Gila River Basin Native Fishes Conservation Program – Annual Reporting Meeting

December 11, 2023
8:00 am to 4:30 pm MST

Gila National Forest – Silver City District Office:
3005 Camino del Bosque, Silver City, NM 88061

*Virtual Option: **Click HERE to join the meeting!***

Draft Meeting Notes

Annual Reporting Meeting Objectives:

- Provide updates on 2023 Program accomplishments.
- Discuss upcoming non-Program funding opportunities.
- Overview of YY Male – Next Steps, Geomorphology Surveys Using LiDAR, and Tularosa Fish Passage Project.

Participants: Kent Mosher, Betsy Grube, Yale Passamack, Lisa Rivera (USBR), Scott Richardson, Jess Newton, Jill Morrow, Mary Fuegate, Steve Mussmann, Steven Ingram, Karlee Jewell, Alanna Simmons, Wade Wilson, Chad Baumler, Ryan Gordon, Tiffany Love-Chezem, Tracey Driver, Nathan Franssen, David Ward, Daniel Leavitt (USFWS), Heidi Blasius, Tim Frey, Christina Perez (BLM), Jackson Leonard, Yvette Parov, Eileen Henry, Stephanie Coleman, Albert Silas (USFS), Zac Jackson, Serena Kucera (FWCO), Crosby Hedden, Zach Beard, Brian Hickerson, Josh Walters, Brett Montgomery, (AZGFD), Jill Wick, Jasmine Johnson (NMDGF), Paul Reap, Wes Franklin, Alex Marini (Marsh and Associates), Mariana Mateos, Angela Haggard (Texas A&M), Chris Jenny, Scott Bonar, Peter Reinthal (UArizona), Chad Teal (USU), Lauren Tango (NAU), Jeremy Monroe (Freshwater Illustrated), Mark Haberstitch, Jeffrey Smith (TNC), Sami Hammer (Pima County), Marc Wicke (SRP), Rob Clarkson, Doug Duncan, Jeff Simms (Retired Fish Biologists), Joel Unema (USGS)

Welcome *Kent Mosher, USBR*

Agenda Review and Introductions *Betsy Grube, USBR*

Species Status Update *Scott Richardson, USFWS*

- See information on current species leads, and ongoing recovery tasks *HERE*
- Discussion:
  - Q: USFWS is working on delisting Gila chub and no longer recognizing the species, however, AFS still recognizes Gila chub. How is the AFS recognition being incorporated?
  - A: USFWS is having ongoing discussion regarding the delisting package, most recent genetics work is under review, the AFS reference is also being considered.
  - Q: Is there a proposal to delist Gila chub?
  - A: No

Gila River Basin Fish Monitoring *Paul Reap, Marsh and Associates & Yale Passamaneck, USBR*

- Gila River Basin Fish Monitoring Presentation: *HERE*
  - Q; What will the East Fork Black River Watershed monitoring be replaced with in 2024 (these streams are proposed to be removed due to overlapping effort with AZGFD)?
  - A: KP and Grant Creek have been proposed as replacements but concurrence from USFWS is needed prior to the amendment.
  - Q; [Based on the summary slide, it] looks like the fish populations have gone up in 2023. What are the 3 nonnatives you caught?
  - A: Brown trout, Rainbow trout, and Western mosquitofish.
  - Q: What time of year were you seeing these contractions in pools at some of the topminnow sites?
  - A: April.
  - Q: Which Sycamore Creek were you in?
  - A: The one in the Agua Fria watershed.
  - Q: Is the data so variable for topminnow that is largely just presence absence?
  - A: We can see some trends in the data, but it is largely a product of habitat variability.
  - Q: Can the water be too deep/shallow to sample for POOC?
  - A: In Coal mine the pool was too deep and we were not able to effectively sample the middle/lower water column where the fish were.

- CAP eDNA Metabarcoding Presentation
  - Q: How long are the target sequence? How many base pairs are your primers detecting with the metabarcoding?
  - A: We use MiFish and it targets the 12S mitochondrial DNA resulting in 180 base pairs in length. This is a limited resolution but can generally give us confidence is species specific identification. This size range is the ideal size to be able to get a good sequence and has been preforming well given its small size.
  - Q: The MiFish primer is an overall teleost detection, how do you get species?
  - A: We use multiple methods. We bioinformatically go through to distinguish unique sequences and match them back to known sequences using the gen bank sequence database and we also build a phylogenetic tree.
  - Q: Have you or others used this for native fish across a similar scale.
  - A: We haven't but others have. The USFS has done nice work looking at salmonids in the upper southwest with similar techniques. They have also used this or a similar technique in Sonora, Mexico for Native fish.

Native Fish Genetics Management Plans *Steven Mussmann, USFWS*

- Presentation: *HERE*
- Discussion:
  - Q: In your example of two populations being added to a new one, can you make a quick statement on how this would be changed for multiple populations?
  - A: We would be expanding it out. It would also depend on how many primary donor sites are being managed. It would require yearly decisions depending on status of existing populations and new pops. You don't want to move to fast to minimize impacts on existing sites. This is a unique situation in that we do not have the luxury of maintaining them at a hatchery with a set broodstock for multiple generations. Its an example of moving around the actual broodstock vs just the offspring

- Q: You described taking from primary donor sites; can you define this?
- A: Primary donor site is a refuge population that would be used as an established extensively managed site to carry out these genetically management actions. Regularly monitored, regularly managed, good size, good representatives of their lineage. As a group, we have been meeting and discussing this but they have not yet been established yet.
- Q: Are the 15 individuals per generation transferable to other desert fish species, or RBS, or Apache Trout?
- A: Probably not. I calculated that figure based upon effective population sizes that I determined for individual populations. It could be more or less for other species based upon their effective population sizes and census sizes.
- Q: Do you think N_c should account for variability in sex ratios?
- A: That's a good point. I guess my calculations assumed an equal sex ratio, which might not always be the case (especially for Poeciliopsis). If we had a way to account for that it would probably be helpful, but I didn't have sex ratio information for the census sizes of populations.

Genetic Diversity of US and Mexico Topminnow Populations *Mariana Mateos, Texas A&M*

- Presentation: *HERE*

Aquatic Research and Conservation Center *Josh Walters & Hudman Evans, AGFD*

- Presentation: *HERE*
- Discussion:
  - Mary: Josh mentioned we are setting up a meeting for a hatchery discussion. I also wanted to point out that we have been moving things forward, but they seem to be sliding back. This future discussion will be critical.

Arizona Game and Fish Department *Brian Hickerson & Crosby Hedden, AGFD*

- Presentation: *HERE*

Bureau of Land Management – Safford Field Office *Heidi Blasius, BLM*

- Presentation: *HERE*
- Discussion:
  - Q: is there historic records of Topminnow in Aravaipa Creek?
  - A: There were historic records at the confluence. There also was a historic Cienega near the side tributary that may have had Gila Topminnow historically. We don't expect the mainstem to have a huge population, but we expect it to be similar to Fossil Creek where they are surviving in patches.

New Mexico Native Fish Conservation Projects *Jill Wick & Jasmine Johnson, NMDGF*

- Presentation: *HERE*
- Discussion:
  - Q: What gears were you using for San Francisco remote site inventory?
  - A: Primary electrofishing with some seining or combination of the two gears.
  - Q: Have you compared catch rates at Heart Bar to previous years? Are there any trends?
  - A: We haven't been seeing any obvious trends. We have been seeing more suckers after the flooding. We didn't catch any adult desert suckers this past year, which is highly unusual. Upstream of this reach we were catching adults of both sucker species.

West Fork Black River Native Fish Restoration on Tribal Lands *Zac Jackson, AZFWCO*

- Presentation: *HERE*

Upper Verde River Fish Habitat Assessment *Jackson Leonard, USFS*

- Presentation: *HERE*
- Discussion:
  - Q: Jaeger looked at climate change in the Verde River system around 2015 and predicted things were going to get drier and drier over time. Are you seeing similar results?
  - A: That upper basin is being efficiently pumped so flow doesn't start until right there at the confluence of gratinate creek. The pumping plan has been litigated by SRP for the last several years. That pumping may already be having an effect on base flows but we don't really know how connected these activities are to base flows. That is a future area of research that many would like to investigate.

Razorback Sucker Investigations in the Verde River *Chris Jenny, UArizona*

- Presentation: *HERE*
- Discussion:
  - Q: What is the DO tolerance for razorbacks?
  - A: The standard in fisheries is 4-5% DO, but Tiffany Love-Chezem reported suckers in their pond being able to survive until 1.5ish. She said they tend to hunker down and the ponds are super deep.

Mechanical Investigations Using YY Male Fish *Chad Teal, USU*

- Presentation: *HERE*

CART (formerly known as CCAST) *Karlee Jewell, USFWS*

- Presentation: *HERE*
- For questions or to join the Nonnative Aquatic Workgroup please reach out to Karlee at karlee_jewell@fws.gov

Gila River Basin Film Project *Jeremy Monroe, Freshwaters Illustrated*

- Presented a sneak peak of the Gila River Basin video they are developing.
- Still looking for areas to take clear water photos/videos of Gila topminnow in natural habitats.

Upcoming Funding Opportunities *Lisa Rivera, USBR*

- Presentation: *HERE*

YY Male – Next Steps *Chad Teal, USU*

- Presentation: *HERE*
- Discussion:
  - Q: If you don't have a drug sponsor in the INAD process, you will still need approval? Will it always stay as an INAD?
  - A: Opening the INAD there are a lot of hurdles to get the drug approved, and we are hoping to use this data for indexing.

Geomorphology Surveys Using LiDAR *Lauren Tango, NAU*

- Presentation: *HERE*
- Discussion:

    - Q: That 1600 CFS flood, did it knock down the cattail lining the channel?
    - A: Yes. However, now you can barely tell the flood came through. It laid down the cattails and when the water came back down, they came back.

Tularosa Fish Passage Project *Yvette Parov and Eileen Henry, USFS*

- Presentation: *HERE*
- Discussion:
    - Q: What time of year did you complete this work/find the snakes?
    - A: It was the summer, the construction started in May.

Flex Items/Open Discussion *All*

- Scott Bonar: The book on Standard Sampling by the American Fisheries Society is coming out in a few months.

Wrap-up and Adjourn

Gila River Basin Native Fishes Conservation Program – Technical Committee Meeting

December 12, 2023
8:30 am to 12:30 pm MST

Gila National Forest – Silver City District Office:
3005 Camino del Bosque, Silver City, NM 88061

Virtual Option: ***Click HERE to join the meeting!***

Draft Meeting Notes

Technical Committee Meeting Objectives:

- Discuss 2024 workplan adjustments, 2025 proposed projects, and Tier 2 projects.
- Provide updates on other projects.

Participants: Kent Mosher, Betsy Grube, (USBR), Scott Richardson (USFWS), Heidi Blasius, Tim Frey (BLM), Yvette Parov, (USFS), Serena Kucera (FWCO), Crosby Hedden, Zach Beard, Brian Hickerson (AZGFD), Jill Wick, Jasmine Johnson, Matt Zeigler (NMDGF)

Program Updates *Kent Mosher, USBR*

- Technical/Policy Committee Representative Updates
  - Sean Heath has been replaced by Dominic Graziani as the USBR Policy Representative
  - Scott Richardson is still the standing replacement for Doug Duncan as the USFWS Technical Representative
  - Action: Betsy update Jill's contact information on website
- CAP Consultation Re-initiation
  - USBR is going through reinitiation for the CAP due to the listing of gartersnakes.
  - USBR is hoping to submit for formal consultation in January 2024 and then USFWS will have 135 days to complete.
  - USFWS indicated that this has taken longer than expected, in part due to staff (Doug Duncan) retiring last year.
  - USBR has met the funding commitment outlined for the 5 fish species.
- Timeline Review
  - February 1, 2024: Draft annual reports due for review to USFWS and USBR
  - April 1, 2024: Final Report Due
  - March 2024: Technical Committee Call (if needed)
  - March/April 2024: USBR will send out FY25 Work Plan for project scoring
  - May/June 2024: Joint Policy/Technical committee meeting
  - May-August 2024: USBR and USFWS will finalize workplan
  - October- September 2024: Reclamation and FWS will procure agreements to implement
  - November 2024: Send FY25 Work Plan project changes to Dec Technical Meeting

FY 2024 Workplan

- Workplan Clarifications/Adjustments
  - Arizona Game and Fish Department (Brian Hickerson) – A few revisions primary stemming from Eagle Creek Barrier being pushed back a year. AZGFD was originally planning on completing pre-barrier monitoring, however, with the barrier delay they have moved up other work and allocated

the funds to existing projects. There is no net change for funds allocated to AZGFD. See table HERE for project details.

  - New Mexico Department of Game and Fish (Jill Wick) – Adjusting their methods for Heart Bar so they can better asses the efficacy of the nonnative removal effort. This will require additional passes and effort. They also added Bear Creek to their T&E Fish Repatriation and Monitoring task as they translocated Loach Minnow there in 2023. Kent also identified that the monitoring contract will be monitoring Bear Creek in 2023. Tim Frey requested to be kept in the loop as well to reduce redundance of surveys in Bear Creek. Allred Pond stocking will be delayed and continued investigations were added to 2024 plan. Burro Cienaga will be resurveyed after previous monitoring failed and a stocking will happen regardless. Based on AZGFD recent surveys the San Francisco remote site inventory will not be continued in 2024.
    - Bear Creek is on the 2024 Monitoring Contract schedule and there was a brief review and discussion of streams being monitored under this 5-year cycle.
    - Action: Kent to send all the Monitoring Contract schedule
    - Action: Kent to email Scott Richardson to finalize change in monitoring contact schedule (KP and Grant Creek resurveyed in 2024)
  - Bureau of Land Management (Heidi) – Updated background of project but no expected changes in the work.

FY 2025 Proposed Projects

- 2025 Proposed Projects
  - Arizona Game and Fish (Brian Hickerson)
    - No new projects proposed, indirect went up from 48 to 56%, and expected 3% increase in costs.
    - See presentation HERE for details.
  - New Mexico Fish and Game
    - No new repatriation projects proposed, just continuing existing ones.
      - Tularosa restocking planned in 2025
      - Allred Pond could be a potential topminnow and chub stocking
      - Potential Gila topminnow stocking in Burro Cienaga
    - Remote Site inventory
      - Potentially: Upper Gila Box, Upper San Francisco, or Turkey Creek. Potentially eDNA at some of these sites.
    - Moving New Mexico populations of Spikedace and Loach Minnow to Biopark in Albuquerque, NM
      - Still need to discuss needs and costs. Exploring other hatcheries is a built-in part of the strategic plan.
      - Postpone additional conversations until Spikedace/Loach minnow Hatchery Meeting.
  - BLM
    - Continuing Nonnative Removal effort in Aravaipa and Bonita Creek at the same amount. Heidi is trying to hire technicians and funding request is dependent on other funding sources.
    - No Work Plan requests from New Mexico BLM
  -
- Q&A and Next steps

Information and Education *Betsy Grube, USBR*

- Gila River Basin Video – in progress; see presentation from yesterday.
  - Was scheduled to be completed this winter but is expected to be extended another few months so interviews from fisheries professionals can be included.
- Sharing Tails – Ended
  - Program was overall successful, but Reclamation could not support the continued cost of the program solo.

- Fishes of Arizona Field Guide by Paul Marsh – In Progress
    - Publishing deadline of January 29th but expected to be complete this spring.
- Reclamation will continue to seek out and support future I&E projects. If anyone has project suggestions, please reach out to Betsy at egrube@usbr.gov

Fish Barriers *Kent Mosher, USBR*

- Continued annual inspections on new fish barriers or when there are large flood events.
- Aravaipa Creek – Graffiti was painted over. There have been concerns about access to the barrier, but Reclamation staff feels it is out of scope and they would be unable to maintain. The fence would also be on tribal allotment so there may be issues with restricting access.
- Spring Creek – There were erosion concerns and rock gabions were installed.
- Blue River – Sediment is building up slowly. Someone went out and attempted to pry off metal plates. Reclamation is assessing how best to handle current and future sedimentation issues.
- Bonita Creek – New grate installed last year. There is a large log that needs to be removed. USBR engineers are also concerned with the vegetation growth and are looking into removing some of it and replacing signage.
- Cottonwood – Still functioning.
- Hot Spring – Still functioning.
- West Fork Black River – No updates
- Eagle Creek – ongoing investigations
    - SHA still in draft stage
    - BA drafted by Reclamation
    - NEPA for SHA and barrier construction will be led by Reclamation
    - Initial scoping planned to occur in September 2023 but was pushed back to February 2024.
    - License and Easement agreement – still in progress
    - Construction package to be submitted Feb 2025 with proposed construction in October 2025.
- San Francisco River – ongoing investigation
    - Reclamation visited the site and met with private landowner who would allow for access to the barrier site.
    - Reclamation out this week or next to survey and assess potential hydrological changes/impacts that may occur if structure is improved.
- Verde River – on going investigation
    - Upper Verde River Wild and Scenic Suitability Study EA finalized, and Decision Notice issued. Decision recommends all but two small sections of the Upper Verde River to Congress for designation under the WSR act. Identification of the two sections as not suitable will allow for the consideration of the two proposed fish barriers to be considered in these areas.

Tier 2 Project Discussion

- Review Previous Ideas
- New Ideas
    - Brian: Can unfunded Work Plan projects be added to this in the future?
    - Kent: Potentially. However, funding for multi-year projects is not guaranteed as funds are prioritized towards barrier-related projects and other Reclamation priorities. Availability of funds for “Tier 2” projects is dependent upon barrier-related needs and management approval. We have been able to funds Work Plan projects over 550k in the past with these available funds; however, there is no obligation and we’ve had to cut projects in the past when funding wasn’t available. With the proposed Eagle Creek and Verde River fish barriers, “additional funding” will likely be non-existent or limited.
    - Yvette: requested update on metabarcoding chip
    - Kent: Need to reach out to USFS again to discuss the total # of species per biochip and verify which species markers are available.
    - Action: Yvette will reach out and set up meeting to move the metabarcoding chip along.

  - Action: Kent will evaluate workload and potentially coordinate Betsy taking over metabarcoding chip project.

Wrap-up Next Steps

- 2024 Meting Location and Date: December 10-11th, 2024, in Tucson, AZ
- The virtually meeting was difficult this year, as building wi-fi was not available. But all discussed the importance of the virtual option and emphasized the need for additional coordination to ensure we have all we need.

Adjourn – 10:47

USFWS, Scott Richardson:

Species	Contact and Office	Preferred Contact Information	Lead FWS Region
Gila chub	Ryan Gordon (AESO) TBD (NMESO)-currently vacant	Ryan_gordon@fws.gov	2
Gila topminnow	Scott Richardson (AESO) (Acting)	Scott_richardson@fws.gov	2
Razorback Sucker	Dan Leavitt (AESO) Scott Durst (AESO)	Daniel_leavitt@fws.gov Scott_durst@fws.gov	6
Spikedace and Loach Minnow	Mary Fugate (AESO) Jill Morrow (AESO) Chad Baumler (NMESO) Alana Simmons (NMESO)	Mary_fugate@fws.gov Jill_morrow@fws.gov Chad_baumler@fws.gov Alana_simmons@fws.gov	2

Species	5-Year Review		Revised Recovery Plan		Current Recovery Plan	Species Status Assessment
	FY Initiation	FY Completion	Draft FY	Final FY		
Razorback Sucker	2016	2018	TBD	TBD	2022 Razorback Sucker - Recovery Goals	Final in August 2018 Razorback Sucker SSA 2018
Loach Minnow	2022	2023	2024	2025	1991 Loach Minnow Recovery Plan 2019 Loach Minnow RP Amendment1	Will be completing a biological report, with draft due in 2024
Spikedace	2022	2023	2025	2026	1991 Spikedace Recovery Plan 2019 Spikedace RP Amendment1	Will be completing a biological report, with draft due in 2025
Gila chub			2015			
Gila Topminnow (includes Yaqui Topminnow)	2018	Following completion of SSA	1999	??	1984	?? – shooting for this FY
Chiricahua Leopard Frog	2022	2023			2007 Chiricahua	

					Leopard Frog Recovery Plan	

RECOVERY TASKS – Initiated or Underway in FY2024

Species	Recovery Action	Draft	Fi
Narrow-headed Gartersnake	SSA	Underway	2024
	Five-year Review	Following SSA	2024/2025
	Recovery Plan	2025	
Desert Pupfish	Five-year Review	2025 but dependent on filling Vice Duncan position.	??
Gila Topminnow	Five-year Review	Following SSA	??
Loach Minnow	Recovery Plan	Partially complete	2024
Spikedace	Recovery Plan	2025	2026

Gila River Basin Native Fish Monitoring 2023



Paul C. Reap, Brian R. Kesner, and Paul C. Marsh

Marsh & Associates, LLC

Acknowledgements

ILA RIVER BAS
ATIVE FISH
NSERVATION PROGR

U.S.
FISH & WILDLIFE
SERVICE

ARIZONA
GAME & FISH

The Nature
Conservancy

NEW MEXIC
GAME & FIS

Sampling Design and Methodology

50 monitoring sites

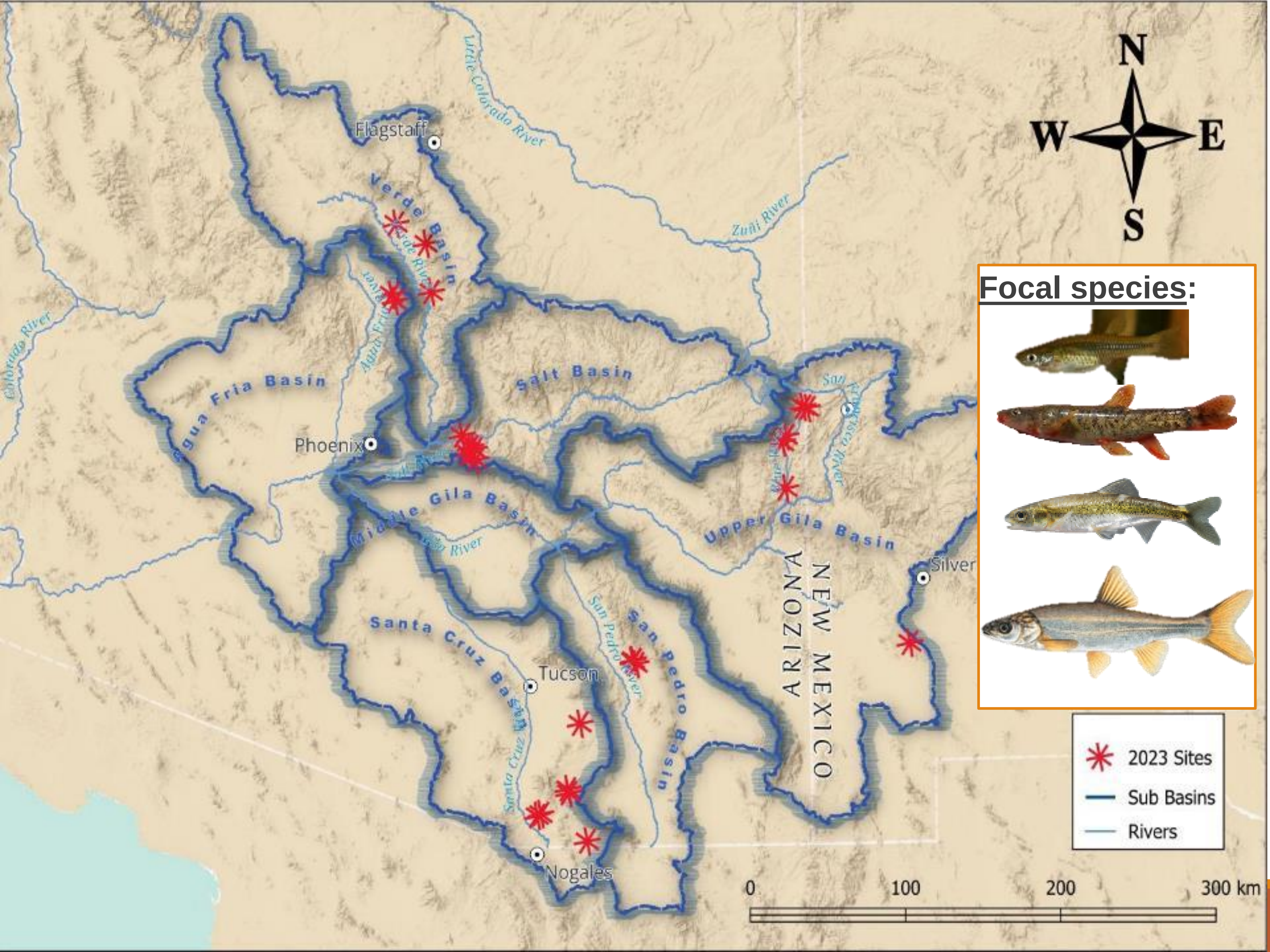
- 9 Surveyed Annually
- Rest are on a 3- or 5-year rotation

Gear type specific to focal species and water type (spring pools, ponds, streams, rivers)

Number of sampling stations cover a minimum of 20% of available habitat throughout the survey reach

- Station length typically 100 meters (200-m in NM)

Sites consist of at least 1 fixed station and the remaining stations are randomly selected.


N
W
E
S
Flagstaff
Little Colorado River
Zuñi River
Verde Basin
Colorado River
Agua Fria Basin
Salt Basin
Phoenix
Middle Gila Basin
Gila River
Upper Gila Basin
Silver
Santa Cruz Basin
Tucson
San Pedro Basin
San Pedro River
Santa Cruz River
Nogales
ARIZONA
NEW MEXICO
Focal species:
2023 Sites
Sub Basins
Rivers
0
100
200
300 km

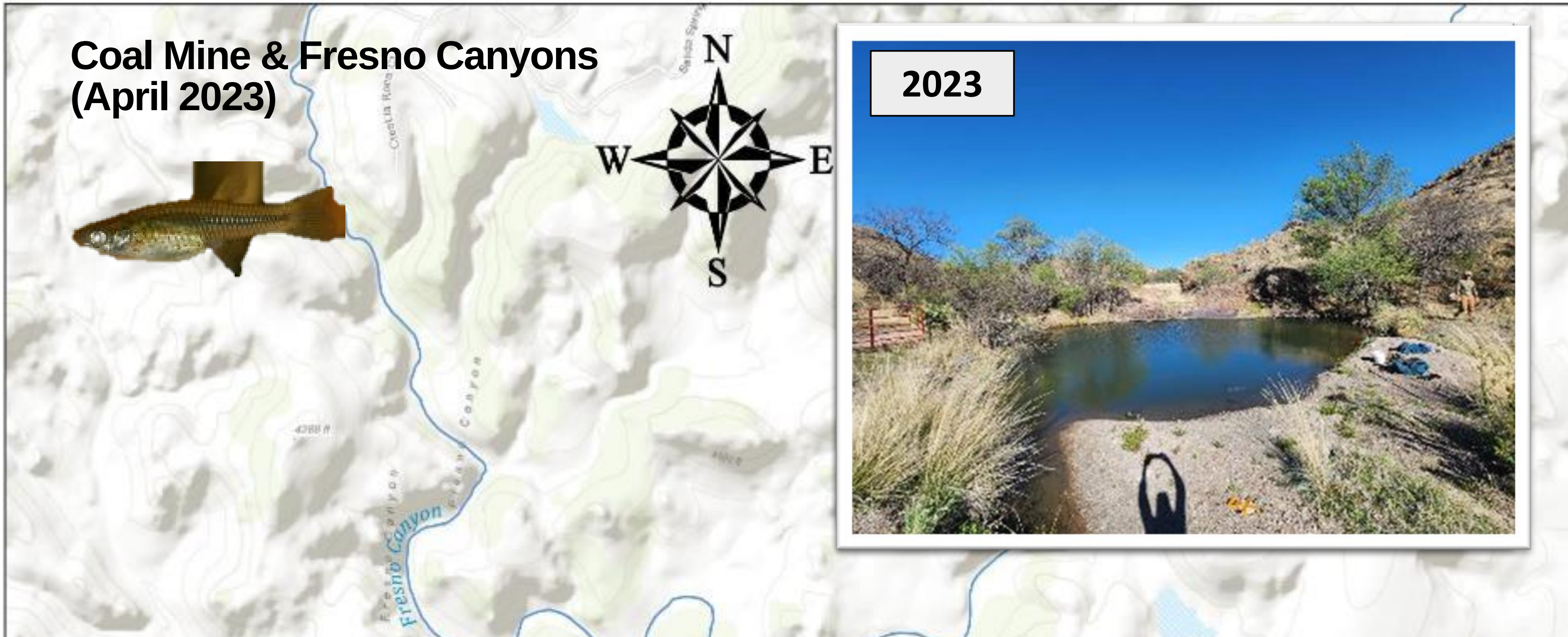
Gila

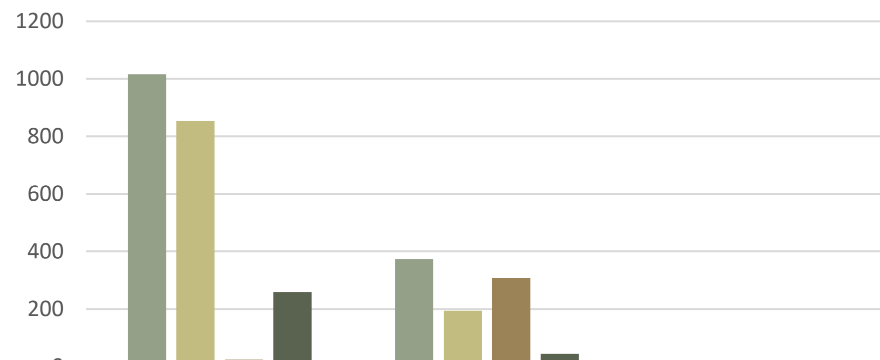
Stream	2023 Catch	Last Surveyed for GRBMP	Previous Catch
Cottonwood Spring	**173**	2022	292
Monkey Spring	**103**	2022	225
Burro Cienaga	**0**	2018	4
Charlesbois Spring	**24**	N/A	-
La Barge Creek	**42**	2020	2,367
Fossil Creek	**0**	2020	*0
Hidden Water Spring	**0**	2015	0
Spring Creek	**166**	2022	0
Headquarters Spring	**1,945**	N/A	-
Cienega Creek*	**0**	2022	6
Mesquite Creek	**35**	N/A	-
Tortilla Creek (upper and lower)	**24**	N/A	-
Wildcat Canyon	**393**	2020	737

Legend
- Detected
- Not Detected

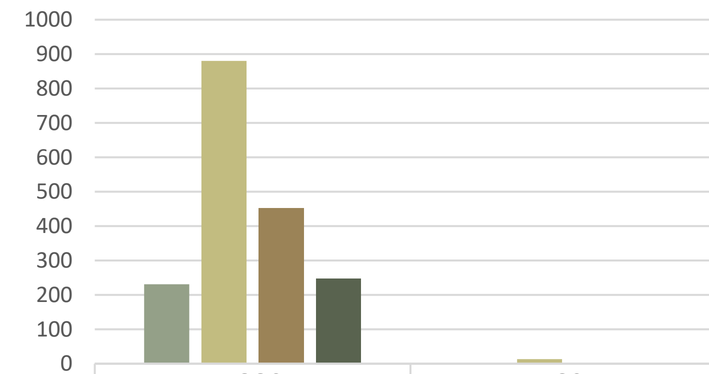
0 50 100 150 km

Coal Mine & Fresno Canyons (April 2023)





	POOC	AGCH	LECY
2023	1016	374	0
2022	853	194	1
2021	24	308	0
2019	259	44	0

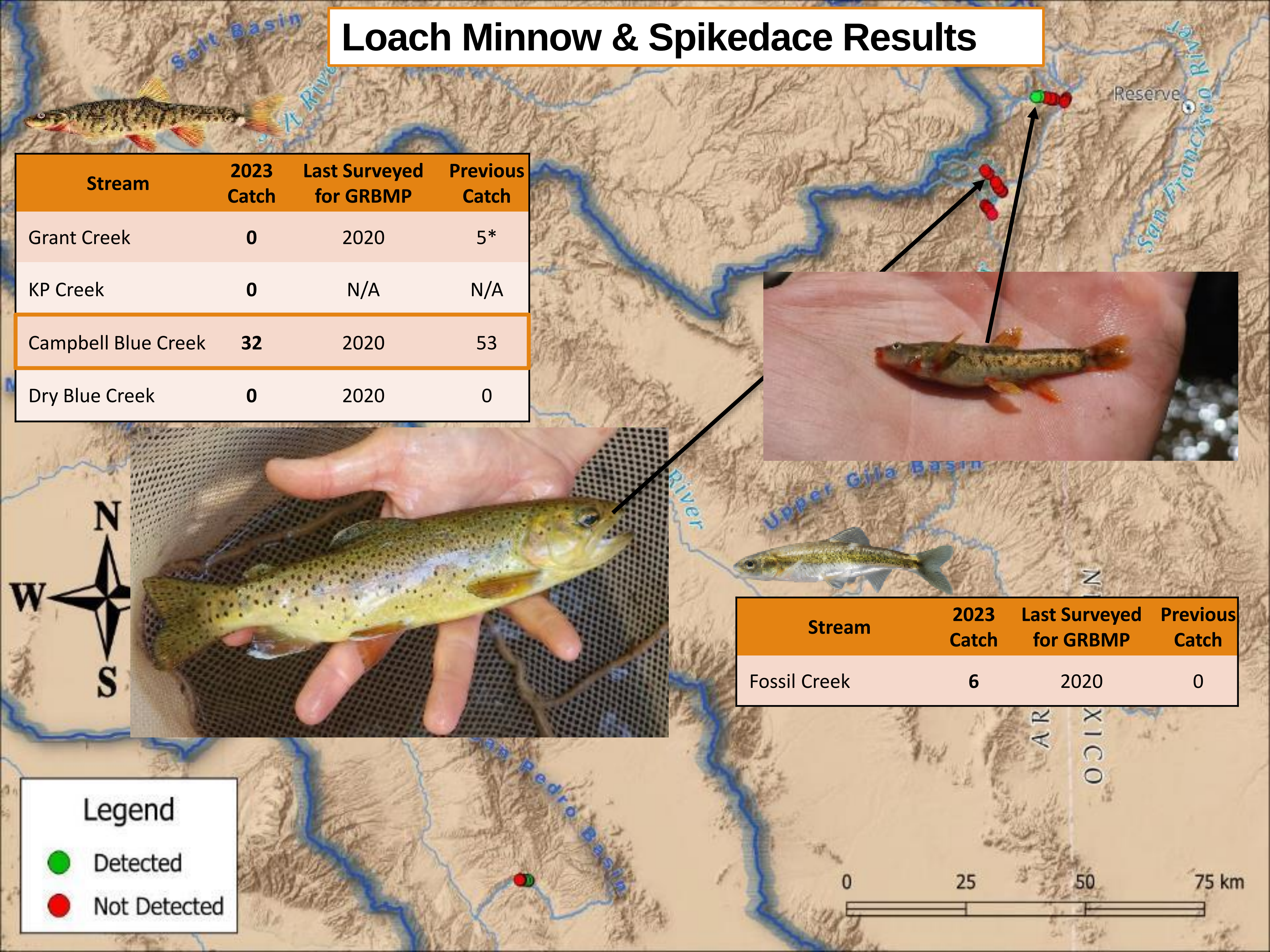


	POOC	AGCH
2023	231	1
2022	880	13
2021	452	0
2019	247	0

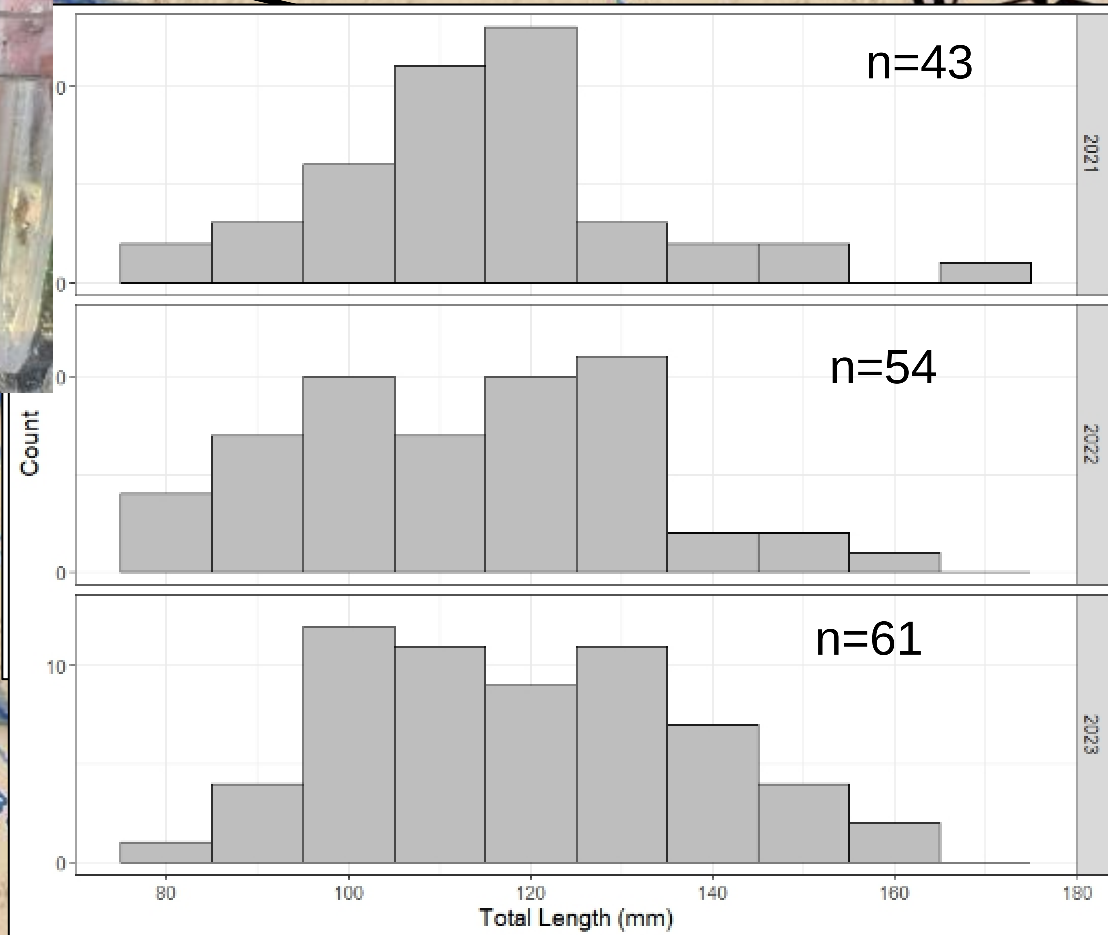
Loach Minnow & Spikedace Results

Stream	2023 Catch	Last Surveyed for GRBMP	Previous Catch
Grant Creek	**0**	2020	5*
KP Creek	**0**	N/A	N/A
Campbell Blue Creek	**32**	2020	53
Dry Blue Creek	**0**	2020	0

Stream	2023 Catch	Last Surveyed for GRBMP	Previous Catch
Fossil Creek	**6**	2020	0



Gila Chub Results

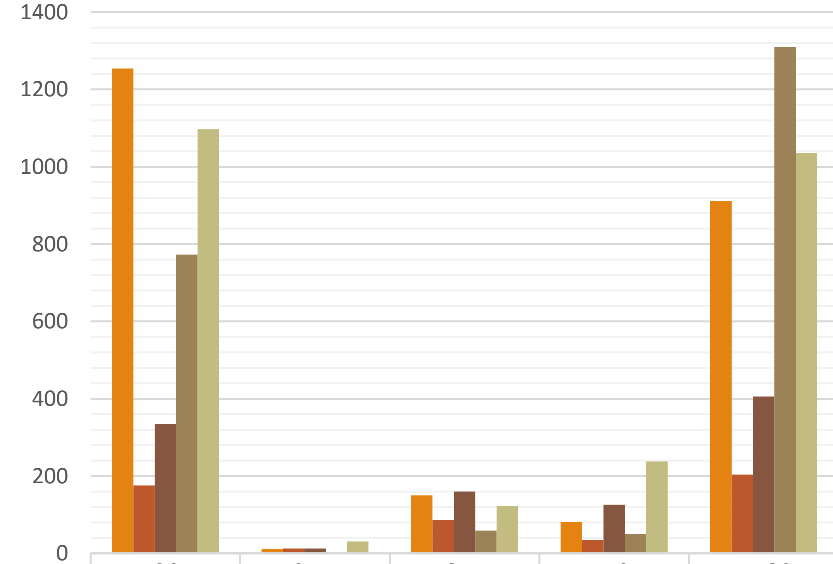


Stream	2023 Catch	Last Surveyed for GRBMP	Previous Catch
Sheehy Spring	**61**	2022	54
Walker Canyon	**83**	2020	26
Sycamore Creek	**68**	2018	12
Little Sycamore Creek	**12**	2019	22

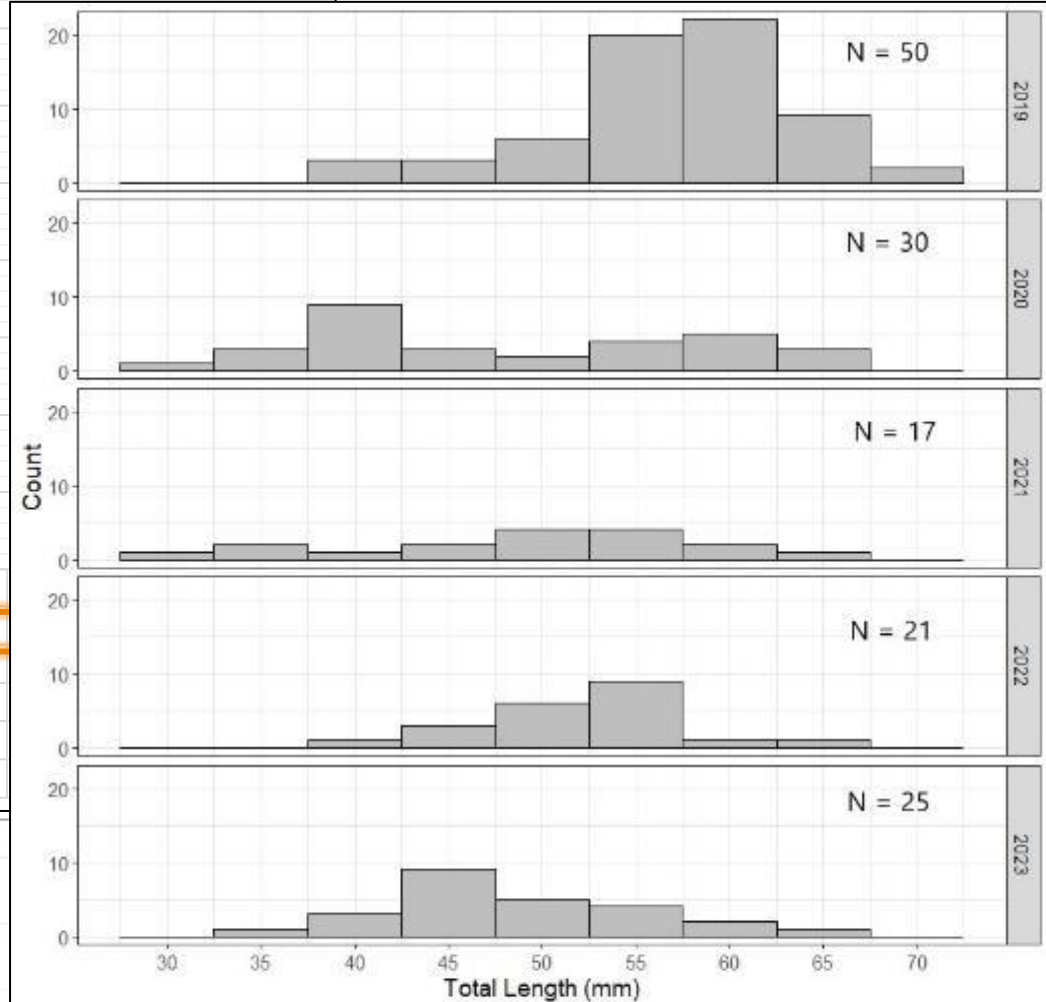
Legend
Detected
Not Detected

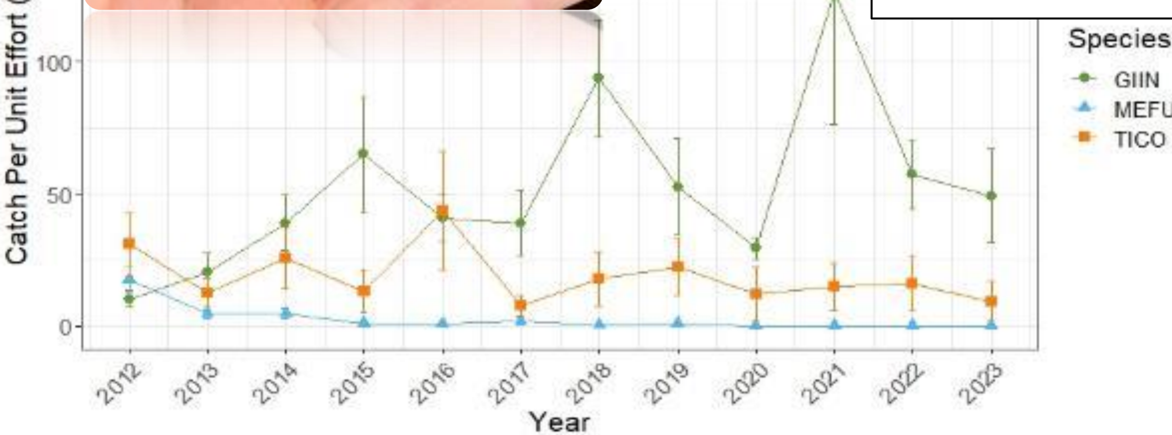
0 50 100 150 km

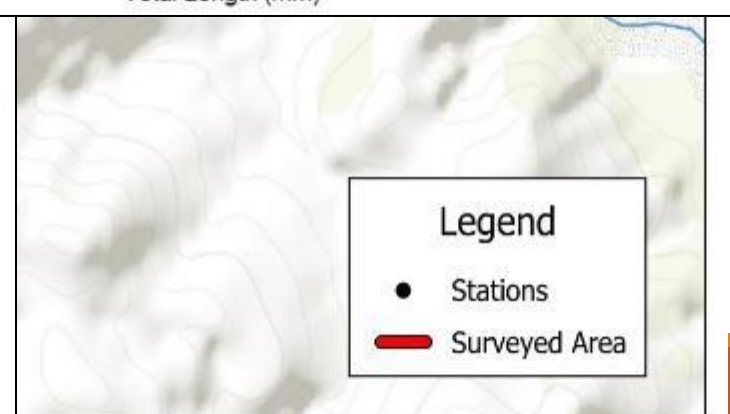
Nogales

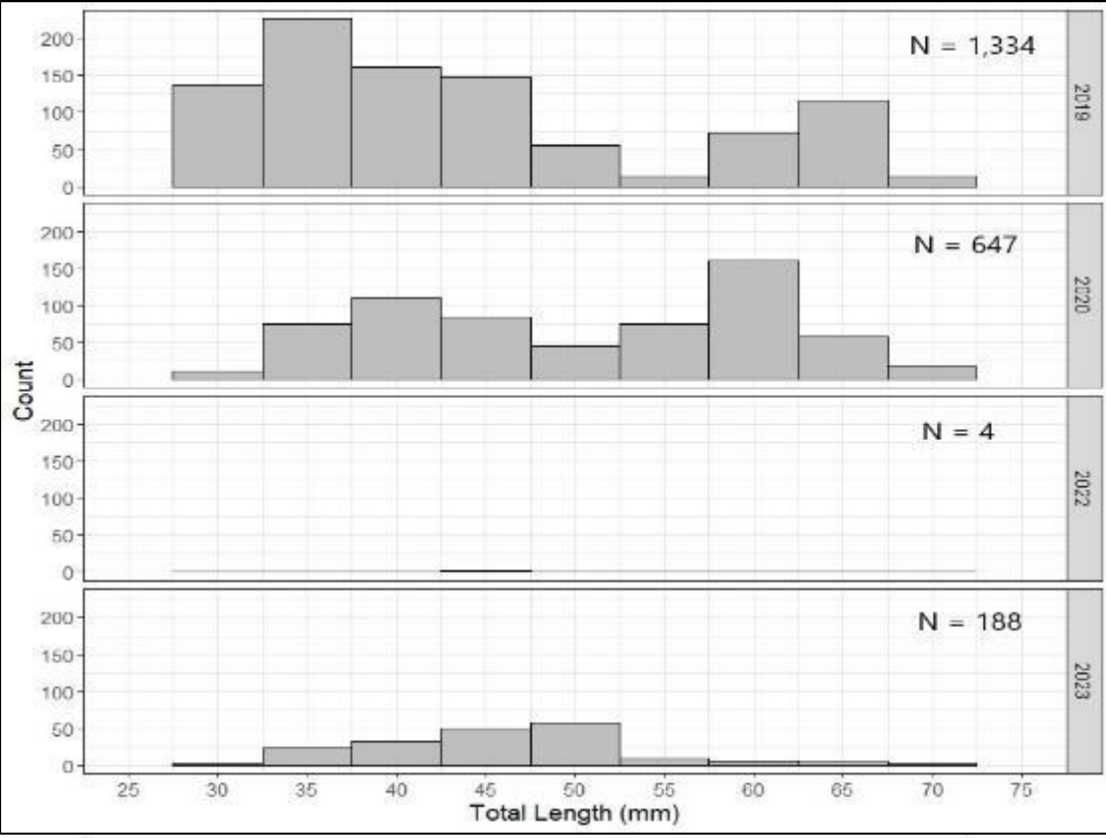


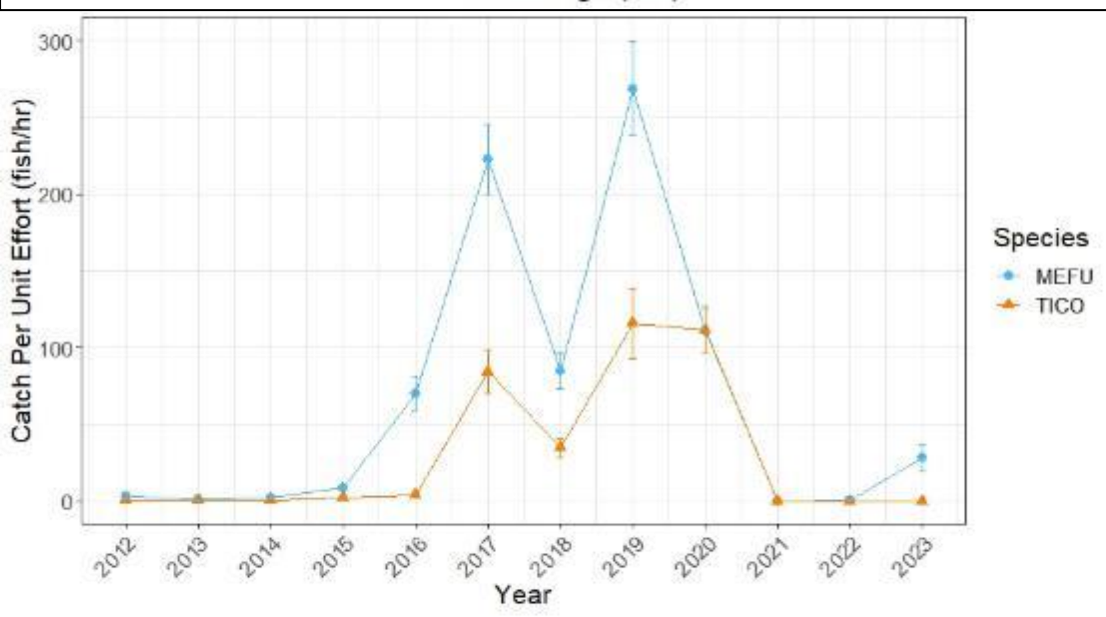
	AGCH	CAIN	GIIN	PACL	RHOS
2023	1254	11	150	81	912
2022	176	13	86	35	204
2021	335	13	160	126	406
2020	773	2	59	51	1309
2019	1097	31	123	238	1036








N = 1,334
2019
N = 647
2020
N = 4
2022
N = 188
2023
Count
0
50
100
150
200
25
30
35
40
45
50
55
60
65
70
75
Total Length (mm)


Catch Per Unit Effort (fish/hr)
0
100
200
300
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year
Species
MEFU
TICO


LBL64
LBL58
3655000N
0
0.75
1.5
2.25
3 km

2023 Summary

Stream	AGCH	CAIN	GAAF	GIIN	GIRO	MEFU	ONAP	ONMY	PACL	POOC	RHOS	SATR	TICO
Burro Cienega	-	-	-	-	-	-	-	-	-	-	-	-	-
Campbell Blue Creek	187	10	-	-	-	-	-	-	181	-	926	13	32
Charlesbois Spring	-	-	-	-	-	-	-	-	-	24	-	-	-
Cienega Creek	1173	-	-	-	-	-	-	-	-	-	-	-	-
Coal Mine Canyon	1	-	-	-	-	-	-	-	-	231	-	-	-
Cottonwood Spring	-	-	-	-	-	-	-	-	-	173	-	-	-
Dry Blue Creek	23	-	-	-	-	-	-	-	-	-	419	8	-
Fossil Creek*	82	100	-	-	2835	6	-	-	329	-	345	-	-
Fresno Canyon	374	-	-	-	-	-	-	-	-	1016	-	-	-
Grant Creek	3	1	-	-	-	-	90	-	31	-	175	3	-
Headquarters Spring	-	-	-	-	-	-	-	-	-	1945	-	-	-
Hidden Water Spring	81	-	-	-	-	-	-	-	-	-	-	-	-
Hot Springs Canyon	1254	11	-	150	-	-	-	-	81	-	912	-	25
KP Creek	3	8	-	-	-	-	-	-	92	-	193	13	-
La Barge Creek	-	-	-	-	-	-	-	-	-	42	-	-	-
Little Sycamore Creek	8	-	-	12	-	-	-	-	-	-	-	-	-
Lower Blue River	1128	763	-	-	471	188	-	-	1729	-	1068	-	-
Lower Tortilla Creek	-	-	-	-	-	-	-	-	-	7	-	-	-
Mesquite Creek	-	-	-	-	-	-	-	-	-	35	-	-	-
Monkey Spring	-	-	-	-	-	-	-	-	-	103	-	-	-
Sheehy Spring	-	-	16	61	-	-	-	-	-	-	-	-	-
Spring Creek	505	-	-	325	-	-	-	-	1	166	293	-	-
Sycamore Creek	-	2	-	68	-	-	-	2	-	-	-	-	-
Upper Tortilla Creek	-	-	-	-	-	-	-	-	-	17	-	-	-
Walker Canyon	-	-	-	83	-	-	-	-	13	-	80	-	-
Wildcat Canyon	-	-	-	-	-	-	-	-	-	393	-	-	-
Total	4822	895	16	699	3306	194	90	2	2457	4152	4411	37	57

Year	Trap Effort (hrs)	Trap Catch	Trap CPUE (hr)	BPEF Effort (sec)	BPEF Catch	BPEF CPUE (hr)
2021	877.1169444	***6814***	***7.768633411***	47290	5329	405.6756185
2022	1126.294958	6309	5.601552203	32302	2274	253.4332239
2023	***998.8219192***	6544	6.551718454	***50718***	***10466***	***742.8841831***

- 13
- 98.12%
- 10,466
- 6,448
- 50,718 seconds
- 998.8 hours

2024 Monitoring Schedule

Region(s)	Start Date	End Date	Site #1	Site #2	Site #3	Site #4
5	April 8, 2024	April 10, 2024	Cottonwood Spring	Monkey Spring	Coal Mine Canyon	Fresno Canyon
5	April 22, 2024		Sheehy Spring			
6	May 6, 2024	May 8, 2024	AD Wash	Buckhorn Spring	Tule Creek	Morgan City Wash
1	June 10, 2024	June 14, 2024	Middle Blue River			
1	August 5, 2024	August 8, 2024	*East Fork Black River Watershed*			
1	August 19, 2024	August 22, 2024	Dix Creek	Harden Cienega		
5	September 10, 2024	-	Cienega Creek			
5	September 16, 2024	September 19, 2024	Hot Springs Canyon	Bass Canyon		
2	September 24, 2024	-	Spring Creek			
1	October 7, 2024	October 10, 2024	Lower Blue River			
NM	October 21, 2024	October 24, 2024	Lower Turkey Creek	Bear Creek		
5	November 4, 2024	November 7, 2024	Romero Canyon	Sabino Canyon	Bear Canyon	

Focal Species Key
Gila Topminnow
Gila Chub
Loach Minnow
Gila Topminnow/Gila Chub
Spikedace/Loach Minnow
Gila Chub, Loach Minnow, Spikedace

Questions?

