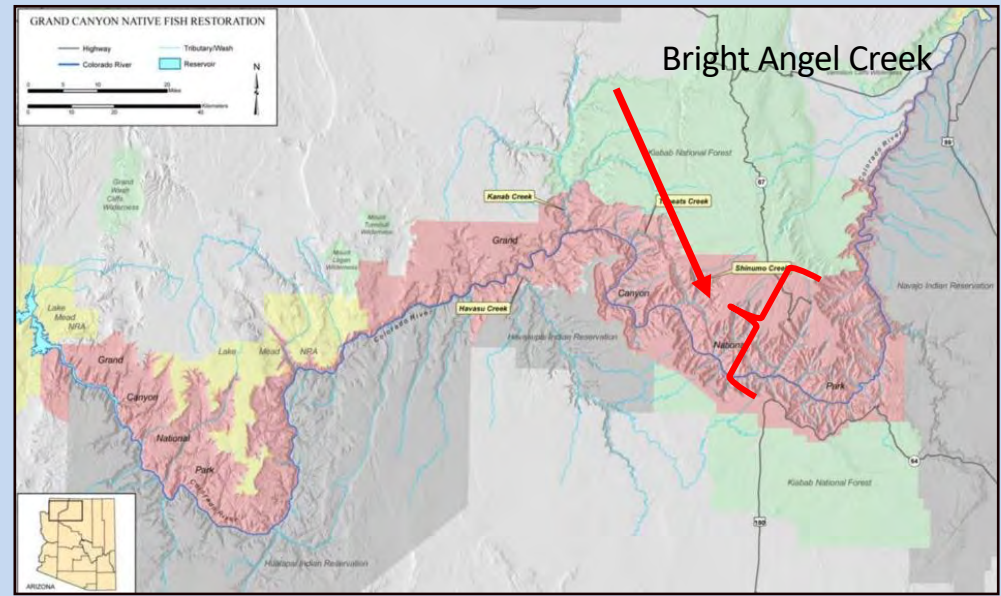
Sometimes nature throws us a bone and “management opportunities”

- Grand Canyon is now 95% native fishes
- **Why?**
- Difficult for non-natives to move from Lake Mead to GC as it also drops
- Pearce Ferry Rapid



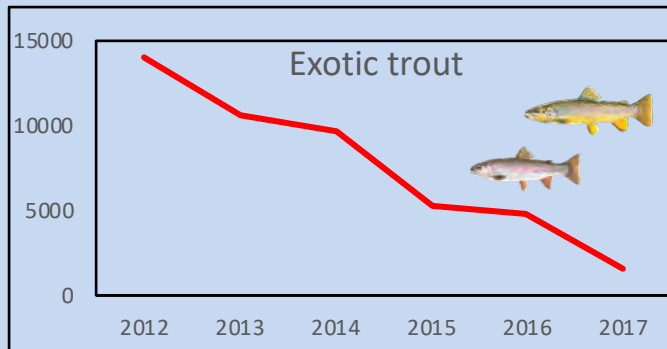
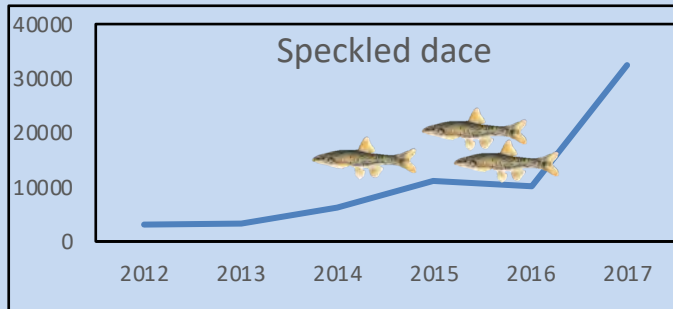
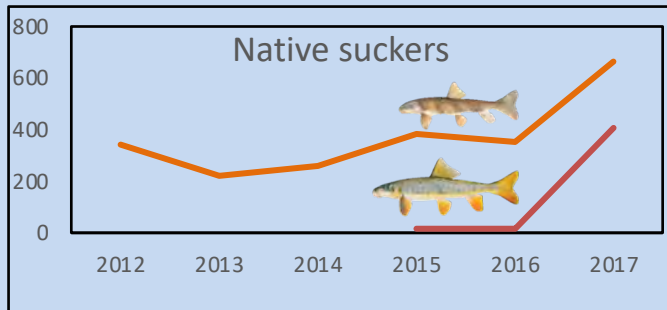
Tributaries are key: selective removal of non-native trout