Email: preap@nativefishlab.net

Gila Topminnow Genetic Management Plan

Photo Credit: J. Sartore

Steve Mussmann

U.S. Fish & Wildlife Service

Abernathy Fish Technology Center

12/11/2023

GILA RIVER BASIN NATIVE FISHES CONSERVATION PROGRAM

Acknowledgements

- AZGFD
  - Brian Hickerson
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  - Steven Ingram
  - Jennifer Smith-Castro
  - Wade Wilson

Outline

- Genetic Profile
  - What patterns do we see in the distribution of Gila Topminnow genetic diversity among populations?
  - How does this relate to Gila Topminnow life history and conservation management?

- Genetic Management Plan
  - Needs for proper genetic management.
  - Suggestions for mitigating further loss of genetic diversity.

Genetic Profile

- Mussmann et al. 2022
  - 43 localities
  - 2,065 samples

- Results:
  - Low genetic diversity
  - Low N_E
  - Genetic bottlenecks
  - Non-native species in Santa Cruz River (*P. monacha-occidentalis*)

- Impacts of translocation events evident in genetic data

SCAN ME

Relevant Population Genetic Concepts

- Genetic Drift
  - Changes in population allele frequencies due to random chance
  - Occurs in all populations, but effects more evident in small populations

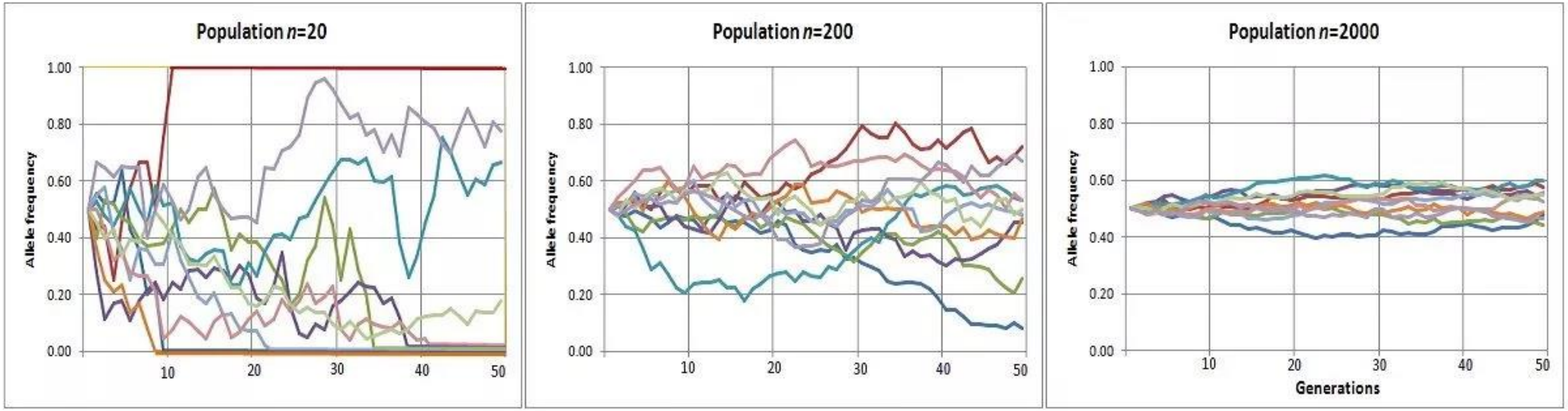


Figure reproduced from https://biologydictionary.net/genetic-drift/

Relevant Population Genetic Concepts

- Founder effect
  - Reduced genetic diversity that can result when a small number of individuals colonizes a new area

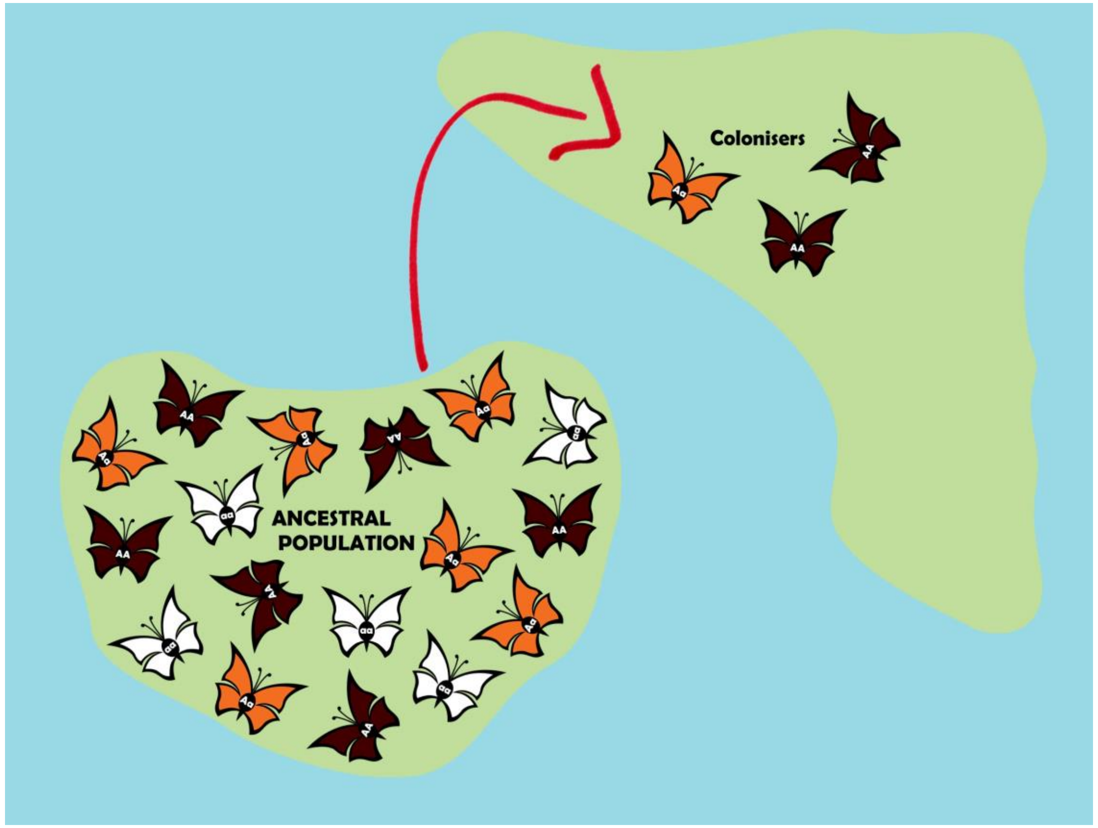
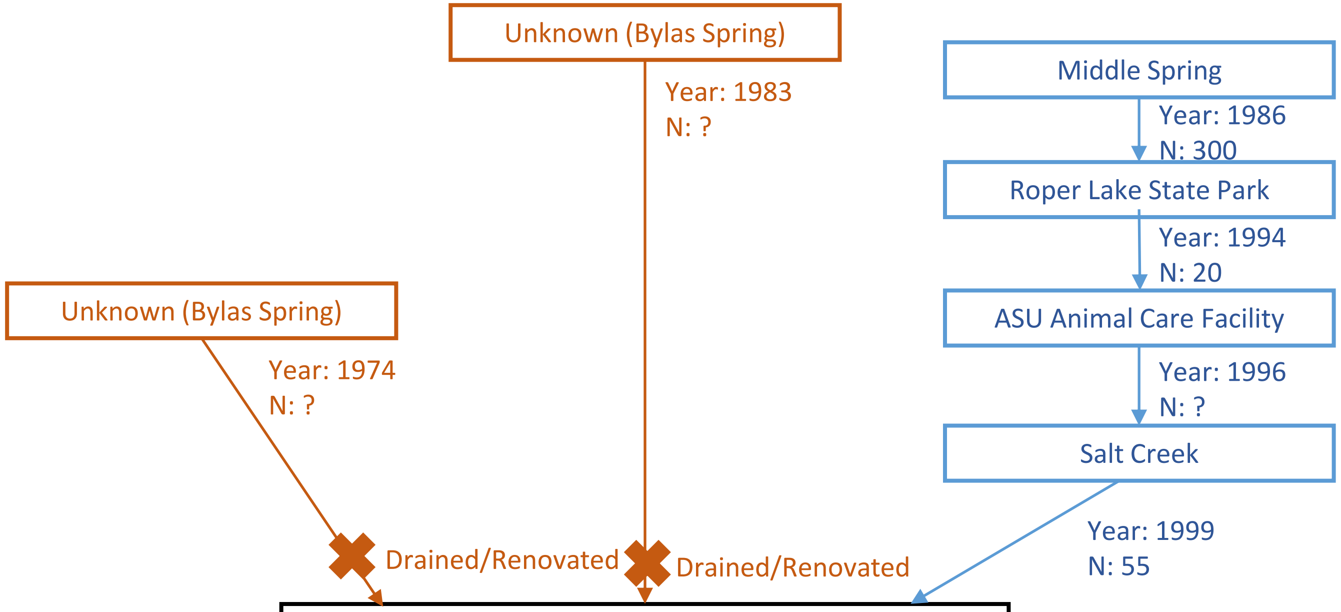


Figure reproduced from: https://www.pathwayz.org/Tree/Plain/FOUNDER+EFFECT

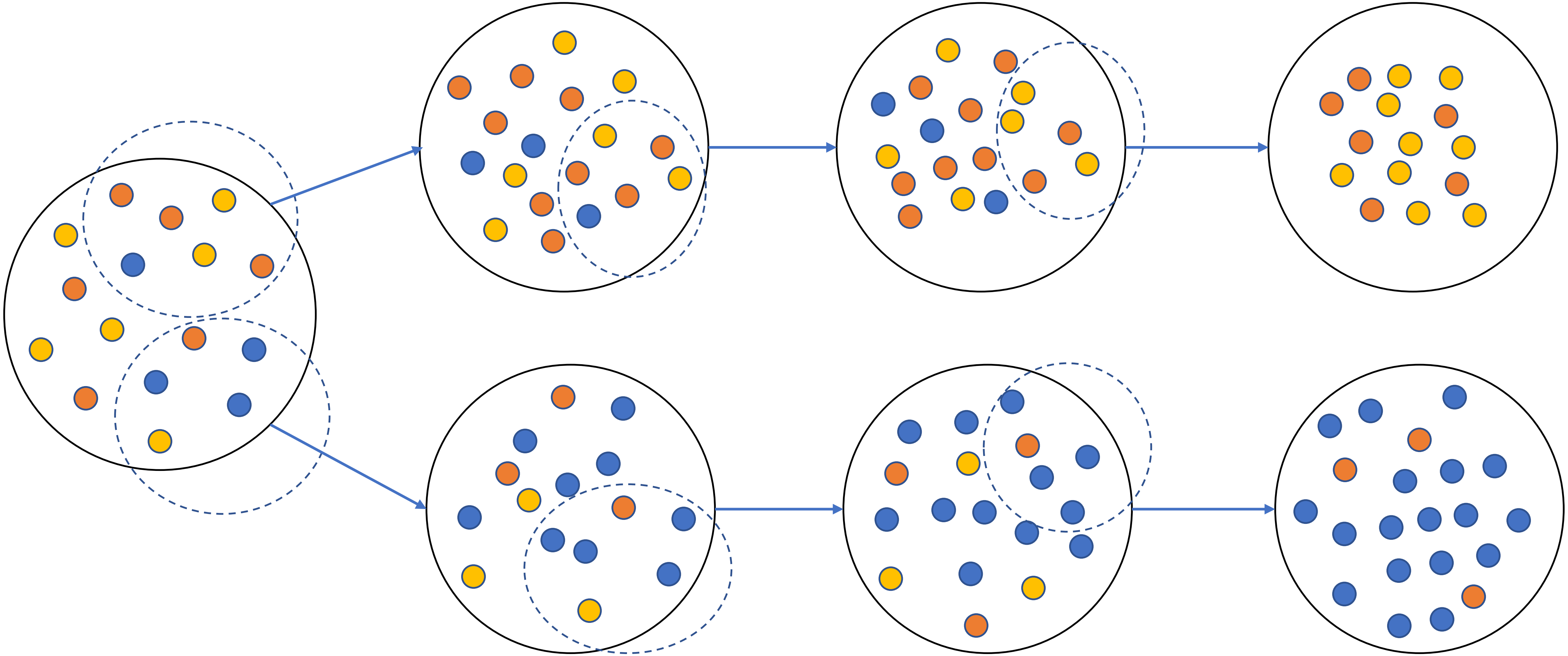
Stocking Set #1: Stocking Set #2: Stocking Set #3:



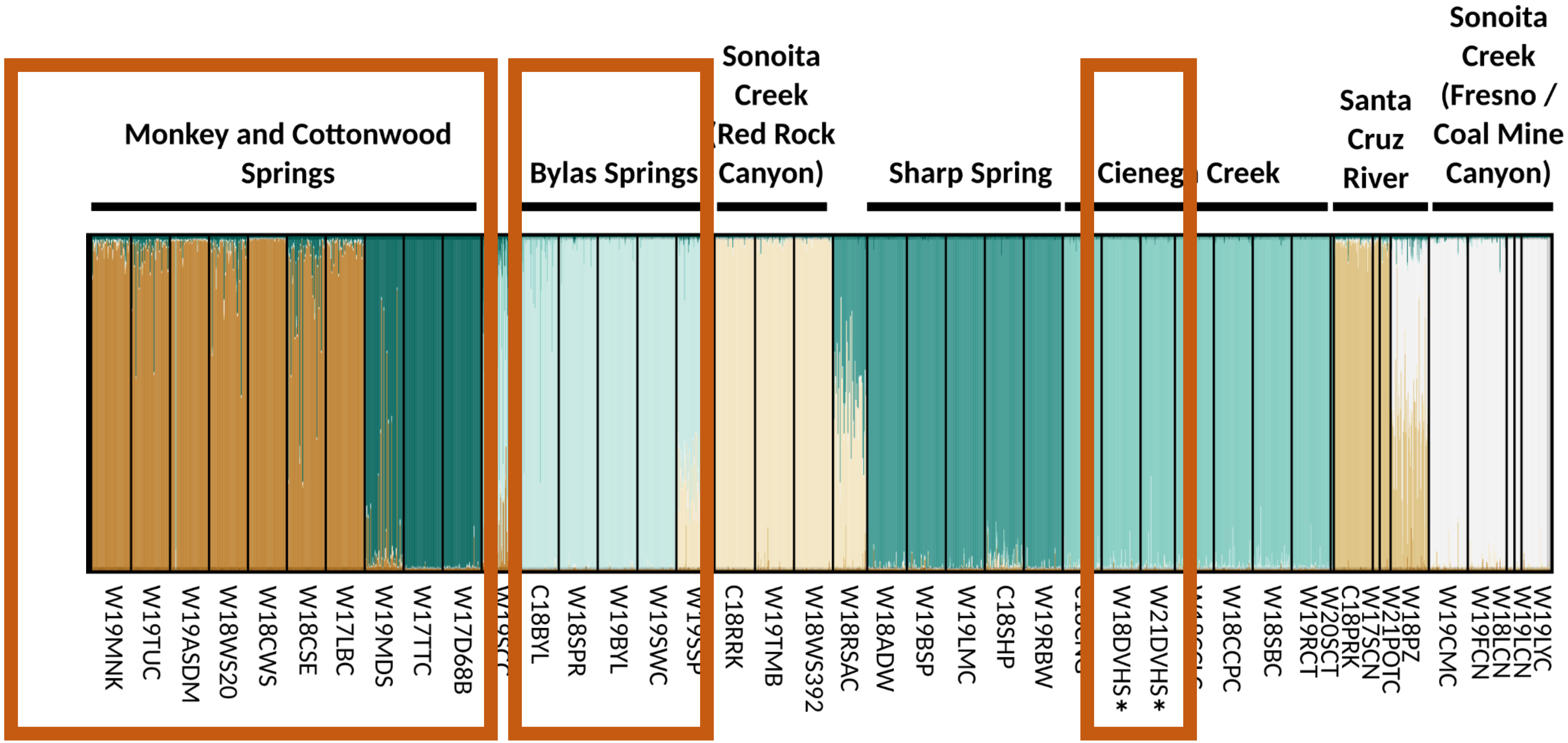
Deer Valley High School (#113)

- Gila Topminnow were stocked into the pond in 1974 and 1983; however, the pond was invaded by Western Mosquitofish and was drained/renovated in 1990 and 1997.
- In 1999, 55 Gila Topminnow were stocked into Deer Valley High School from Salt Creek.

Serial Translocation



Impacts of Genetic Drift and Founder Effect are Evident in Population Structure Results



Impacts of Genetic Drift and Founder Effect are Evident in Population Structure Results

Locus	Bylas Springs (ASU)	Deer Valley High School	Lower San Pedro River Preserve Pond	Bylas Spring Complex	Swamp Springs Canyon
Pocc02	203	203	203	203	203
Pocc03	181	181	181	181	181
Pocc07	169	169	169	169	169
Pocc09	-	-	177	177	177
Pocc15	159	159	159	159	-
Pocc16	-	-	-	-	186
Pocc18	-	-	-	-	-
Pocc21	127	127	127	127	127
Pocc25	-	-	-	356	356
Pocc26	-	-	-	-	-
Pocc27	-	-	-	-	-
Pocc28	207	207	207	207	207
Pocc29	197	-	-	-	197

Impacts of Genetic Drift and Founder Effect are Evident in Population Structure Results

Locus	Bylas Springs (ASU)	Deer Valley High School	Lower San Pedro River Preserve Pond	Bylas Spring Complex	Swamp Springs Canyon
Pocc02	203	203	203	203	203
Pocc03	181	181	181	181	181
Pocc07	169	169	169	169	169
Pocc09	-	-	177	177	177
Pocc15	159	159	159	159	-
Pocc16	-	-	-	-	186
Pocc18	-	-	-	-	-
Pocc21	127	127	127	127	127
Pocc25	-	-	-	356	356
Pocc26	-	-	-	-	-
Pocc27	-	-	-	-	-
Pocc28	207	207	207	207	207
Pocc29	197	-	-	-	197

Current State of Gila Topminnow Populations

- Overall genetic diversity within any management unit (MU) is distributed among multiple sites rather than replicated among those sites.

- Populations are isolated from one another with no potential for gene flow among populations.

- Loss of any population carries risk for permanent loss of diversity.

Needs

- Minimize further loss of diversity
  - Ease pressures on donor sites.
  - Found new populations using adequate individuals to mitigate founder effect.
- Biosecurity
- Facilitate gene flow among populations of the same MU.

Suggested Actions

- Establish or designate ‘Primary Donor Sites’
  - Accessible
  - Large population size
  - Regularly visited/monitored
  - Two or more per MU

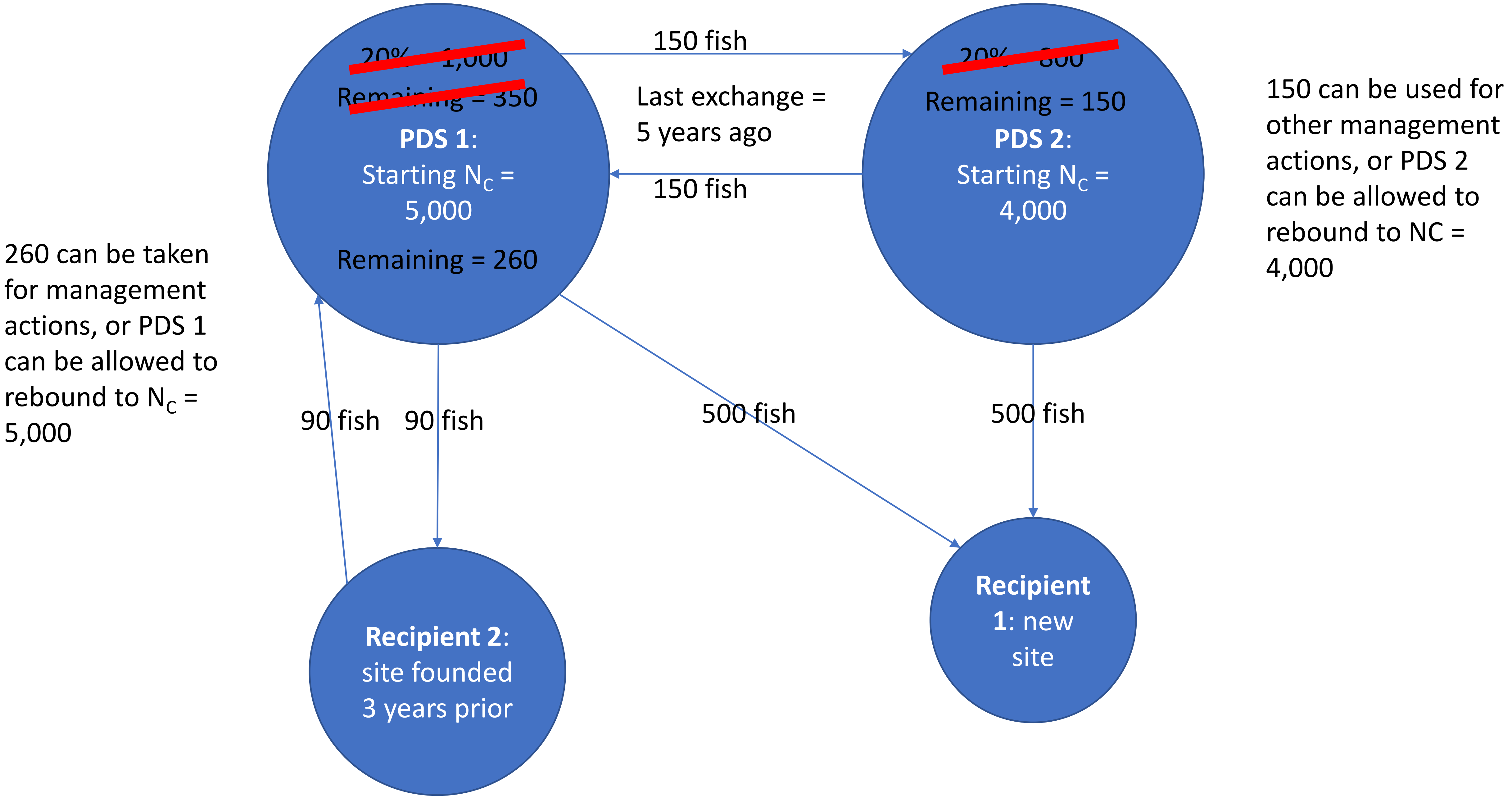
- Found new populations from ≥2 donor sites.

- Facilitate gene flow among populations (emphasis: donor sites)

Number of Fish for Management Actions?

- Reviewed similar cases in literature
  - Utilize maximum of 20% of ‘Primary Donor Site’ N_C before allowing population to rebound.

- Number of migrants per generation
  - 1 effective migrant per generation
  - N_E/N_C ratio
    - N_E values from Mussmann et al. 2022
    - N_C values from AZGFD downlisting petition
    - Mean N_E/N_C = 0.068
    - ~15 individuals = 1 effective migrant per generation


~~20% = 1,000~~
~~Remaining = 350~~
PDS 1:
Starting N_C = 5,000
Remaining = 260
150 fish
Last exchange = 5 years ago
150 fish
~~20% = 800~~
Remaining = 150
PDS 2:
Starting N_C = 4,000
150 can be used for other management actions, or PDS 2 can be allowed to rebound to NC = 4,000
260 can be taken for management actions, or PDS 1 can be allowed to rebound to N_C = 5,000
90 fish
90 fish
500 fish
500 fish
Recipient 2: site founded 3 years prior
Recipient 1: new site

Suggested Actions (continued)

- Develop 5-year augmentation plan (AZ FWCO or AZGFD).
- Conduct genetic evaluation ~5 years after implementing GMP to see if actions are having desired impact.
- Conduct genetic evaluation of any newly discovered Gila Topminnow populations.

Genetic Management Plan Timeline

- 9/29/2023
  - Plan sent for review
- 12/31/2023
  - Receive feedback from reviewers
- 2nd Quarter FY2024
  - Address comments; send revised plan

Questions?

Email: steven_mussmann@fws.gov

Genetic Diversity of US and Mexico Topminnow Populations: a project update

R23AP00362

start date 08/01/2023

Mariana Mateos

Ecology and Conservation Biology, Texas A&M University

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- Alanna Fulkerson and Angela Haggard (Texas A&M Univ)
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- Steven Mussmann (USFWS)
- Wade Wilson (USFWS)
- Elizabeth Grube (USBR, formerly AZGFD)
- Kent Mosher (USBR)
- Kin-Lan Han (USFWS)
- Chuck Minckley (retired)
- 2022-23 season: Rancho El Aribabi, Sky Island Alliance (Monica Montaño, Angel García, Miguel Enriquez), Biol. Luis Fernando Duarte
- Constantino Macias & Edgar Avila (UNAM) for help with permits
- Robert Vrijenhoek (retired) and former lab members (Oris Sanjur, Luis Hurtado, Joe Quattro)
- Dean Hendrickson (Univ. Texas Austin)
- Funding: USBR R23AP00362, Universidad de Sonora, Desert Fishes Council and Mohamed bin Zayed Conservation Fund for *Poeciliopsis jackschultzi* (Rio Concepcion Topminnow), Texas A&M Univ seed funds for molecular evolution of asexual hybrids

Background

- In the US, the Gila Topminnow has experienced severe declines over the past century, mostly because of habitat degradation and the introduction of nonnative species (USFWS 1998), particularly the Western Mosquitofish (*Gambusia affinis*).

- Recovery efforts have led to the re-establishment of Gila Topminnow at several stretches of the Gila River.

- A recent study developed numerous microsatellite markers and used them to characterize genetic diversity in a subset of the US populations sampled between 2017 and 2021 (Mussmann et al. 2023).

- The same team analyzed a larger number of populations and reported low levels of genetic diversity (low heterozygosity and a small number of alleles per locus) in all but one population (i.e., Santa Cruz River), consistent with the low population sizes experienced by this species over the last century.

Goal

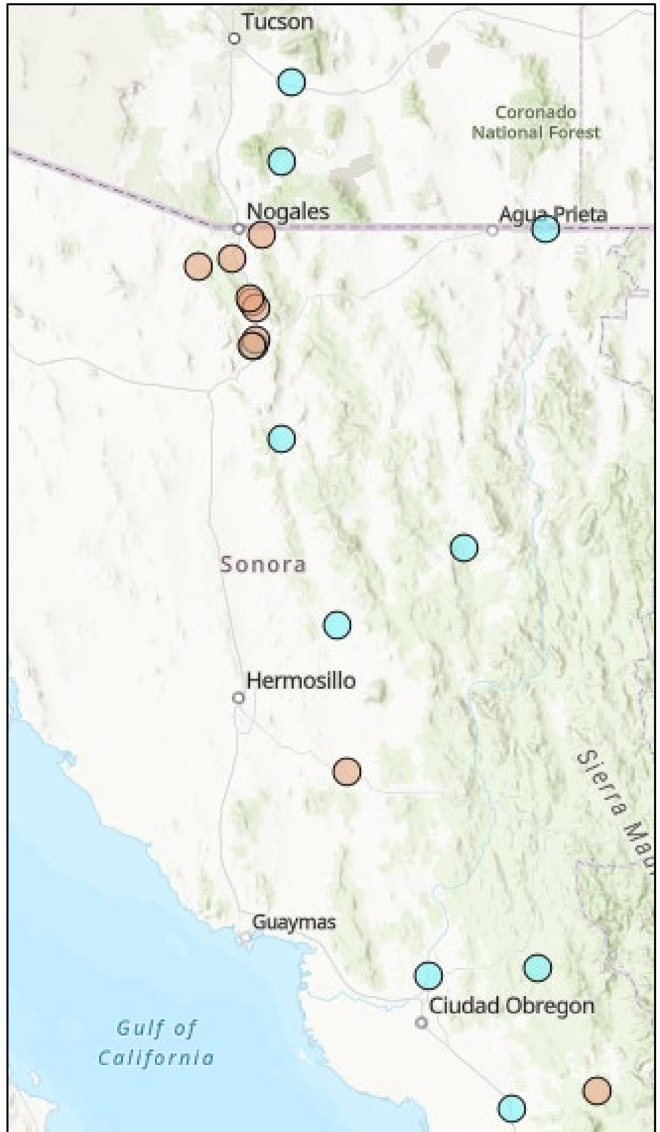
- compare the patterns of genetic diversity over space and time among the US and Mexican populations of the Gila (and Yaqui) topminnow, with the set of microsatellite markers already characterized for Arizona captive and wild populations (Mussmann et al. 2021; Mussmann et al. 2023).

Update

- ~140 individuals from 6 Mexican localities **ready** for microsatellite work

- Geographical sampling (**Mexico**) includes the following rivers:
  - Santa Cruz
  - De La Concepción
  - Sonora
  - Matape
  - upper and lower Yaqui
  - upper and lower Mayo

- Arizona samples are "old" (pre-1990's)
- Mexico samples include "old" (pre-2000's) and 2022-23



ready = DNA extracted & species ID confirmed based on mitochondrial gene sequence

pending = specimens in freezer at Texas A&M or Univ. Sonora


The Aquatic Research and
Conservation Center's
2023 year in review

ARCC 2023 objectives:

- Stock fish remaining from previous spawns
- Continue research on tagging options for brood stock management
  - Continue 1st year of VIE tag retention and mortality study
  - Start a second round of VIE fish for retention and mortality
  - Look into other tagging options such as PIT
- Conduct annual Spikedace and Loach Minnow propagation and research
  - Continue looking at Loach Minnow nest spacing as way to increase brood per tank during spawn
  - Spawn all lineages of both species for stocking and refuge
- ARCC infrastructure
  - Phase 3 of planned expansion

Feb 21st 2023

- Stocked **650** Gila River Spikedace
- Stocked **2096** Eagle Creek Roundtail Chub

Stocked in to lower Blue River

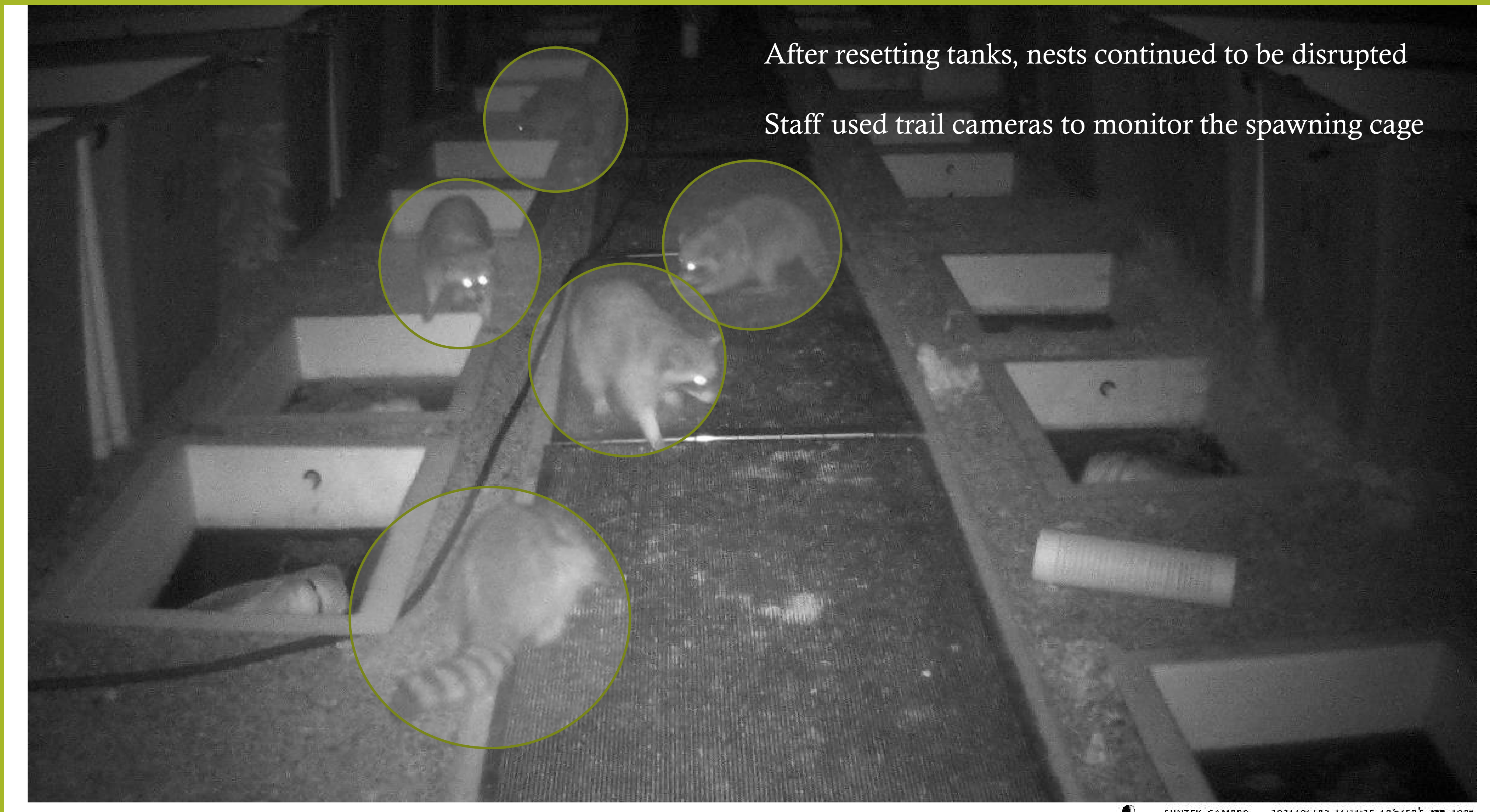
Feb 28th 2023

- Stocked **1017** Gila River Spikedace
- Stocked **4544** Eagle Creek Roundtail Chub

Stocked into upper Blue River and ponds

Spawn tank setup was completed in early April

At the end of April staff noticed nest disruption
and attempted reset the affected tanks


After resetting tanks, nests continued to be disrupted
Staff used trail cameras to monitor the spawning cage
SUNTEK CAM000 2021/01/03 11:11:25 10°C/50°F 100%

Emergency lids were built and multiple raceways were unsuccessfully reset for spawn in mid May

Trapping attempts using various traps were unsuccessful

No specific point of entry was found

Unsalvageable spawn season

Hatchery hurdles for the GRBNFCP

- Lack of a brood stock management plan (needs genetic management plan)
- Lack of genetic management plan (needs brood stock management plan)
- Multiple lineages of multiple species
  - Increased chance of lineage mixing
- Lack of funding for regular genetic testing
  - Increased chance of lineage mixing
- Low wild counts during surveys
  - Hesitancy to "over collect"
    - Low collection counts for brood stock
  - Low wild genetic input into brood stock
- Insufficient stocking locations for most lineages
  - Results in logistics problems for spawn and holding
- Short lived species
  - Brood stock is not refuge
- Establishment of new wild populations
  - Hesitancy to "overstock"
  - Historically difficult
- Lack of research into spawn triggers
- Lack of funding for expansion of property
  - Phase 3 money returned to BOR
- Lack of staff housing results in hiring and retention issues

Spawn season 2023

Species	Lineage	Raceways	Brood start	Brood end	Larvae	%M Brood
Spikedace	Aravaipa	A6	143	113	0	20.98%
Spikedace	Gila River	B4	125	72	0	42.40%
Spikedace	Gila Forks	B6	109	96	0	11.93%
Loach Minnow	Aravaipa		184	174	0	5.43%
Loach Minnow	Blue River	A1,A3,A5,B1,B3, B5	229	127	0	44.54%
Loach Minnow	Bear Creek	A4	68	21	0	69.12%
Loach Minnow	Gila Forks	A2	52	40	0	23.08%
Loach Minnow	San Francisco	B2	84	51	0	39.29%

Current brood counts

Species	Lineage	Brood count	Last wild caught	Last wild caught date	#needed from wild	# To add to brood
Spikedace	Aravaipa	180	67	2023	320	23
Spikedace	Gila River	72	75	2019	428	14
Spikedace	Gila Forks	96	52	2021	404	19
Loach Minnow	Aravaipa	174	56	2023	326	35
Loach Minnow	Blue River	222	95	2023	278	25
Loach Minnow	Bear Creek	0	221	2020	0	0
Loach Minnow	Gila Forks	40	102	2021	460	8
Loach Minnow	San Francisco	51	41	2013	449	10
Roudtail Chub	Eagle Creek	50	?	2012	450	10

Total stockable fish minus added to brood

Loach Minnow	Aravaipa	31
Loach Minnow	San Francisco	0
Loach Minnow	Bear Creek	0
Loach Minnow	Blue River	46
Loach Minnow	Gila Forks	88
Spikedace	Aravaipa	0
Spikedace	Gila River	0
Spikedace	Gila Forks	1588
Roudtail Chub	Eagle Creek	0

Solution suggestions

- Lack of a brood stock management plan (needs genetic management plan)
  - Establish a working group to divide and conquer sections of a brood stock management plan
- Lack of genetic management plan (needs brood stock management plan)
  - Establish a working group to divide and conquer sections of the genetics management plan
- Multiple lineages of multiple species
  - Increased chance of lineage mixing
    - Continue discussion of NM lineages at NM hatchery
    - Find funding for better genetic management
- Lack of funding for regular genetic testing
  - Increased chance of lineage mixing
- Low wild counts during surveys
  - Hesitancy to "over collect"
    - Low collection counts for brood stock
      - Prioritize hatchery collections
  - Low wild genetic input into brood stock
- Insufficient stocking locations for most lineages
  - Results in logistics problems for spawn and holding
    - Complete barriers
    - Conduct stocking research into non renovated systems
- Short lived species
  - Brood stock is not refuge
    - Prioritize wild collection
    - Increase holding capacity for offspring to be held as refuge when no stocking location is available
- Establishment of new wild populations
  - Hesitancy to "overstock"
    - The Zap Brannigan method
  - Historically difficult
    - Reassess stocking only into renovated systems
    - Reassess age classes stocked
    - Don't set stocking schedule, develop from surveys
- Lack of research into spawn triggers
  - Find funding to conduct indoor and paired spawning
- Lack of funding for expansion of property
- Lack of staff housing results in hiring and retention issues

A happy note!

Oct 10th 2023

- Stocked 205 San Francisco Loach Minnow into Saliz Canyon

Oct 10th 2023

- Repatriated 41 bear Creek Loach Minnow offspring into Bear Creek from 2020 salvage spawned in 2021-2022

Looking forward

- Discuss the hatchery role in the GRBNFCP
- Establish achievable goals for hatchery brood stock management and stockings
- Prioritize hatchery collections

Arizona Game and Fish Department Work Accomplished 2023

Brian Hickerson and Crosby Hedden

ARIZONA GAME & FISH

GILA RIVER BASIN NATIVE FISHES CONSERVATION PROGRAM

Overview

Species Updates

Nonnative Removals

- Redfield Canyon
- Harden Cienega Creek
- Verde Tanks

Habitat Assessments

Gila Topminnow

Spikedace

Roundtail Chub

Loach Minnow

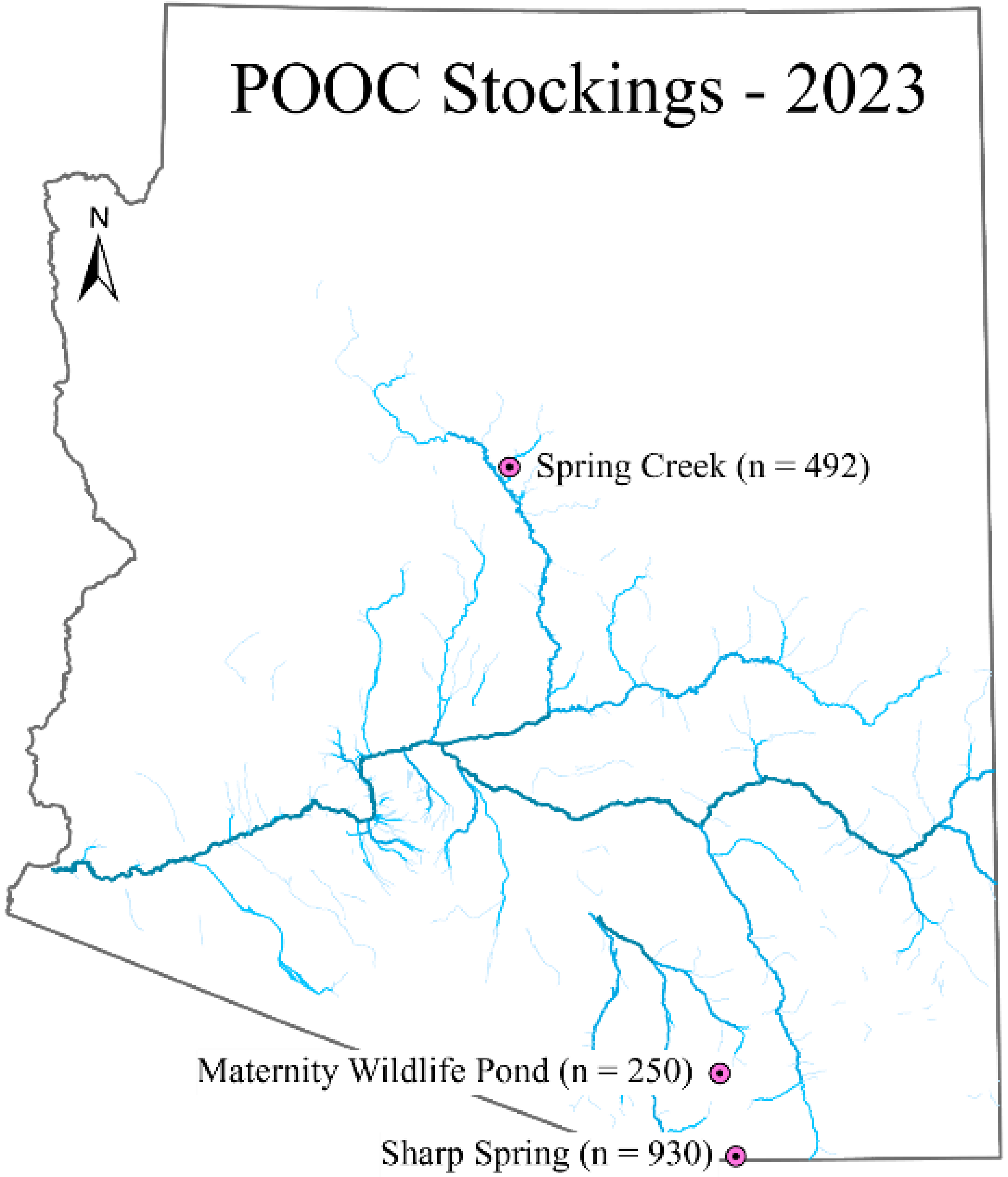
Gila Topminnow

Gila Topminnow

Eight Monitoring Sites

Three Stockings

- Sharp Spring
- Maternity Wildlife Pond
- Spring Creek



Gila Topminnow

Three Stockings

- Sharp Spring
- Maternity Wildlife Pond
- Spring Creek

Gila Topminnow Monitoring

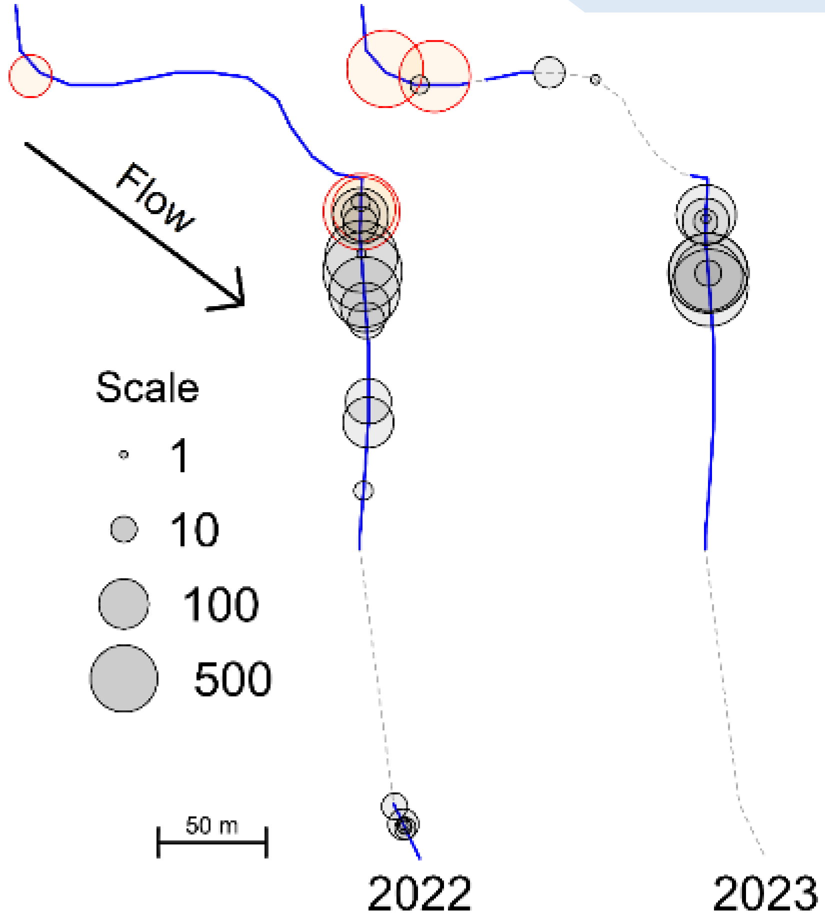
Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Maternity Wildlife Pond	1,554	1,591	6,618	2023
Unnamed Drainage 68B	-	990	1,435	2022
Aravaipa Creek	-	98	229	2022
Telegraph Canyon	564	165	147	2021
Sharp Spring	-	135	117	2023
Rarick Canyon[1]	0	0	0	2020
Harden Cienega Creek[1]	0	0	0	2021
Sabino Canyon (Upper–Above East Fork) [1]	0	0	0	2019

[1]Three years of post-stocking monitoring completed.

Maternity Wildlife Pond

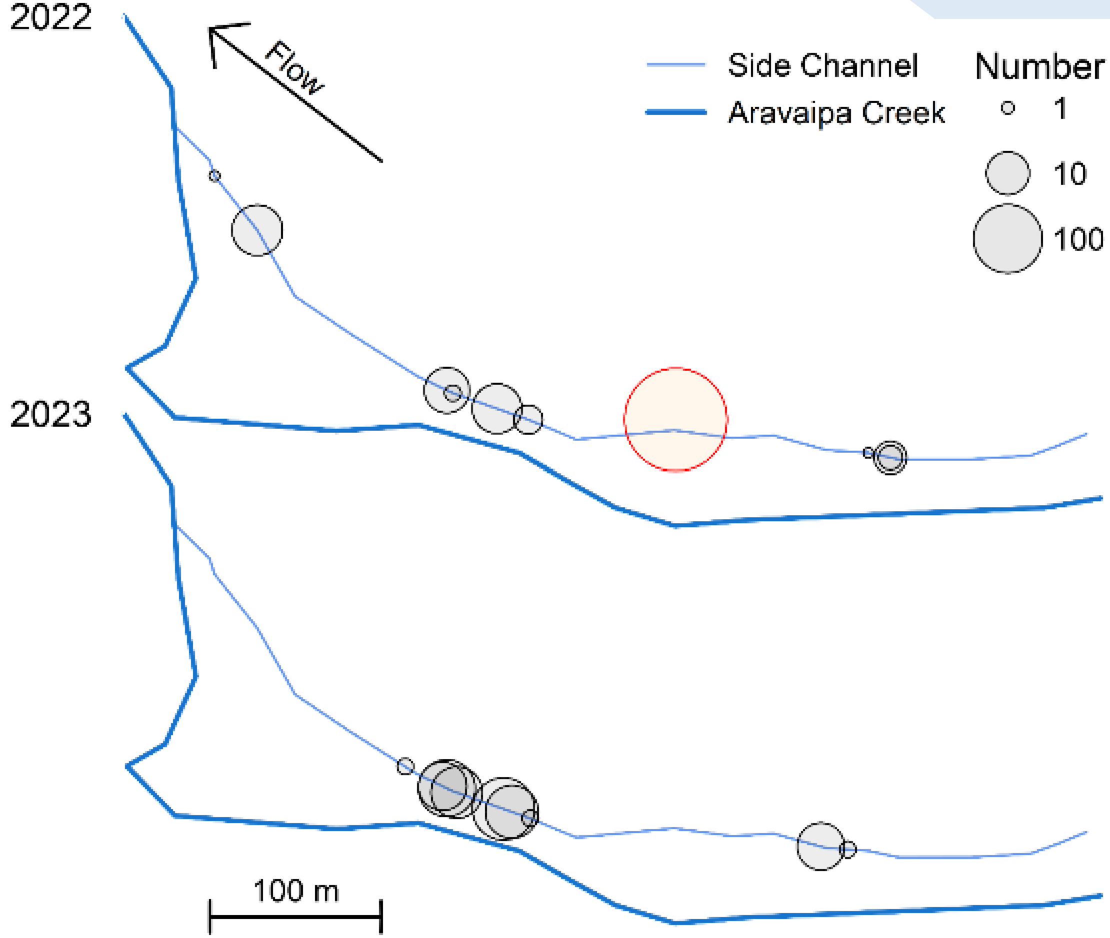
Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Maternity Wildlife Pond	1,554	1,591	6,618	2021

Unnamed Drainage 68B



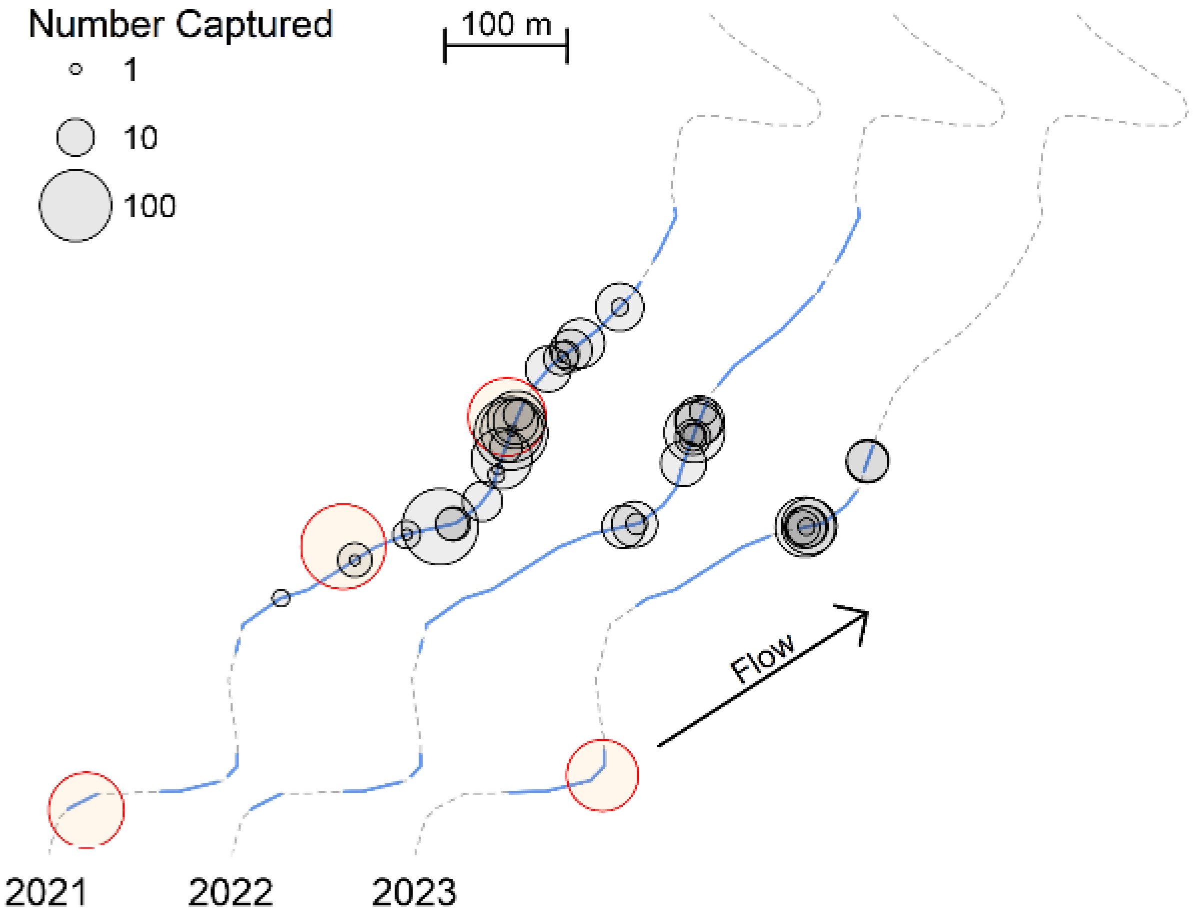
Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Unnamed Drainage 68B	-	990	1,435	2022

Aravaipa Creek



Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Aravaipa Creek	-	98	229	2022

Telegraph Canyon

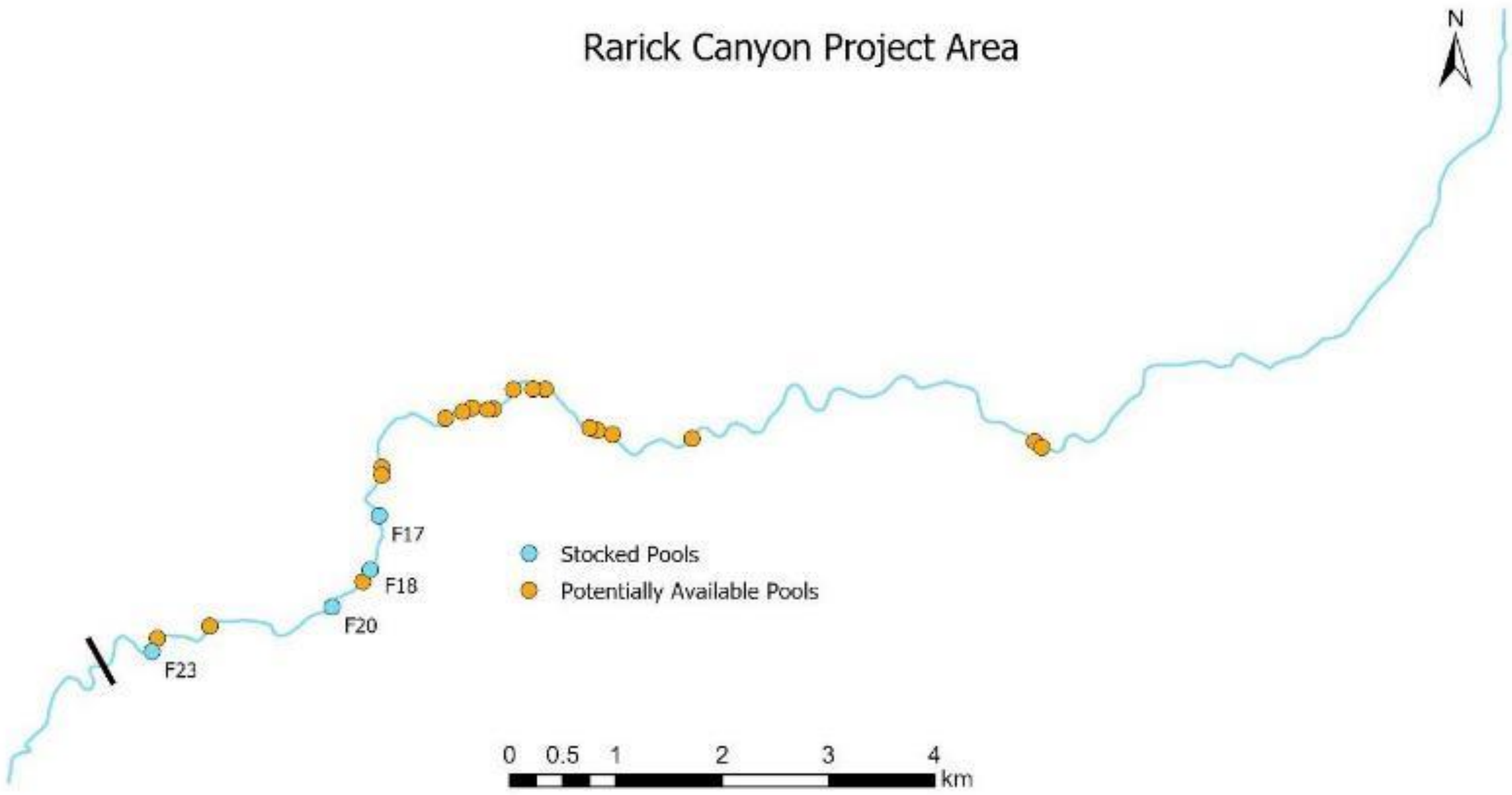


Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Telegraph Canyon	564	165	147	2021

Sharp Spring

Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Sharp Spring	-	135	117	2023

Rarick Canyon



Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Rarick Canyon[1]	0	0	0	2020

Harden Cienega Creek

Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Harden Cienega Creek	0	0	0	2021

Upper Sabino Canyon

Water Name	2021 Catch	2022 Catch	2023 Catch	Year Last Stocked
Sabino Canyon (Upper–Above East Fork) [1]	0	0	0	2019

Spikedace

Spikedace

Three Monitoring Sites

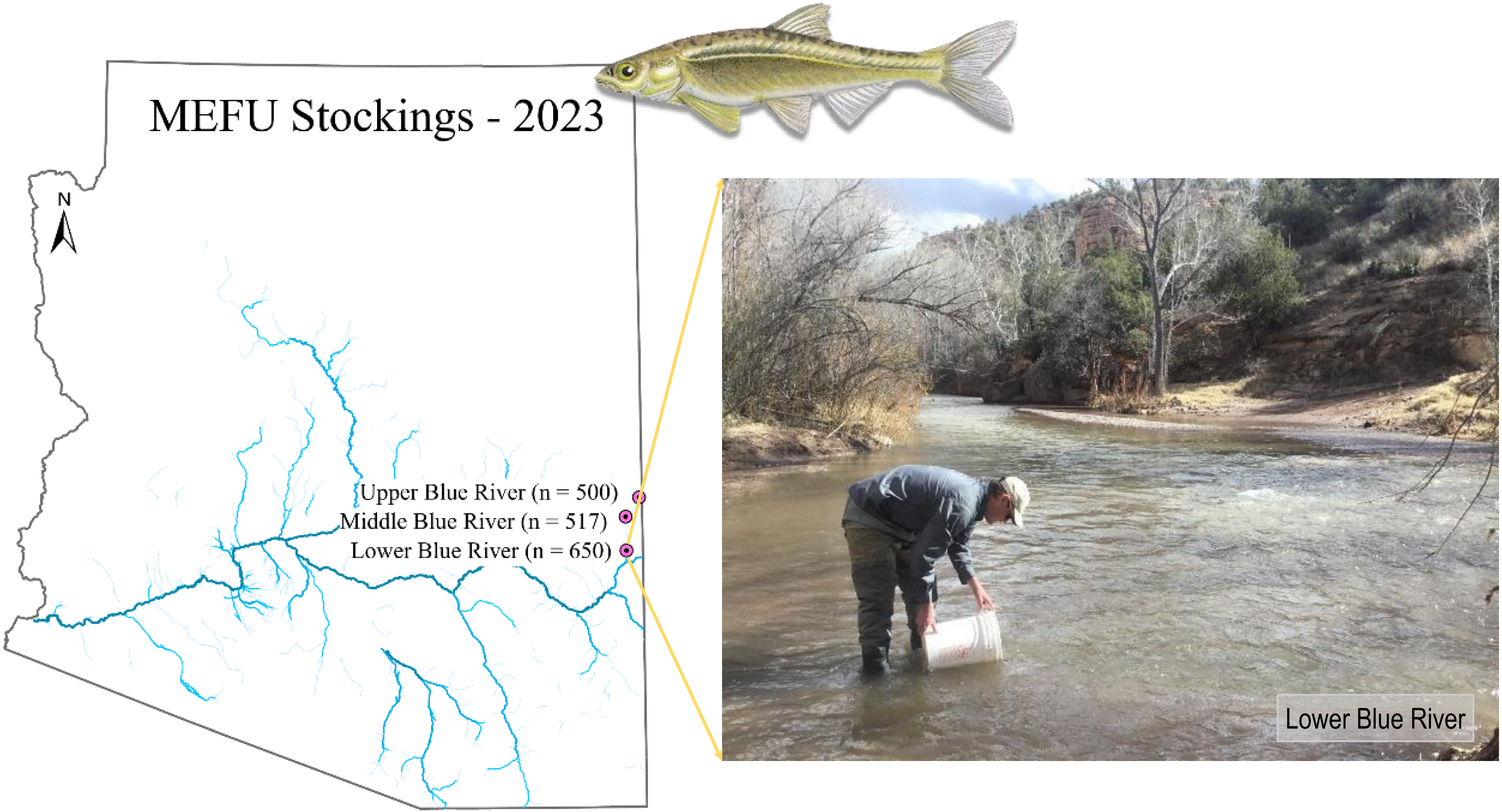
- Spring Creek
- Middle Blue River
- Upper Blue River

Three Stockings

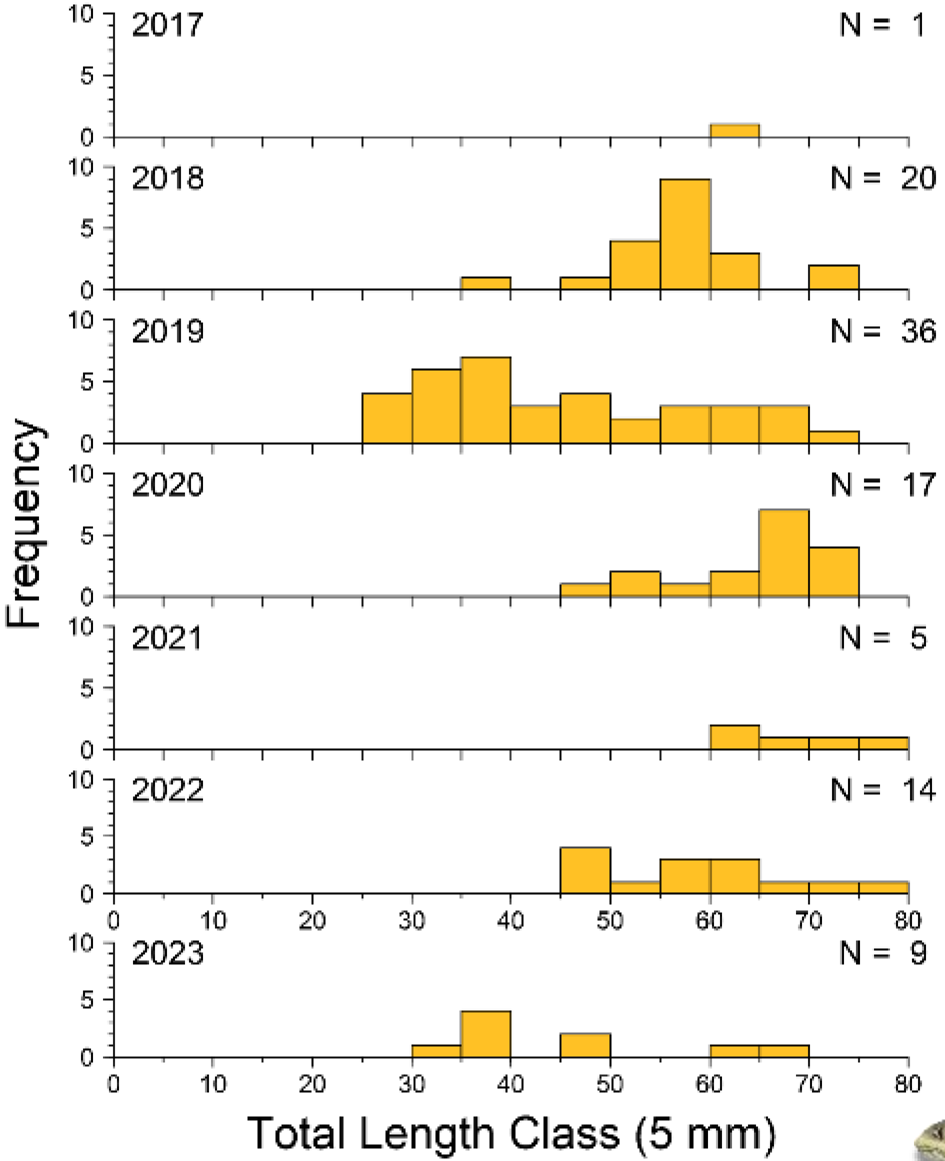
- Lower Blue River
- Middle Blue River
- Upper Blue River

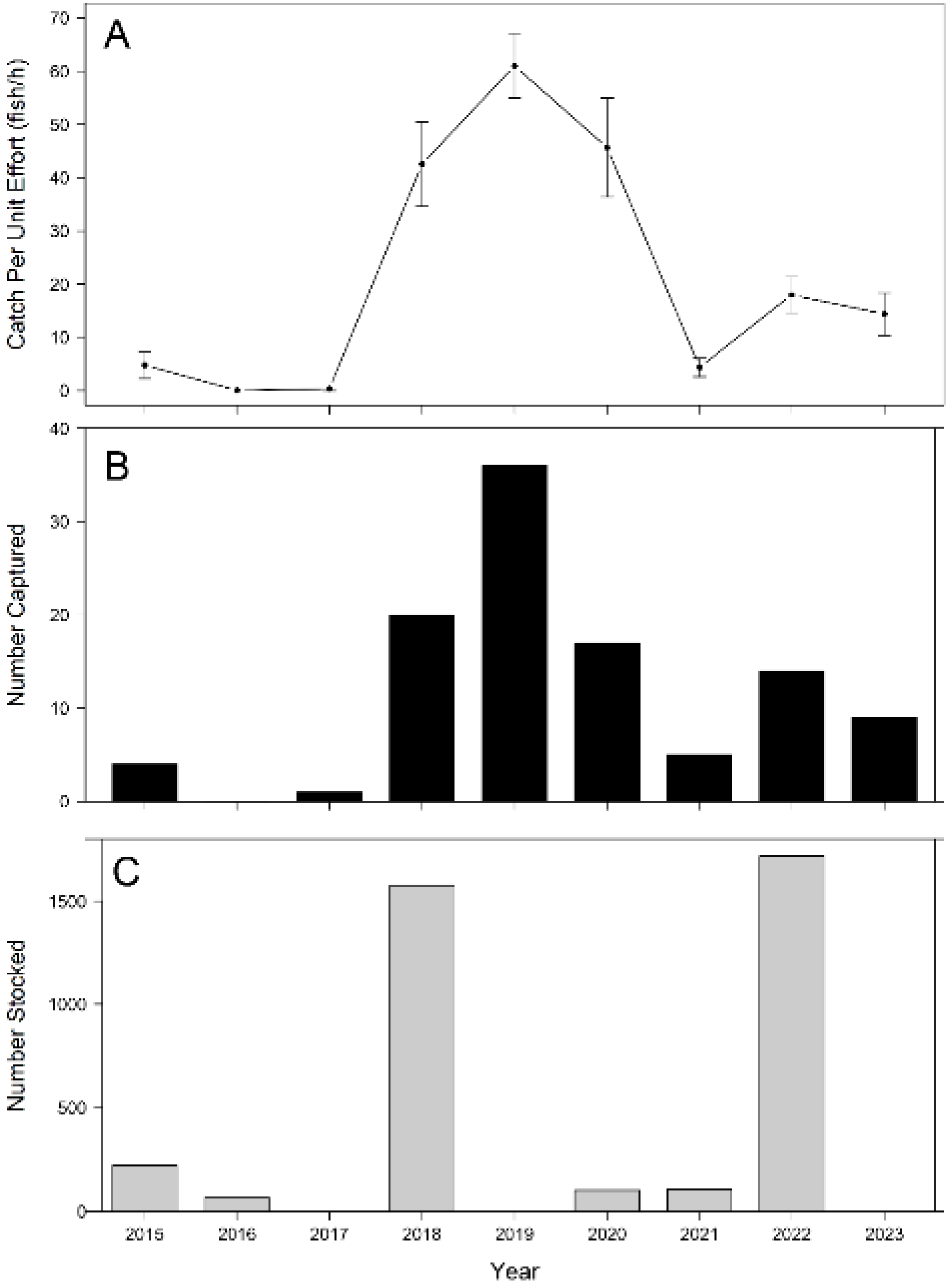
One Collection

- Aravaipa Creek (N = 67)

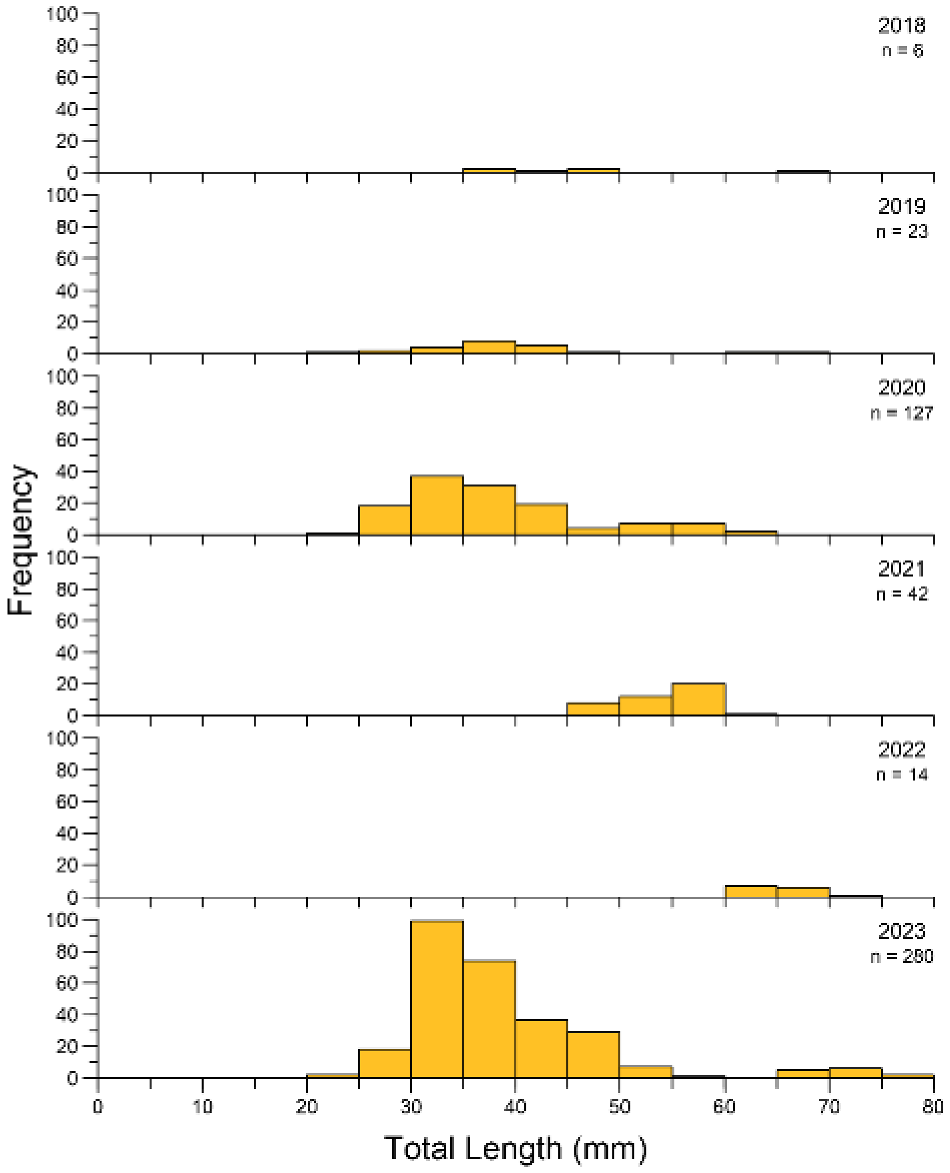

MEFU Stockings - 2023
N
Upper Blue River (n = 500)
Middle Blue River (n = 517)
Lower Blue River (n = 650)
Lower Blue River

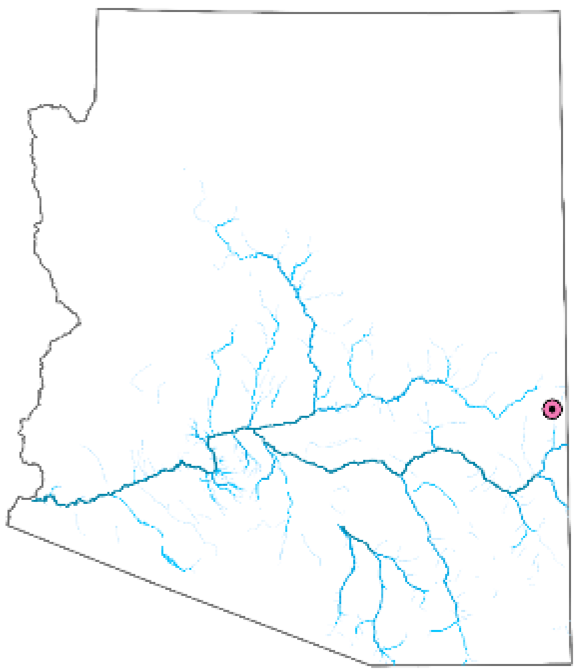
Spring Creek

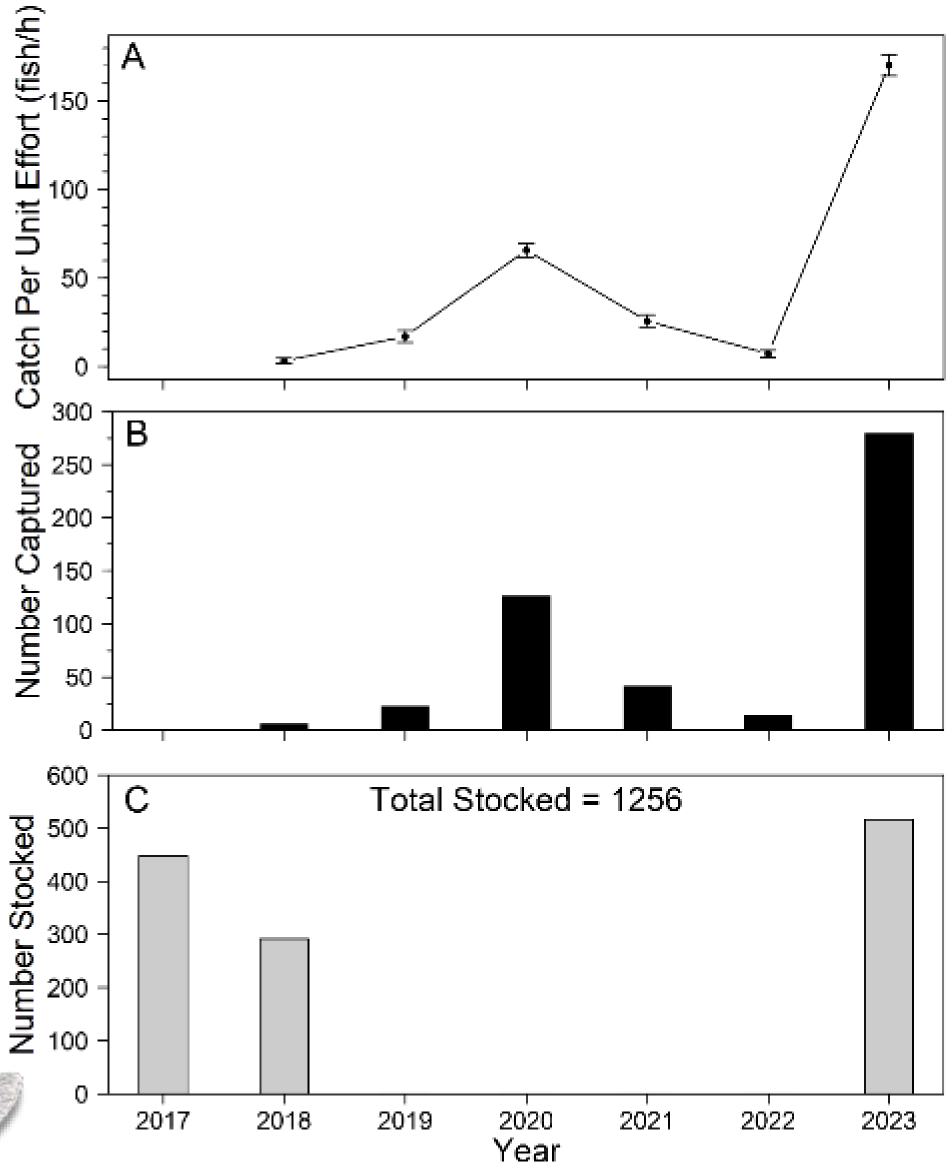




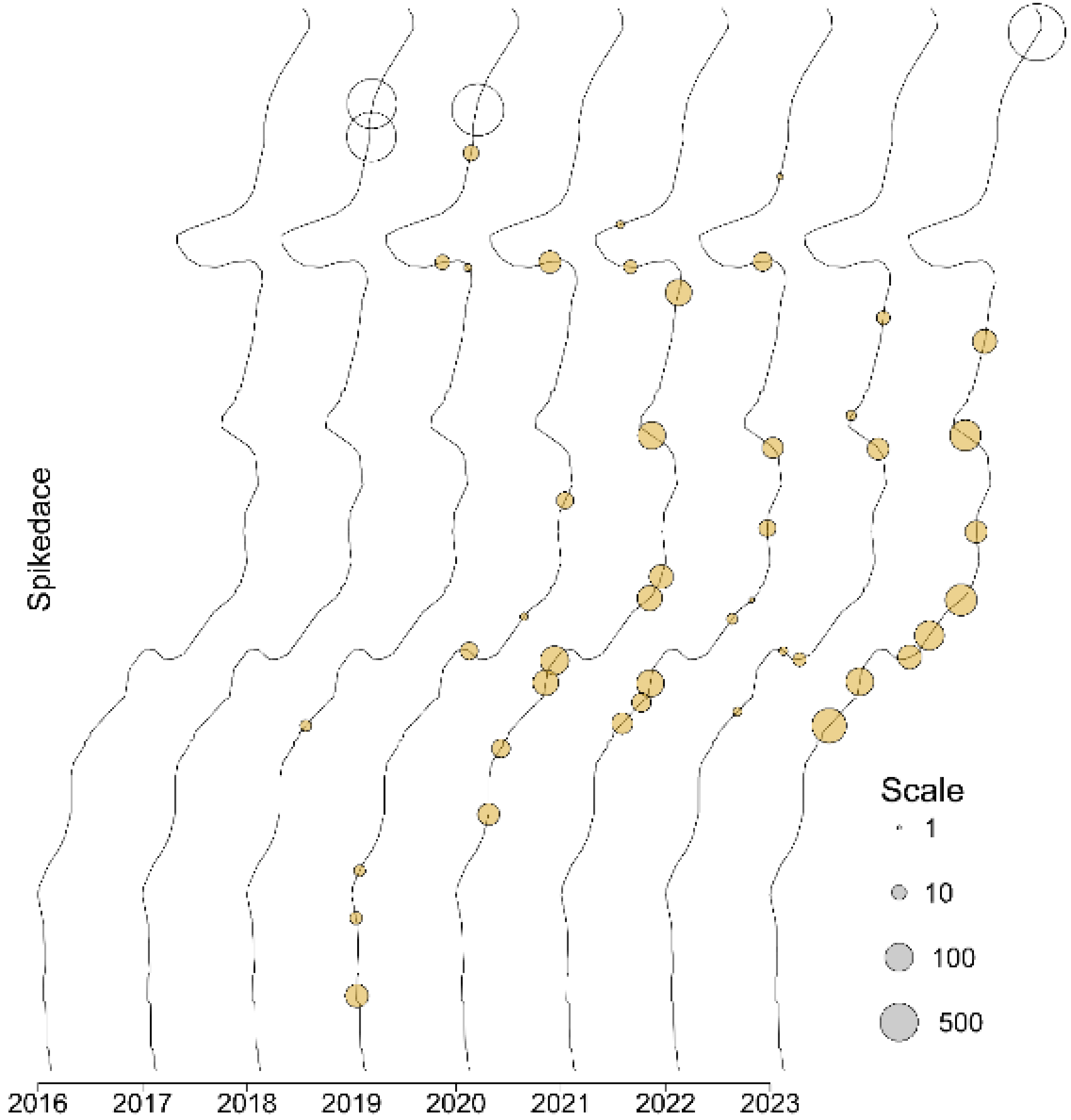
Middle Blue River



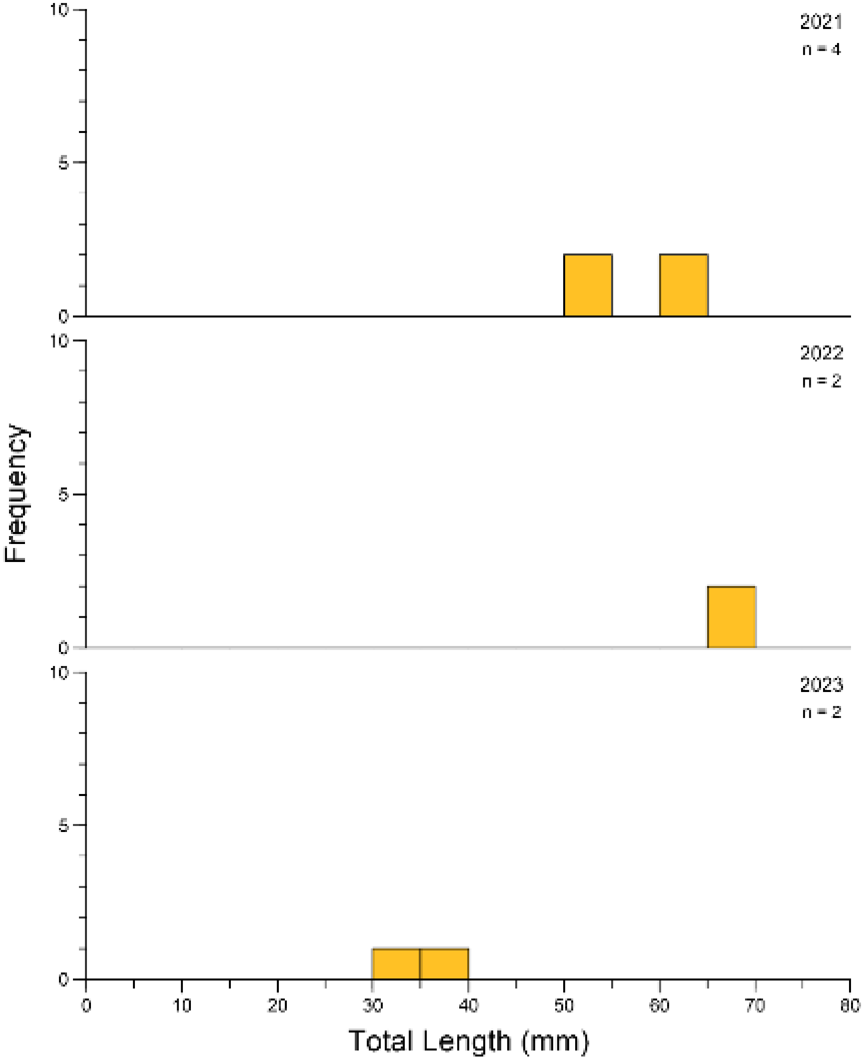


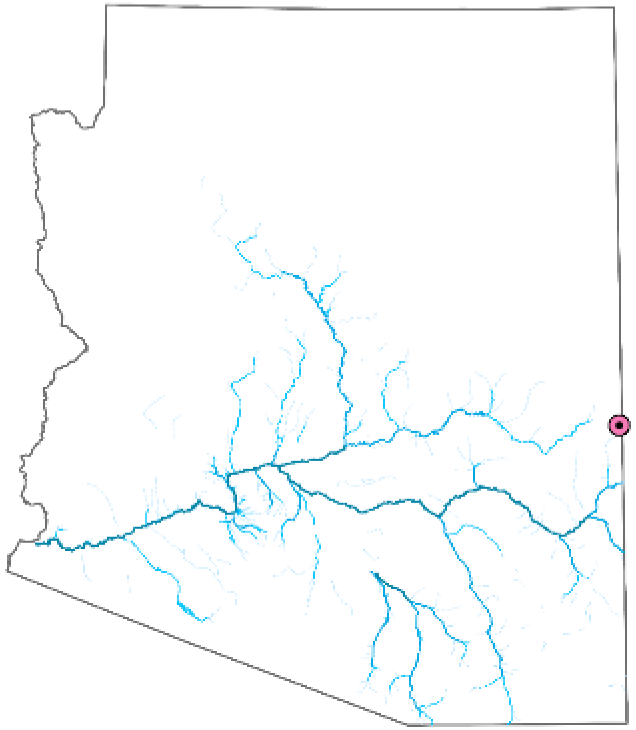


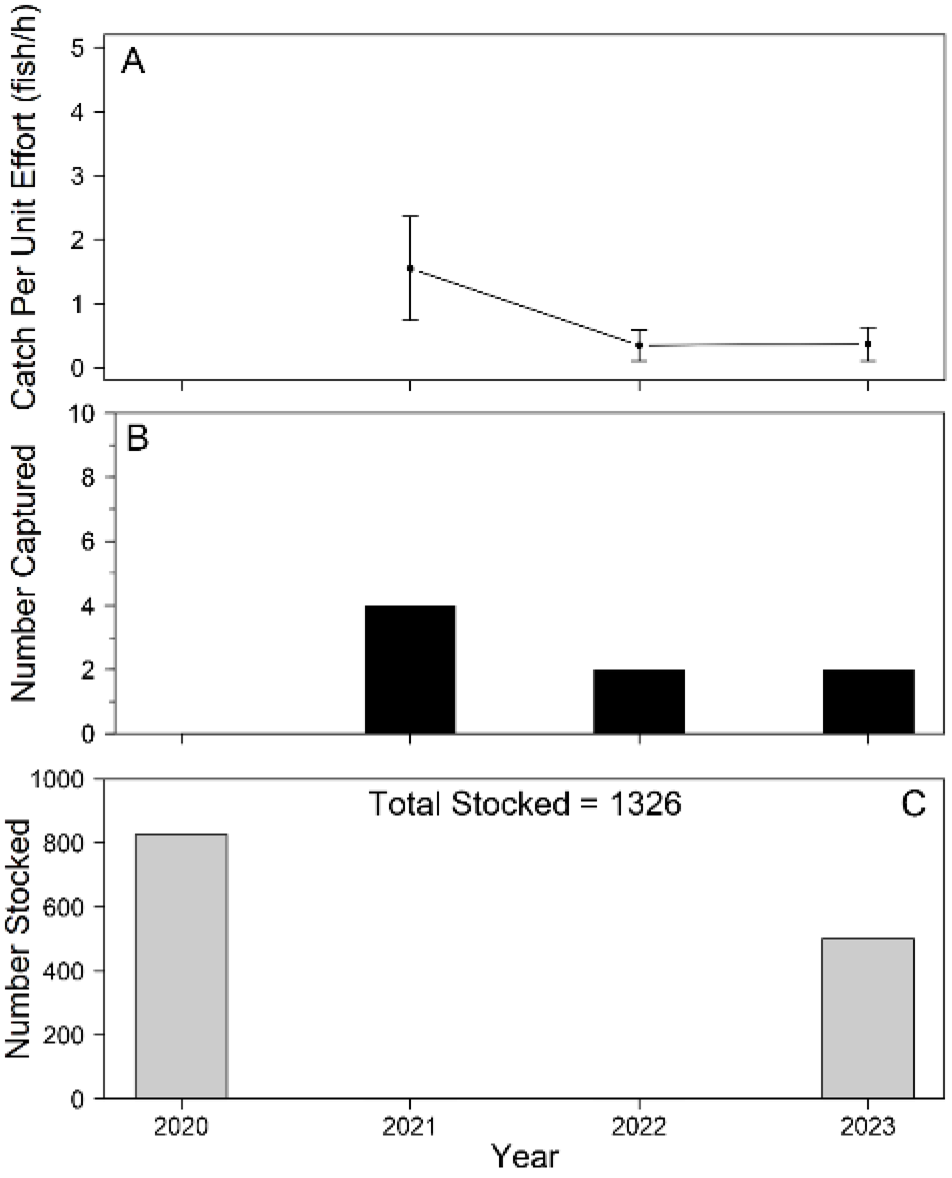
Middle Blue River



Upper Blue River





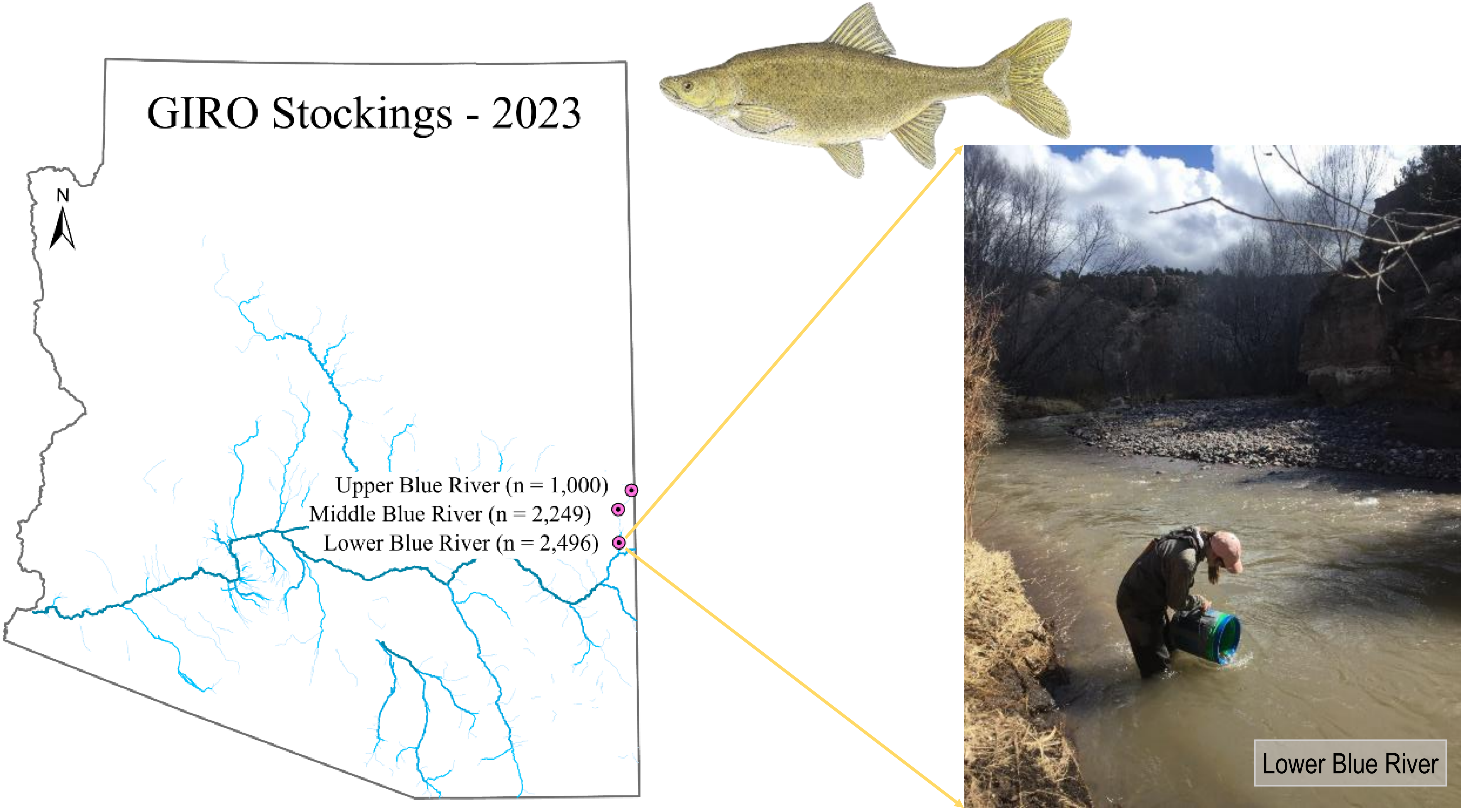


Roundtail Chub

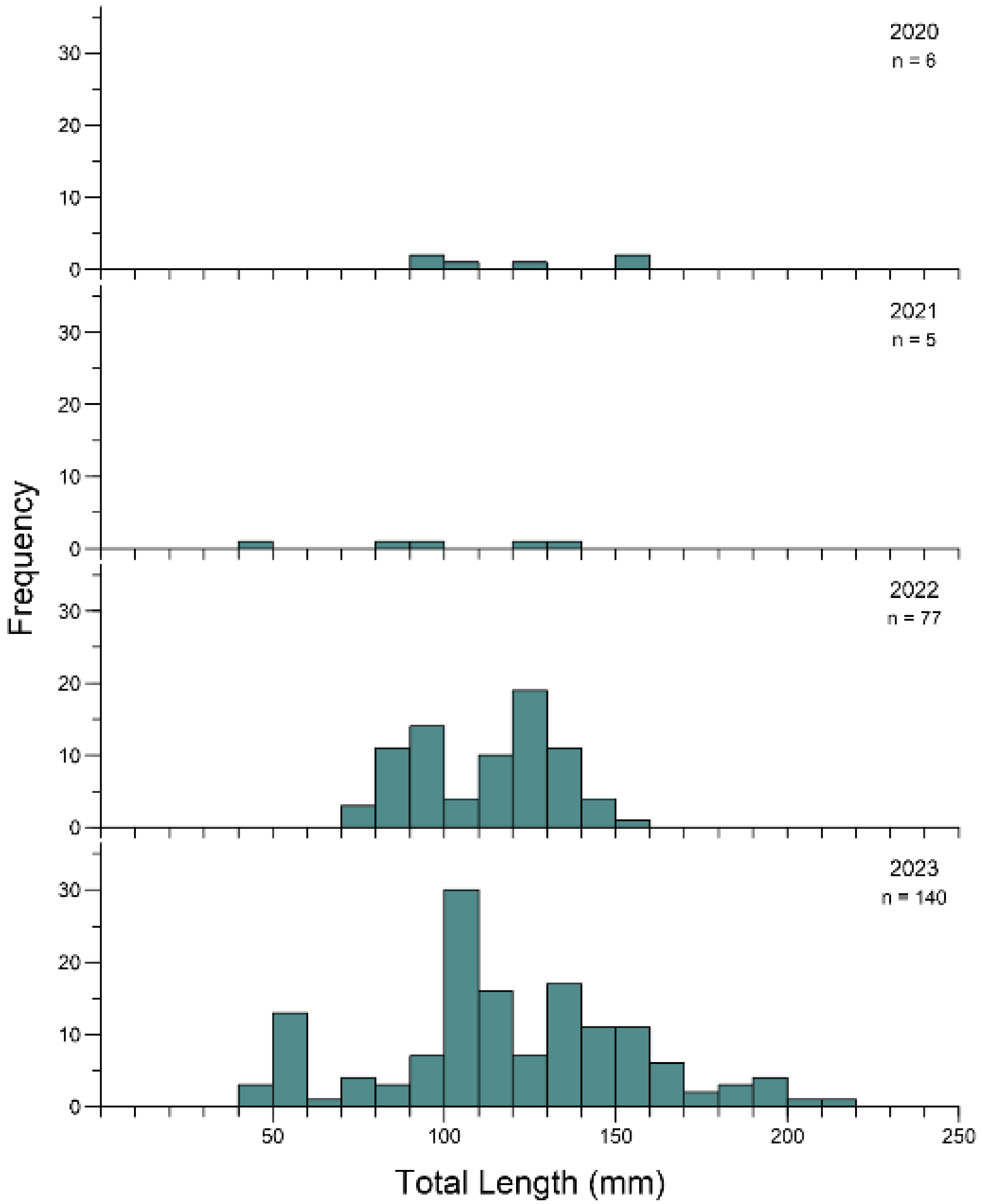
Roundtail Chub

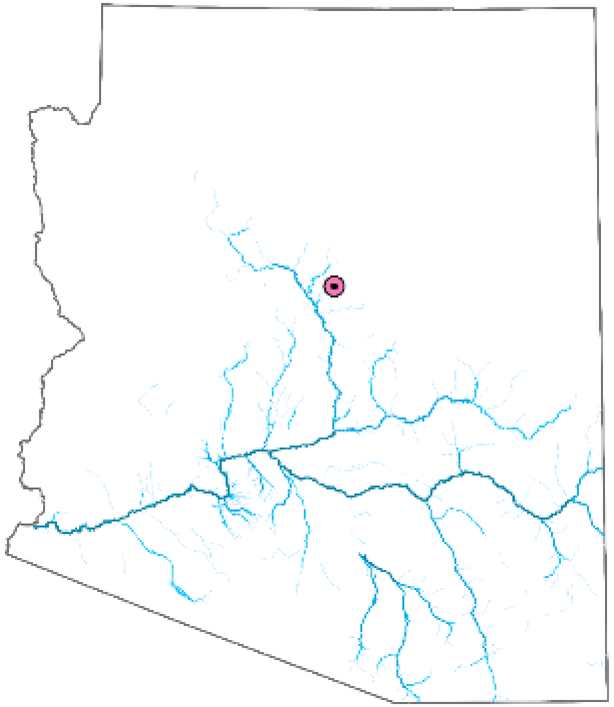
Four Monitoring Sites

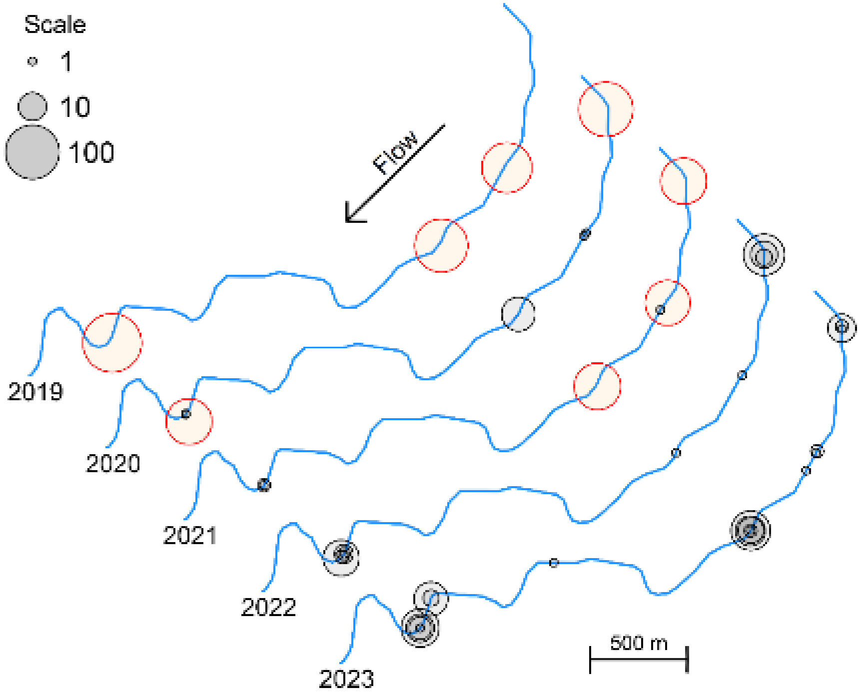
- Rarick Canyon
- Sabino Canyon
- Middle Blue River
- Upper Blue River


GIRO Stockings - 2023
N
Upper Blue River (n = 1,000)
Middle Blue River (n = 2,249)
Lower Blue River (n = 2,496)
Lower Blue River