- Bright Angel Creek
 - Natural hydrograph and temperature regime
 - Home to many natives
 - Full of NN brown trout
 - Source to mainstem
- 2012 - NPS and cooperators began selective, mechanical removal of NN trout creekwide



Provided by B. Healy

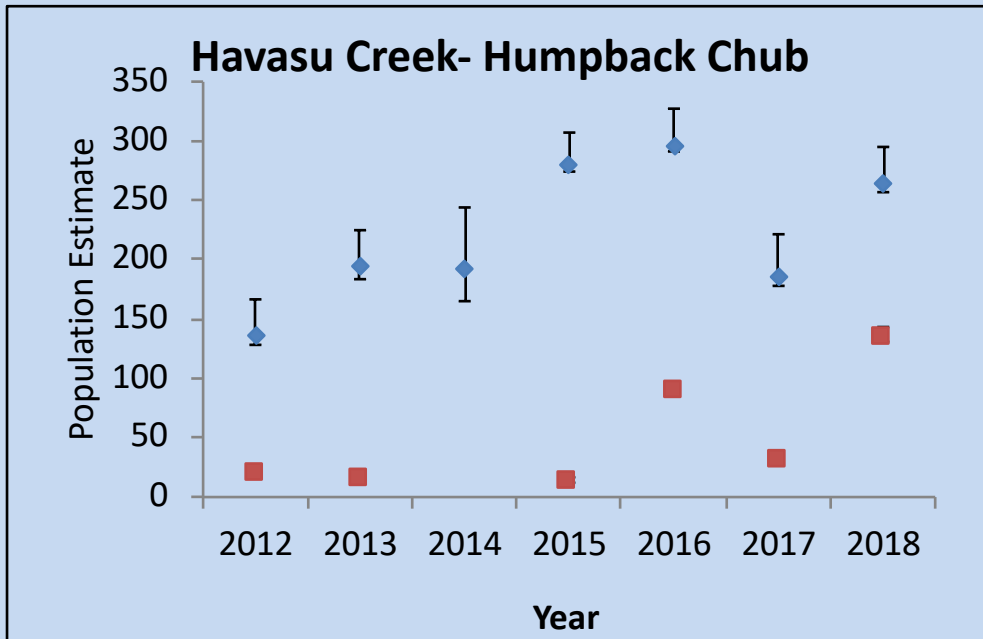
Tributaries are key: selective removal of non-native trout



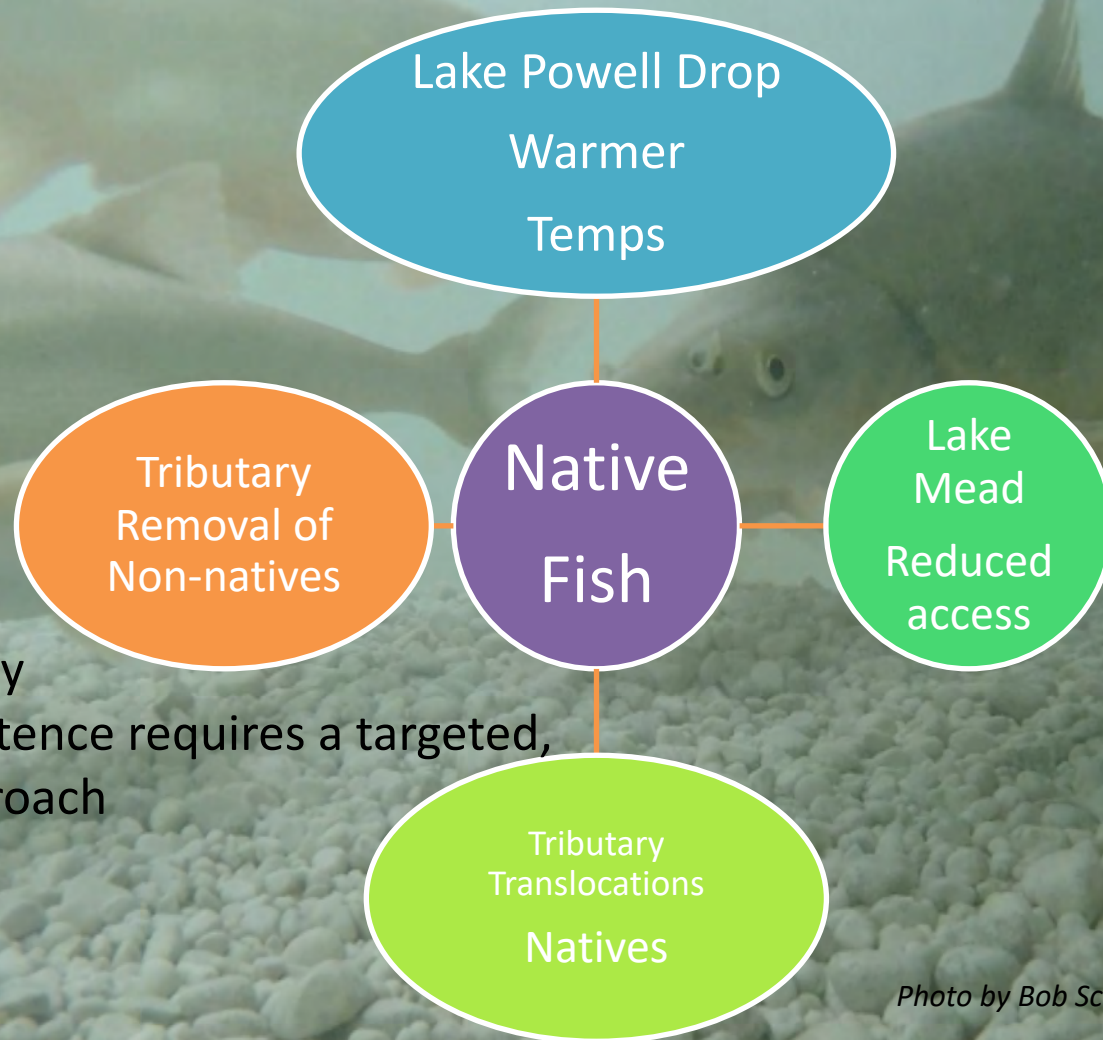
- Response:
 - Positive
 - Rapid
 - Unequivocal
- Native fishes have increased by several orders of magnitude
- Eliminated a likely source of brown in west CG mainstem