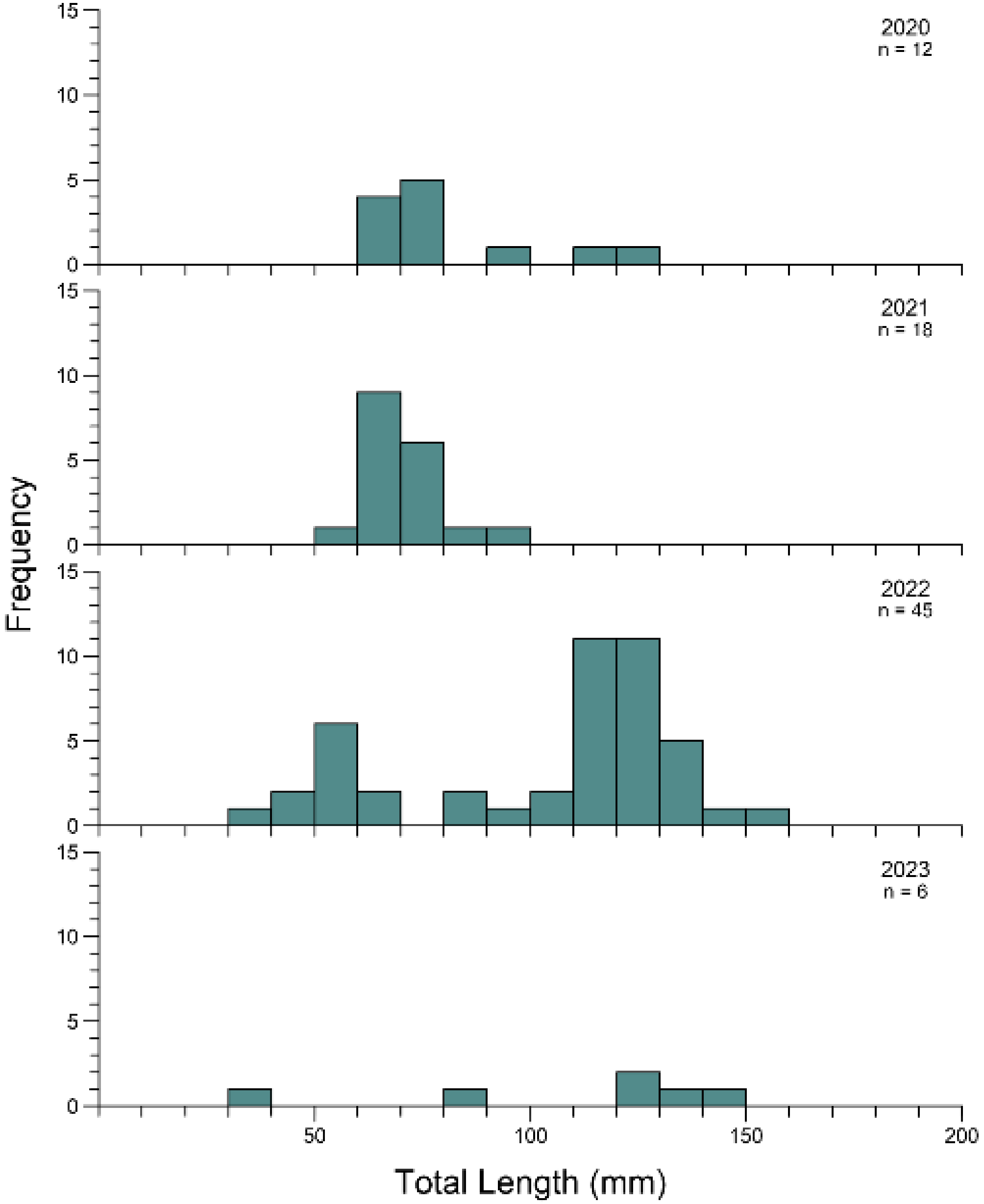
Rarick Canyon

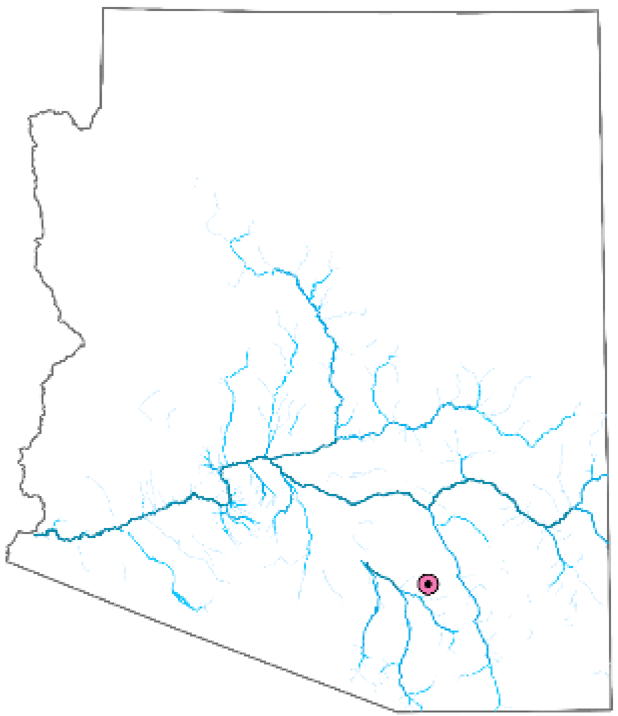


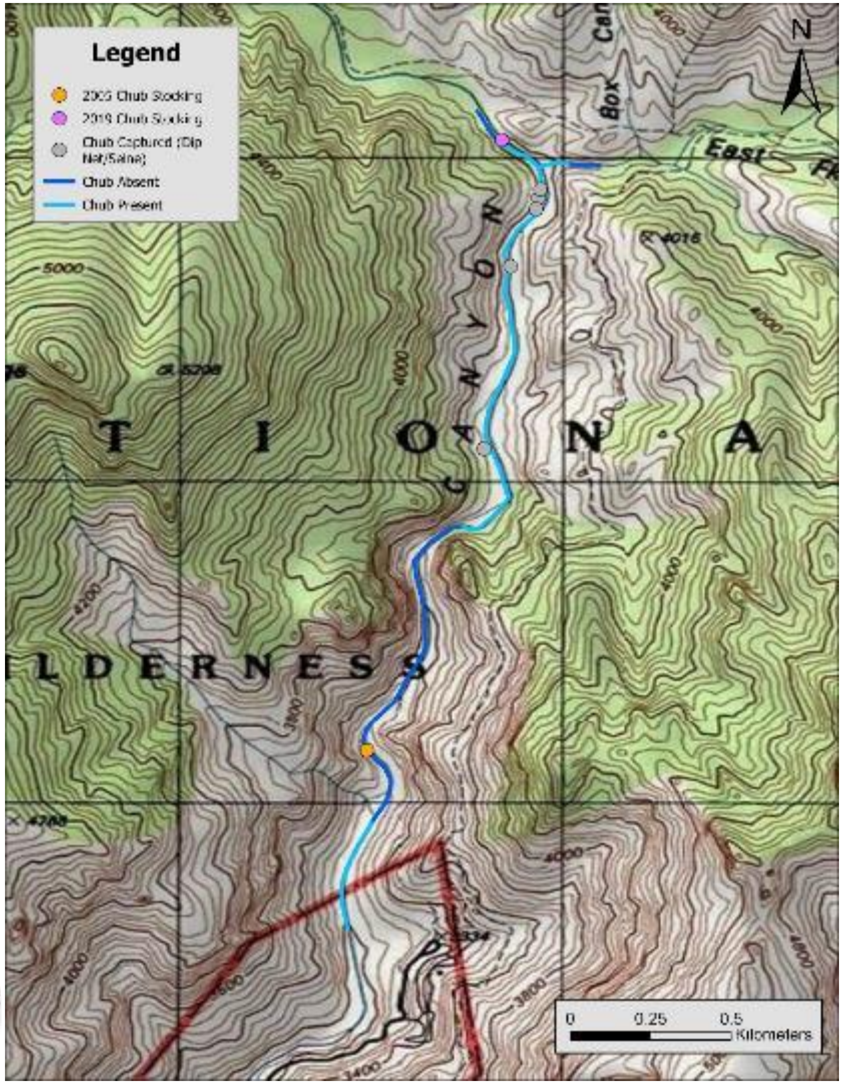




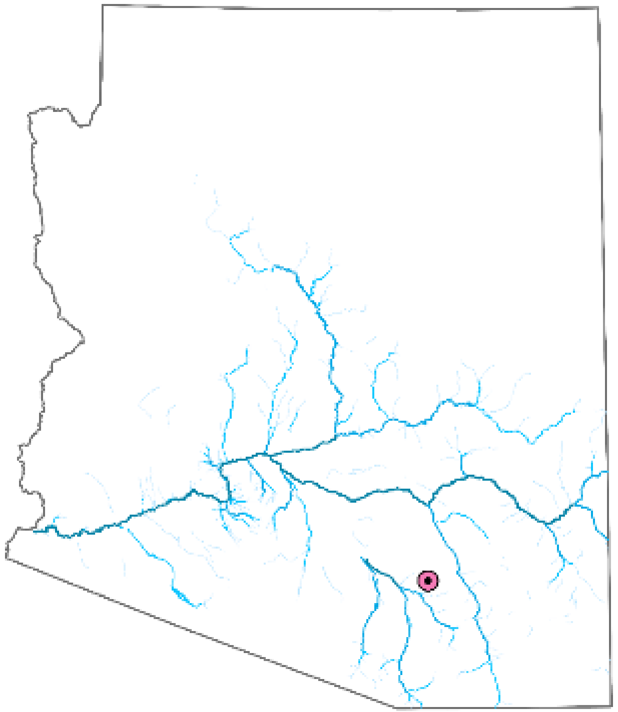
Sabino Canyon

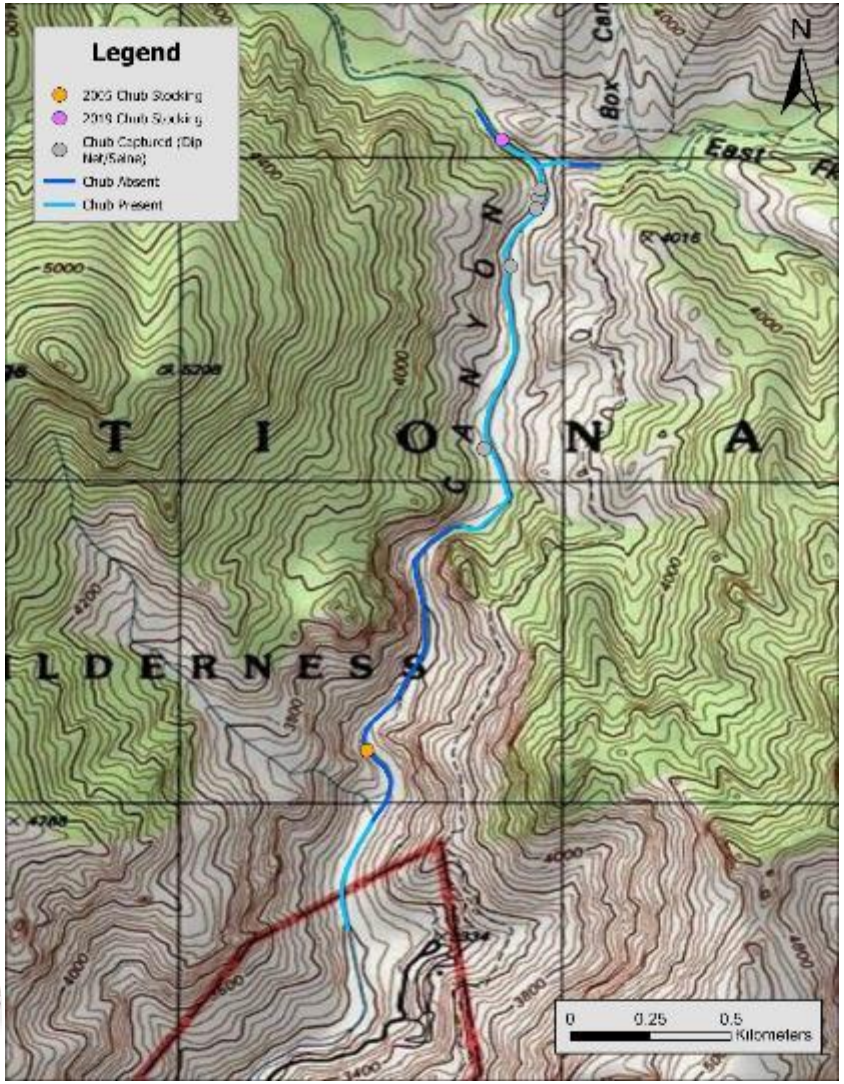




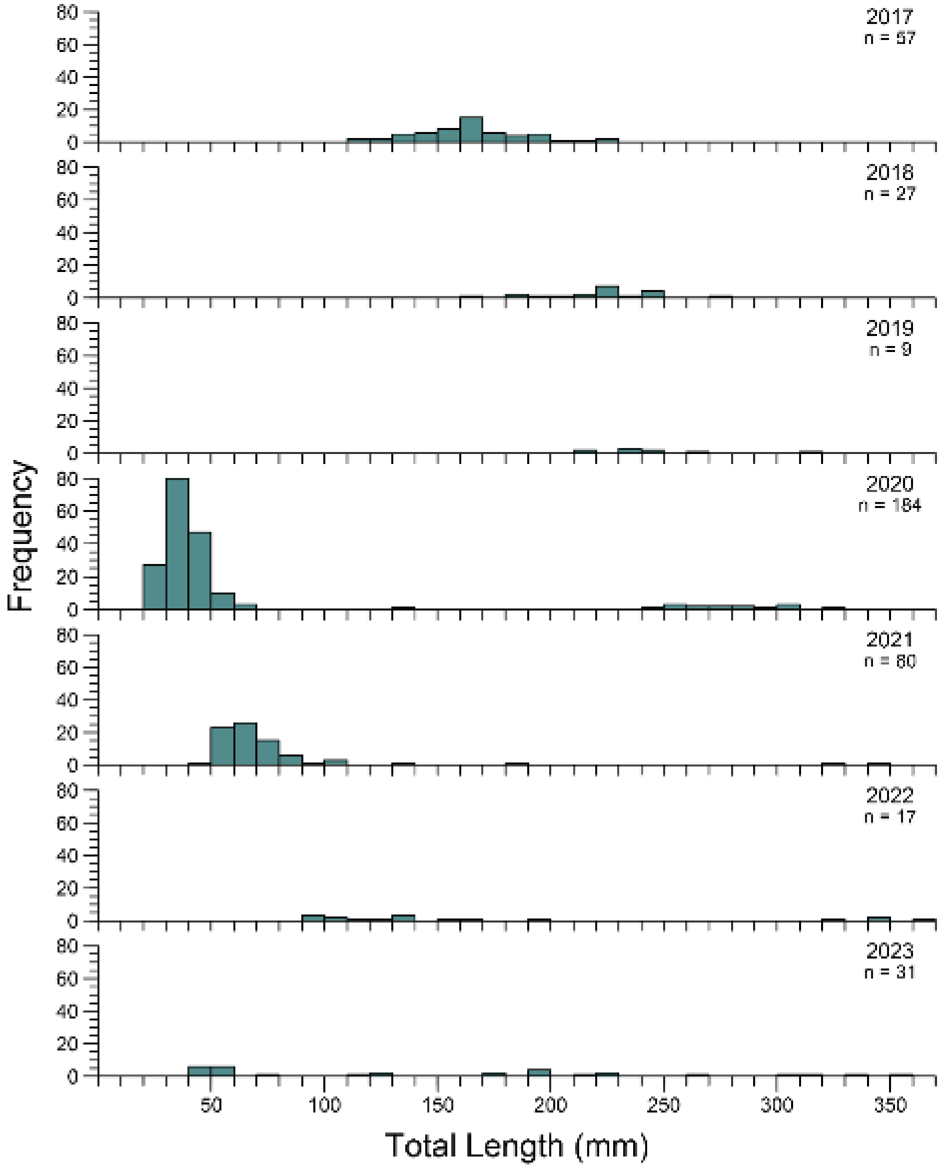


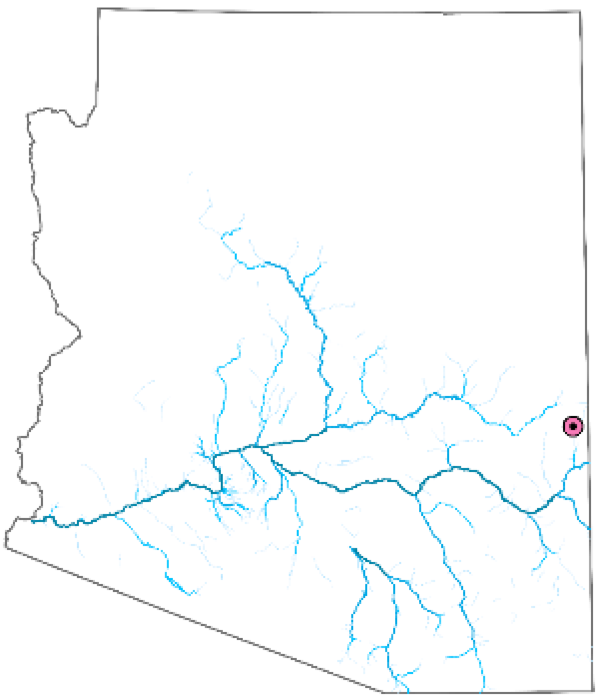
Sabino Canyon

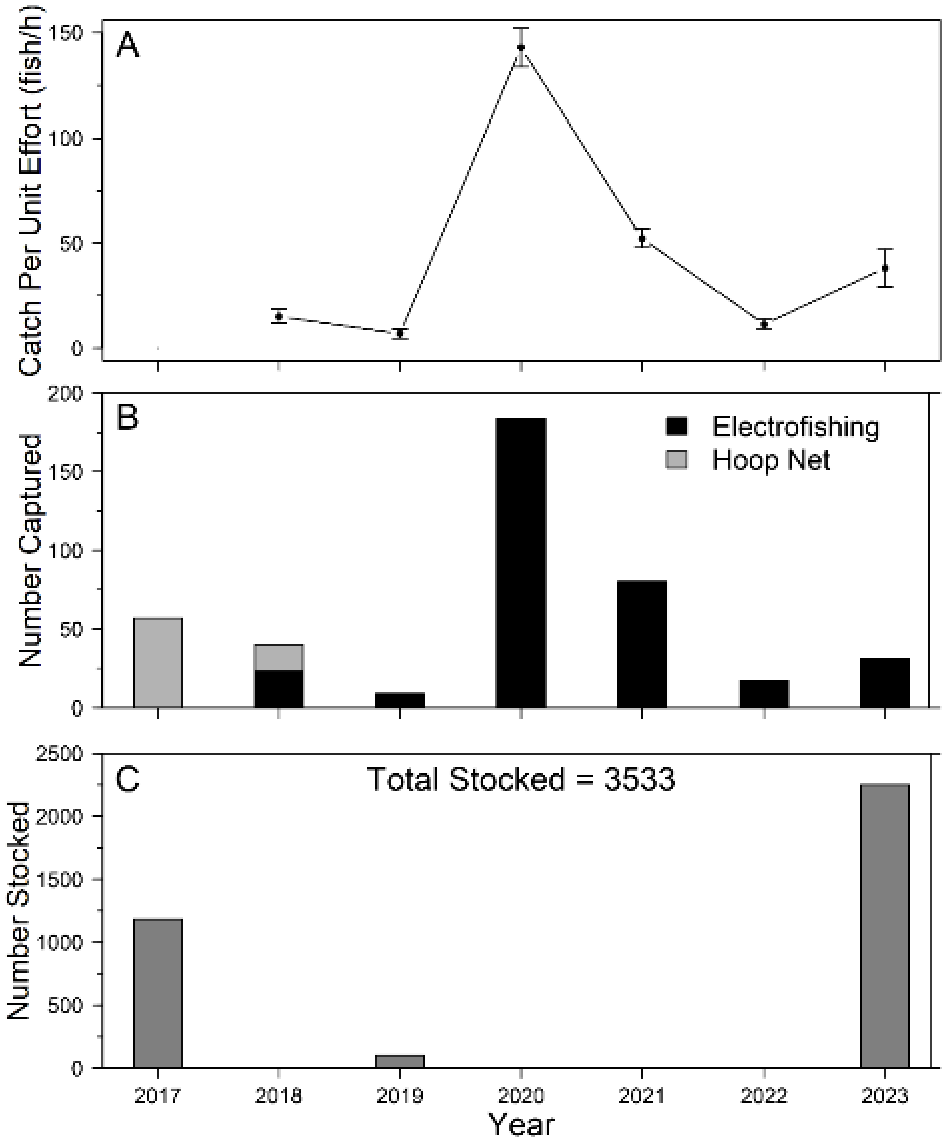




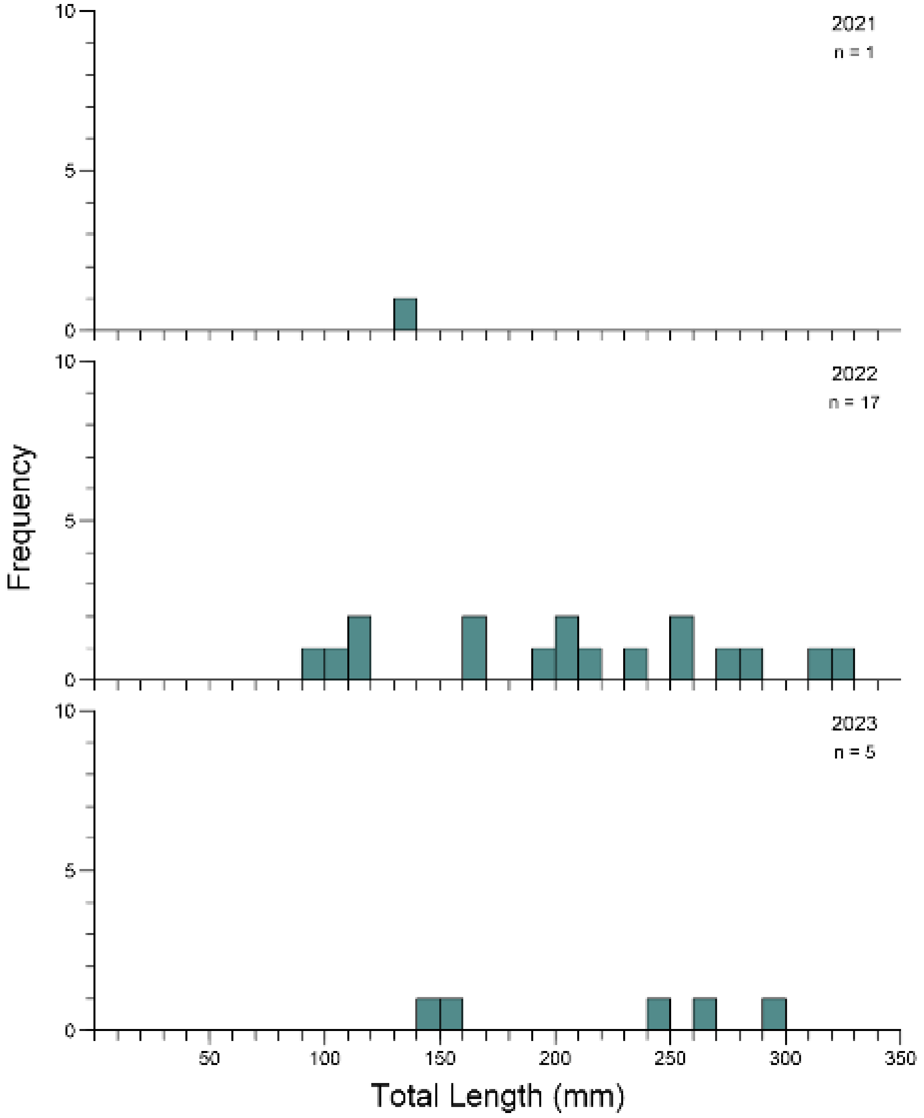
Middle Blue River

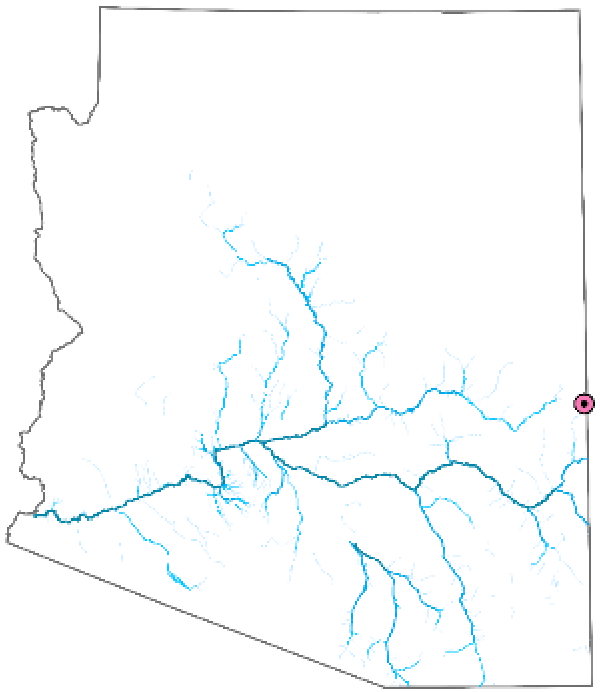


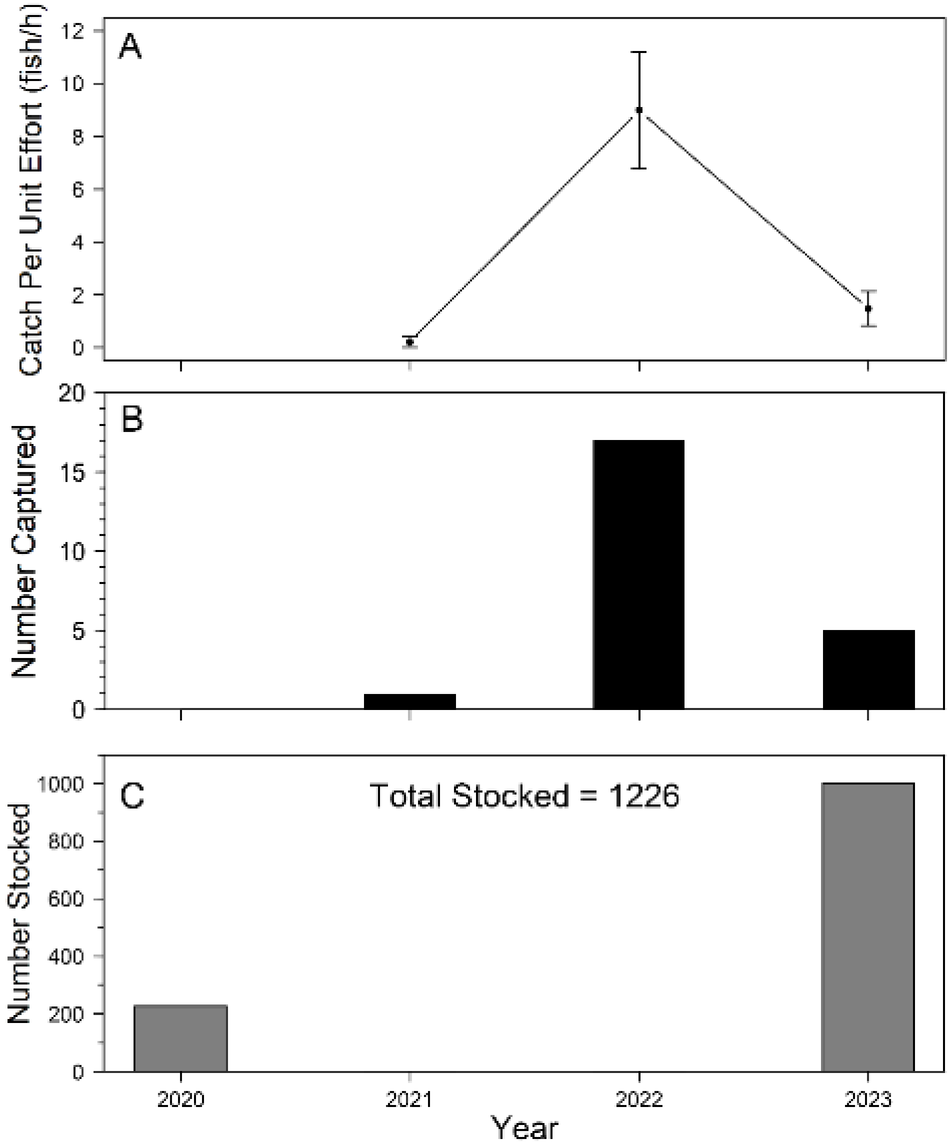




Upper Blue River







Loach Minnow

Loach Minnow

Two Collections

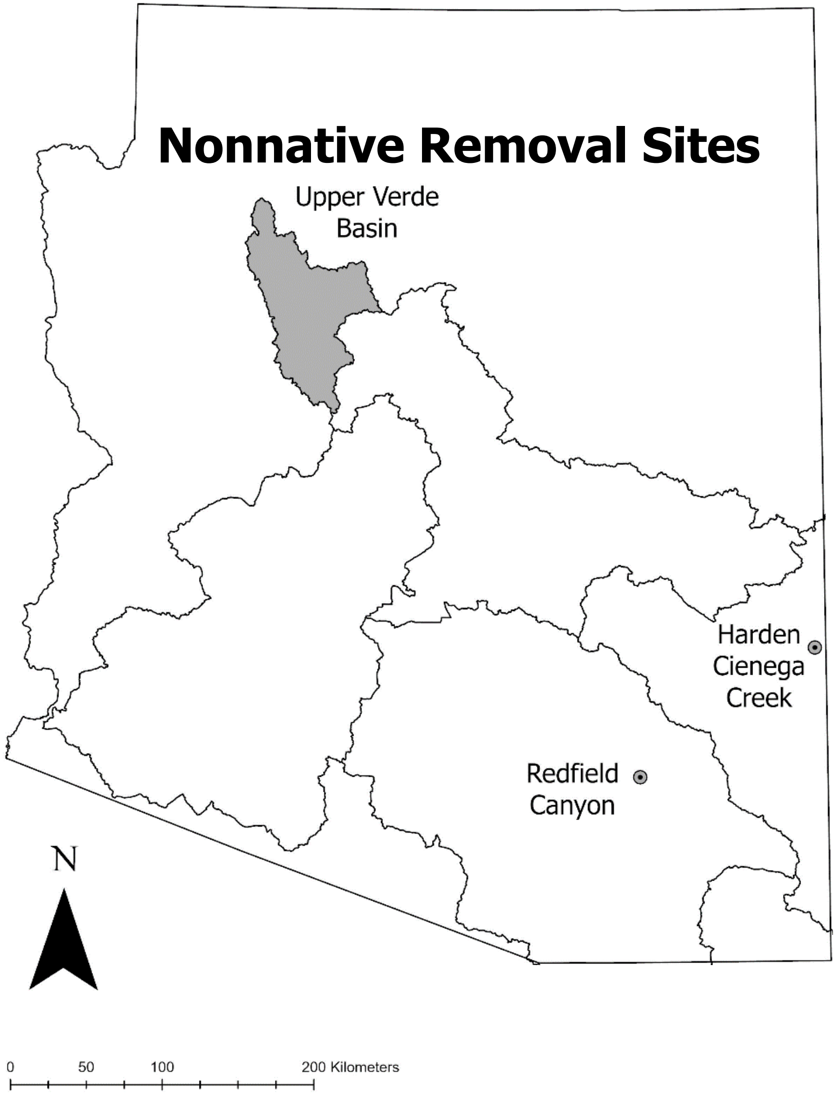
- Upper Blue River (N = 94)
- Aravaipa Creek (N = 56)

Two Collections

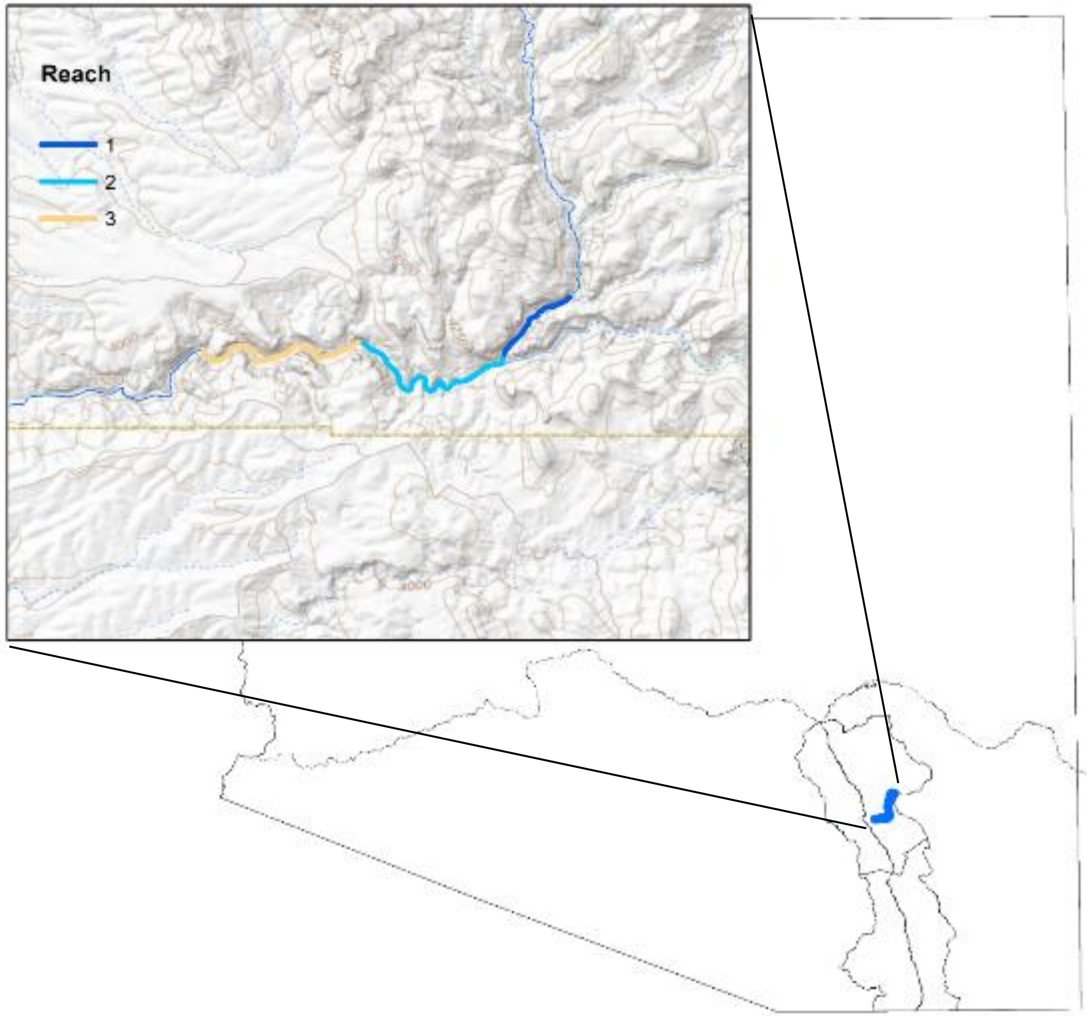
- One salvage from Campbell Blue Creek (N = 134)

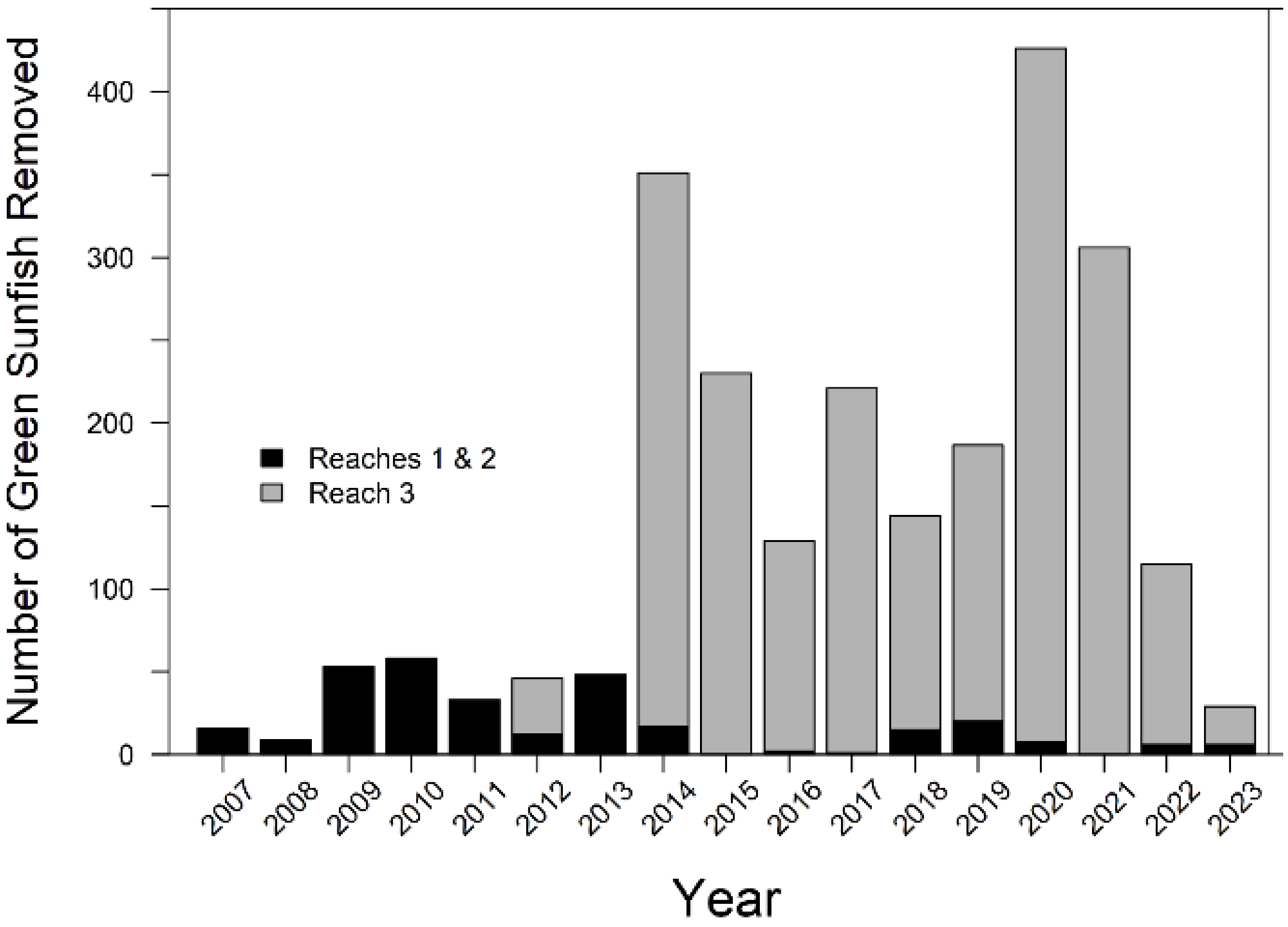
Nonnative Species Removal

- Redfield Canyon
- Harden Cienega Creek
- Upper Verde Basin

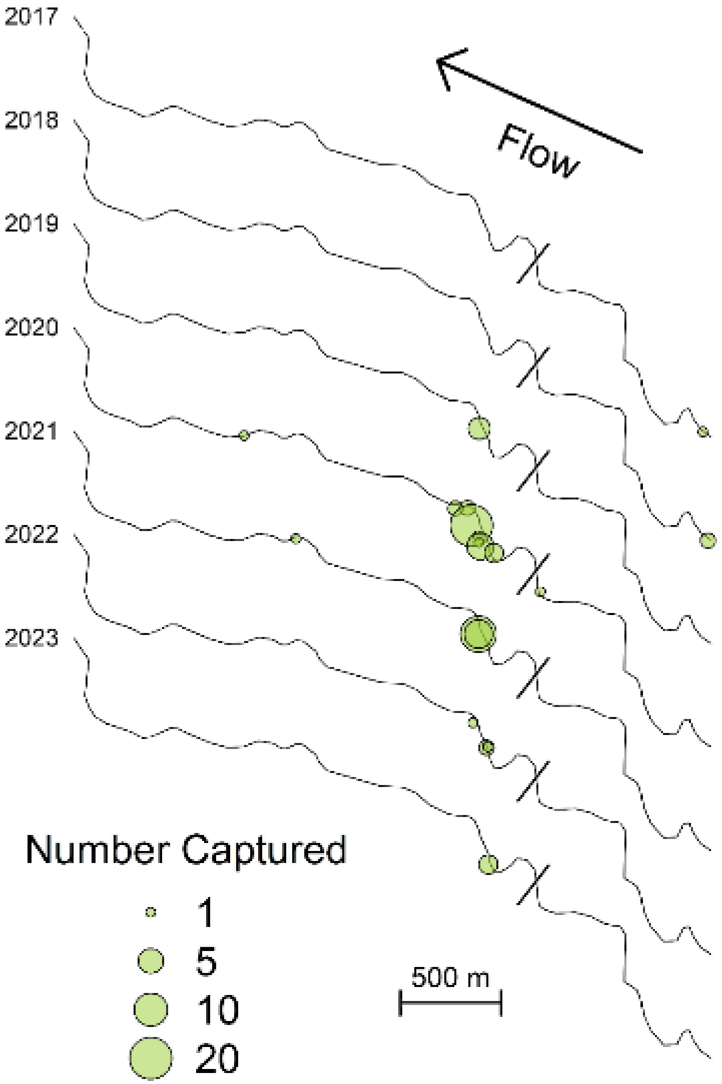


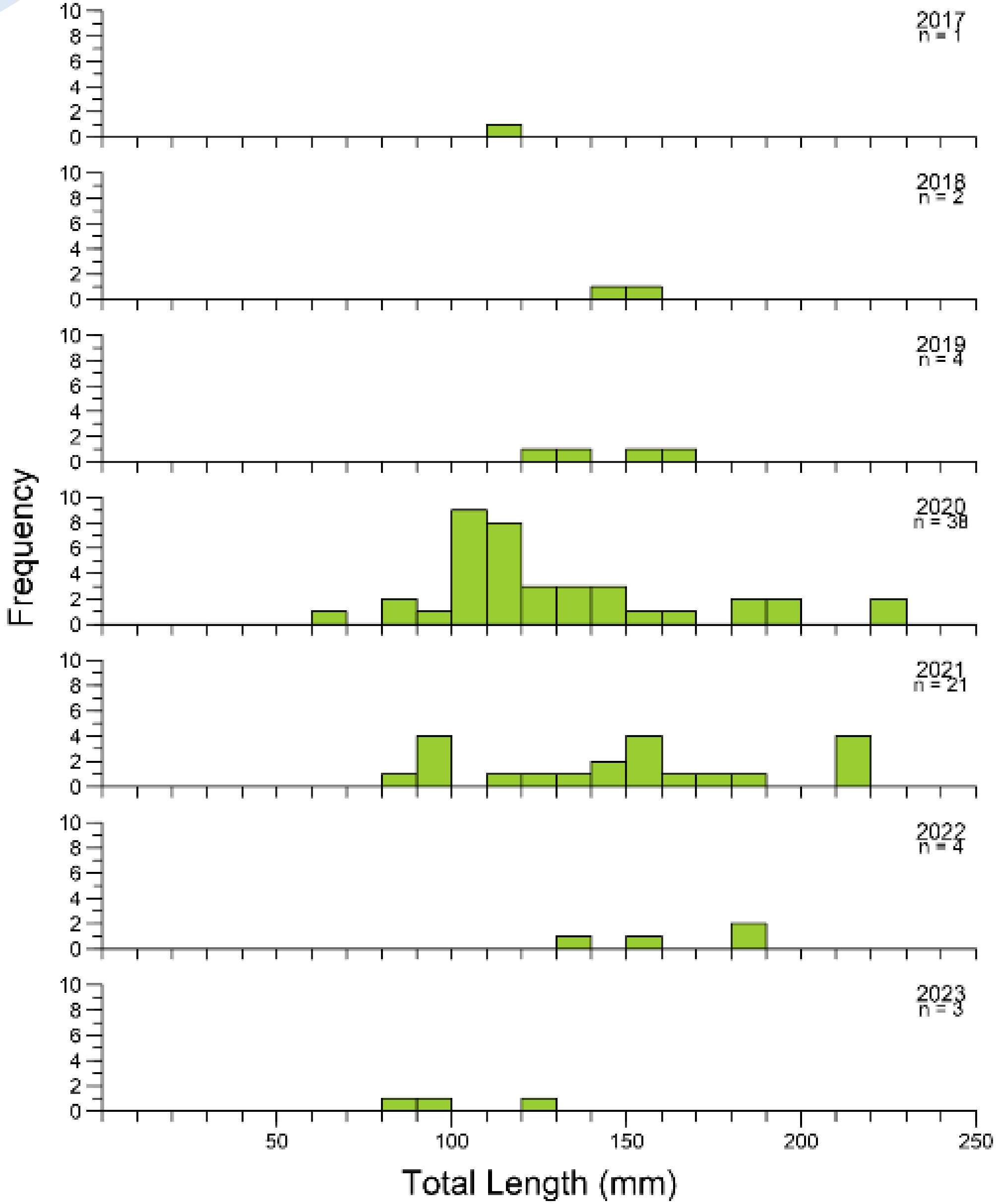
Redfield Canyon



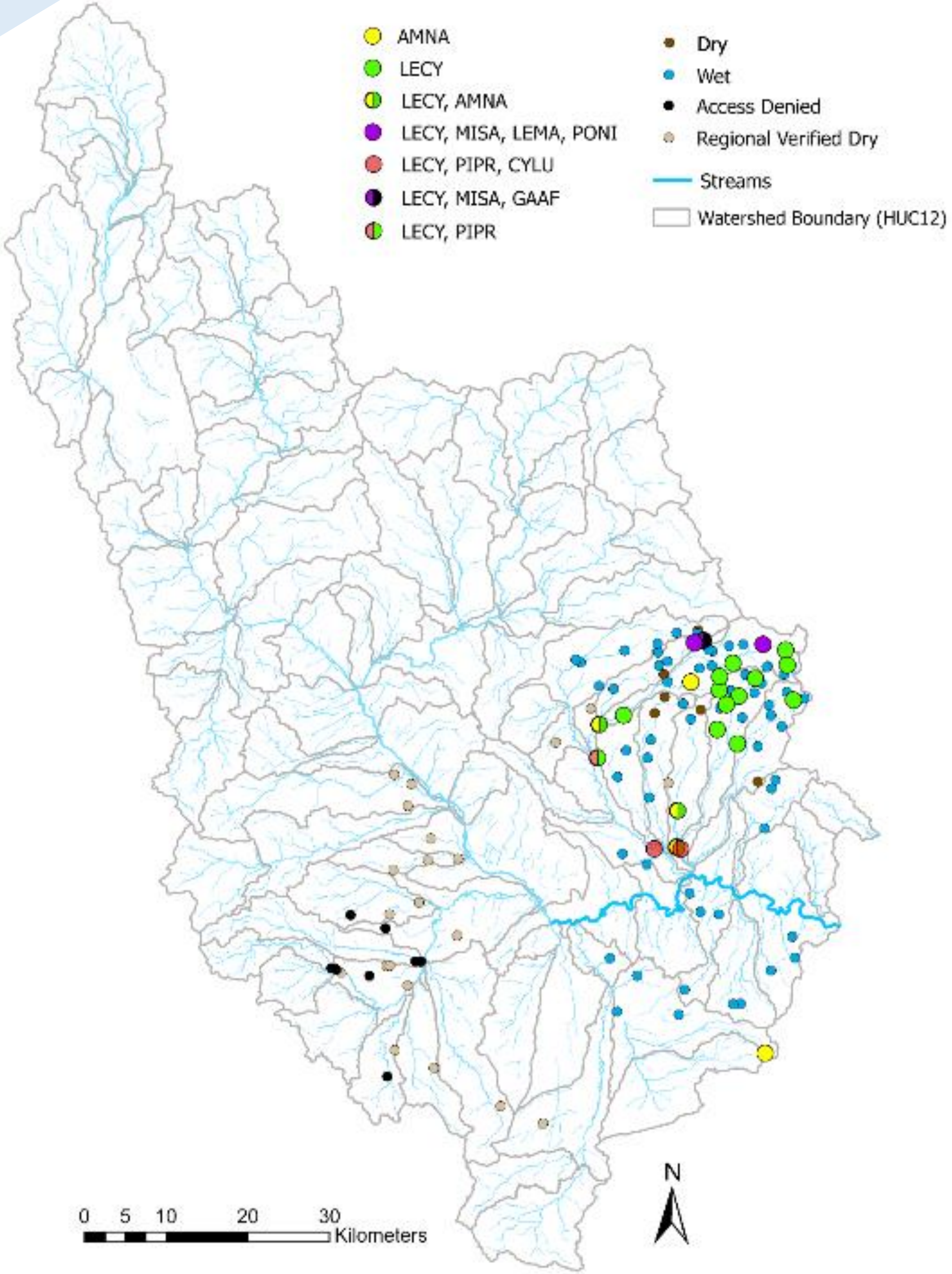


Harden Cienega Creek

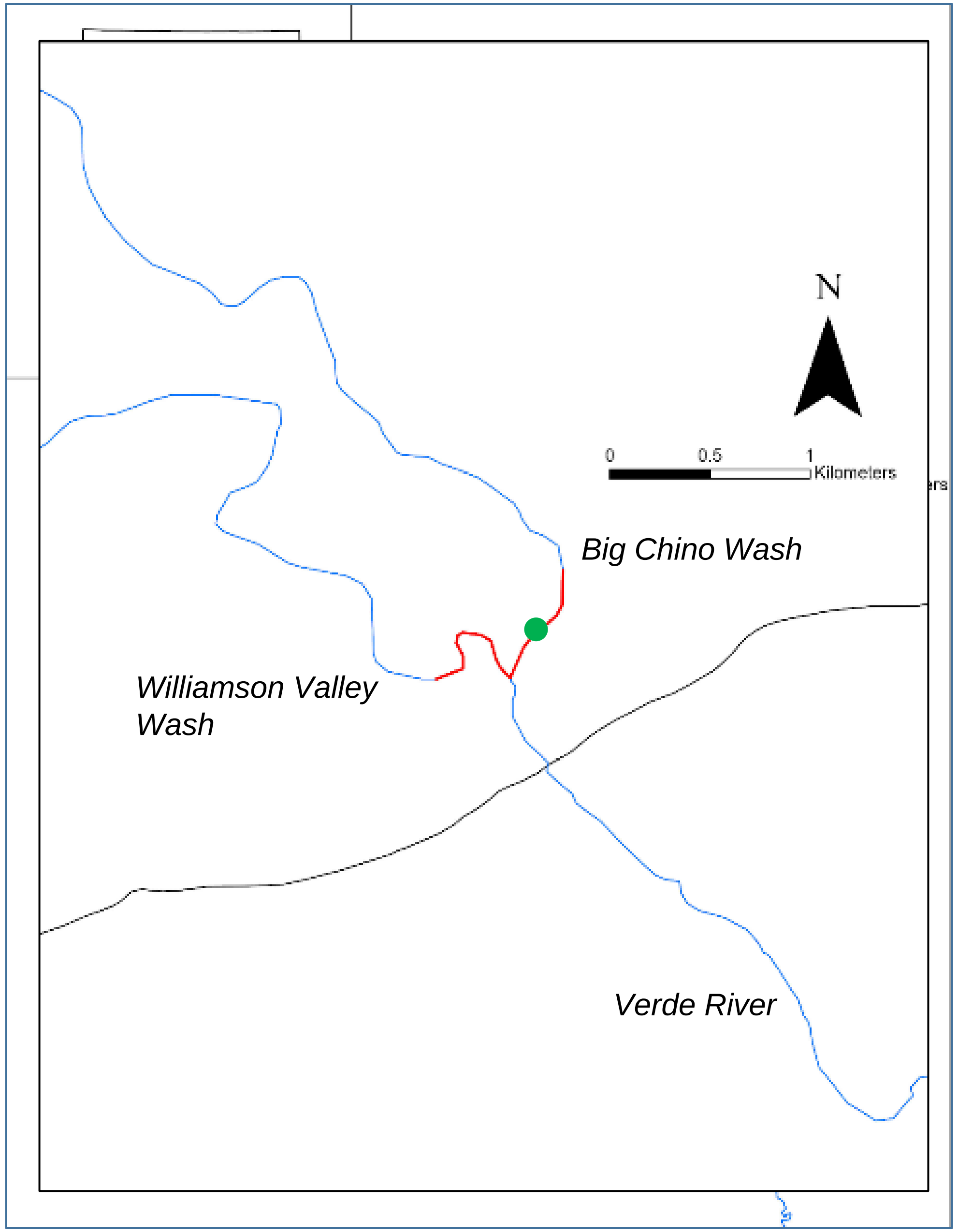




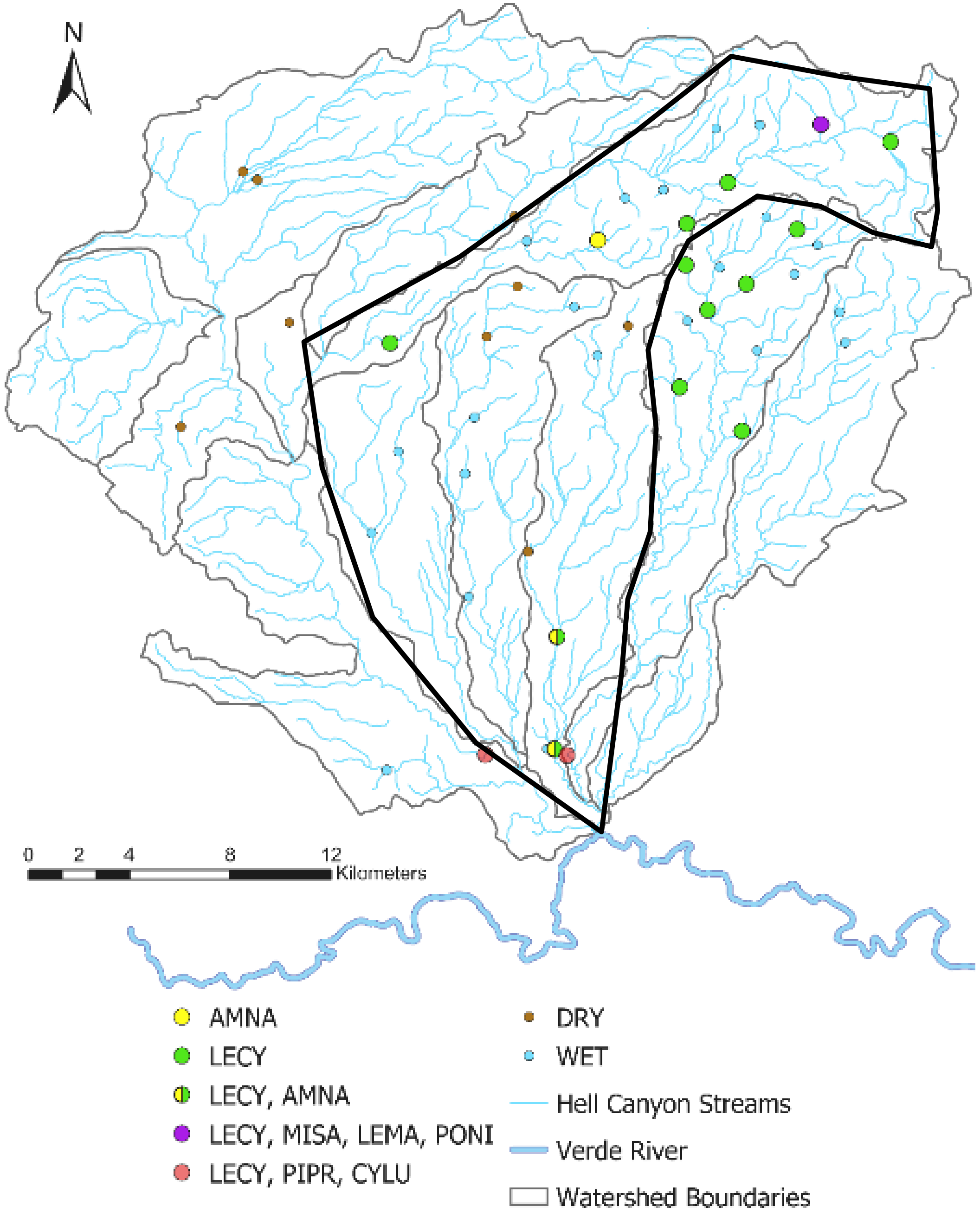
Verde River Tanks



Williamson Valley & Big Chino Wash



Verde River Tanks



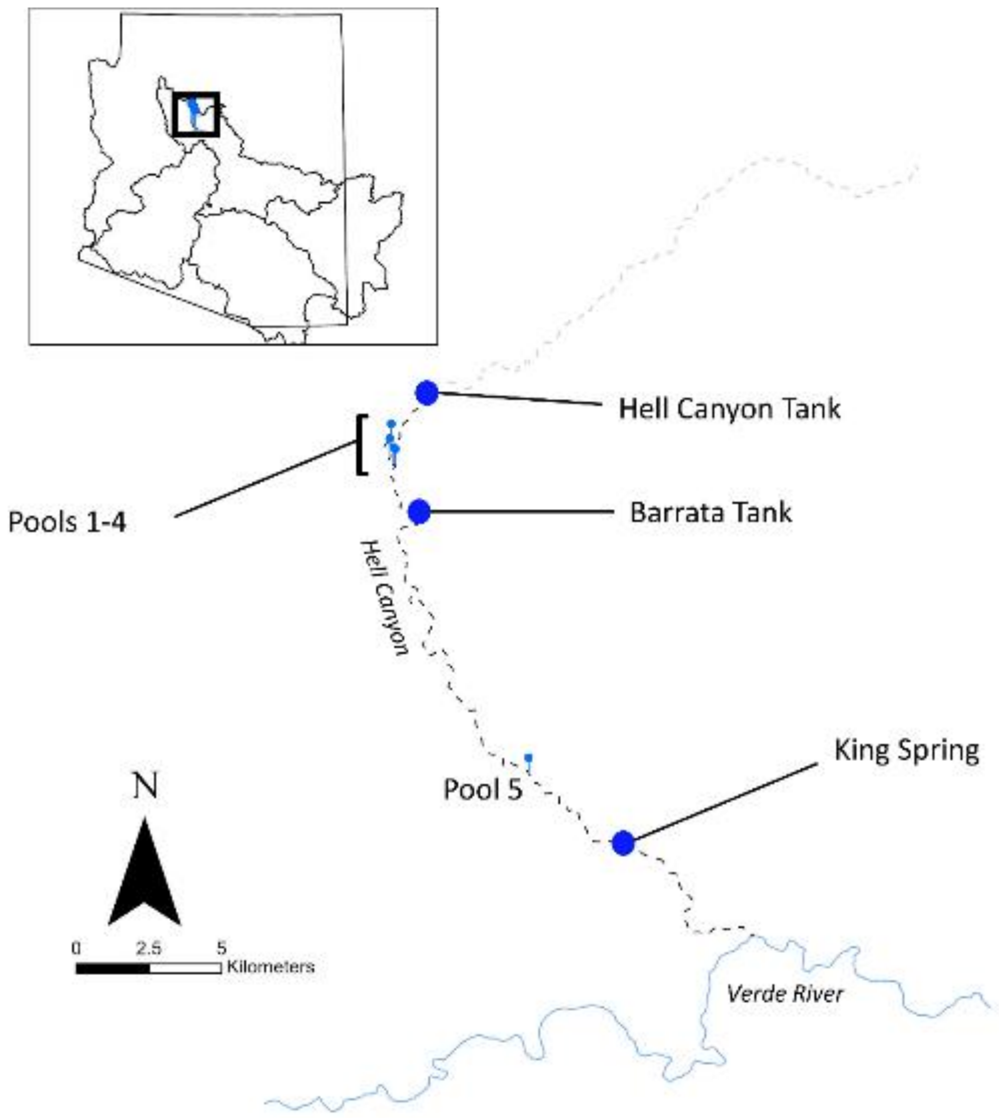
Hell Canyon

2023 Hell Canyon Survey

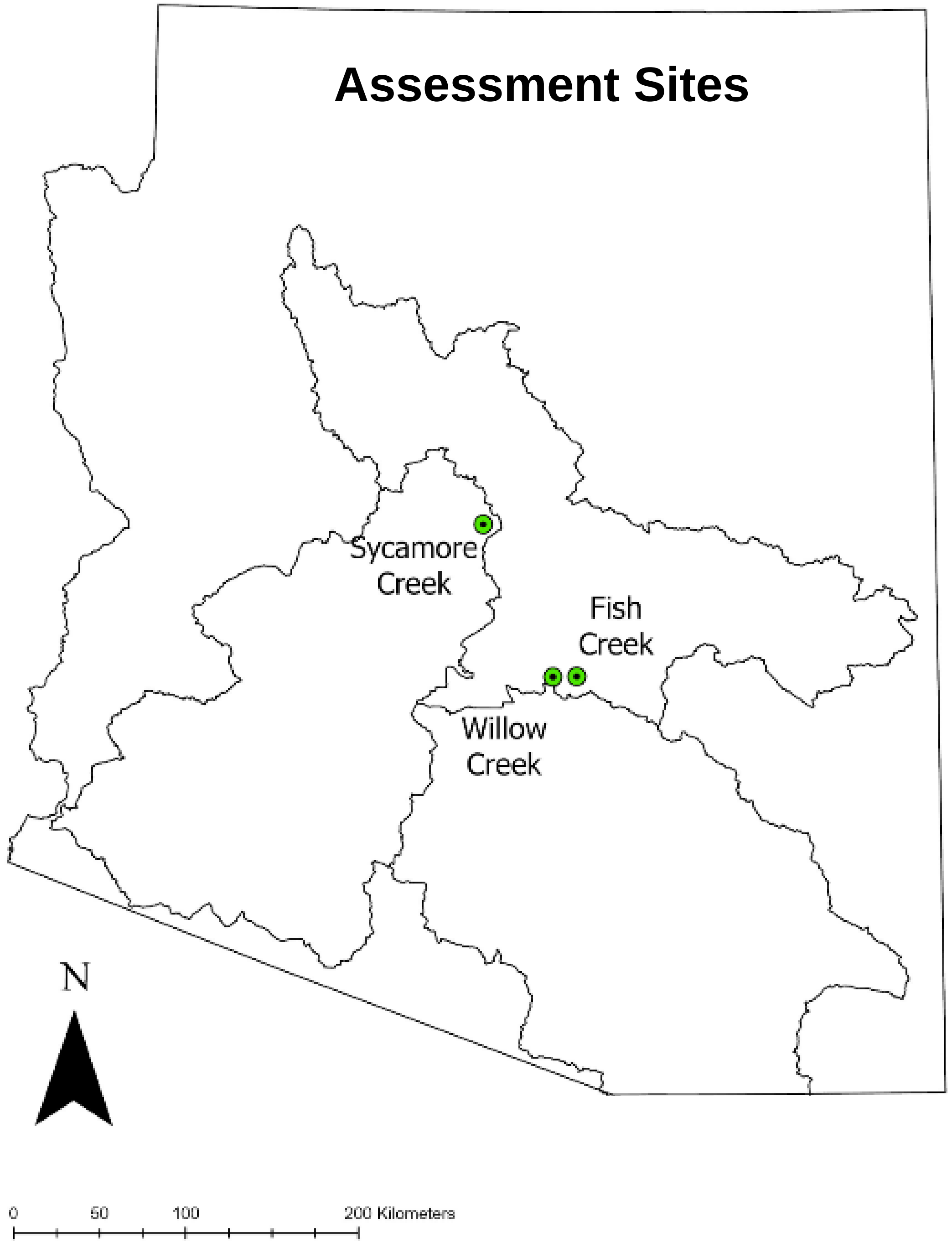
- Five Pools and King Spring Identified

- All pools had fish present
  - Green Sunfish
  - Fathead Minnow
  - Yellow Bullhead
  - Red Shiner (Visually observed)

- Fish Have Access to Reach, extent dependent on year

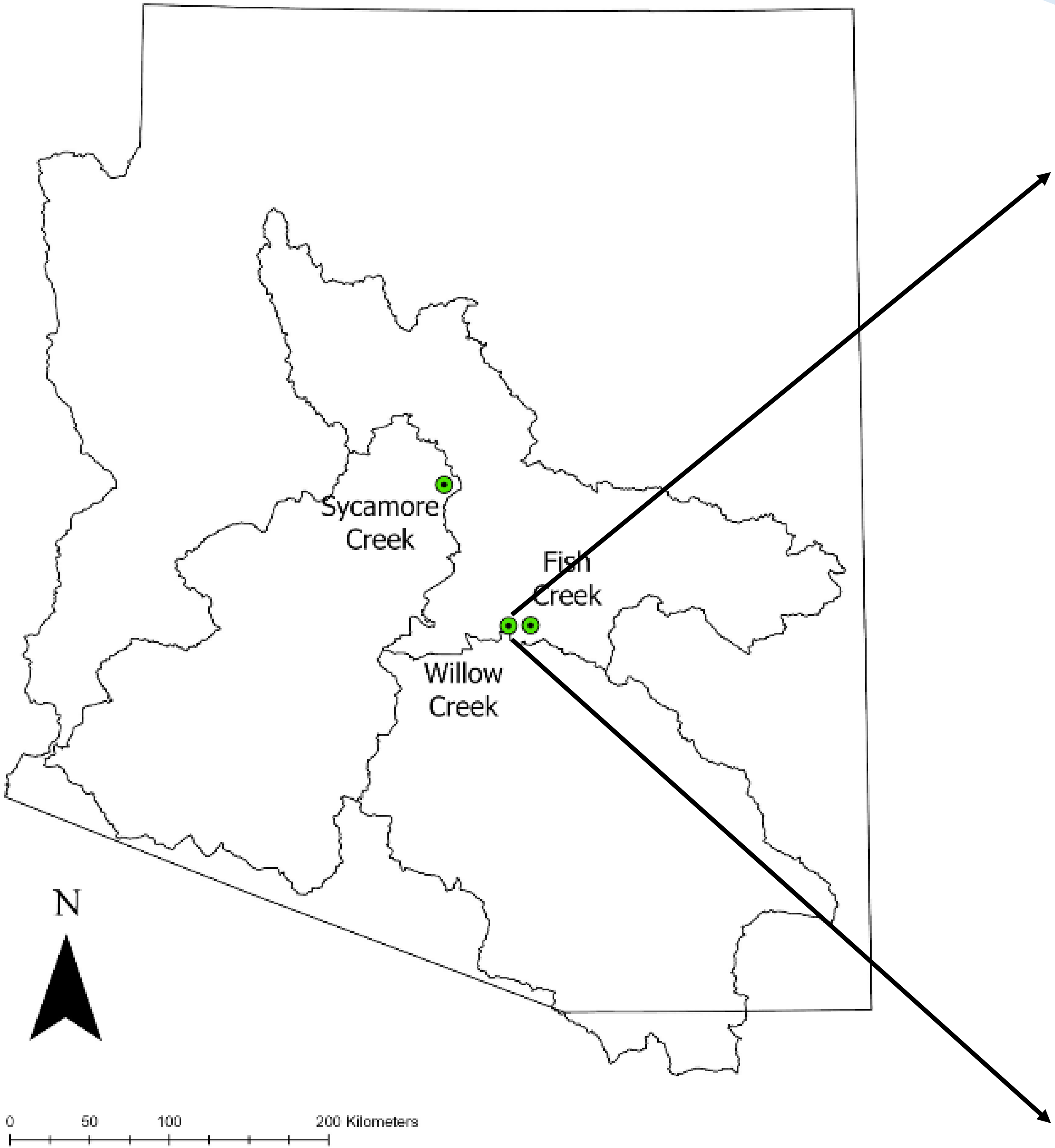


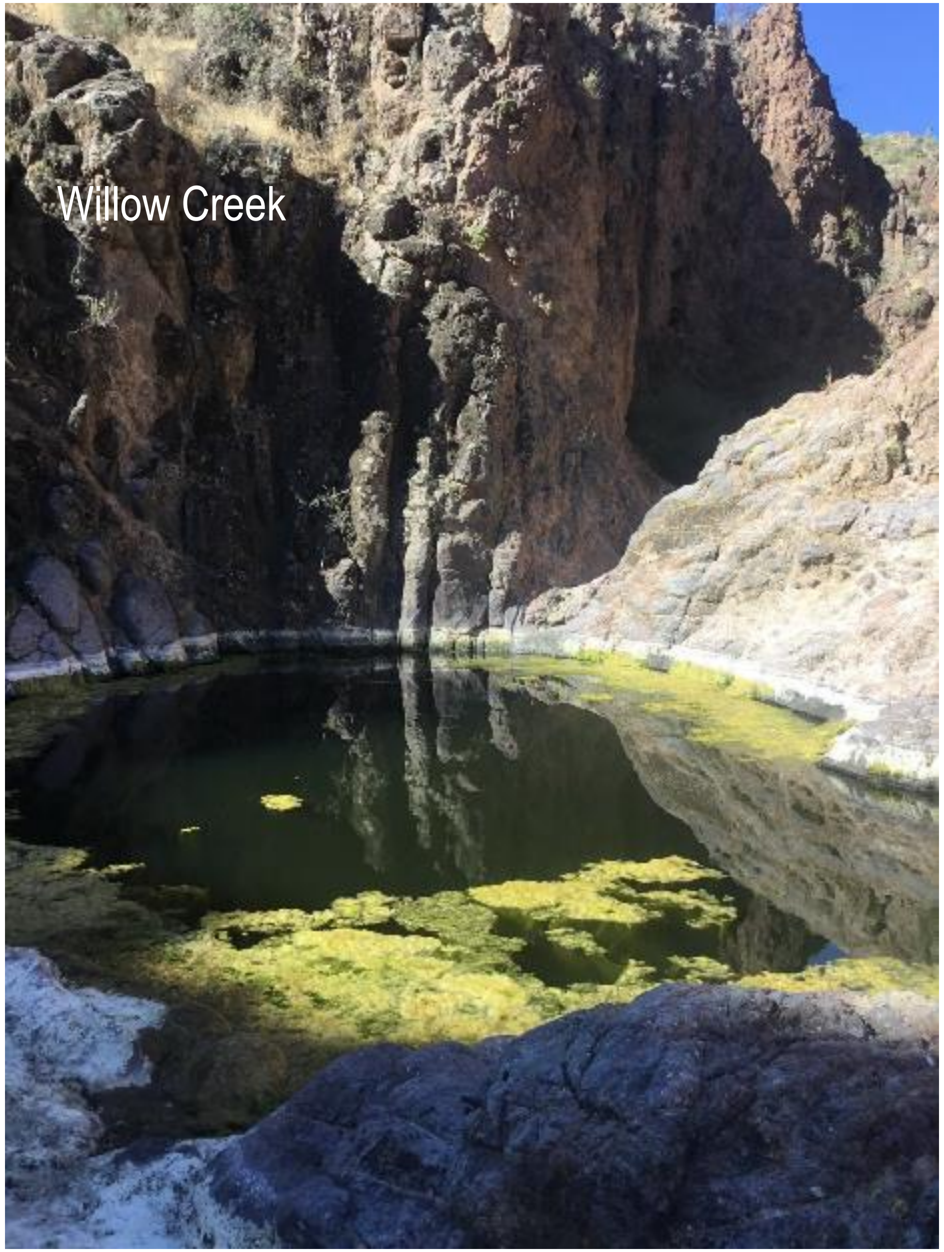
Assessment Sites



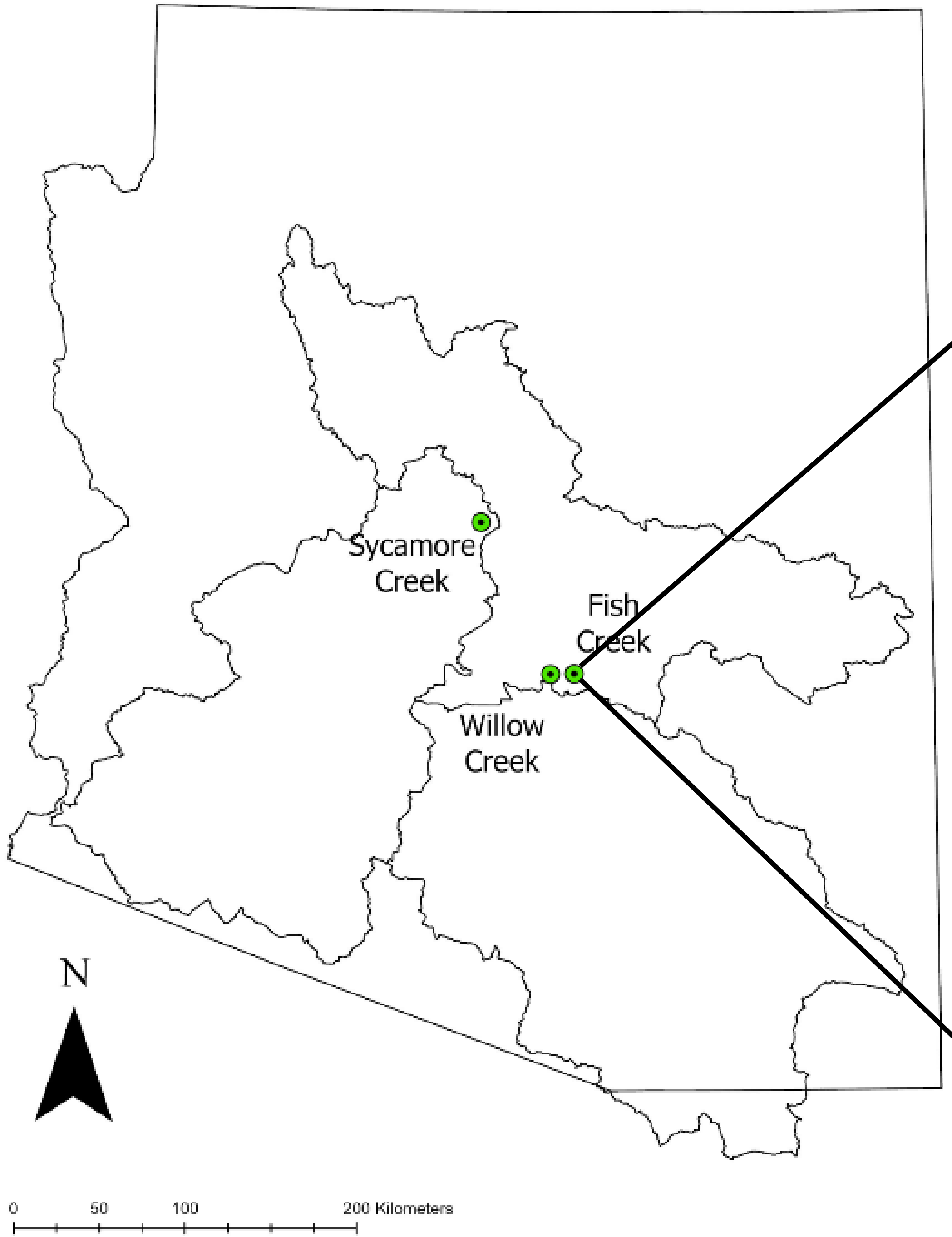
- Willow Creek
- Fish Creek
- Sycamore Creek

Assessment Sites

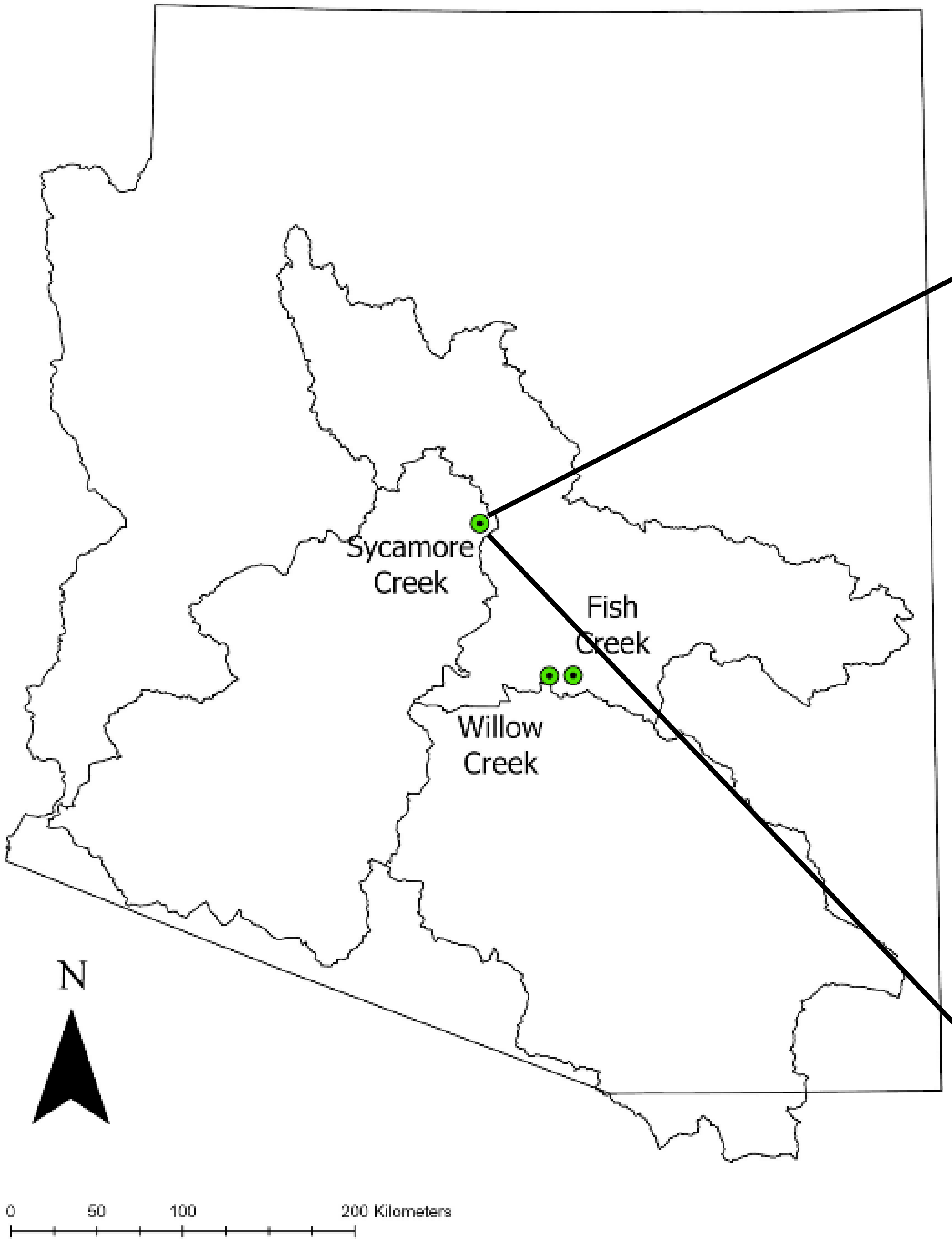


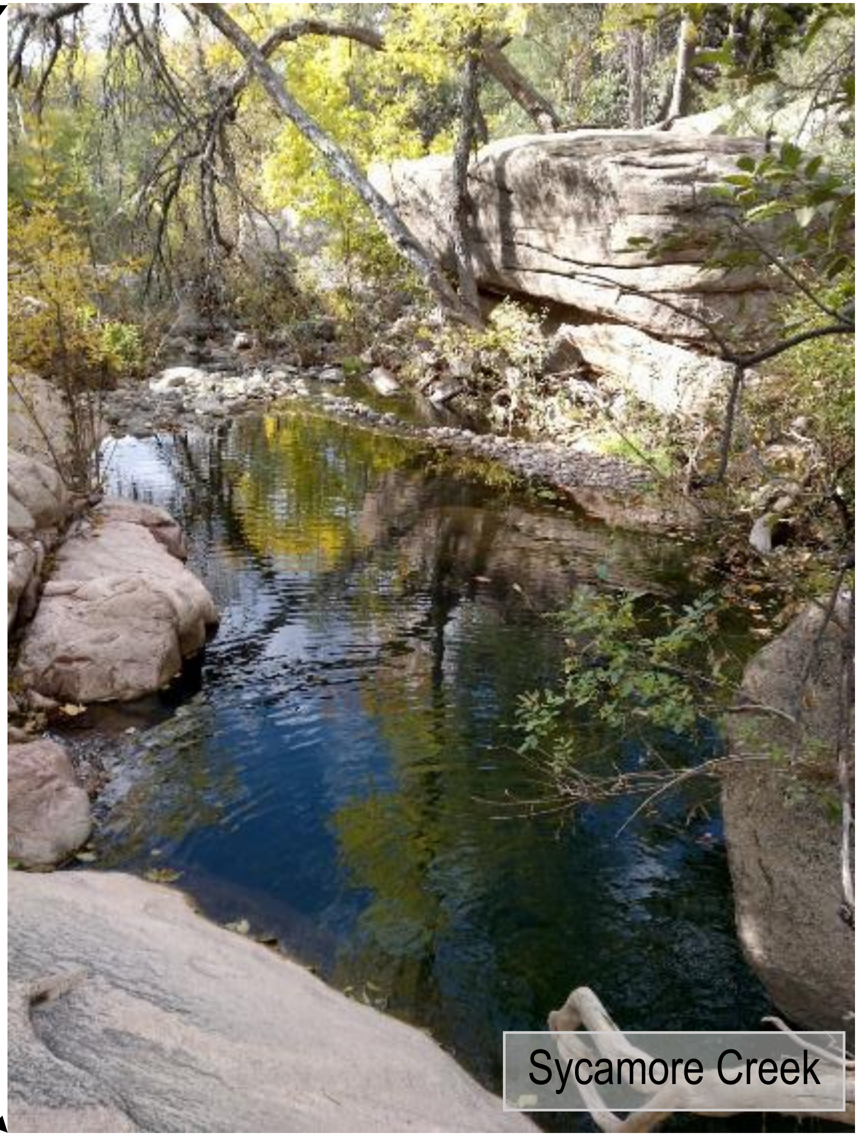


Assessment Sites



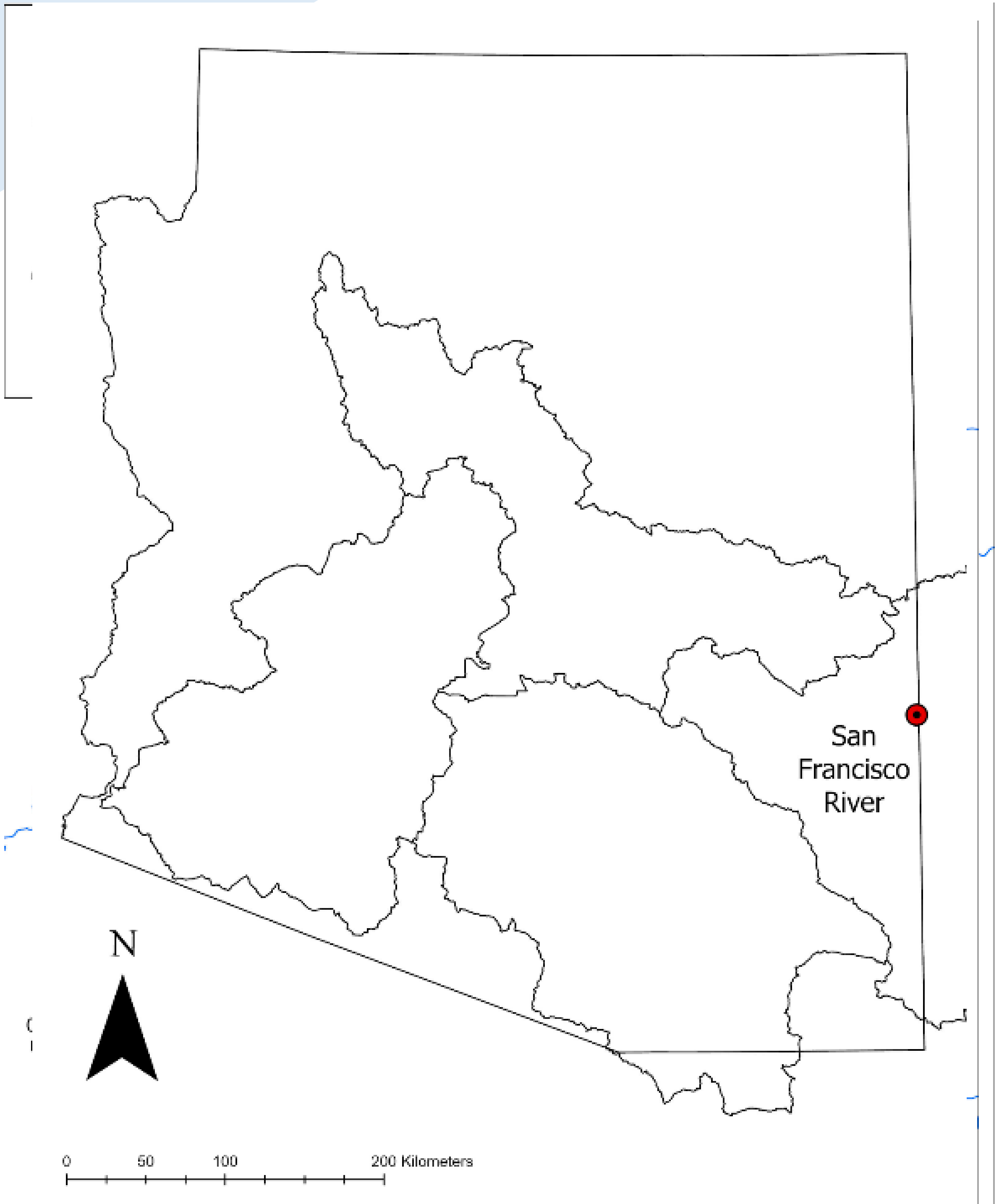
Assessment Sites



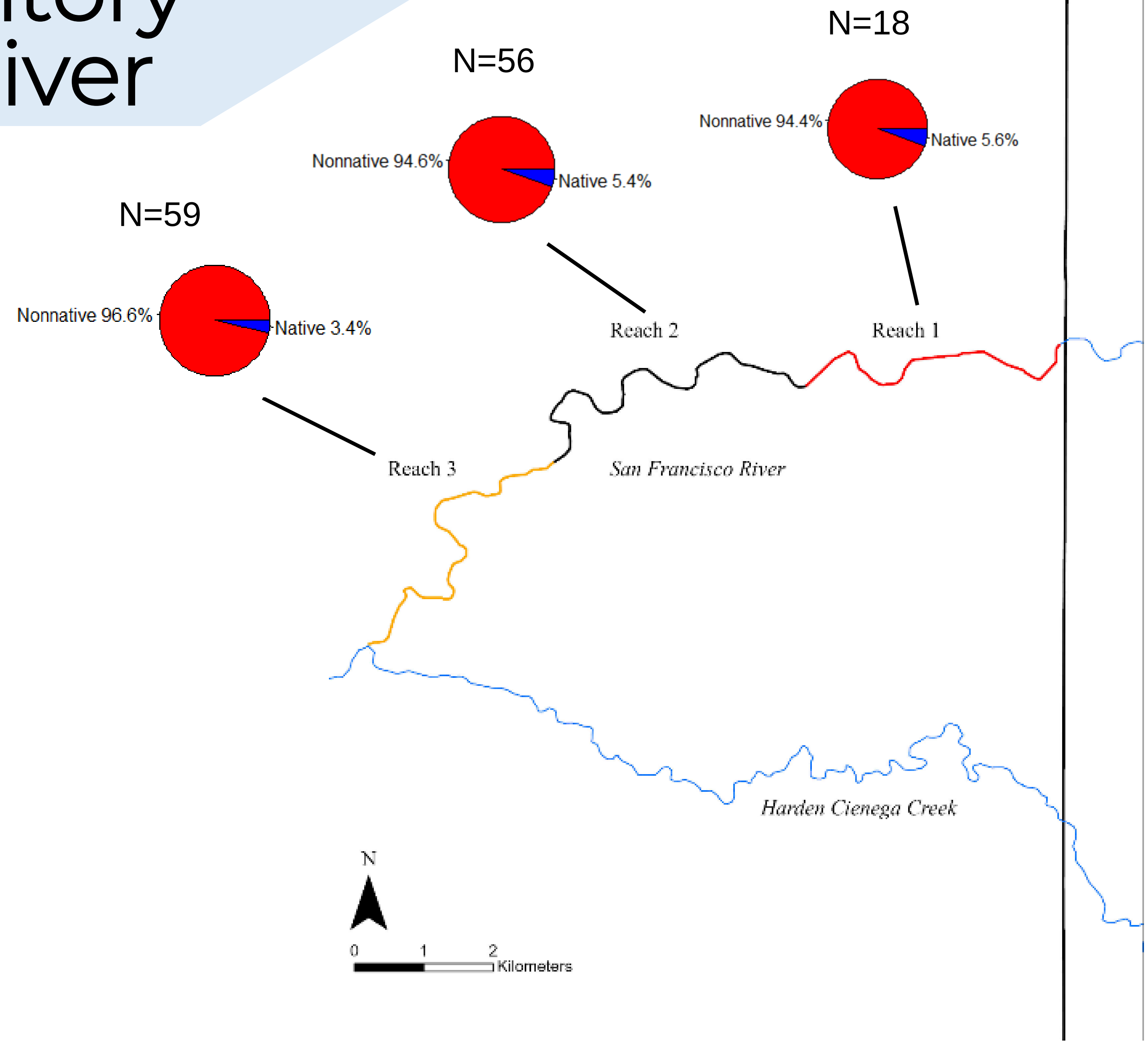


Remote Site Inventory – San Francisco River

- 15 kilometers of stream present
  - Divided into three 5-km reaches
- Completed 39-100m seining sites (26% of Reach)



Remote Site Inventory – San Francisco River



Remote Site Inventory – San Francisco River

Species	Reach 1	Reach 2	Reach 3
Sonora Sucker	**1**	**3**	**0**
Roundtail Chub	**0**	**0**	**2**
Red Shiner	***11***	***48***	***40***
Common Carp	***5***	***4***	***15***
Channel Catfish	***1***	***0***	***1***
Flathead Catfish	***0***	***0***	***1***
Brook Stickleback	*0*	*1*	*0*

GILA RIVER BASIN NATIVE FISHES CONSERVATION PROGRAM

Questions/Discussion

Contact: bhickerson@azgfd.gov
(623) 236-7675

ARIZONA GAME & FISH

2023 NM Projects Update

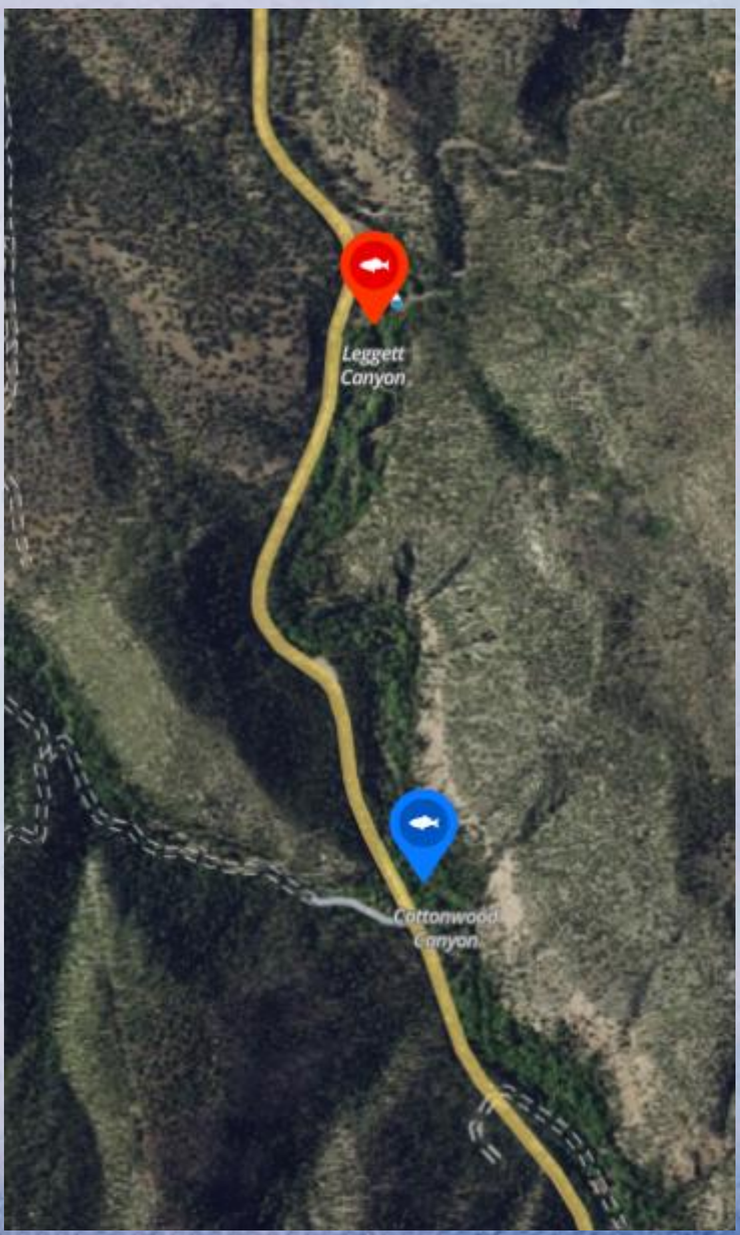
GRBNFCP Annual Reporting Meeting

December 11, 2023

Loach Minnow and Spikedace Activities

Saliz Canyon

- New Loach Minnow stocking site
  - Old site across from Cottonwood Campground
    - Stocked 2016, 2017, and 2019
    - Not dispersing
- Stocked new site October 10
  - 205 individuals
  - Continue 2 more years



Fisheries Division

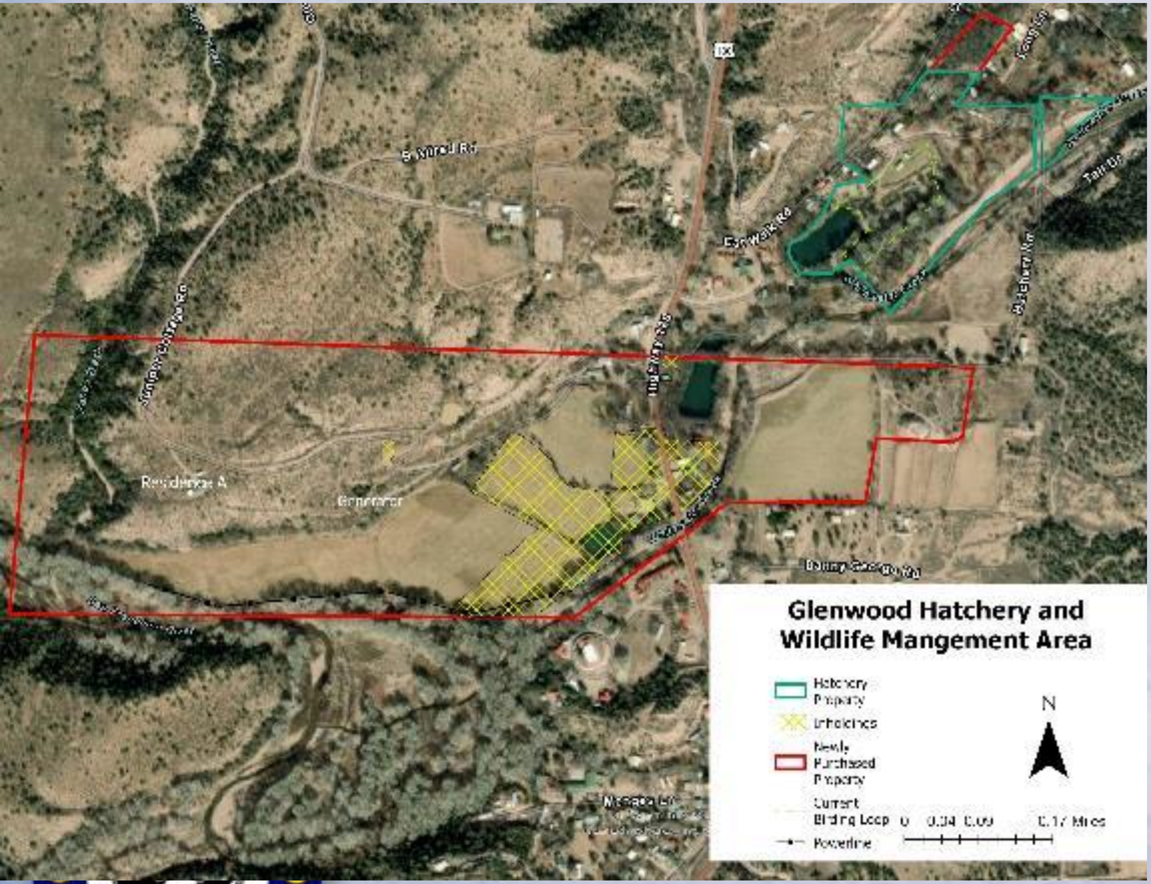
Loach Minnow and Spikedace Activities

Bear Creek

- Salvaged 2020
  - Tadpole fire
  - ARCC
- Progeny stocked October 10
  - 205 individuals
  - 2024 post-repatriation survey

Fisheries Division

Restoration Investigation
Allred Pond

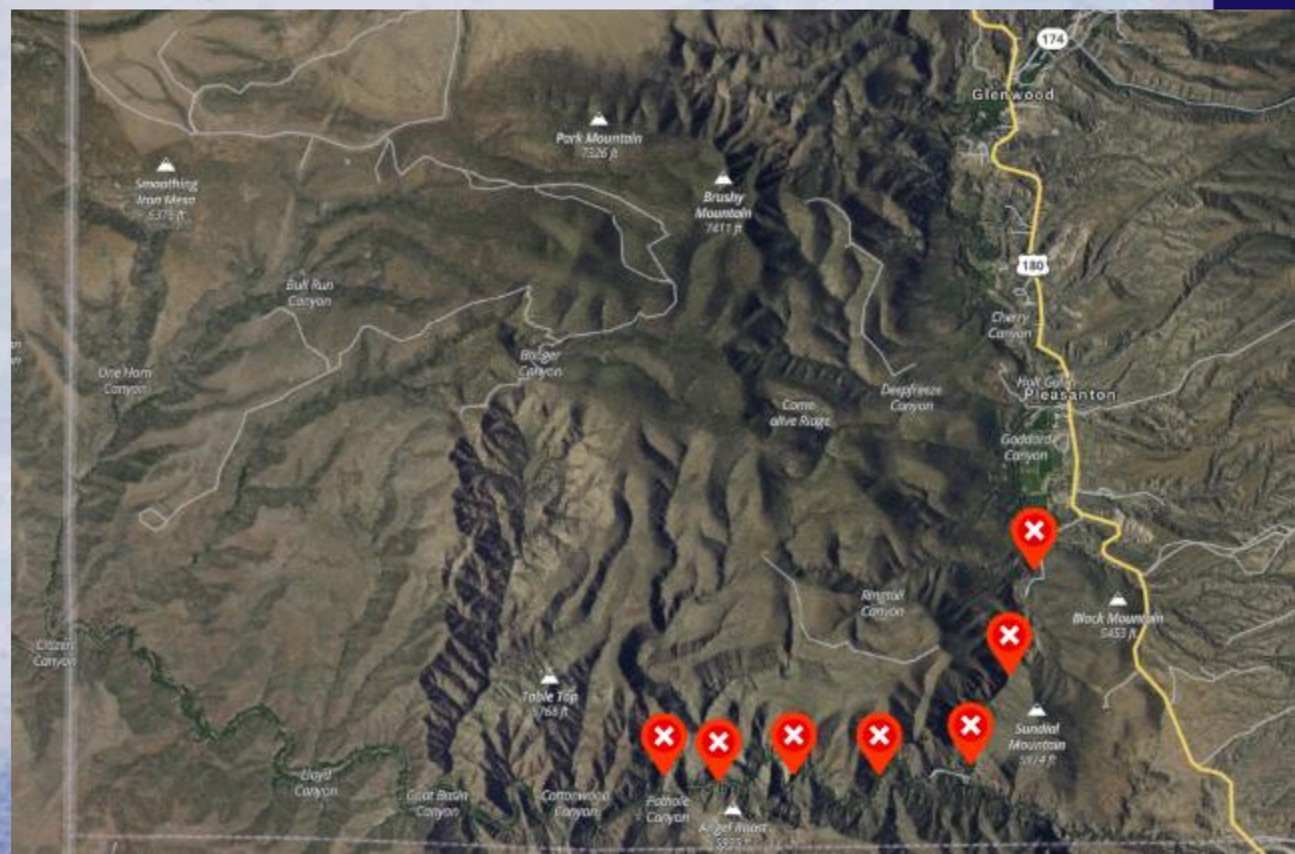


- Property acquired 2021
  - Large pond
- Investigation of fish community
  - June
- Species present
  - Largemouth Bass
    - (n = 13)
  - Sonora Sucker
    - (n = 31)

Fisheries Division

Remote Site Inventory
San Francisco River

- Remote portions of lower San Francisco River
  - Never before surveyed
- Sampled only upper sites
  - High flows



Remote Site Inventory

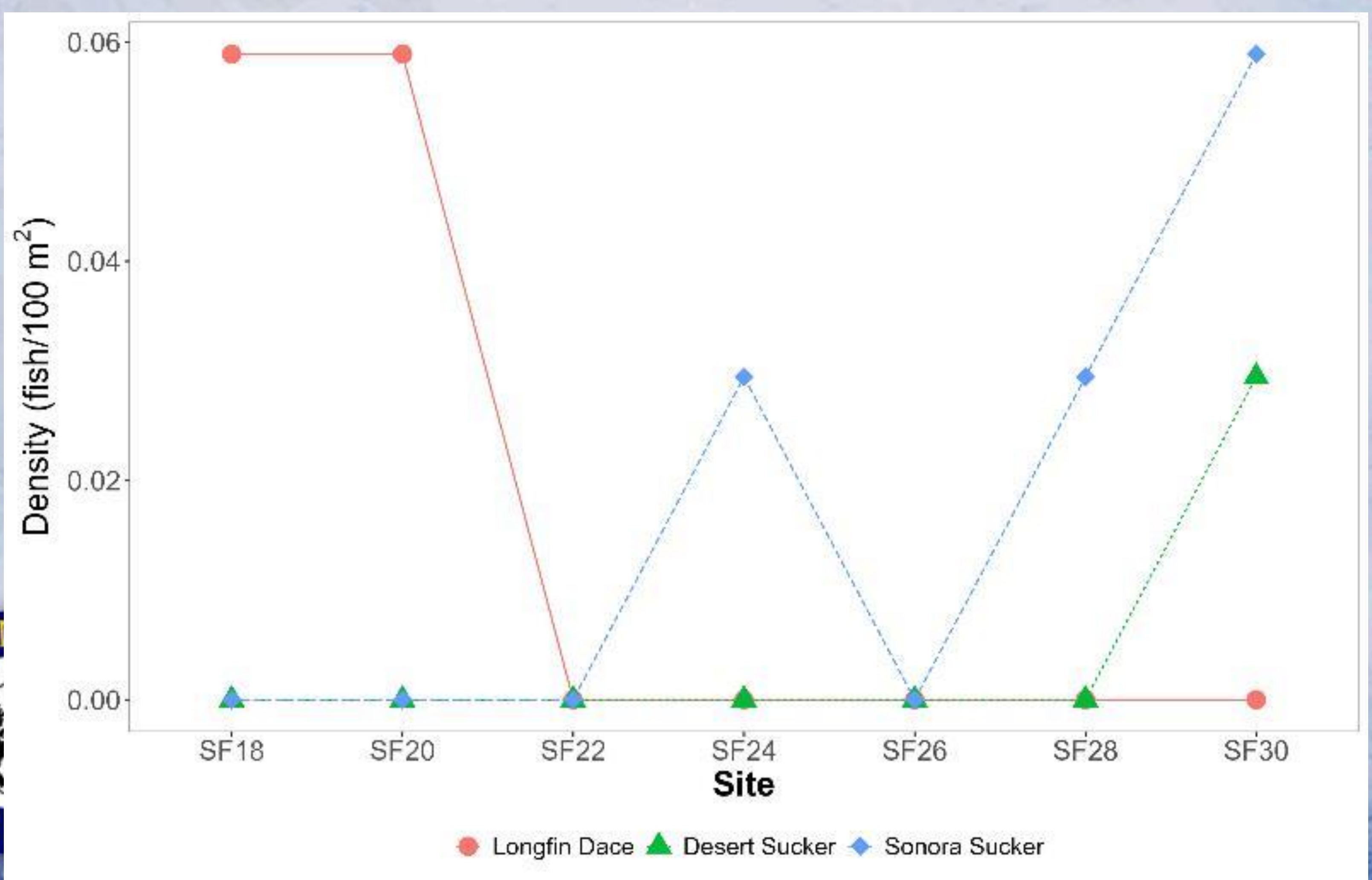
San Francisco River

- Rare native species
  - Loach Minnow, Spikedace, Roundtail Chub
  - None encountered

Remote Site Inventory

San Francisco River

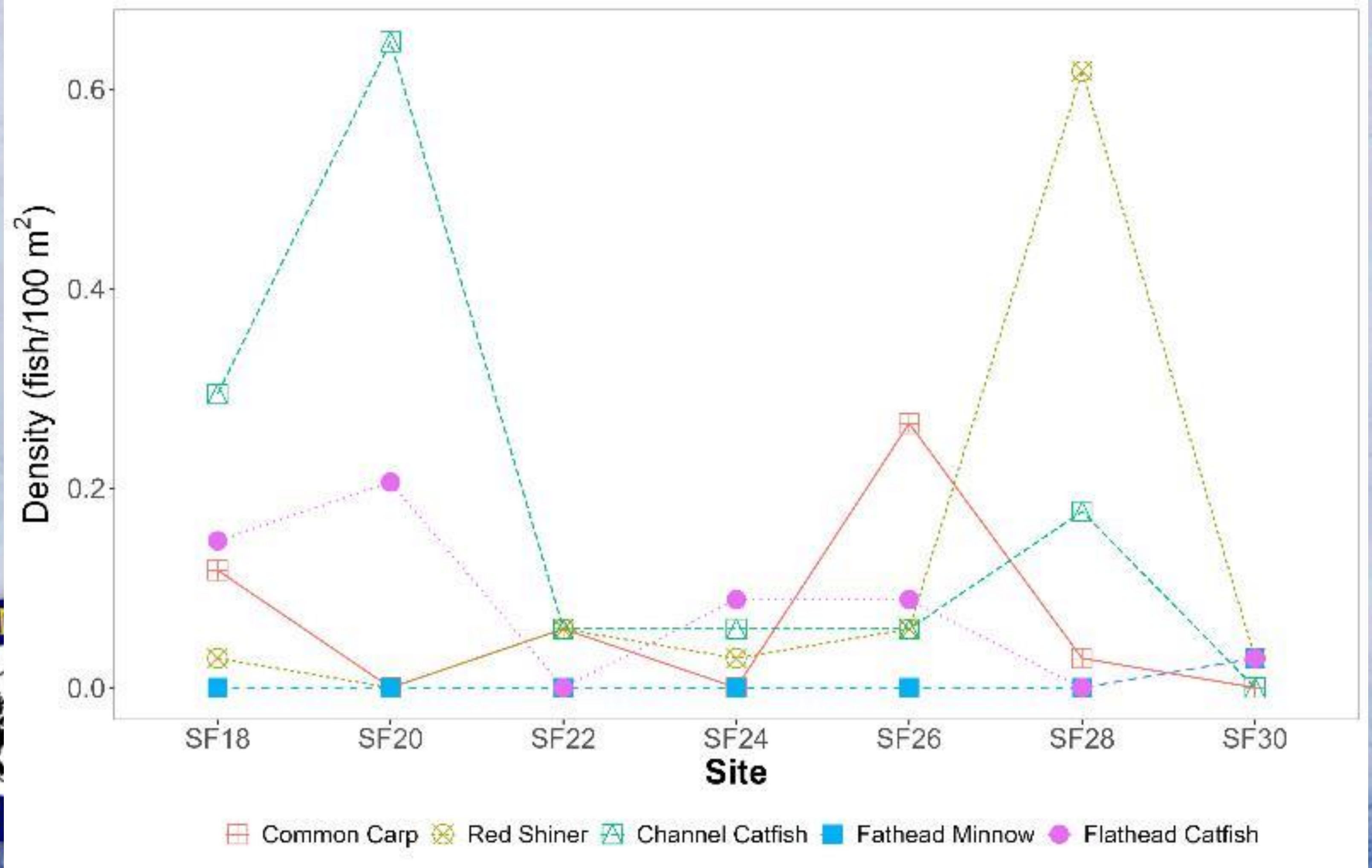
- Low densities of common native species across sites



Remote Site Inventory

San Francisco River

- Low densities of nonnative species across sites



Remote Site Inventory

San Francisco River

- Among all sites
  - Natives 7.7%
  - Nonnatives 92.3%

Species	N	Relative Abundance (%)
Native species		
Desert Sucker	1	0.9
Longfin Dace	4	3.4
Sonora Sucker	4	3.4
Nonnative species		
Channel Catfish	44	37.6
Common Carp	16	13.7
Fathead Minnow	1	0.9
Flathead Catfish	19	16.2
Red Shiner	28	23.9

Removal Efforts

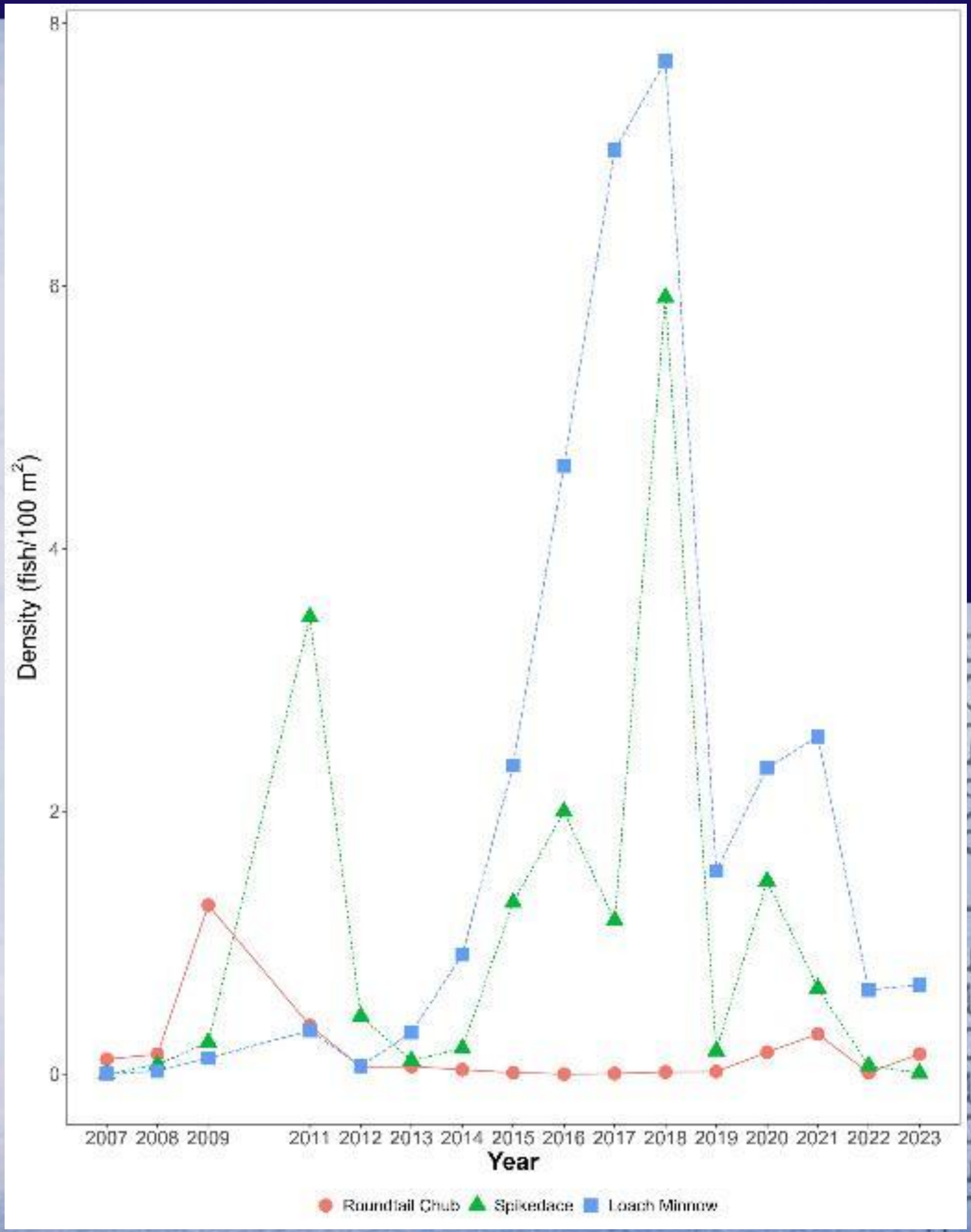
West Fork Gila River-Heart Bar WMA

- Ongoing project since 2006
- 4 km reach on Department Heart Bar property
- Single pass removal, 2 backpack electrofishers
  - Sample by mesohabitat