Tributaries are key: translocations of humpback chub

- 2011-2016
- NPS and partners: Translocating HBC from The Little Colorado R. (LCR) to Havasu Creek
- Goal = establish 2nd spawning population in Grand Canyon (about 100 miles downstream of LCR)
- Created a source to mainstem

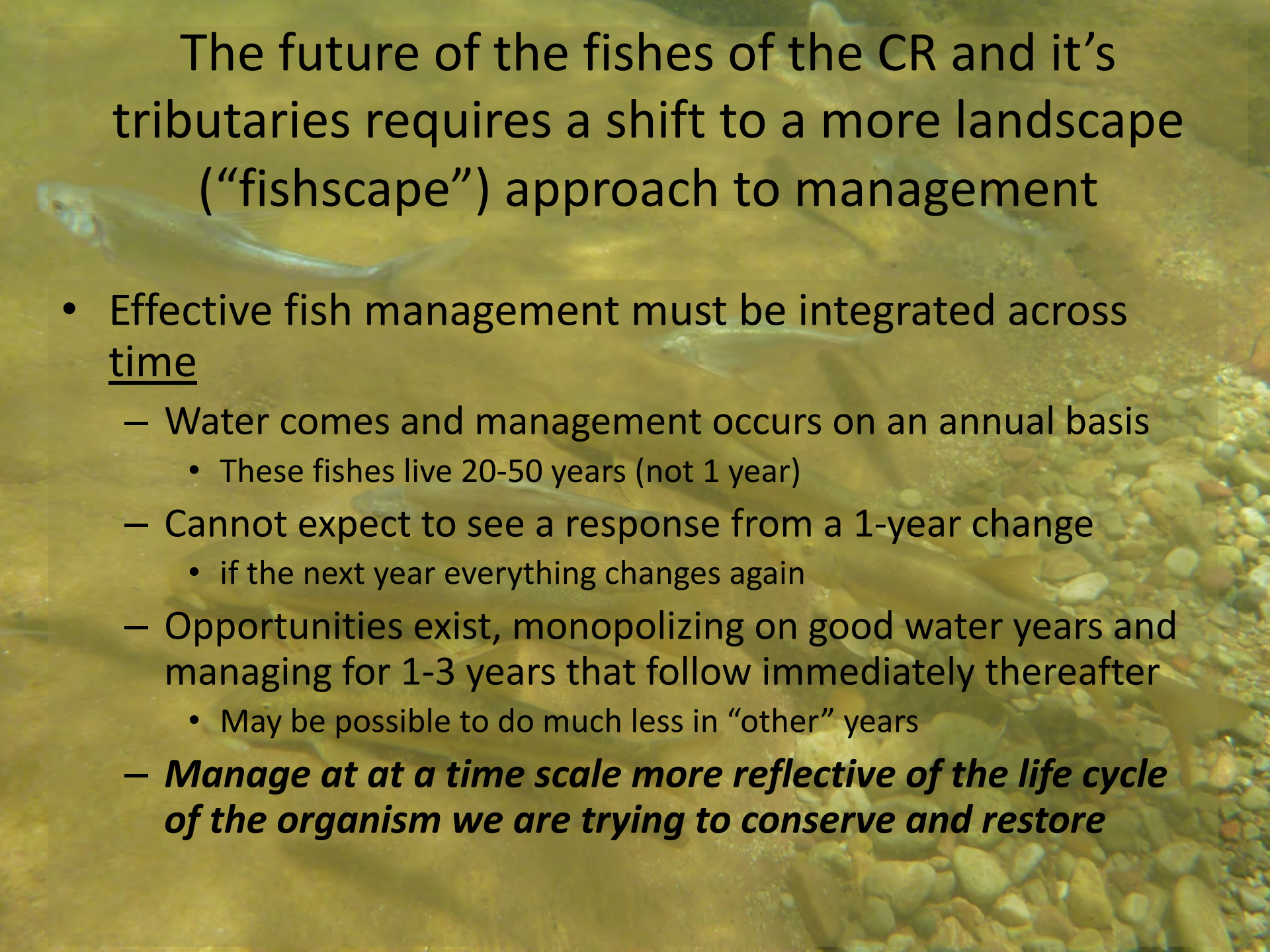


Why is the GC now 95% native fishes?




- Embrace opportunity
- Recovery and persistence requires a targeted, multi-faceted approach
 - Time
 - Space

Photo by Bob Schelly

An underwater photograph of a riverbed with several fish swimming. The water is clear, and the riverbed is composed of smooth, light-colored stones. The fish are silvery and appear to be in motion. The overall scene is bright and natural.

The future of the fishes of the CR and its tributaries requires a shift to a more landscape (“fishscape”) approach to management

- Effective fish management must be integrated across time
 - Water comes and management occurs on an annual basis
 - These fishes live 20-50 years (not 1 year)
 - Cannot expect to see a response from a 1-year change
 - if the next year everything changes again
 - Opportunities exist, monopolizing on good water years and managing for 1-3 years that follow immediately thereafter
 - May be possible to do much less in “other” years