Removal Efforts

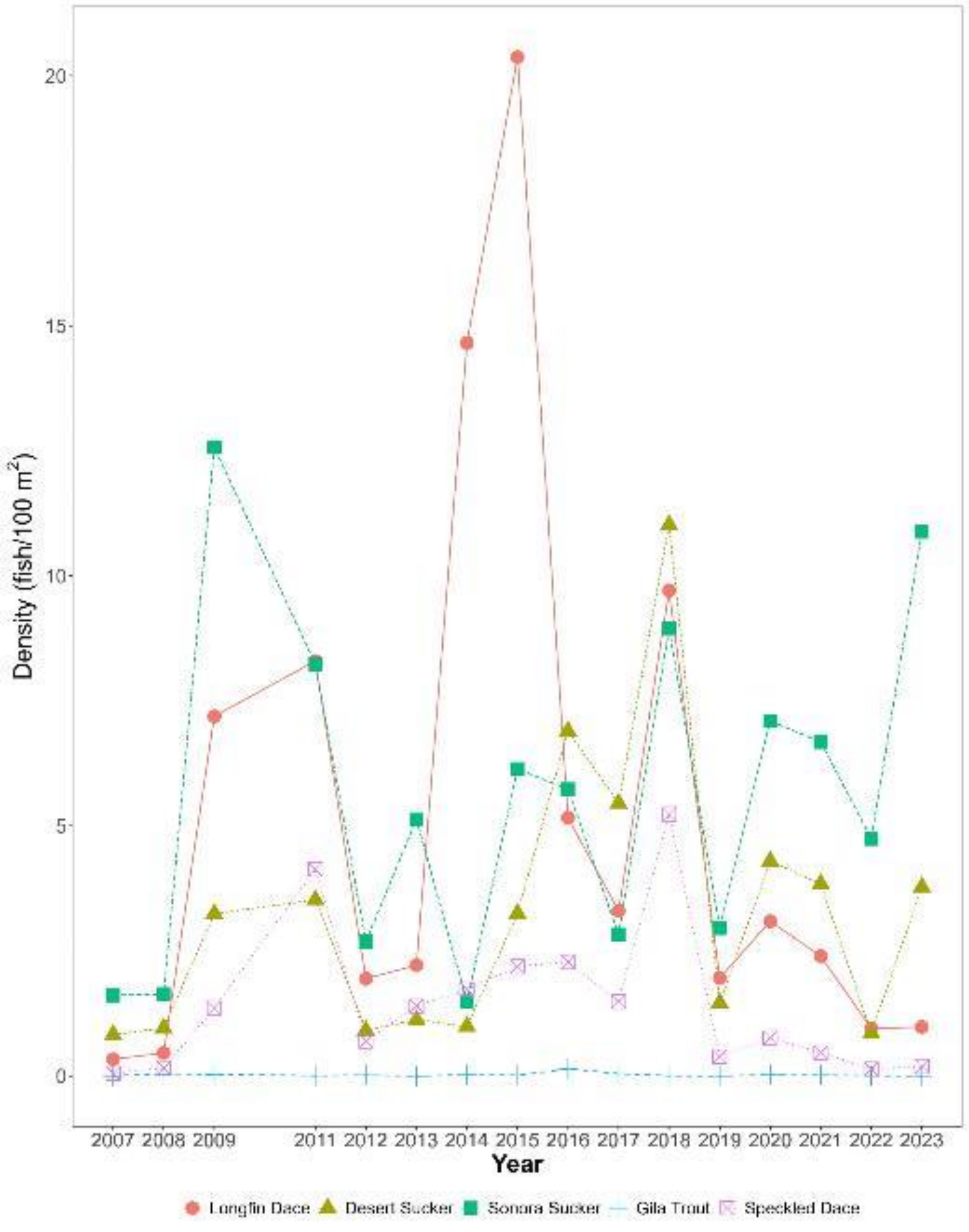
West Fork Gila River-Heart Bar WMA

- Priority species
  - Decline
    - Spikedace
  - Increase
    - Roundtail Chub
    - Loach Minnow



Removal Efforts
West Fork Gila River-Heart Bar WMA

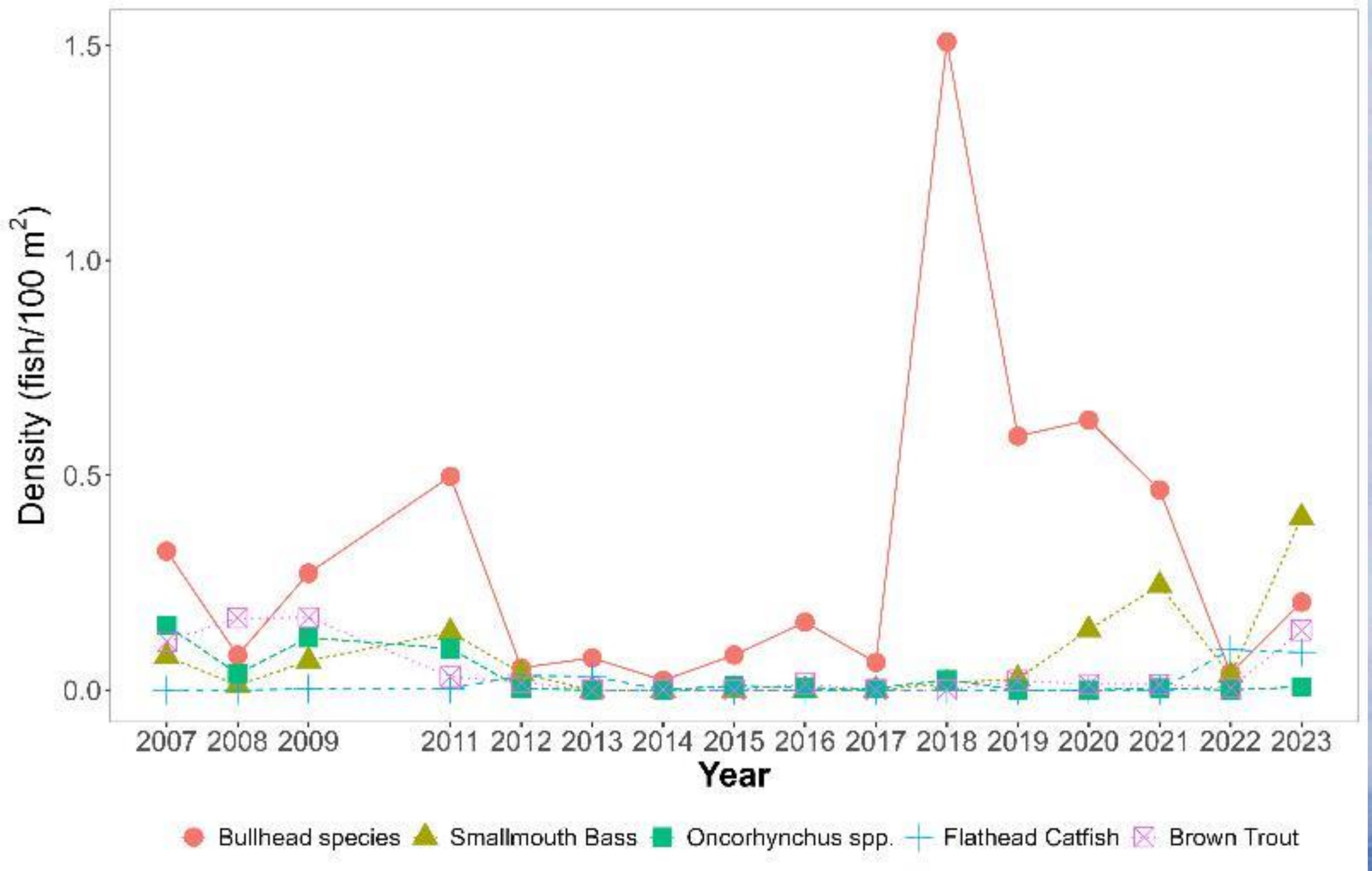
- Other natives
  - Increase in density since last year



Removal Efforts

West Fork Gila River-Heart Bar WMA

- Nonnatives



Fisheries Division

Removal Efforts
West Fork Gila River-Heart Bar WMA

- 2023 captures

Species	N	Density (fish/100 m^2)
Native species		
Desert Sucker	517	3.78
Gila Trout	0	0
Loach Minnow	93	0.68
Longfin Dace	134	0.98
Roundtail Chub	21	0.15
Sonora Sucker	1490	10.89
Speckled Dace	26	0.19
Spikedace	1	0.01
Nonnative species		
Brown Trout	19	0.14
Bullhead species	28	0.20
Common Carp	1	0.01
Fathead Minnow	1	0.01
Flathead Catfish	12	0.09
Green Sunfish	1	0.01
Oncorhynchus spp.	1	0.01
Red Shiner	0	0
Smallmouth Bass	55	0.40
Western Mosquitofish	0	0

Fisheries Division

Removal Efforts

West Fork Gila River-Heart Bar WMA

2022 captures

Species	N	Density (fish/100 m^2)
Native species		
Desert Sucker	173	0.85
Gila Trout	1	0.01
Loach Minnow	130	0.64
Longfin Dace	193	0.95
Roundtail Chub	2	0.01
Sonora Sucker	962	4.74
Speckled Dace	28	0.14
Spikedace	13	0.06
Nonnative species		
Brown Trout	1	0.01
Bullhead species	8	0.04
Common Carp	4	0.02
Fathead Minnow	0	0.00
Flathead Catfish	19	0.09
Green Sunfish	0	0.00
Oncorhynchus spp.	0	0.00
Red Shiner	2	0.01
Smallmouth Bass	7	0.03
Western Mosquitofish	55	0.27

2023 captures

Species	N	Density (fish/100 m^2)
Native species		
Desert Sucker	517	3.78
Gila Trout	0	0
Loach Minnow	93	0.68
Longfin Dace	134	0.98
Roundtail Chub	21	0.15
Sonora Sucker	1490	10.89
Speckled Dace	26	0.19
Spikedace	1	0.01
Nonnative species		
Brown Trout	19	0.14
Bullhead species	28	0.20
Common Carp	1	0.01
Fathead Minnow	1	0.01
Flathead Catfish	12	0.09
Green Sunfish	1	0.01
Oncorhynchus spp.	1	0.01
Red Shiner	0	0
Smallmouth Bass	55	0.40
Western Mosquitofish	0	0

Removal Efforts
West Fork Gila River-Heart Bar WMA

- Conclusions
  - Priority species density
    - Increase in Loach Minnow and Roundtail Chub
    - Decrease in Spikedace
  - Still high numbers Flathead Catfish

Removal Efforts
West Fork Gila River-Heart Bar WMA

- Conclusions
  - Update sampling methods

Questions?

West Fork Black River Native Fish Restoration on Tribal Lands

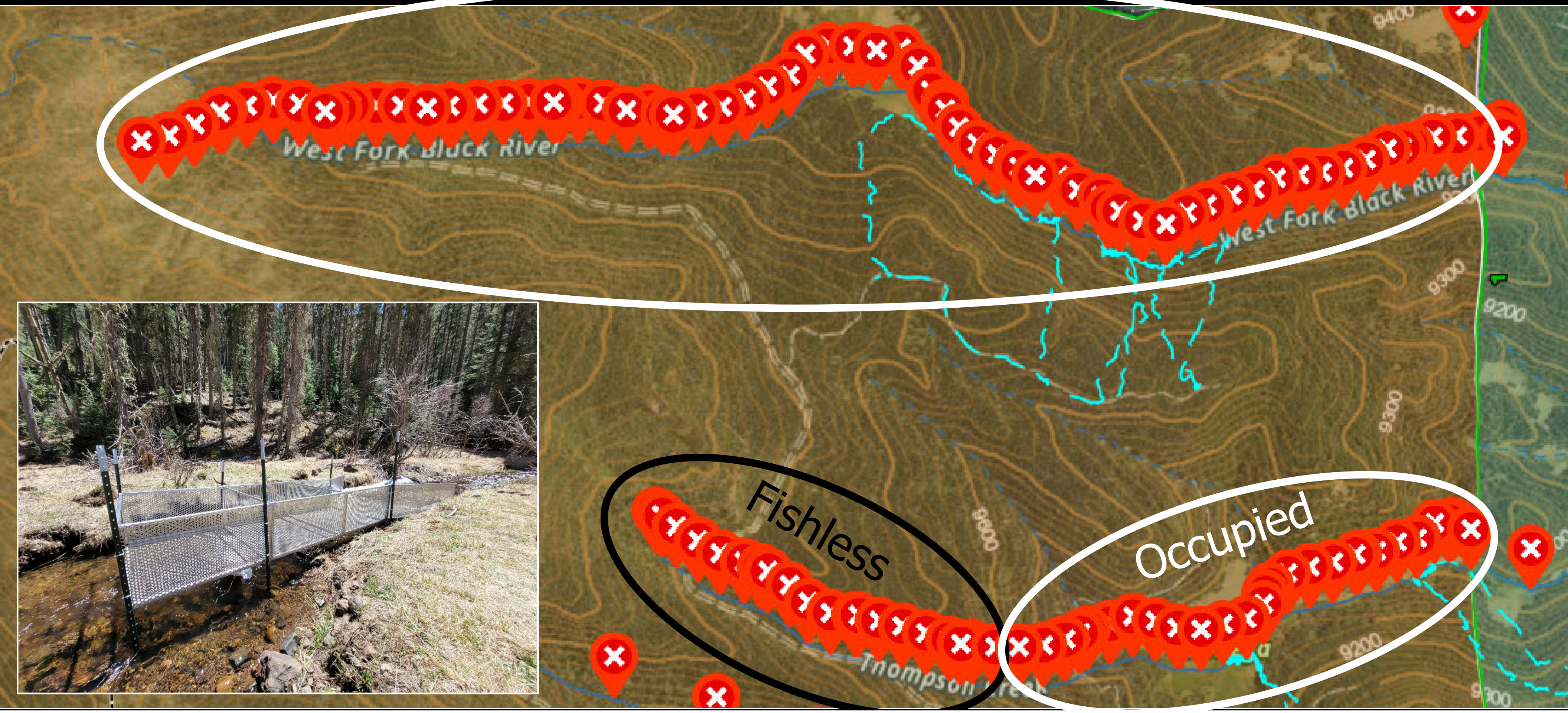
Zachary Jackson
AZ Fish and Wildlife Conservation Office
Whiteriver, AZ

Tim Gatewood
White Mountain Apache Tribe
Whiteriver, AZ

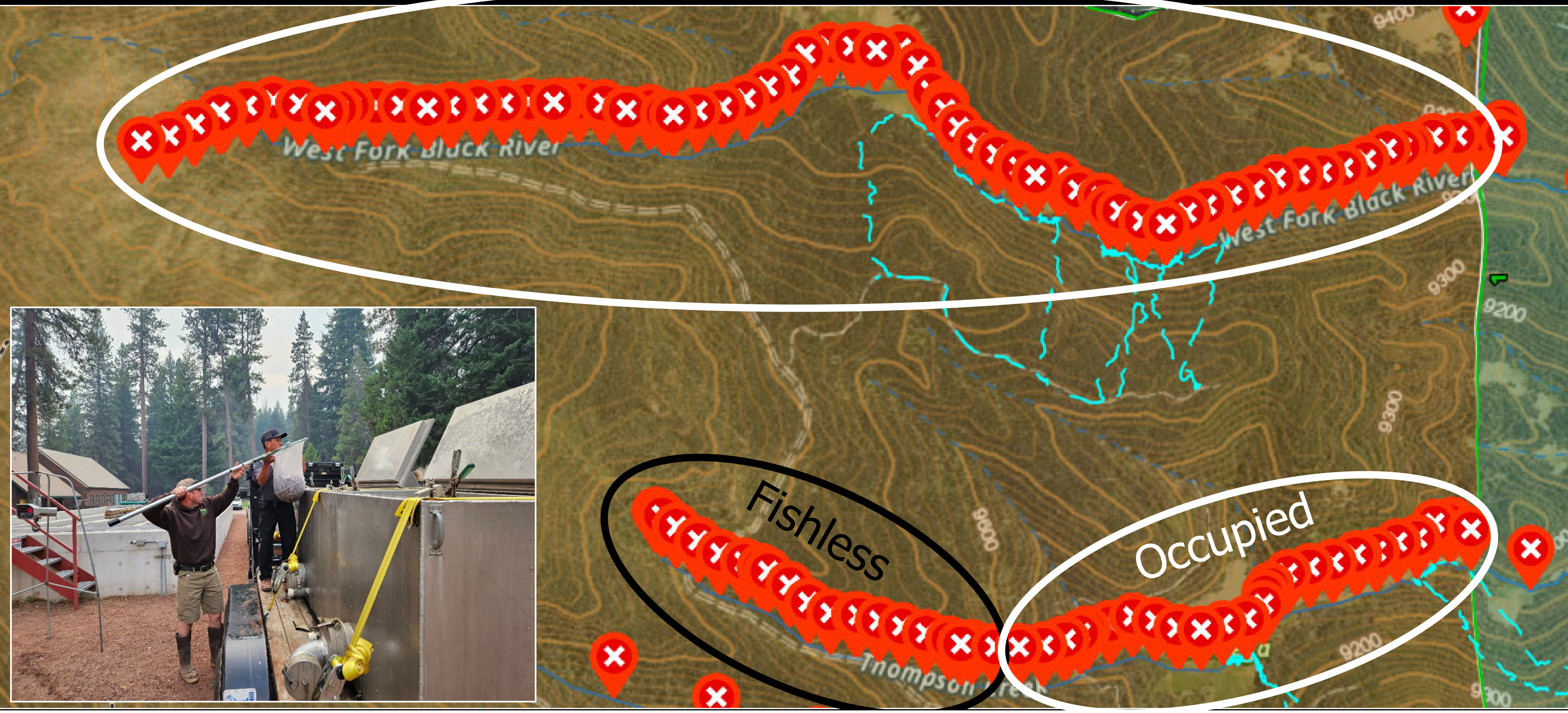
2021

- Methods, briefly
  - 100-m reaches
  - Block nets
  - Depletion

2022


West Fork Black River
West Fork Black River
Fishless
Occupied
Thompson Creek
9400
9300
9200
9300
9200
9300

2023


West Fork Black River
West Fork Black River
Fishless
Occupied
9400
9300
9200

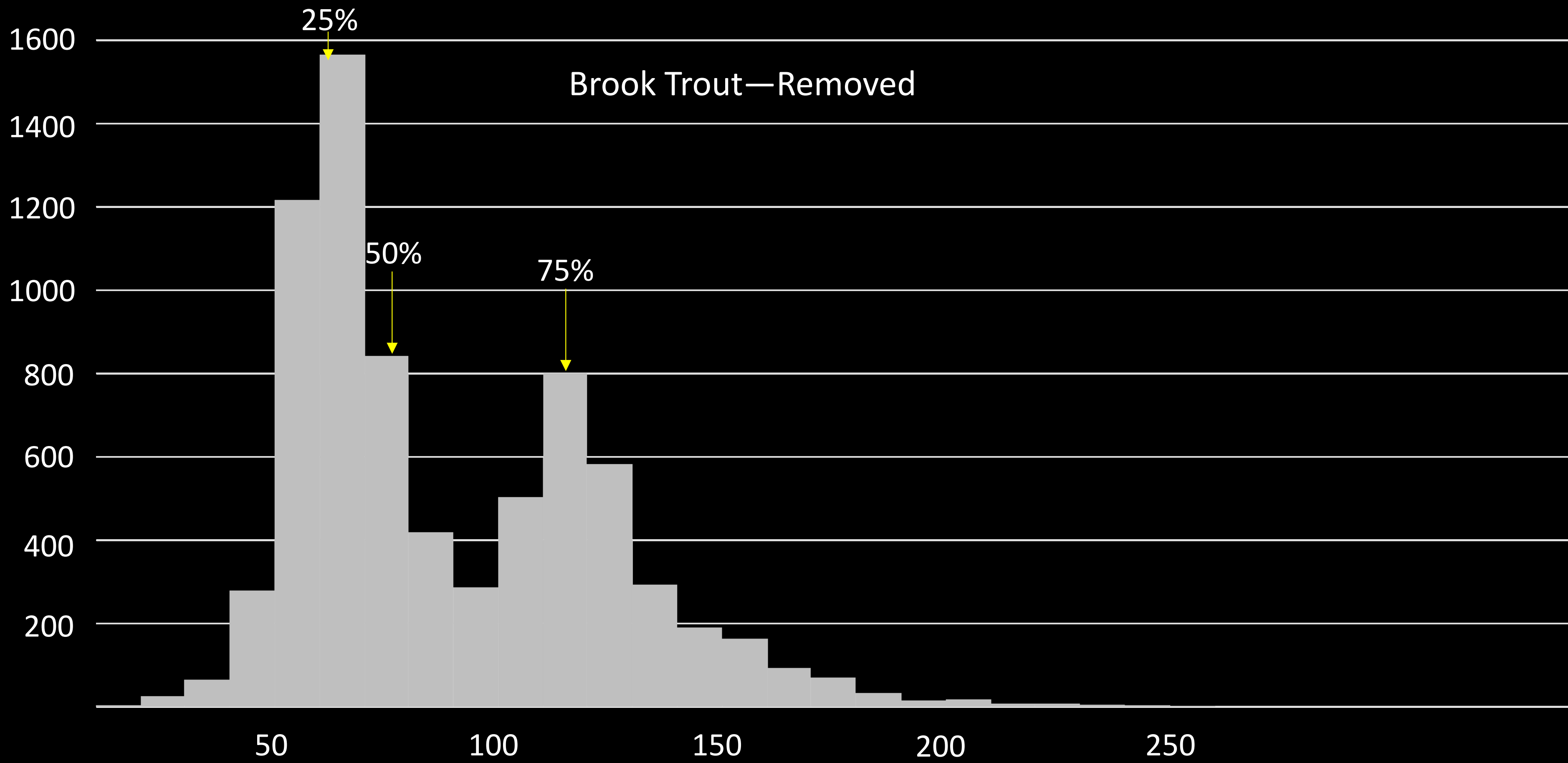
2023—Brook Trout Eradication

- Effort
  - Thompson Creek
    - 3 single passes
    - 32 staff days
    - 40,274 seconds
  - West Fork Black River
    - 2 passes
    - ~252 depletion passes
    - 277 staff days
    - 321,109 seconds

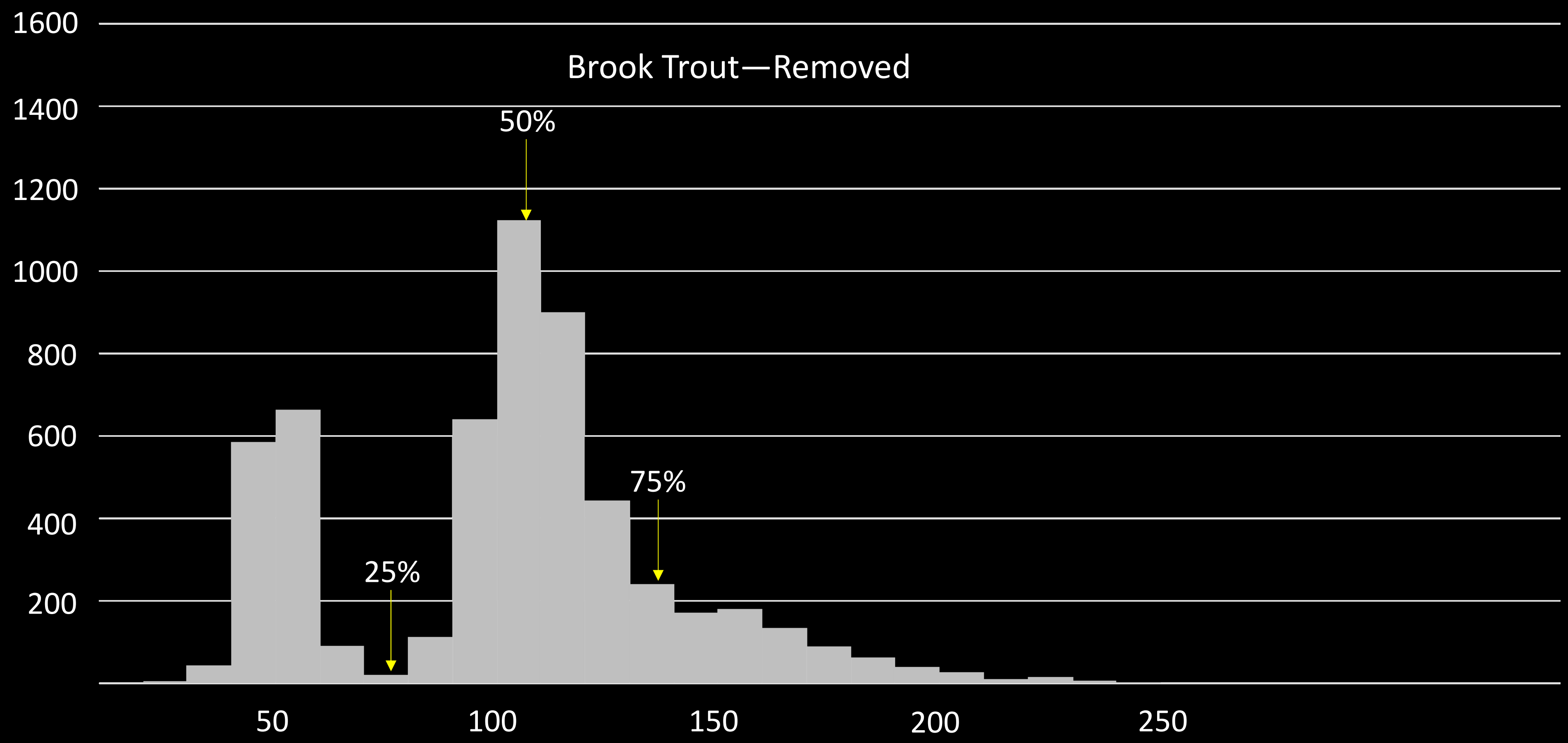
2023—Brook Trout Eradication

- Results
  - Thompson Ck.
    - SP1–3= 108 SAFO
    - Stocked 208 Myy Brook Trout
  - West Fork Black R.
    - EP= 2,263 SAFO
    - SP= 1,665 SAFO + 1,835 recaps
    - Stocked 3,783 Myy Brook Trout

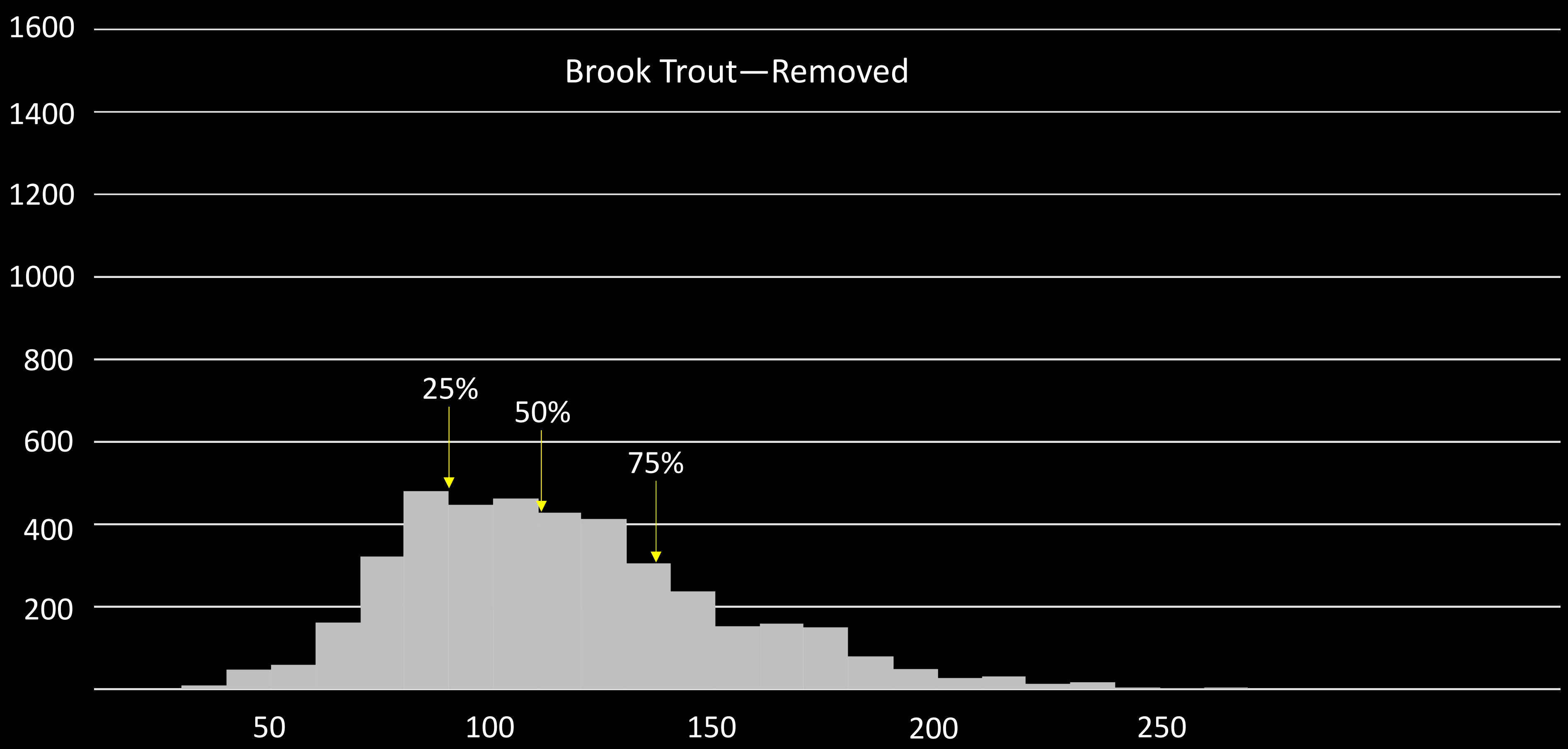
2021 Length-frequency



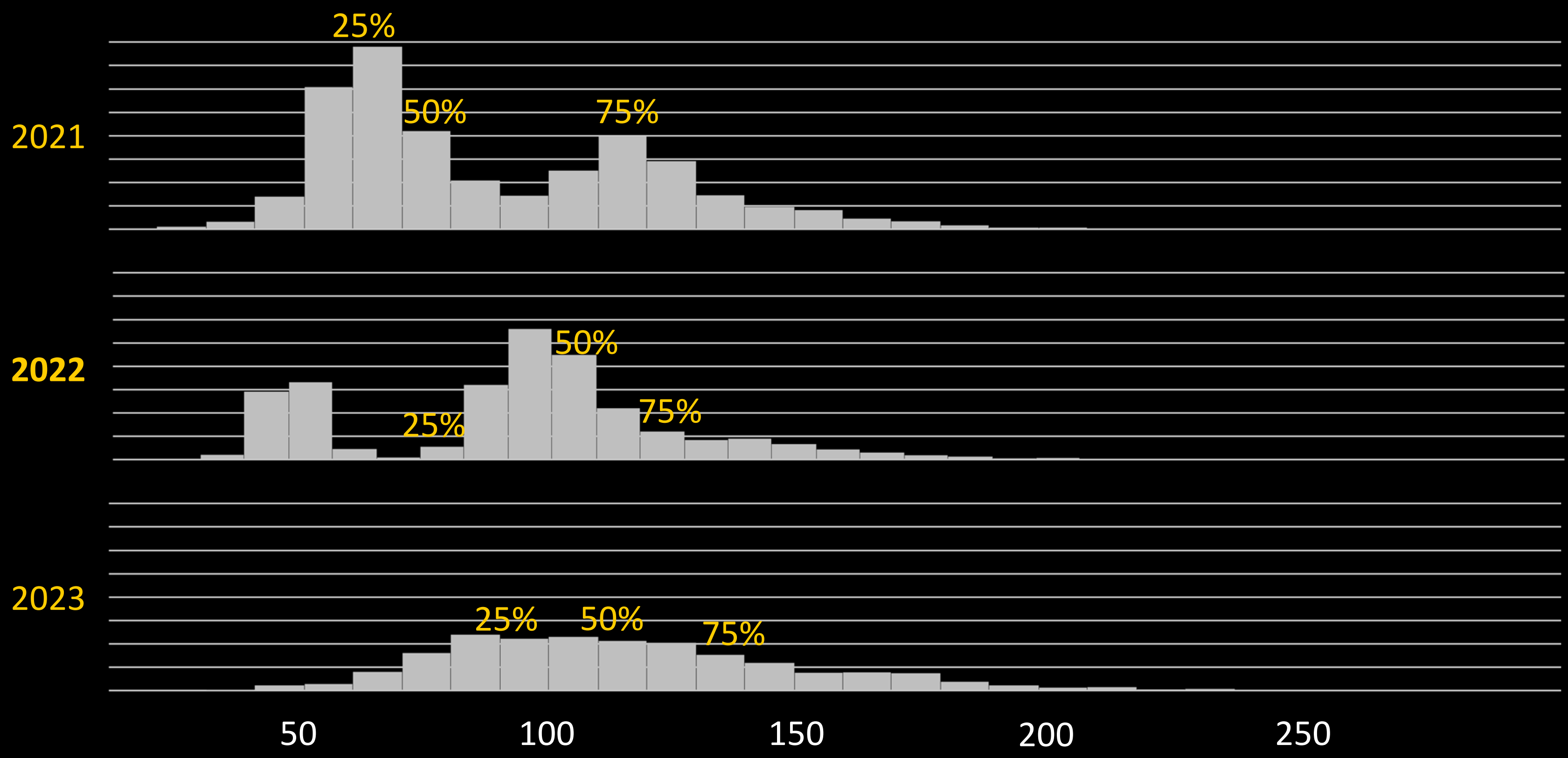
2022 Length-frequency



2023 Length-frequency



2021–2023 Length-frequencies



2021–2023 Summary

Stream × Year	Passes	Staff days	Effort (s)	SAFO removed	SAFO recaps	Cp (all)
Thompson Ck 2021	DP=281	289	557,176	2,744	NA	0.53
Thompson Ck 2022	SP=2	6	10,258	56	NA	.
Thompson Ck 2023	SP=3	32	40,274	108	NA	0.59
West Fk Black R. 2021	DP=280	288	498,302	5,394	NA	0.36
West Fk Black R. 2022	DP=392	390	554,384	5,487	NA	0.40
West Fk Black R. 2023	DP=189, SP=1	277	321,109	3,928	1,835	0.37/ *46.7%
TOTALS	**DP=1,142, SP=6 (12 kms)**	**1,282**	**1,981,503**	**17,684**	**1,835**	**.**

2021–2023 Summary v2

Stream × Year	Effort (hr)	SAFO removed	25th % (mm)	50th % (mm)	75th % (mm)	SAFO RPH
Combined 2021	293.19	5,394	62	77	115	27.76
Combined 2022	156.85	5,487	77	107	121	35.34
Combined 2023	100.38	4,033	90	111	137	40.18
WFBR2023-EP-01	21.09	1,448	.	.	.	67.14
WFBR2023-ER-02	19.27	480	.	.	.	24.91
WFBR2023-ER-03	17.45	305	.	.	.	17.98
TOTALS	**550.42**	**17,684**	**.**	**.**	**.**	**μ=32.13**

Future Plans

- Few SAFO remain in Thompson Creek
  - Similar EF effort
  - Continue stocking Myy
- Many SAFO remain in West Fk Black River
  - At least as much EF effort
  - Continue stocking Myy

2021—Brook Trout Eradication

- Effort
  - Thompson Creek
    - 6 eradication passes
    - 281 depletion passes
    - 289 staff days
    - 583,159 seconds
  - West Fork Black River
    - ~0.5 eradication pass
    - 280 depletion passes
    - 288 staff days
    - 498,226 seconds

2021—Brook Trout Eradication

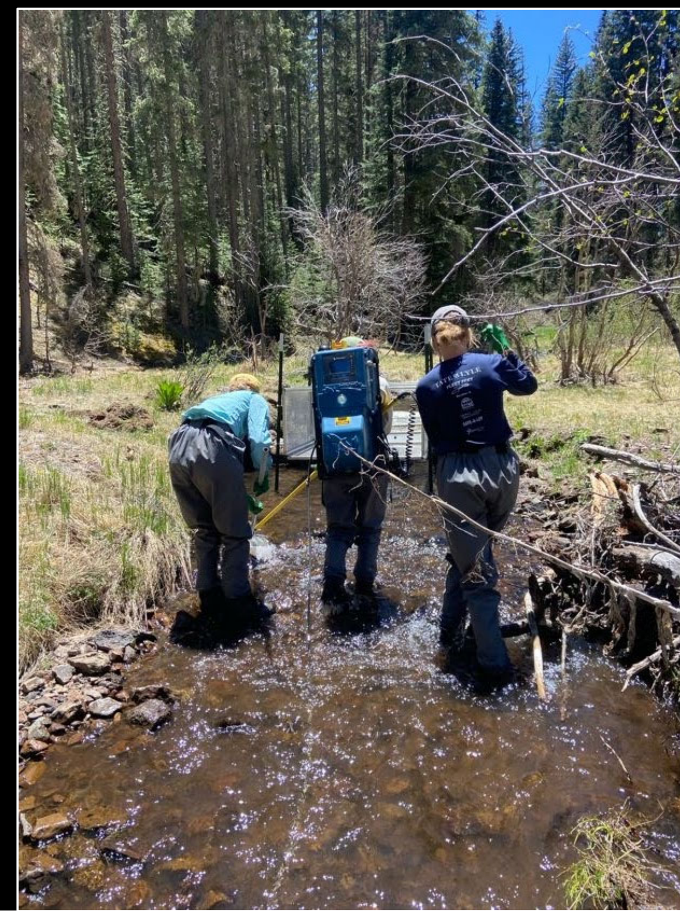
- Results
  - Thompson Ck.
    - EP1= 1,608 SAFO
    - EP2= 988 SAFO
    - EP3= 94 SAFO
    - EP4= 19 SAFO
    - EP5= 28 SAFO
    - EP6= 7 SAFO
  - West Fork Black R.
    - EP1= 5,394 SAFO

2022—Brook Trout Eradication

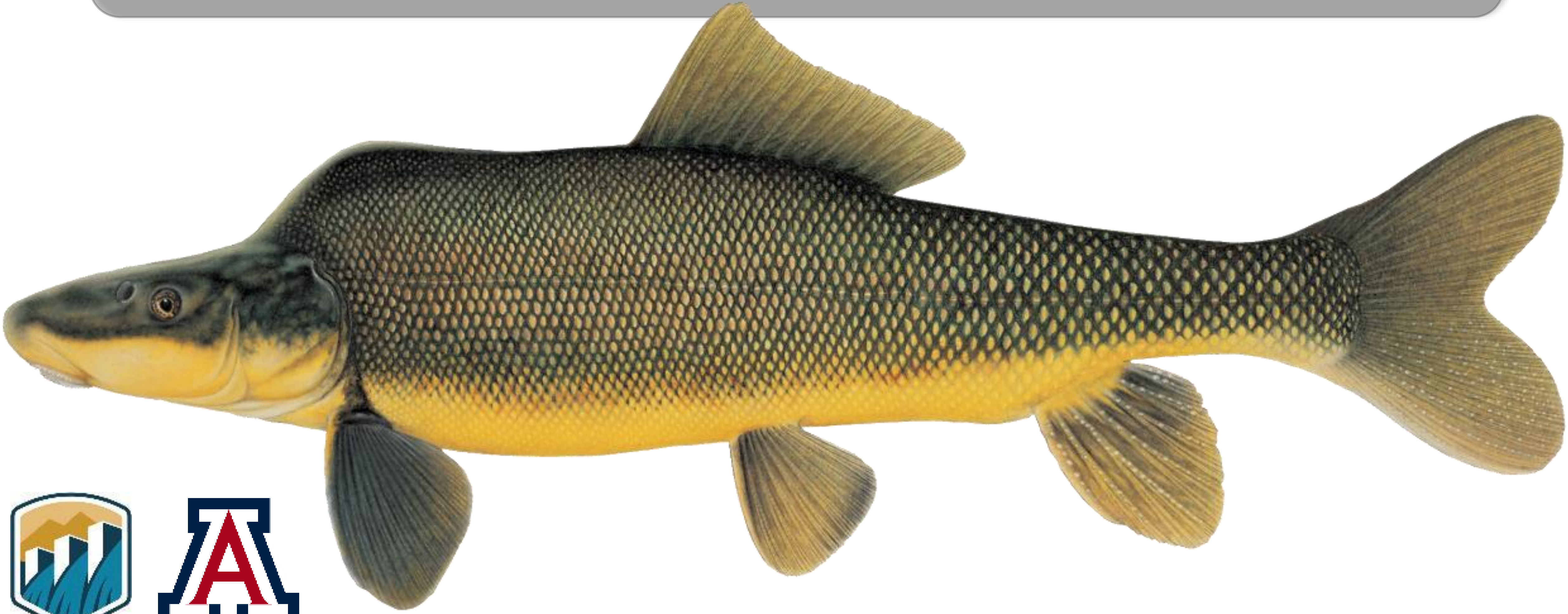
- Effort
  - Thompson Creek
    - 2 single passes
    - 6 staff days
    - 10,258 seconds
  - West Fork Black River
    - 1 eradication pass
    - 392 depletion passes
    - 390 staff days
    - 554,384 seconds

2022—Brook Trout Eradication

- Results
  - Thompson Ck.
    - SP1&2= 56 SAFO
  - West Fork Black R.
    - EP1= 5,487 SAFO



Can we improve the post-stocking success of Razorback Sucker in the Lower Colorado River Basin? Update (Jan 2022 – Present)

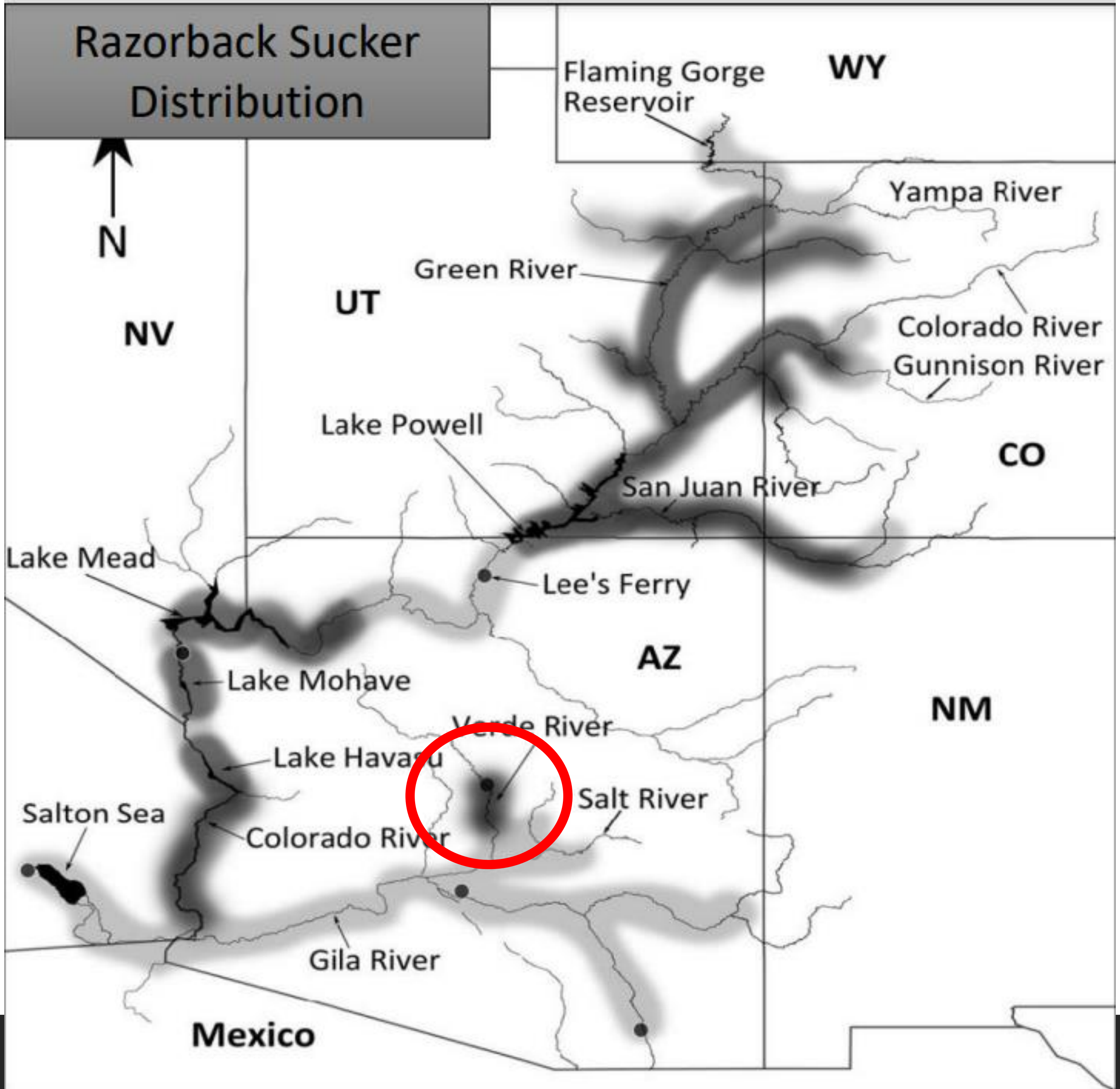


CHRISTOPHER JENNEY: UNIVERSITY OF ARIZONA

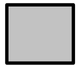
SCOTT BONAR: USGS COOP. FISH AND WILDLIFE RESEARCH UNIT

1 of 4 “big-river” fish of the Colorado River Basin

Current status:
Threatened / endangered



Razorback Sucker Distribution:



Historic range

Current range


1w

Razorback sucker recruitment in Lake Mead, Nevada–Arizona, why here?

B.A. Albrecht,[1,*] P.B. Holden,[1] R.B. Kegerries[1] and M.E. Golden[2]
[1]BIO-WEST, Inc., Fisheries Section, 1063 West 1400 North, Logan, UT 84321
[2]US Forest Service, Dixie National Forest, 1789 N. Wedgewood Lane, Cedar City, UT 84721-7769

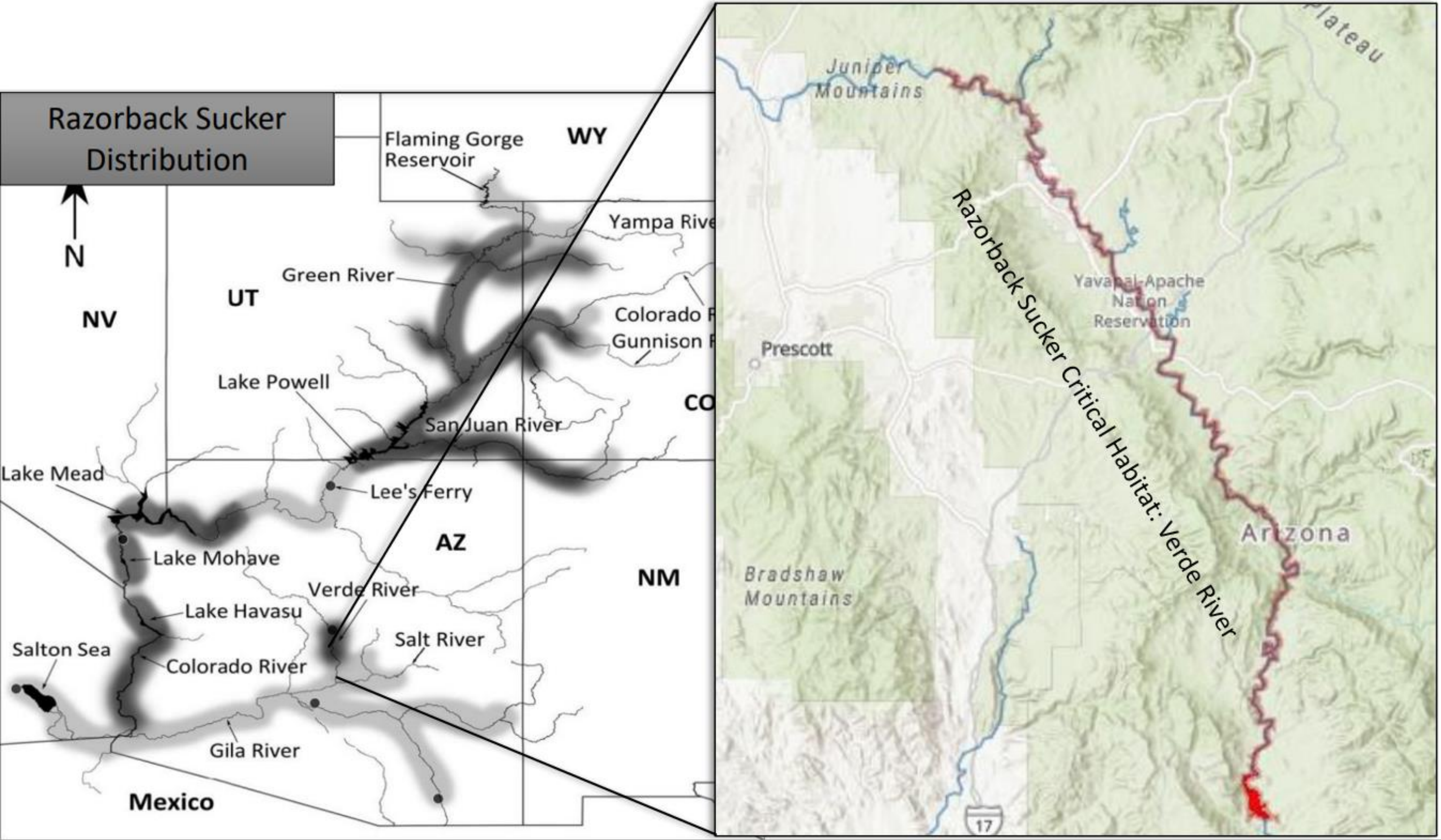
Abstract

Albrecht BA, Holden PB, Kegerries RB. 2010. Razorback sucker recruitment in Lake Mead, Nevada–Arizona, why here? Lake Reserv. Manage. 26:336–344.

Populations of the endangered razorback sucker (*Xyrauchen texanus*) have been reduced in the Colorado River during much of the last century. The inability of razorback sucker to recruit in the presence of nonnative fishes and altered flow regimes is thought to be the major factor contributing to their decline. Through funding from the Southern Nevada Water Authority and the US Bureau of Reclamation, we have conducted an ongoing razorback sucker research project on Lake Mead, Arizona and Nevada, since 1996. A major emphasis of this research has been to determine if natural recruitment was occurring in Lake Mead and identify reasons for that recruitment. Ages calculated using a nonlethal aging technique for 186 individual razorback sucker indicate the Lake Mead population is relatively young and that natural, wild recruitment has regularly occurred since the late 1970s. Comparisons of back-calculated ages of captured fish with historical Lake Mead water elevations provide evidence that a change in annual lake level fluctuations is the most likely mechanism that initiated this recruitment phenomenon. Lake level changes along with inundated terrestrial vegetation and turbidity in specific sites in Lake Mead may provide littoral nursery cover for larval and juvenile razorback sucker, allowing them to avoid predation.

Key words: Lake Mead, littoral zone, razorback sucker (*Xyrauchen texanus*), recruitment, reservoir, spawning

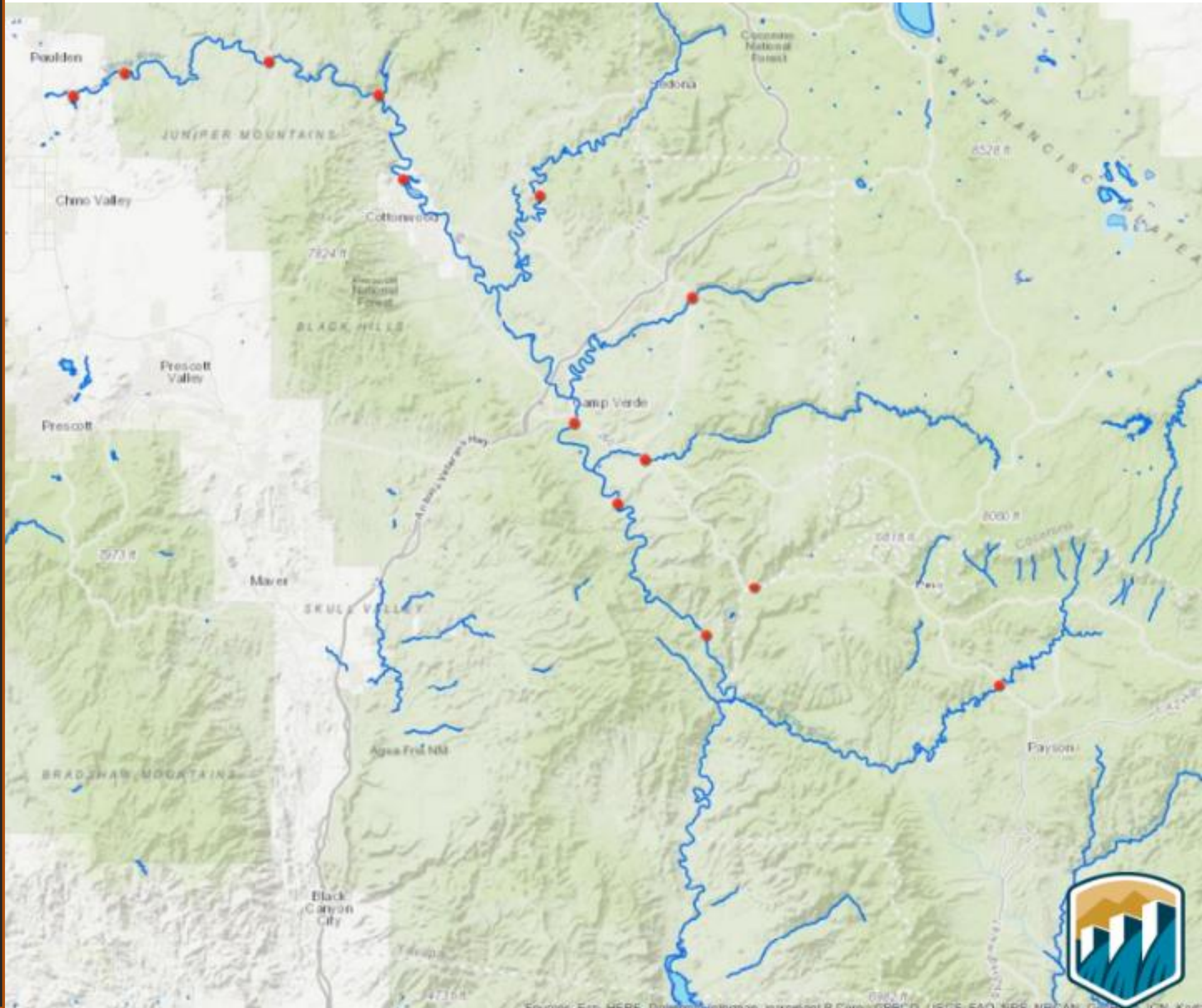

Area
Spawning site


Razorback Sucker Distribution
N
Flaming Gorge Reservoir
WY
Yampa River
Green River
UT
NV
Colorado R
Gunnison R
Lake Powell
CO
San Juan River
Lake Mead
Lee's Ferry
AZ
Lake Mohave
NM
Verde River
Lake Havasu
Salt River
Salton Sea
Colorado River
Gila River
Mexico
Juniper Mountains
Plateau
Razorback Sucker Critical Habitat: Verde River
Yavapai-Apache Nation Reservation
Prescott
Arizona
Bradshaw Mountains
17

Locations of previous Razorback stockings in the Verde River Basin

Why didn't it work?

1. Stockings of juvenile fishes → predation
2. Stocking high in watershed / small tributaries
3. Little post-stocking monitoring



So why again?

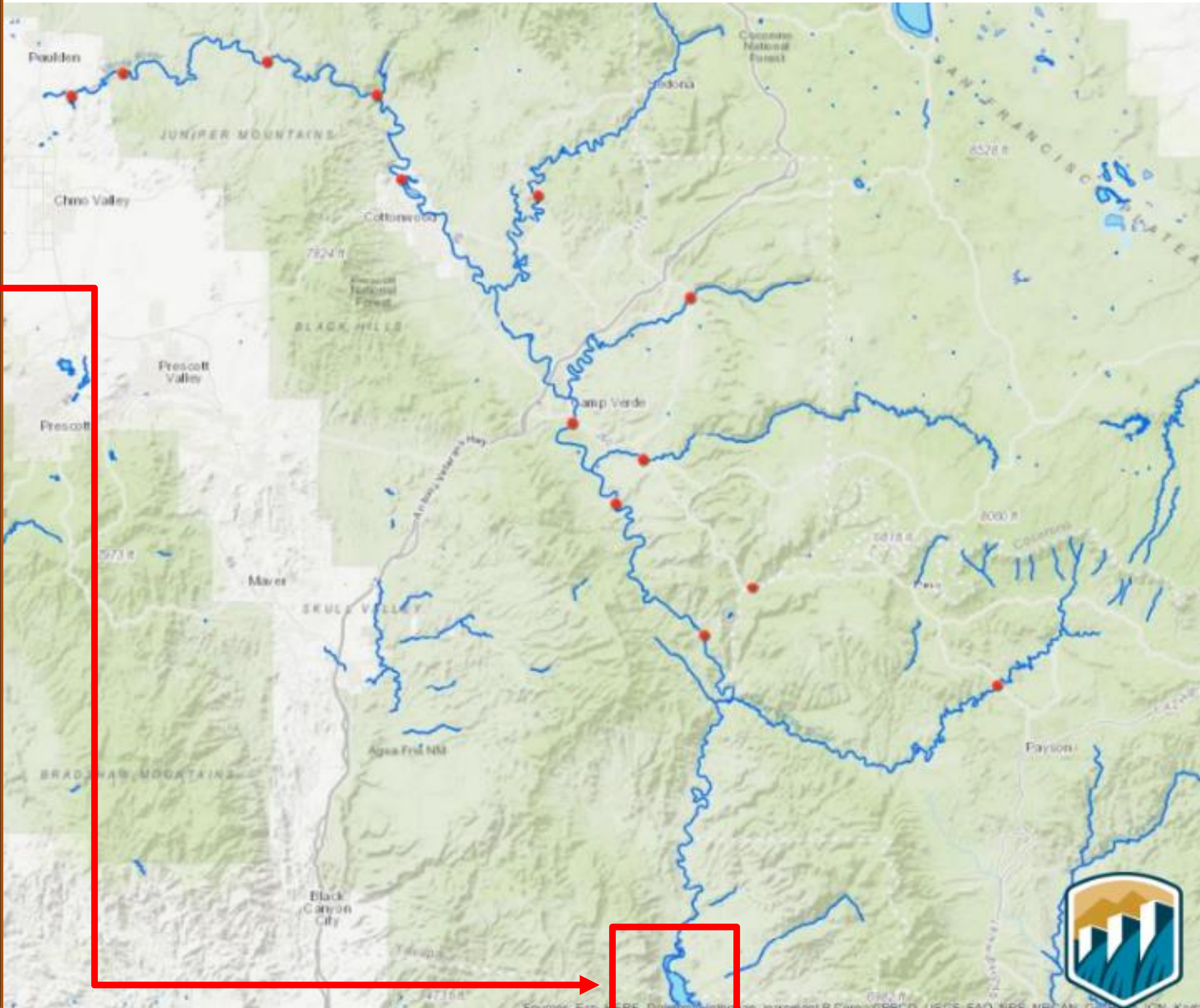
1. New stocking locations

2. Management of Horseshoe Reservoir: drawdowns and timed stockings

Increase resources/reduced predator competitor load

3. Active / constant monitoring of stocked fish → understand fate + behavior to inform future management

Locations of previous Razorback stockings in the Verde River Basin



The fish

- 2,500 total Razorback Sucker x 3 years = 7,500 Razorbacks
- 500 fish ≥ 300 mm total length
- 2000 fish < 200 mm total length

Tagging

70 “large” fish implanted with radio tag

- LOTEK Wireless / 163.74 hZ

All 2,500 fish PIT tagged

- BIOMARK APT-12

Two- stocking locations

1. Horseshoe Reservoir → boat ramp

2. Mainstem Verde River → Sheeps Bridge

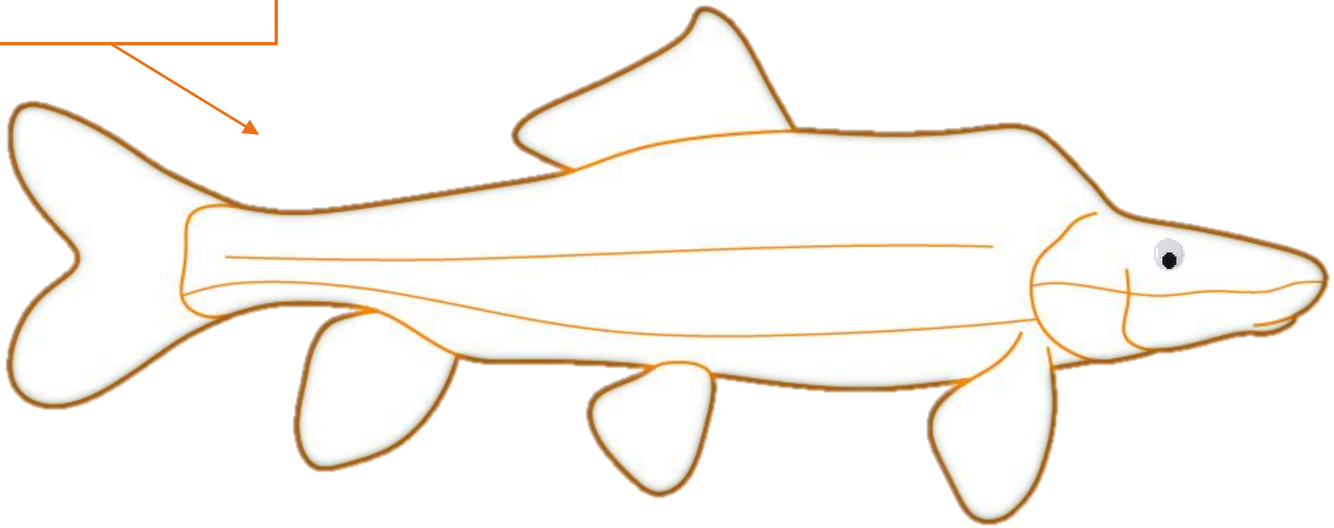
9.8 mi distance between stocking locations

Sheeps Bridge is inaccessible to vehicles


PATROL
TikTok
@stevester707

Survival

- Annual survival 2022, 2023, 2024
- River vs. reservoir
- Juvenile vs. adult

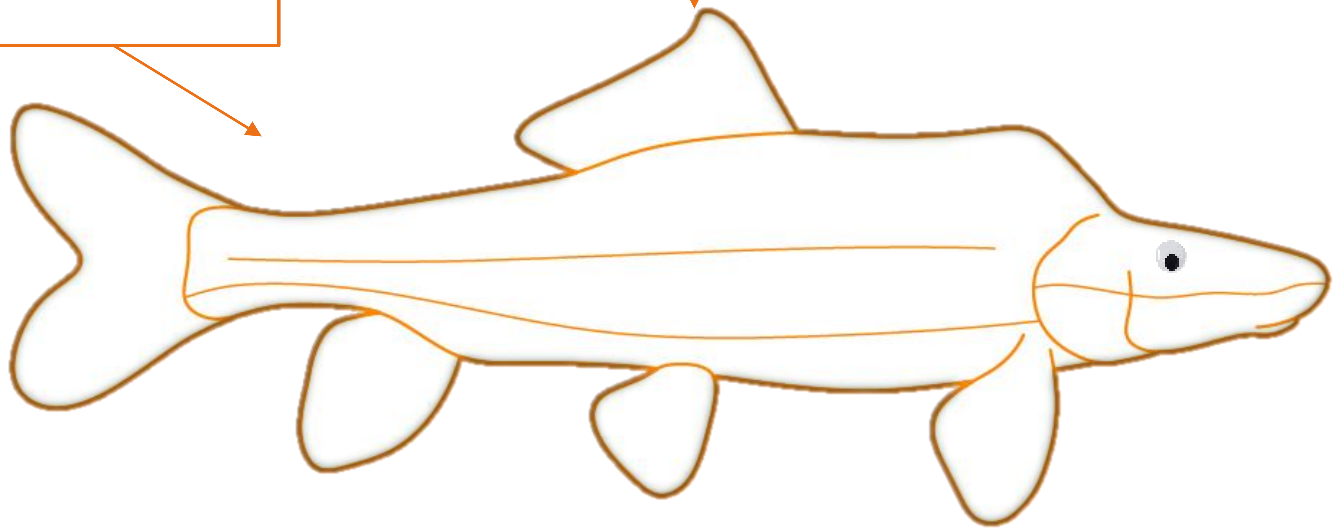


Movement Ecology

- Post-stocking dispersal
- Monthly / annual movements patterns
- Mixing of river / reservoir cohorts?

Survival

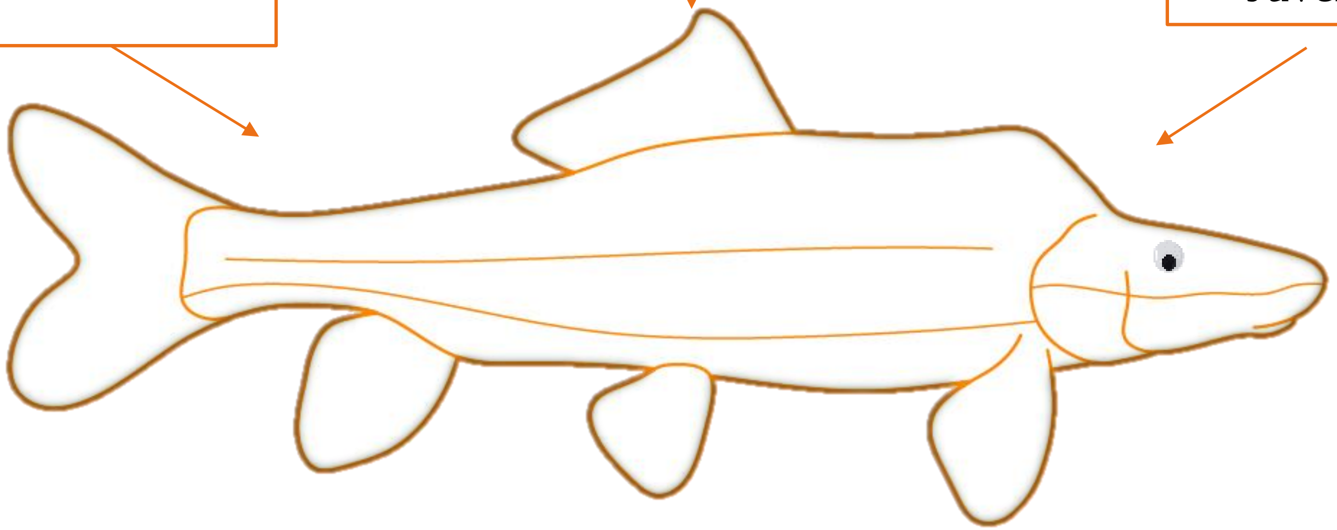
- Annual survival 2022, 2023, 2024
- River vs. reservoir
- Juvenile vs. adult



Survival
- Annual survival 2022, 2023, 2024
- River vs. reservoir
- Juvenile vs. adult

Movement Ecology
- Post-stocking dispersal
- Monthly / annual movements patterns
- Mixing of river / reservoir cohorts?

Habitat Associations
- What habitats are they using?
- River vs. reservoir
- Juvenile vs. adult



Movement Ecology
- Post-stocking dispersal
- Monthly / annual movements patterns
- Mixing of river / reservoir cohorts?

Survival
- Annual survival 2022, 2023, 2024
- River vs. reservoir
- Juvenile vs. adult

Habitat Associations
- What habitats are they using?
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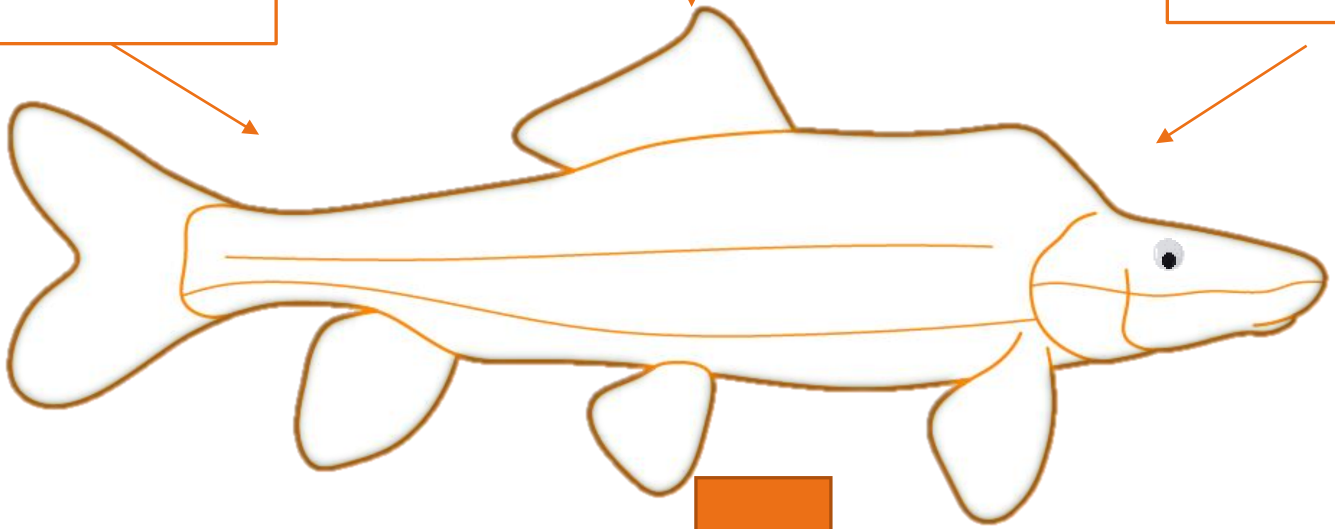


How can we improve the post-stocking success of Razorback Sucker (and other native fish) in the Lower Colorado River Basin?

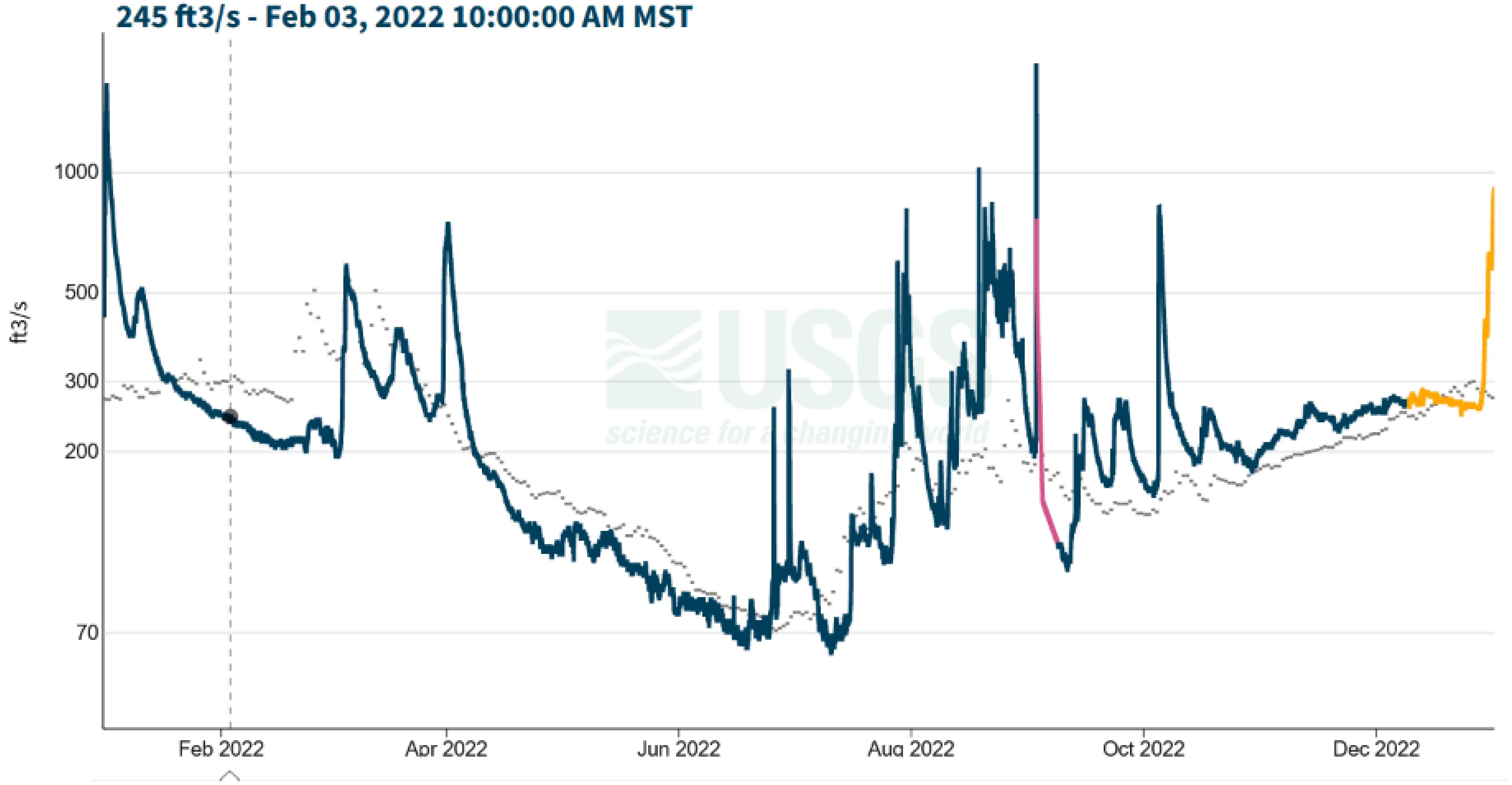
Study design and methods

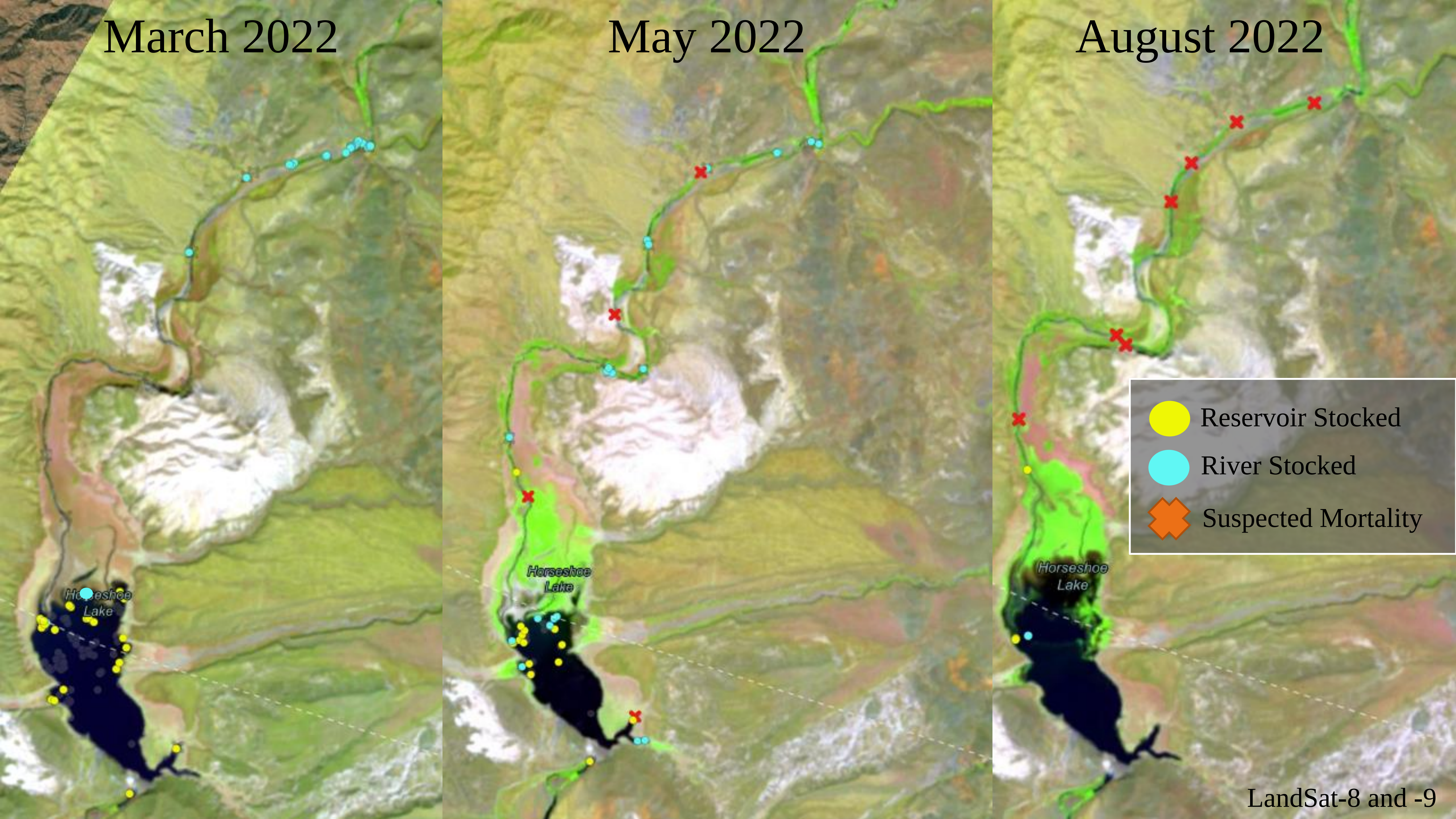

Horseshoe
Lake

Stocking Year One: Low reservoir elevation with moderate instream flow

January 1, 2022 - December 31, 2022

Discharge, cubic feet per second




March 2022
May 2022
August 2022
Horseshoe Lake
Reservoir Stocked
River Stocked
Suspected Mortality
LandSat-8 and -9

Results: March ‘22 - Present

Total Fish Stocked: 67

River = 35

Lake = 32

Confirmed Mortalities: 31/67 = 40%

River = 22/35 = 63%

Lake = 9/32 = 28%

Confirmed emigrants: 8/67 = 18%

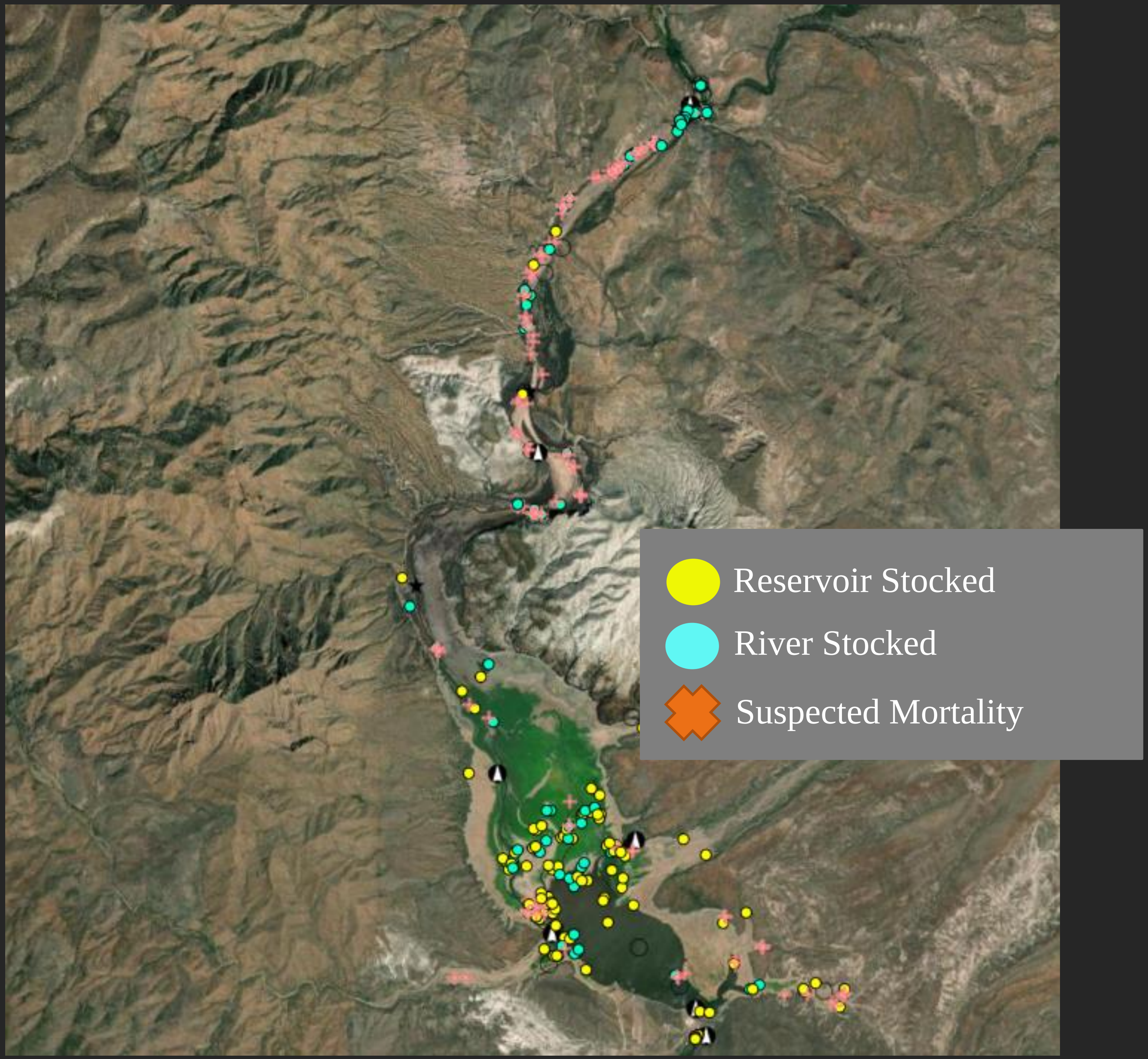
River = 3/35 = 9%

Lake = 5/32 = 16%

Total at large : 28 = 42%

River = 10/35 = 29%

Lake = 18/32 = 56%

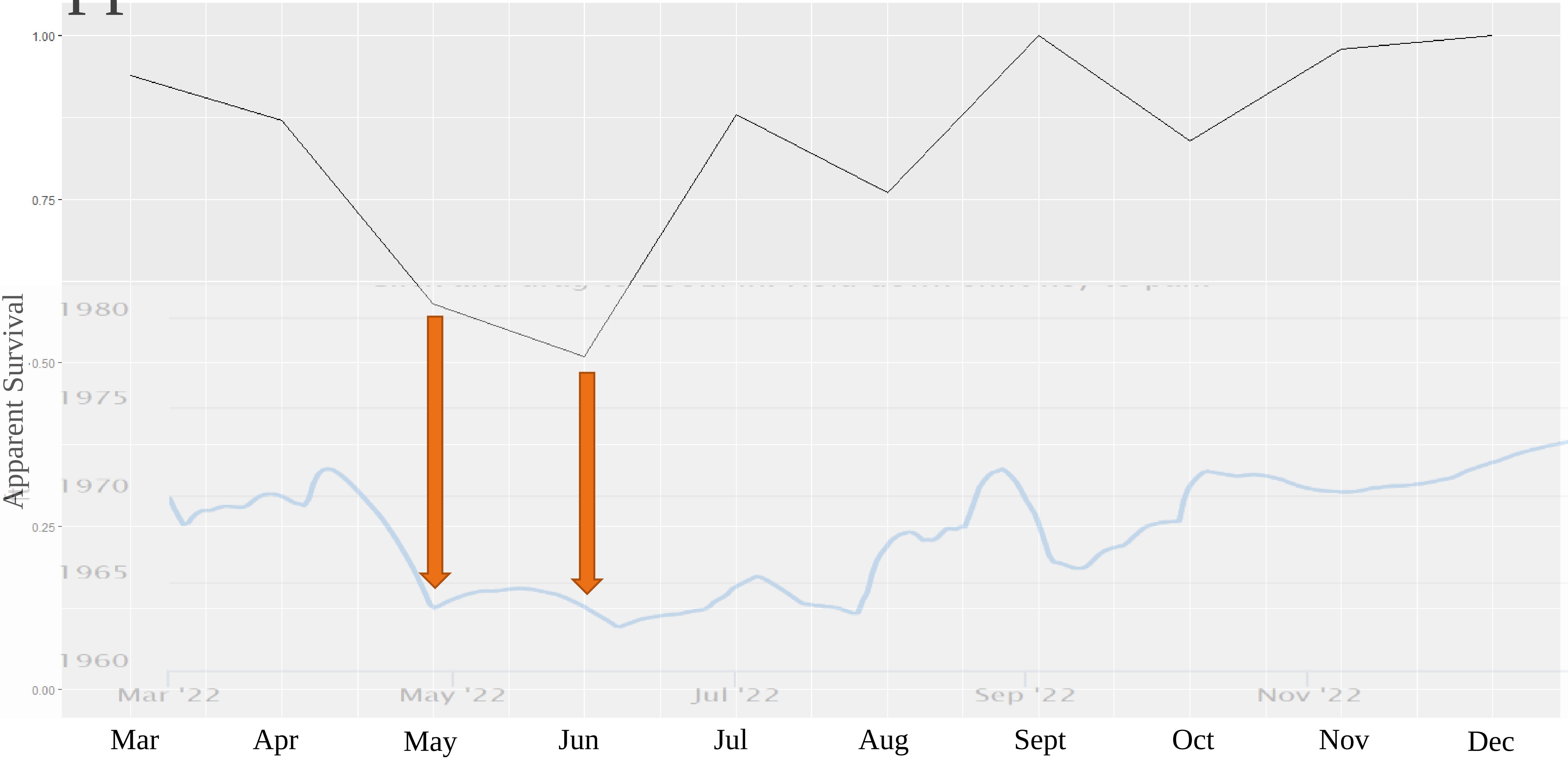


Tag	Stocking Location	March	mort	April	mort	May	mort	June	mort	July	mort	August	mort
101	River	1	0	1	0	0	0	0	0	1	-1	0	
102	River	1	0	1	0	1	0	1	-1	0	0	0	
103	River	1	0	0	0	0	0	0	0	0	0	0	
104	River	1	-1	0	0	0	0	0	0	0	0	0	
105	River	1	0	1	0	1	-1	0	0	0	0	0	
106	River	1	0	1	0	1	-1	0	0	0	0	0	
107	River	1	0	1	0	1	0	1	0	0	0	0	
108	River	1	0	1	0	1	0	1	-1	0	0	0	
109	River	1	0	1	-1	0	0	0	0	0	0	0	
110	River	1	0	1	-1	0	0	0	0	0	0	0	
111	River	1	0	1	0	1	0	1	0	0	0	0	
112	River	1	0	1	0	1	0	1	-1	0	0	0	
113	River	1	0	1	0	0	0	1	0	0	0	0	
115	River	1	0	1	0	1	0	1	-1	0	0	0	
116	River	1	0	1	0	1	0	1	-1	0	0	0	
117	Lake	1	0	1	0	0	0	0	0	0	0	0	
118	Lake	1	0	1	-1	0	0	0	0	0	0	0	
119	Lake	1	0	1	-1	0	0	0	0	0	0	0	
120	Lake	1	0	1	0	1	0	1	0	0	0	0	
121	River	1	0	1	0	1	0	1	-1	0	0	0	
122	Lake	1	0	1	-1	0	0	0	0	0	0	0	
123	Lake	1	0	1	0	1	0	1	-1	0	0	0	
124	Lake	1	0	1	0	1	0	0	0	0	0	0	
125	River	1	0	1	0	1	0	1	-1	0	0	0	
126	River	1	0	1	0	1	0	1	-1	0	0	0	
127	River	1	0	1	-1	0	0	0	0	0	0	0	
128	River	1	0	1	0	1	0	0	0	0	0	0	
129	Lake	1	0	1	0	1	0	1	-1	0	0	0	
130	River	1	0	1	0	1	0	0	0	0	0	1	

Master | March22 | April22 | May22 | June22 | July22 | Aug22 | Sept22 | Oct22 | Nov22 | Dec22 | Jan23 | Feb23

Tag	March	April	May	June	July	August	Sept	Oct
107	1	1	1	1	0	0	0	0…
	Tag107 101010100000000000000000000							

Apparent Survival



2022 PIT Data

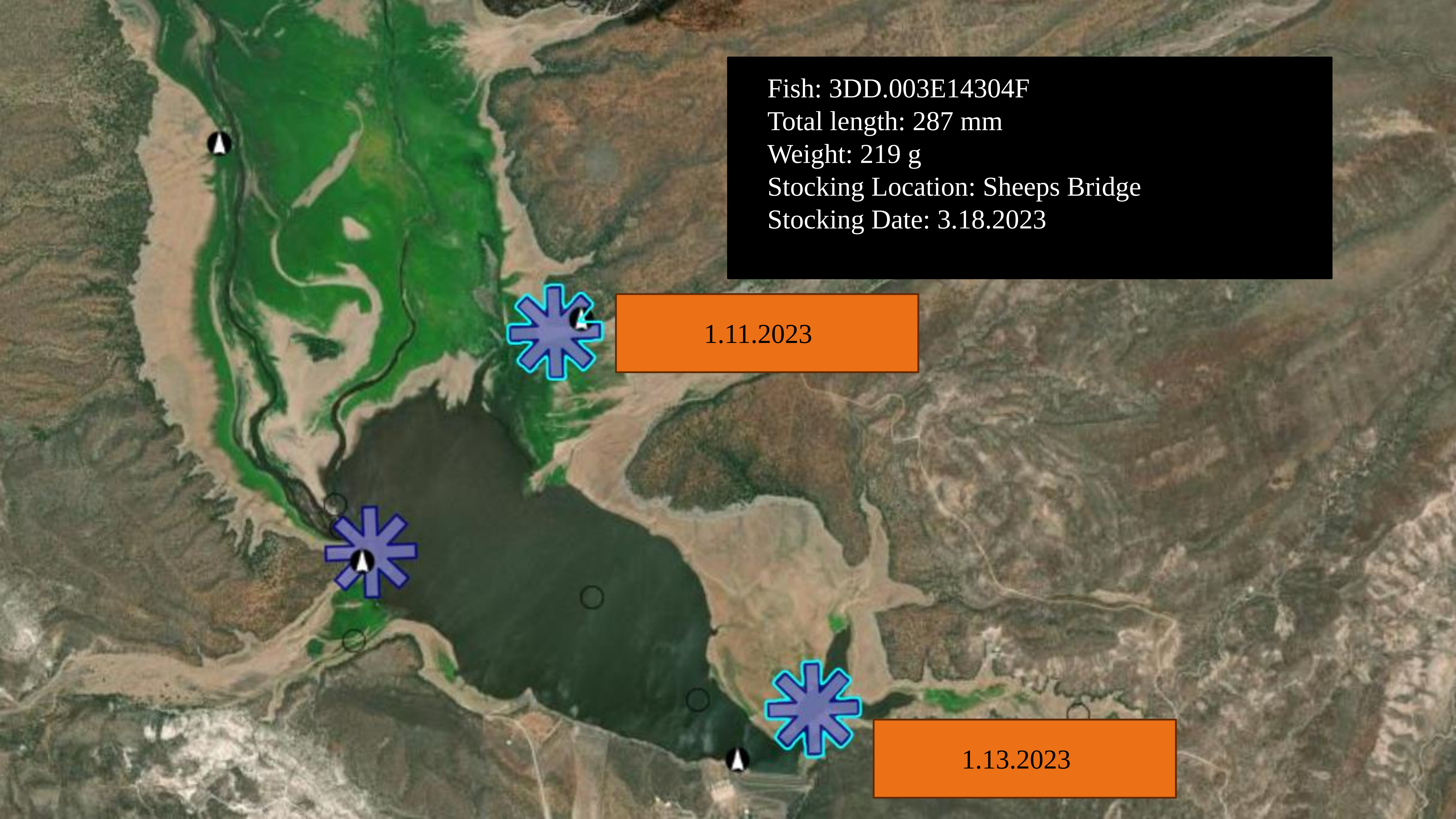
417 individual Razorbacks were contacted

- 5 Razorbacks by July 2022

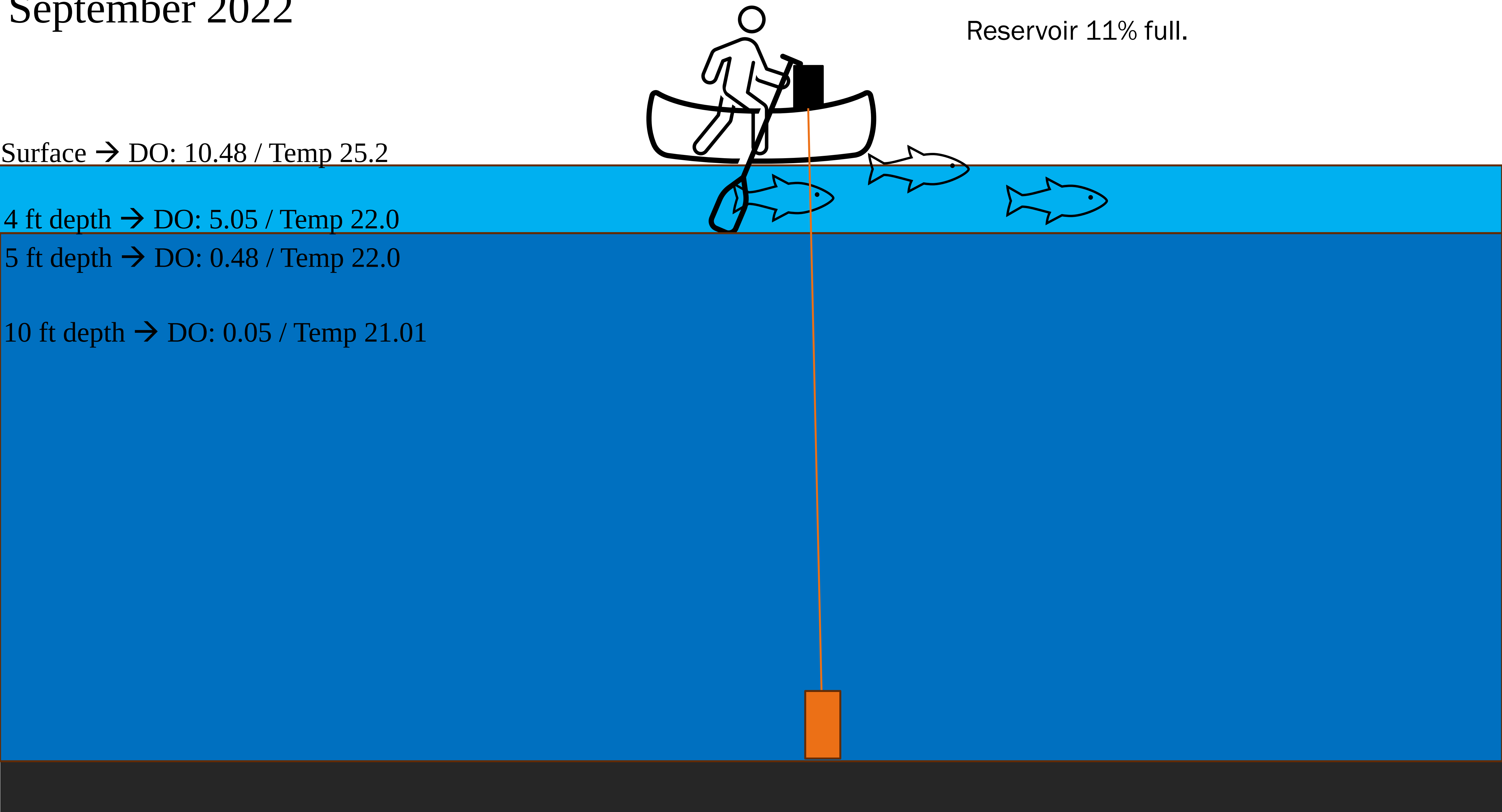
- Zero (0) fish detected after July 22

- Four (4) otters contacted

… except


Fish: 3DD.003E14304F
Total length: 287 mm
Weight: 219 g
Stocking Location: Sheeps Bridge
Stocking Date: 3.18.2023
1.11.2023
1.13.2023

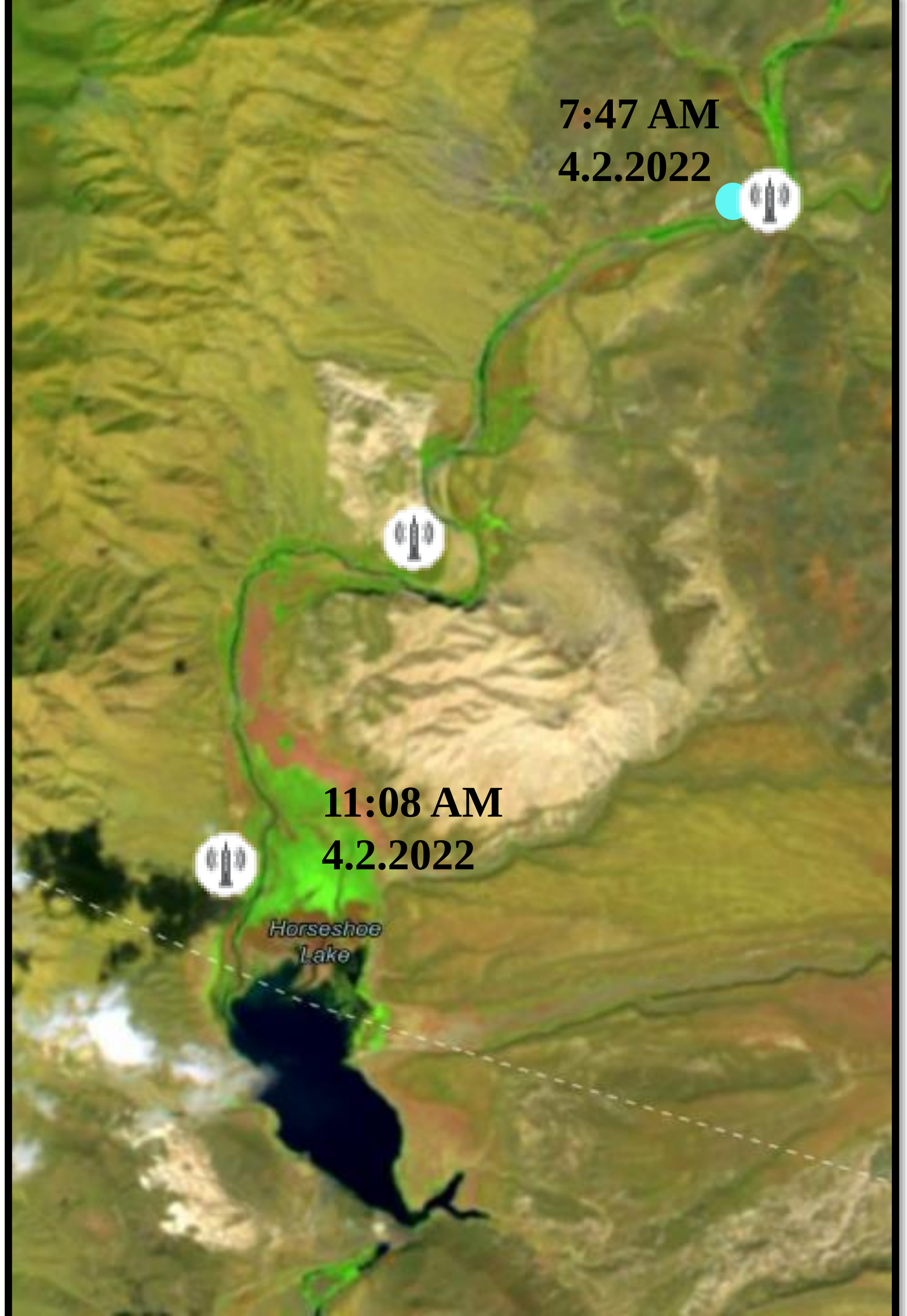
September 2022

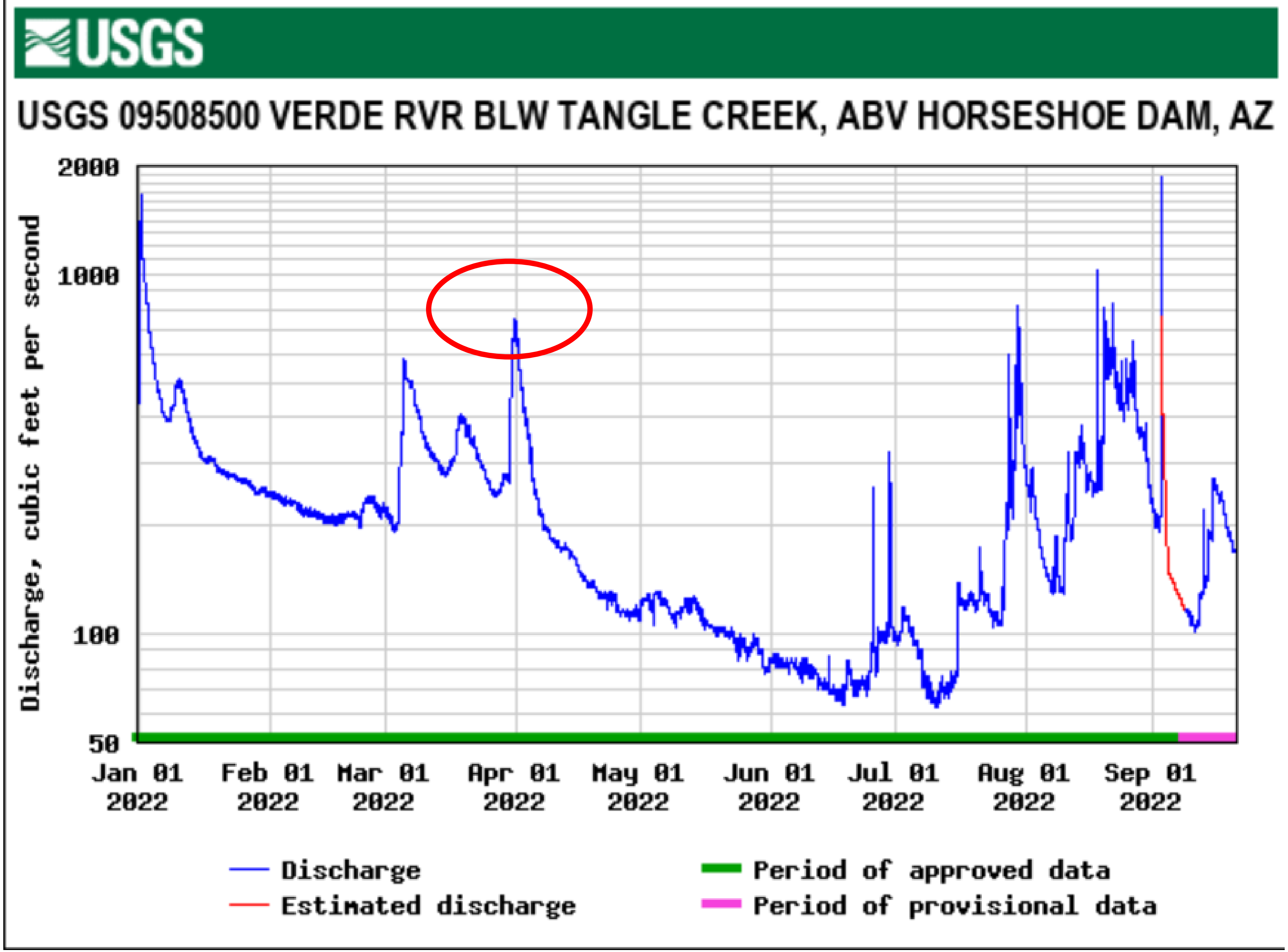


Movement

- 100% (34) of telemetered fish moved downstream from Sheeps Bridge stocking location

- Average time of travel from Sheeps Bridge to Horseshoe was about 22 hrs
    - Fastest = 3 hours 21 min (Fish # 101)




USGS
USGS 09508500 VERDE RVR BLW TANGLE CREEK, ABV HORSESHOE DAM, AZ
Discharge, cubic feet per second
2000
1000
100
50
Jan 01 2022
Feb 01 2022
Mar 01 2022
Apr 01 2022
May 01 2022
Jun 01 2022
Jul 01 2022
Aug 01 2022
Sep 01 2022
Discharge
Estimated discharge
Period of approved data
Period of provisional data

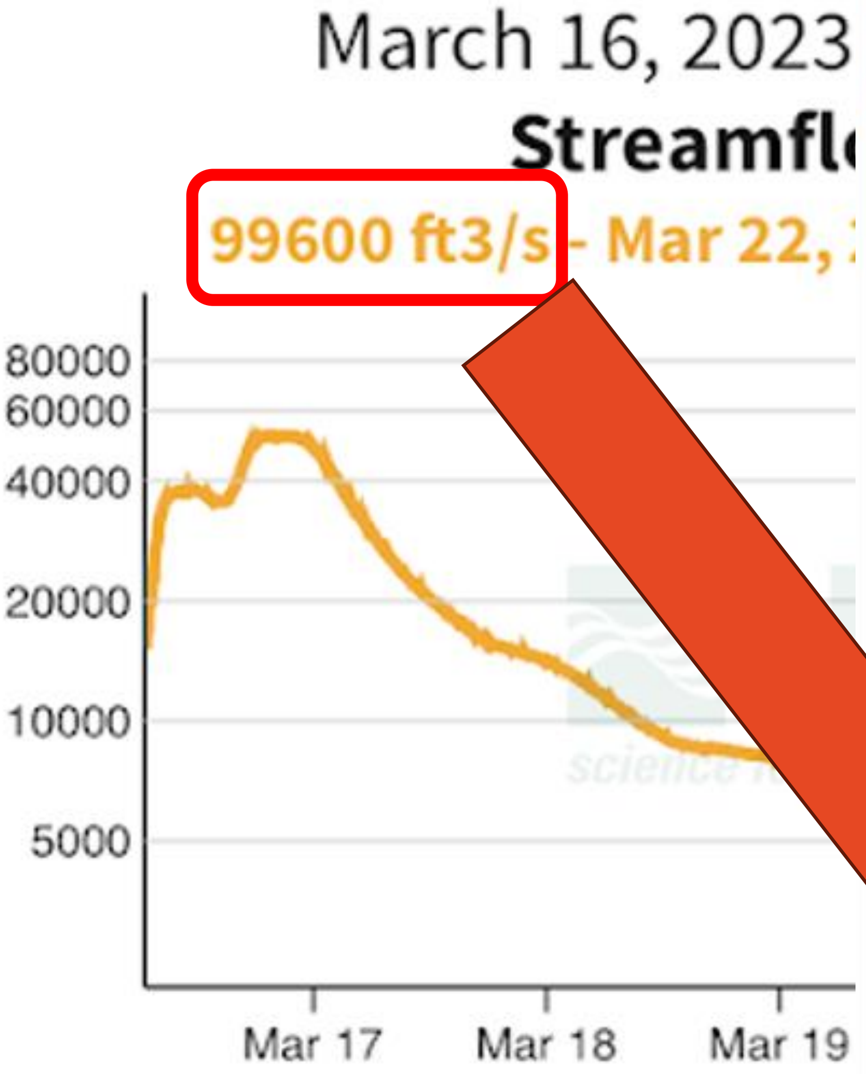
Year-1 Wrap up

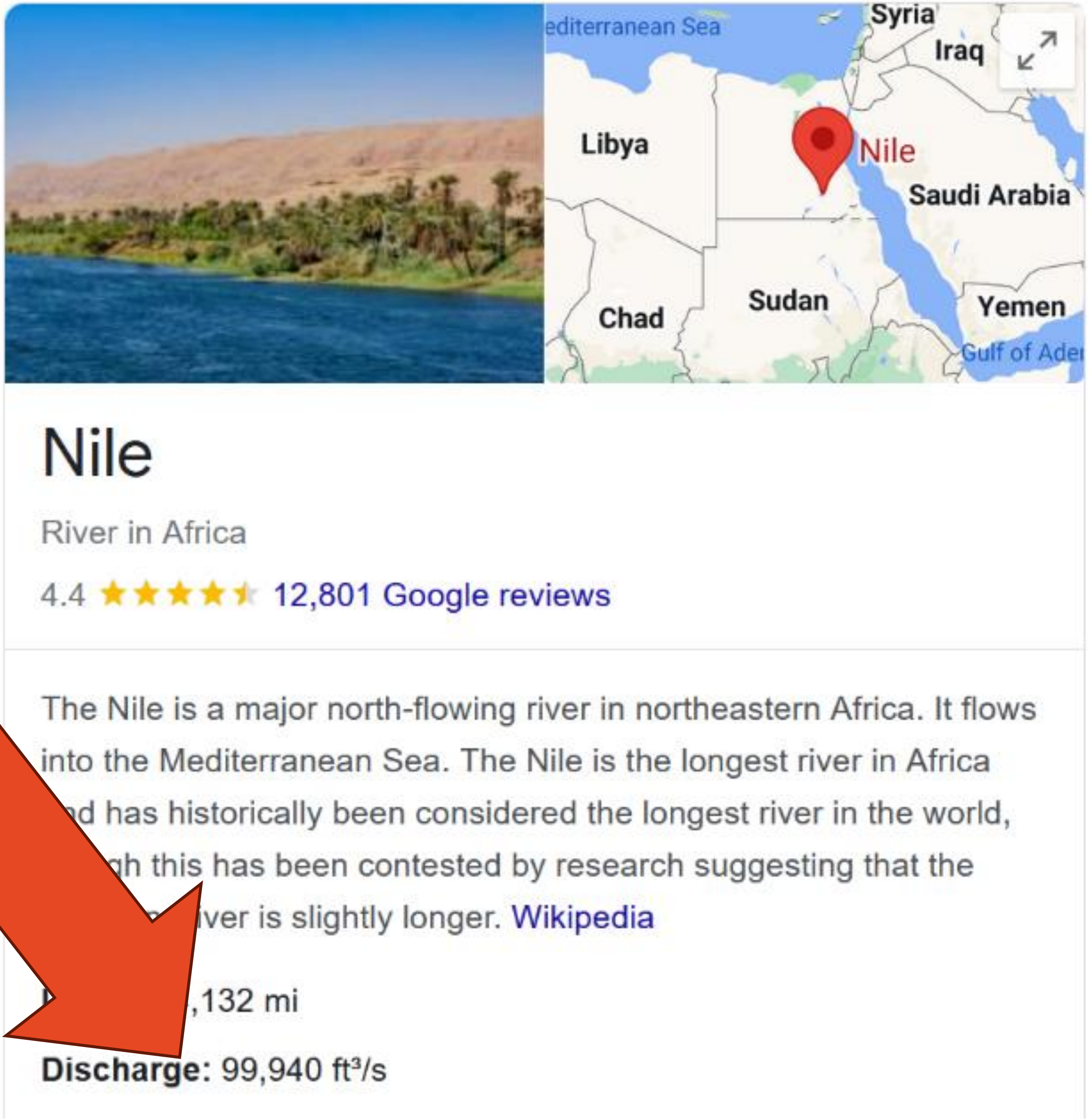
Survival very low

- Juvenile: 0%
- “Adult”: < 5%
- River-stocked fish move downstream
  - Disorientation / stress due to flow?
- Fish pass through Horseshoe Dam