 - ***Manage at a time scale more reflective of the life cycle of the organism we are trying to conserve and restore***



The future of the fishes of the CR and its tributaries requires a shift to a more landscape (fishscape) approach to management

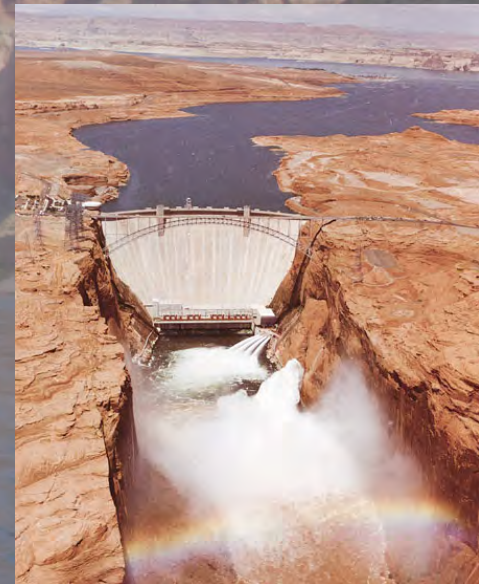
- Effective fish management must be integrated across space
 - Native fishes swim hundreds of miles to utilize complimentary habitat types
 - Fishes don't "know" where the anthropogenic boundaries are
 - State lines are meaningless
 - Basin boundaries are meaningless
 - If they can move, they will
 - Opportunities exist, selective fish barriers that restore connectivity where it matters most
 - And where success can be easily tracked
 - Tributaries are just as important as the mainstem, easier to work in
 - yet often overlooked not included in basinwide recovery programs

The future of the fishes of the CR and
it's tributaries...

uncertainty is no excuse for inertia

*“The only real mistake
is the one
from which we learn nothing”*

Riverwide coordinated experimental flood?



Acknowledgements

- National Park Service, Grand Canyon
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- USU Ecology Center
- ***Many many people...***



***American Southwest
Ichthyological Researchers***