Stocking Year Two: High reservoir elevation with low instream flow

Winter 2022 – 2023: Flood

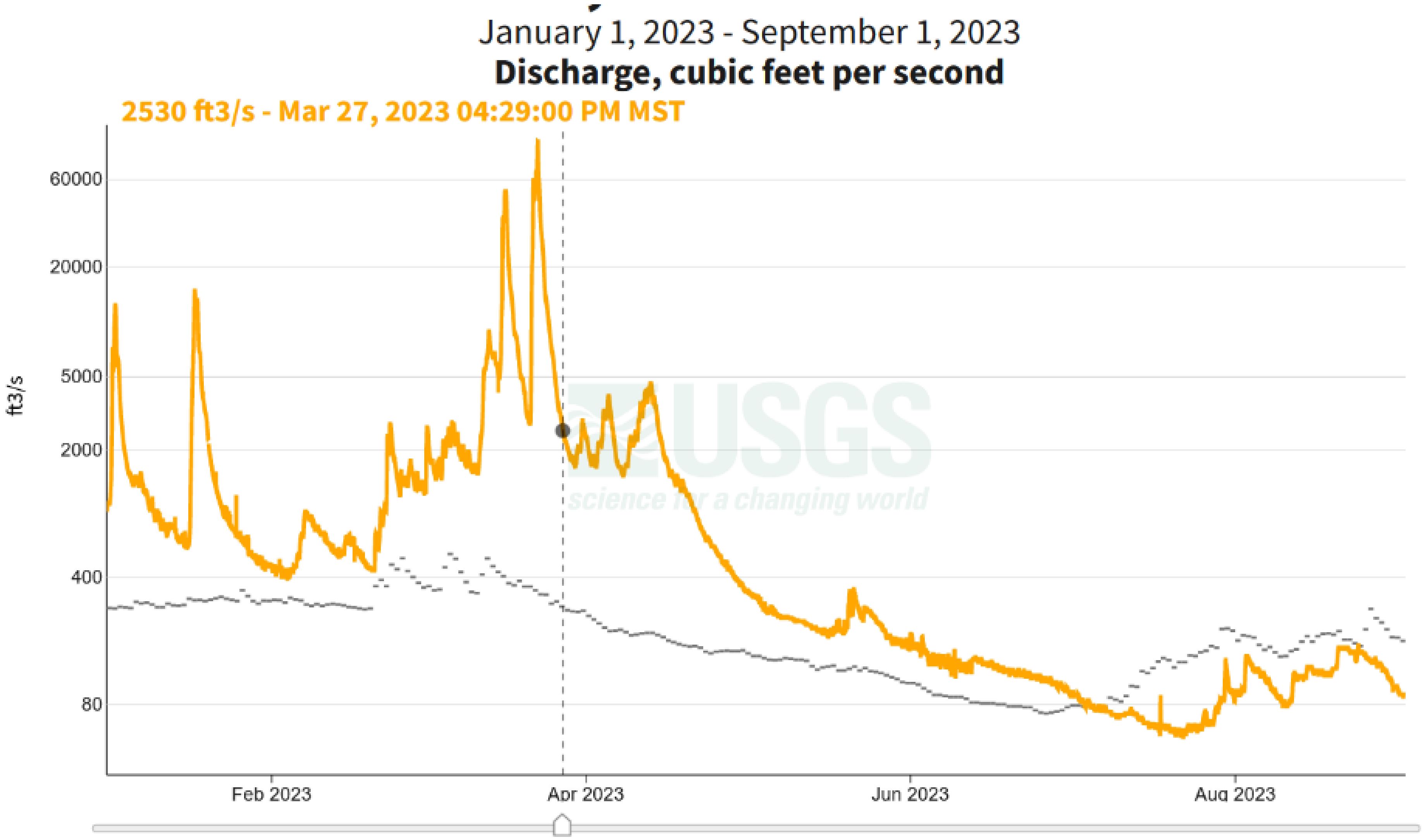




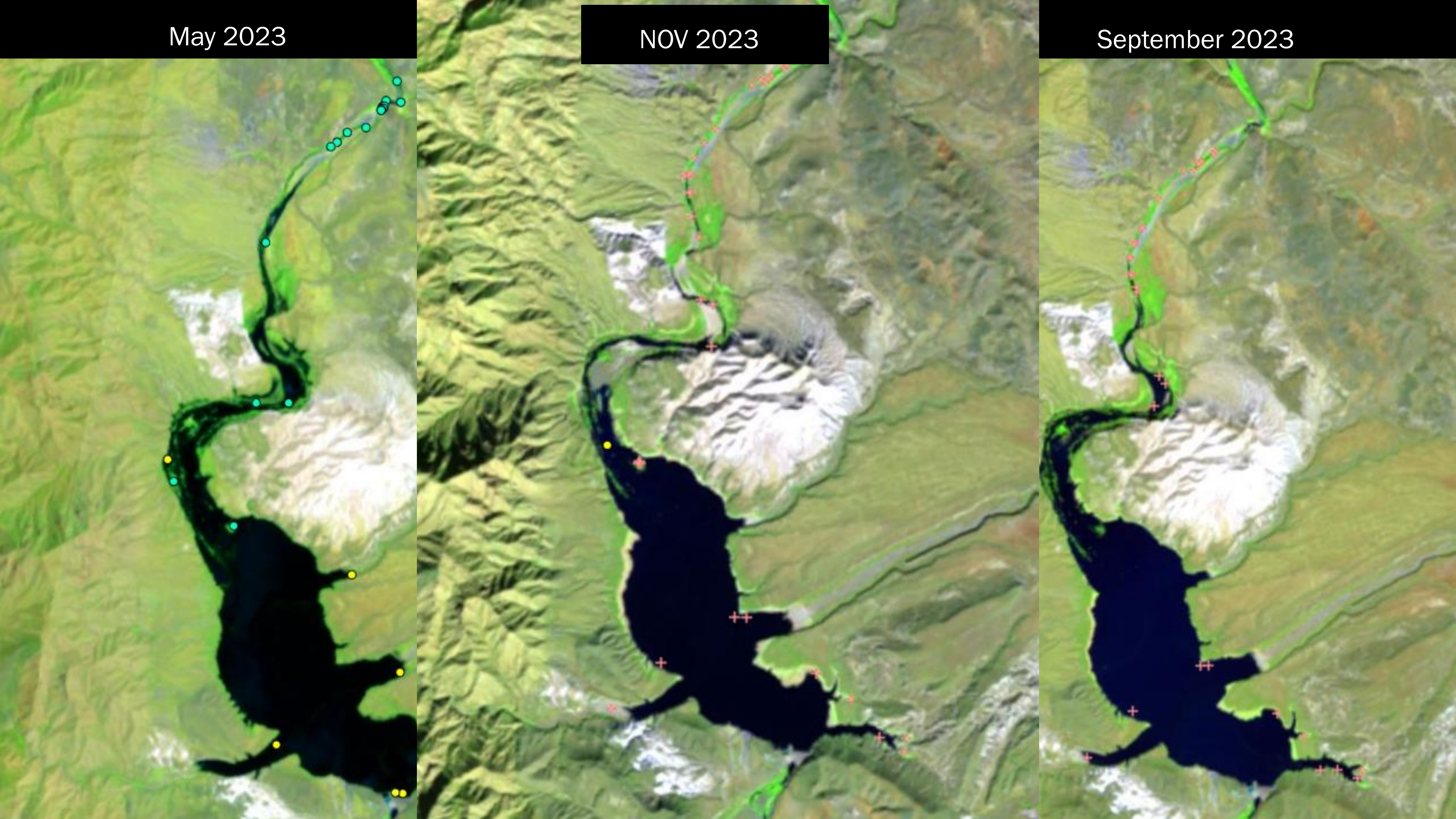

FX4

Reservoir level has increased 65 ft since December 15.


LOAD TRAIL



January 1, 2023 - September 1, 2023
Discharge, cubic feet per second
2530 ft3/s - Mar 27, 2023 04:29:00 PM MST
ft3/s
60000
20000
5000
2000
400
80
Feb 2023
Apr 2023
Jun 2023
Aug 2023
USGS
science for a changing world


May 2023
NOV 2023
September 2023

Results: May 23'-Present

Total Fish Stocked: 62

River = 32

Lake = 30

Confirmed Mortalities: 37/62 = 60%

River = 17/32 = 44%

Lake = 20/30 = 63%

Confirmed emigrants: 0/62 = 0%

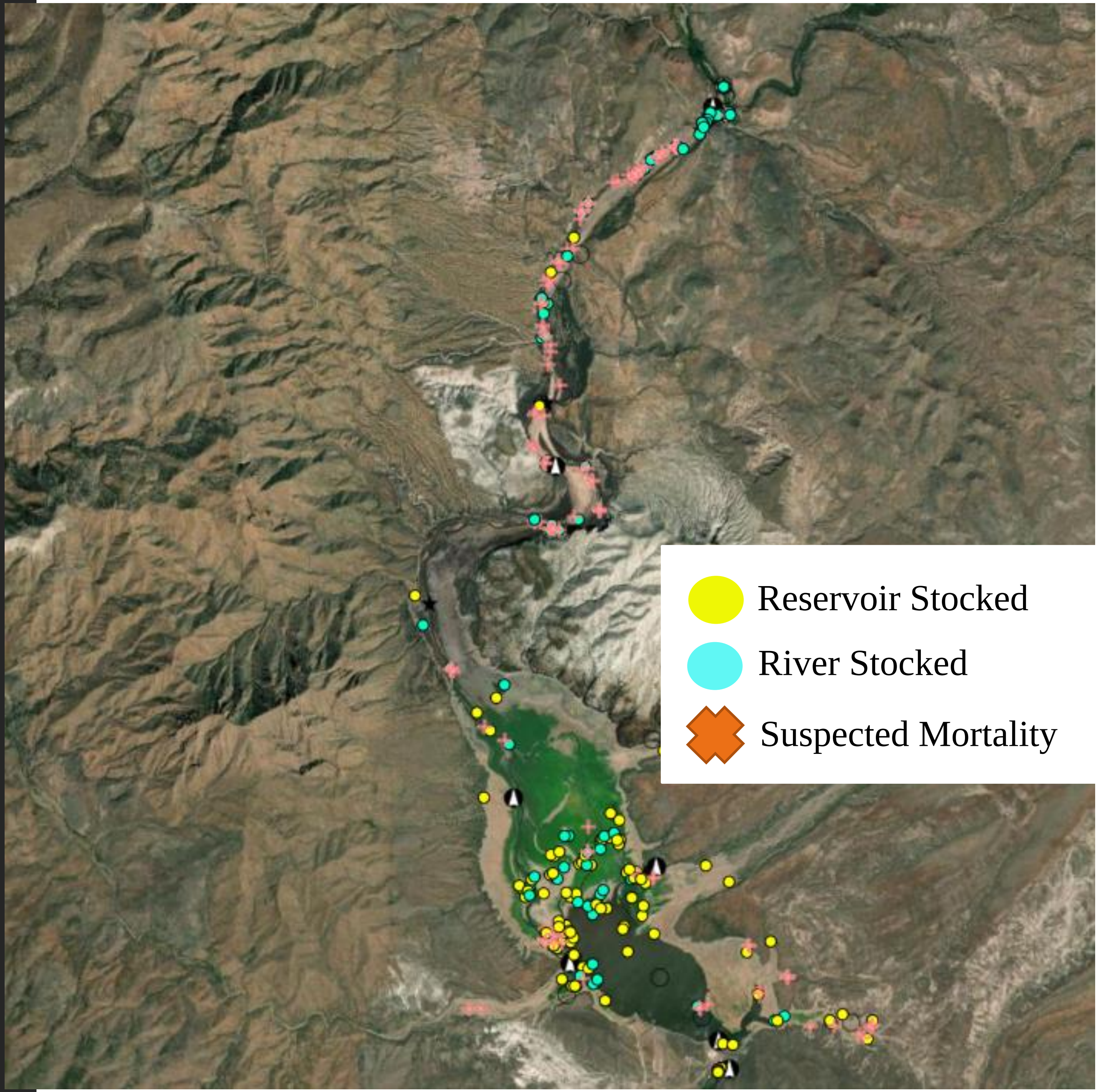
River = 0/32 = 0%

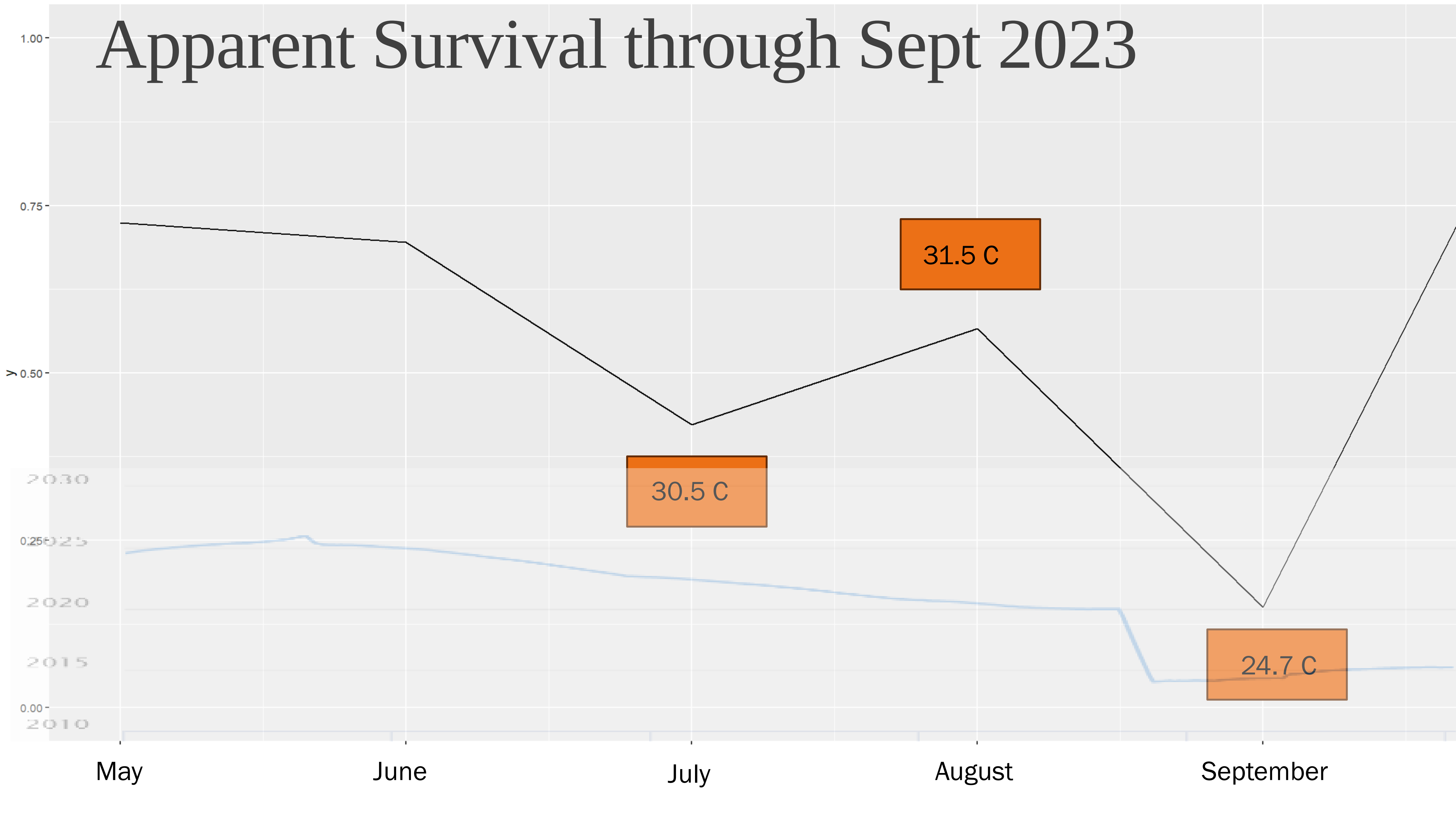
Lake = 0/30 = 0%

Total at large : 25/62 = 40%

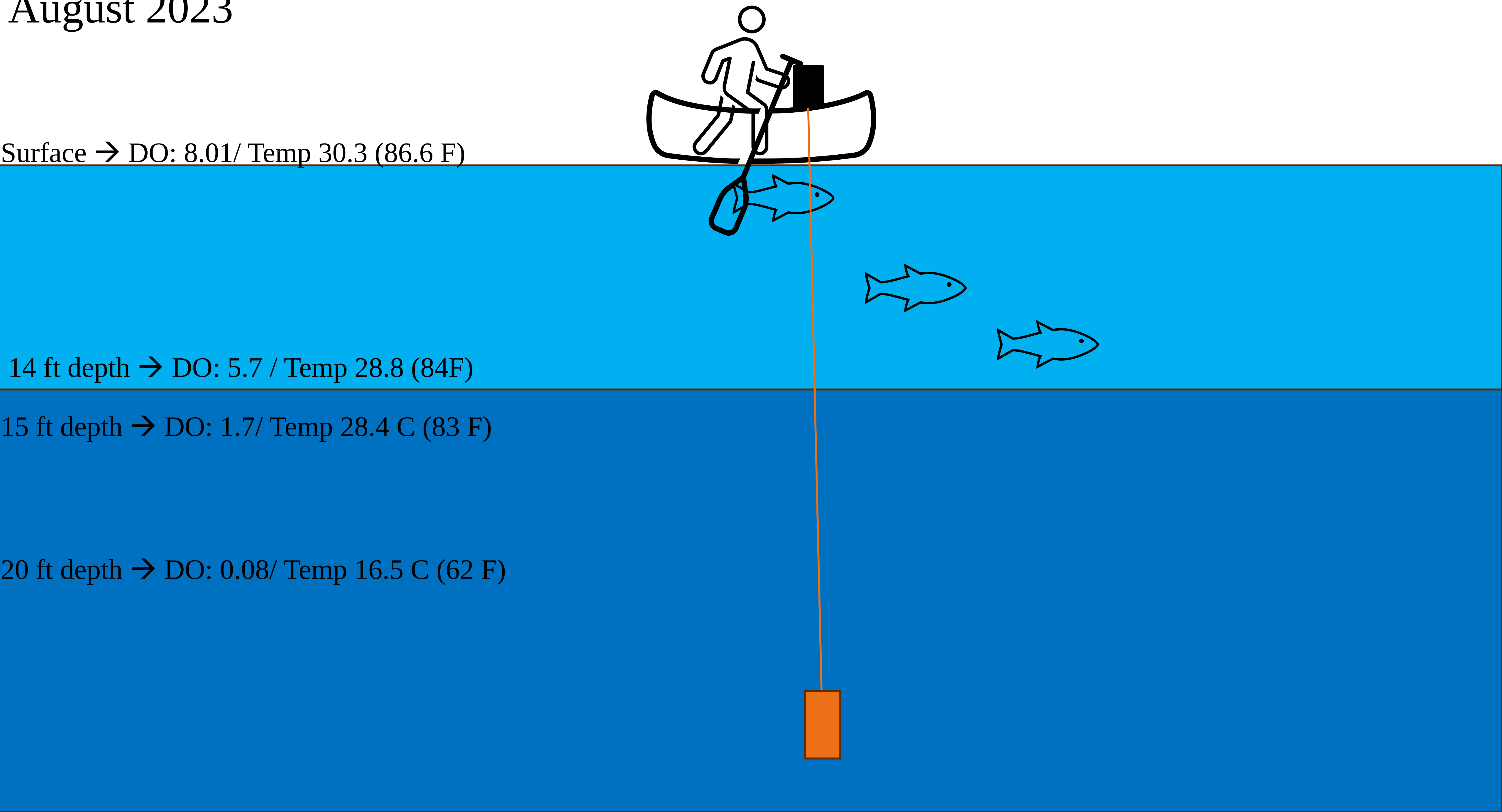
River = 15/32 = 47%

Lake = 10/30 = 33%




Apparent Survival through Sept 2023
1.00
0.75
0.50
0.25
0.00
y
31.5 C
30.5 C
24.7 C
2030
2025
2020
2015
2010
May
June
July
August
September

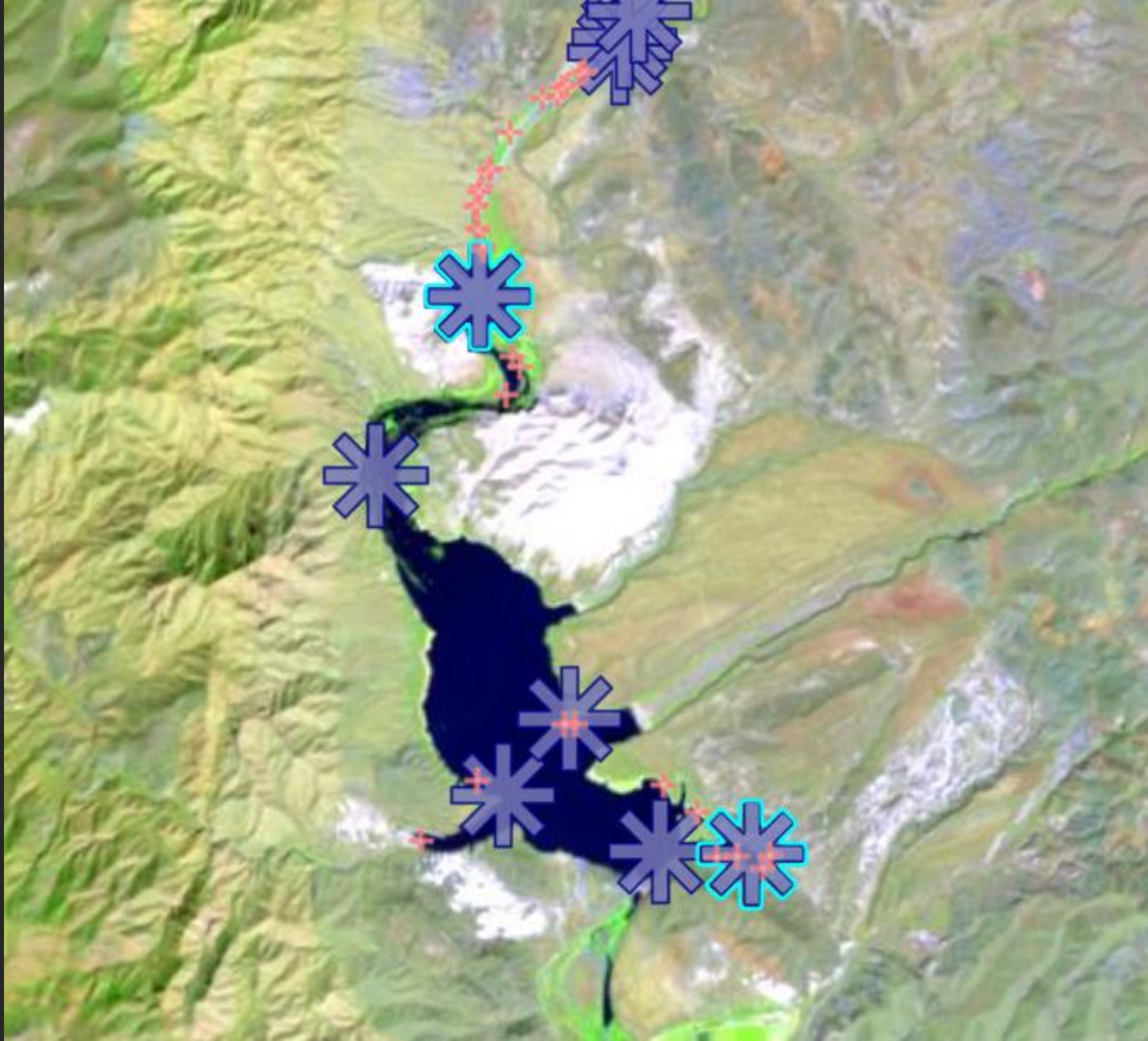
August 2023



Surface → DO: 8.01/ Temp 30.3 (86.6 F)
14 ft depth → DO: 5.7 / Temp 28.8 (84F)
15 ft depth → DO: 1.7/ Temp 28.4 C (83 F)
20 ft depth → DO: 0.08/ Temp 16.5 C (62 F)

2023 PIT Data

- 118 fish contacted
- 51 fish contacted in August 23
- 23 fish contacted in Sept 23
- 8 fish contacted in October



1.5 years in, what do I know?

- Immediate post-stocking survival is high
- Downstream movement of telemetered fish → flow?
  - Adaptation to captivity / lack of flow conditions
  - Disorientation?
- Fish pass through Horseshoe Dam
- In reservoir, fish found near river inflows in areas where cover is high (turbidity and inundated vegetation)

Low survival

- Water temps in summer months
  - Preference → 22.9 C – 24.8 C
  - Avoidance → 27.4 C – 31.6 C
  - Loss of equilibrium → 36.5 C

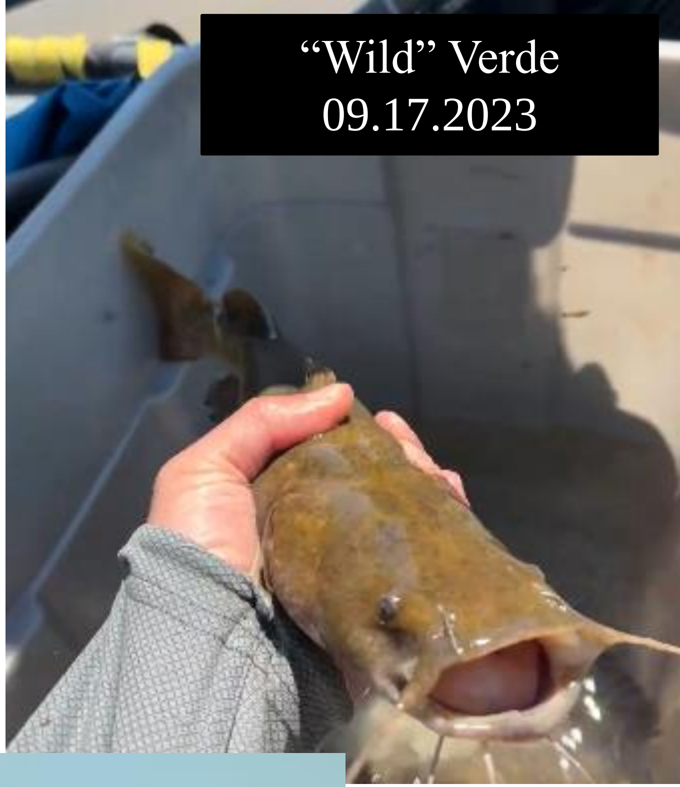
- Lake stratification and low dissolved oxygen

- Reduces availability of habitat + resources

- And…..

Predator-load

- Predator naïve native fishes (Ward et al. 2003)
- Bass, catfish, green sunfish, red shiner, carp, etc.
- Otters
- Avian predators




Lotek

Acknowledgements

BUREAU OF RECLAMATION

U.S. FISH & WILDLIFE SERVICE

DEPARTMENT OF THE INTERIOR

Questions?

Contact info:

Christopher Jenney
chrisjenney@email.arizona.edu
516 286 5961


C / 84 °F
10/10/2023 03:00:43 PM

Simulations of YY Red Shiner *Cyprinella lutrensis* Introductions for Nuisance Population Mitigation in a Southwestern Stream

Chad Teal

Assistant Unit Leader

UT Cooperative Fish and Wildlife Research Unit

Dept of Watershed Sciences, Utah State University

Coauthors: Erin Landguth, Casey Day, Javan Bauder, Scott A. Bonar, Daniel J. Schill, Christopher Jenney, Heidi Blasius, Peter Reinthal

YY Fish Strategies

Male ♂ × *Female* ♀

	Y	Y
X	XY	XY
X	XY	XY

Female ♀ × *Male* ♂

	Y	Y
X	XY	XY
Y	YY	YY

North American Journal of Aquaculture

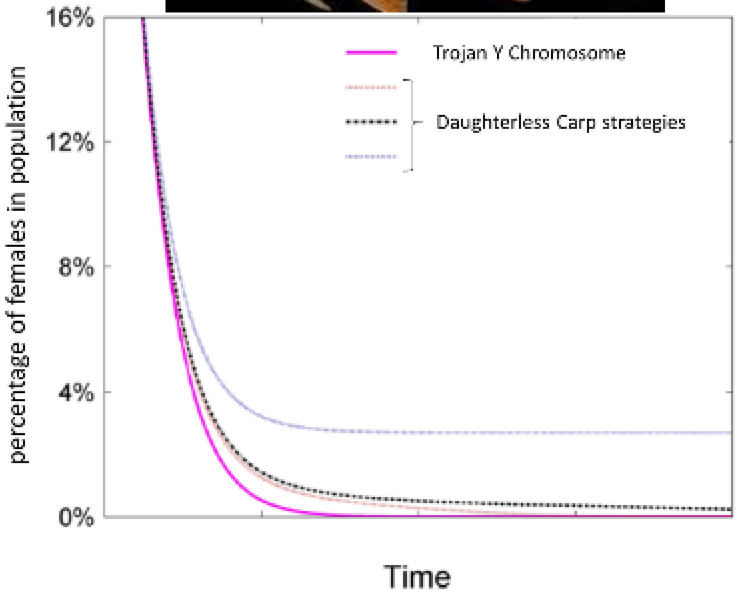
Taylor & Francis

ISSN: 1522-2055 (Print) 1548-8454 (Online) Journal homepage: http://www.tandfonline.com/loi/unaj20

Production of a YY Male Brook Trout Broodstock for Potential Eradication of Undesired Brook Trout Populations

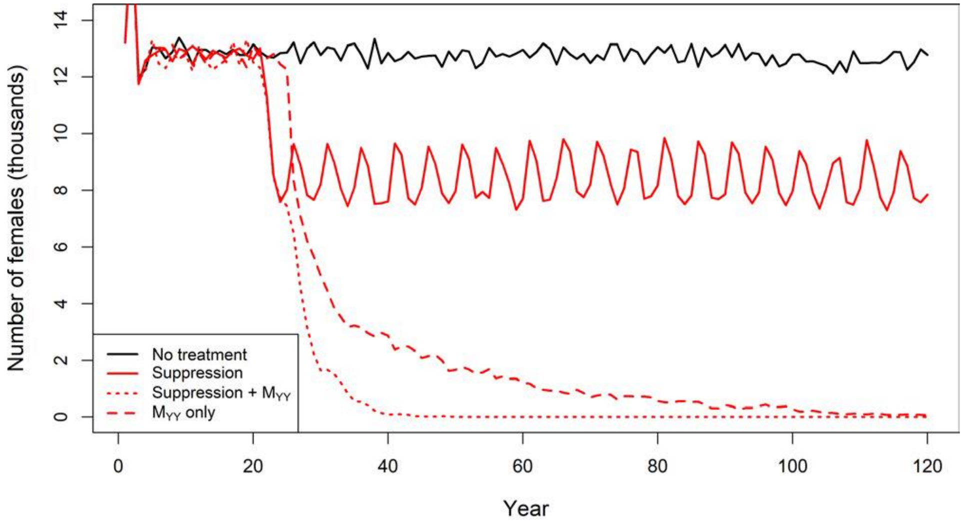
Daniel J. Schill, Jeff A. Heindel, Matthew R. Campbell, Kevin A. Meyer & Elizabeth R. J. M. Mamer

YY Model Outputs

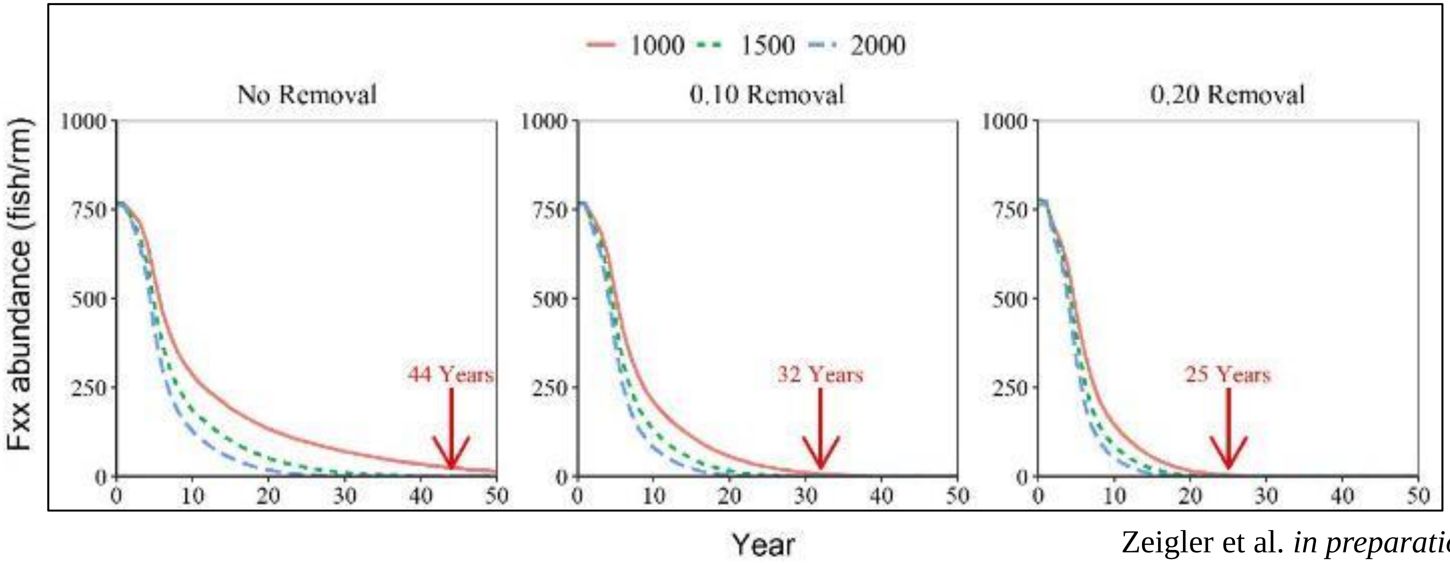


Teem et al. (2014)

Theoretically it works…
most times

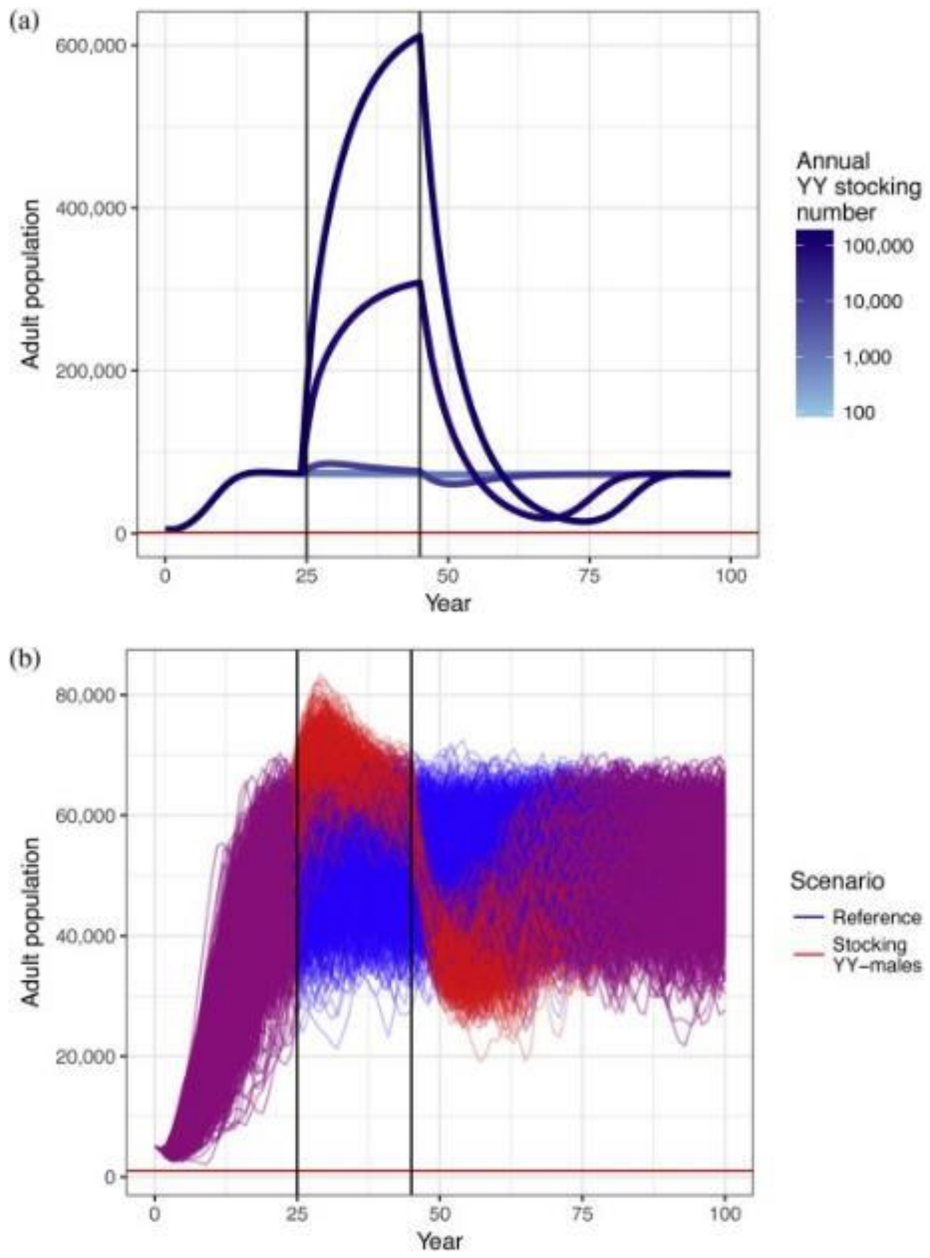


Day et al. (2020)



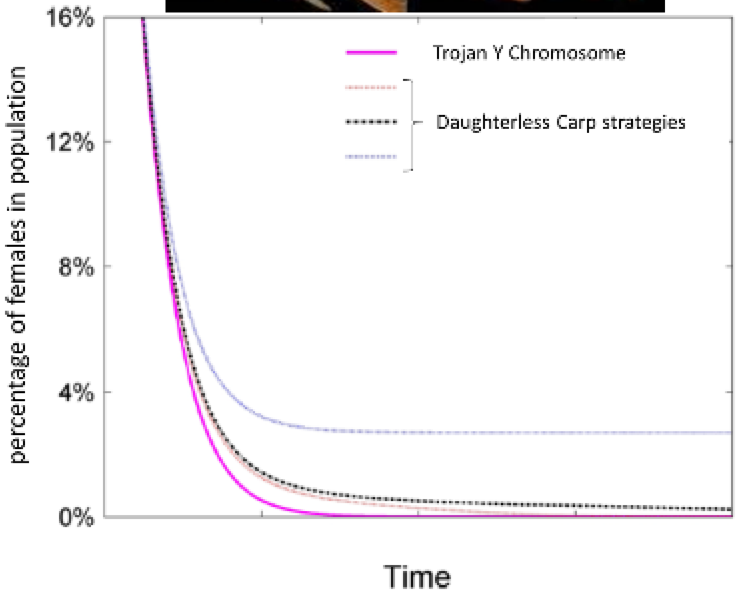
Zeigler et al. *in preparation*

YY Model Outputs



"We found that releasing YY-males would require too many individuals be release to be practical in Lake Erie, North America" Erickson et al. (2017)

YY Model Outputs



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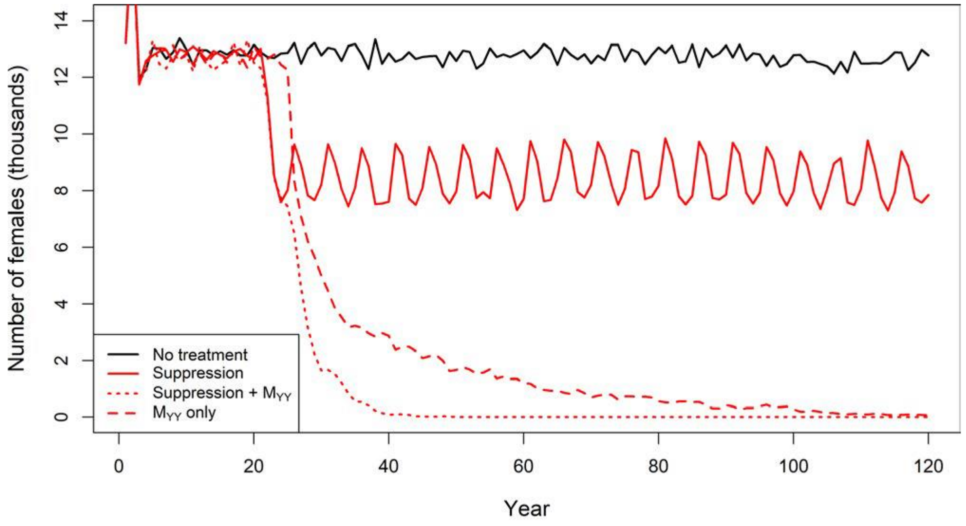

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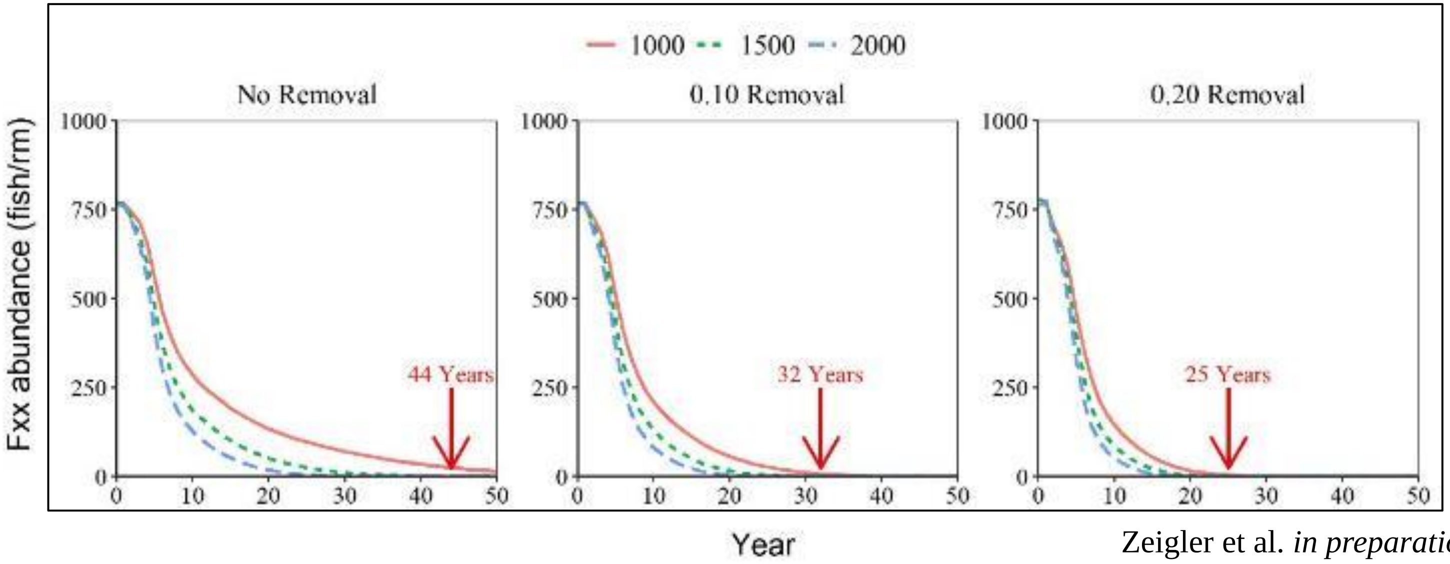


Zeigler et al. *in preparation*

Received: 23 June 2023 | Revised: 30 August 2023 | Accepted: 25 September 2023

DOI: 10.1002/naaq.10314

ARTICLE

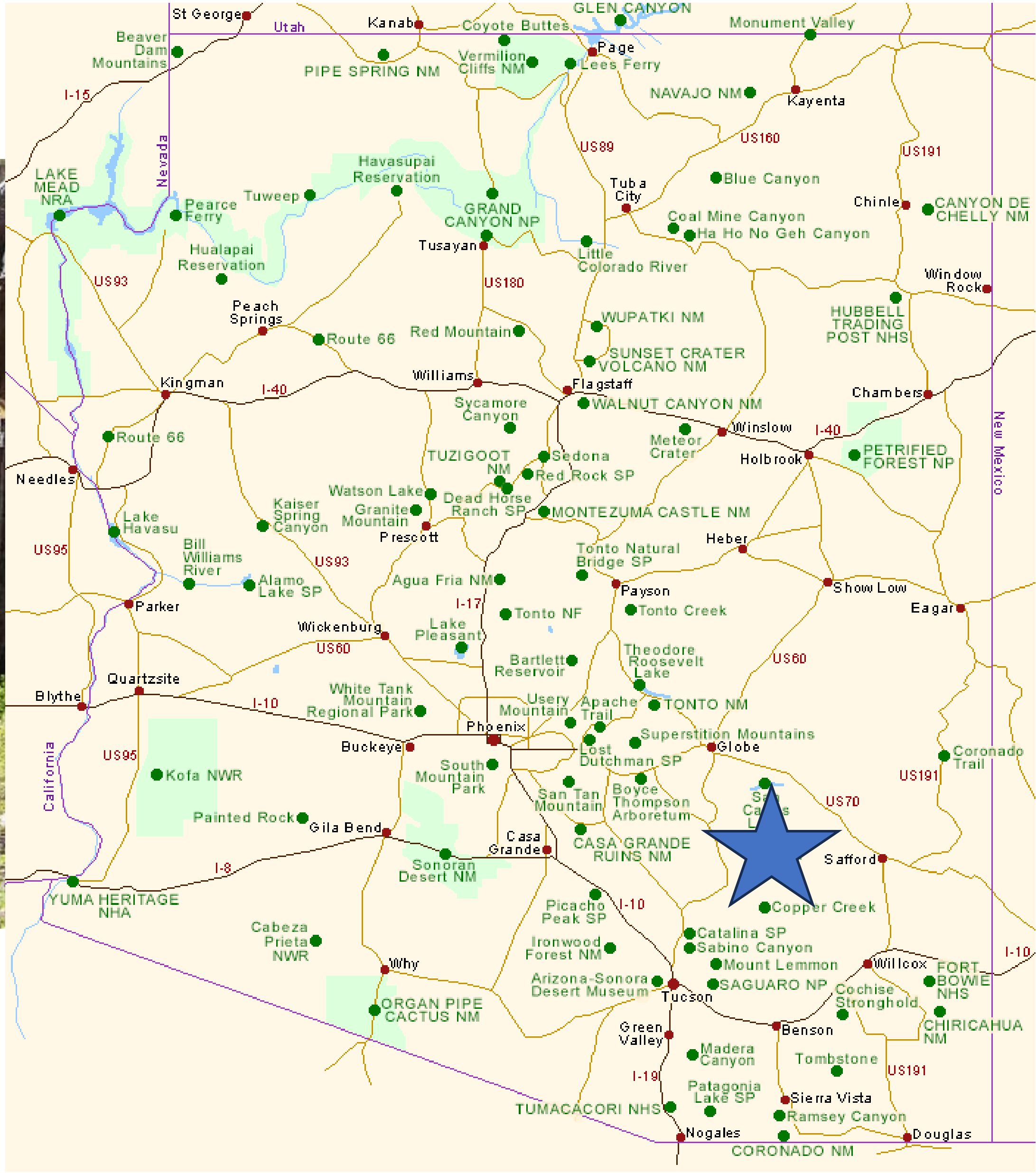
The effects of estradiol-17β on the sex reversal, survival, and growth of Red Shiner and its use in the development of YY individuals

Chad N. Teal[1] | Daniel J. Schill[2] | Javan M. Bauder[3] | Susan B. Fogelson[4] | Kevin Fitzsimmons[5] | William T. Stewart[6] | Melanie Culver[3] | Scott A. Bonar[3]

YY female

YY male

Study System- Aravaipa Creek, AZ



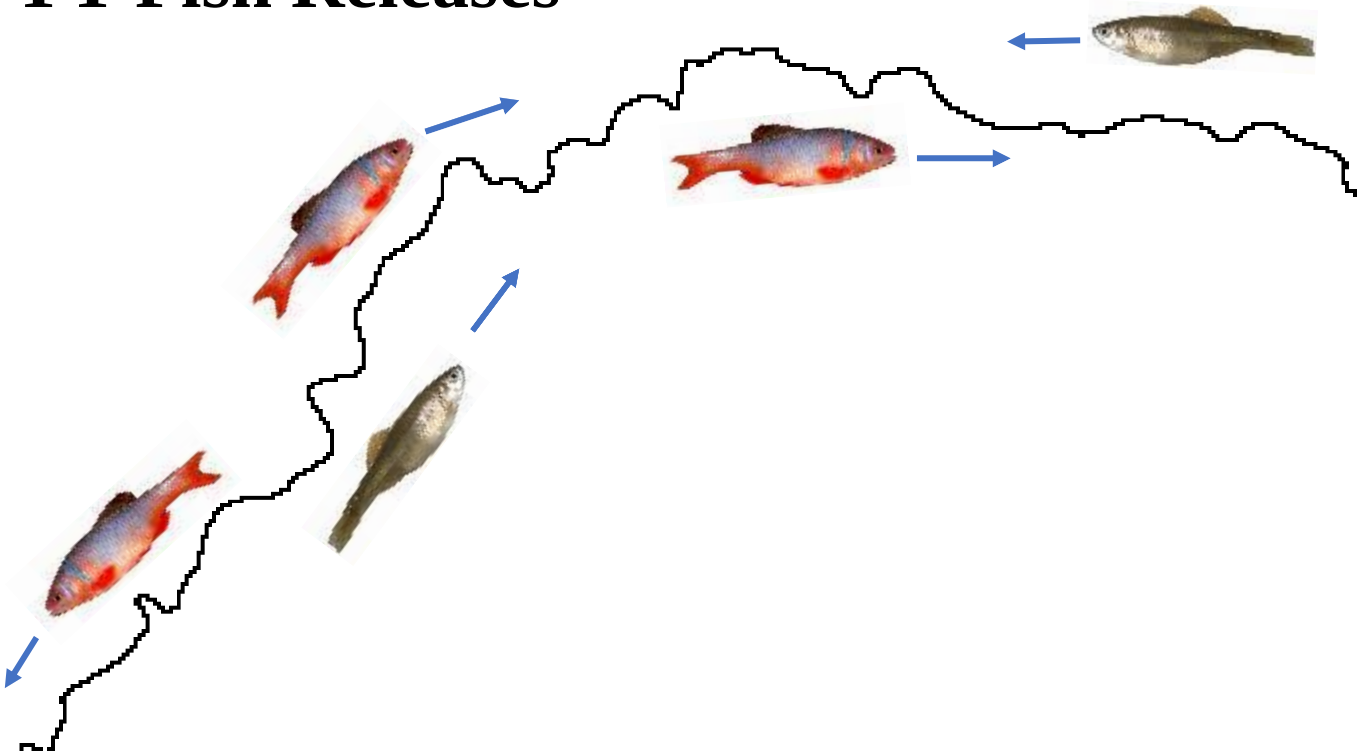
Study System- Aravaipa Creek, AZ

Biannual Aravaipa Creek Surveys

Study System- Aravaipa Creek, AZ

Biannual Aravaipa Creek Surveys

Modelling YY Fish Releases

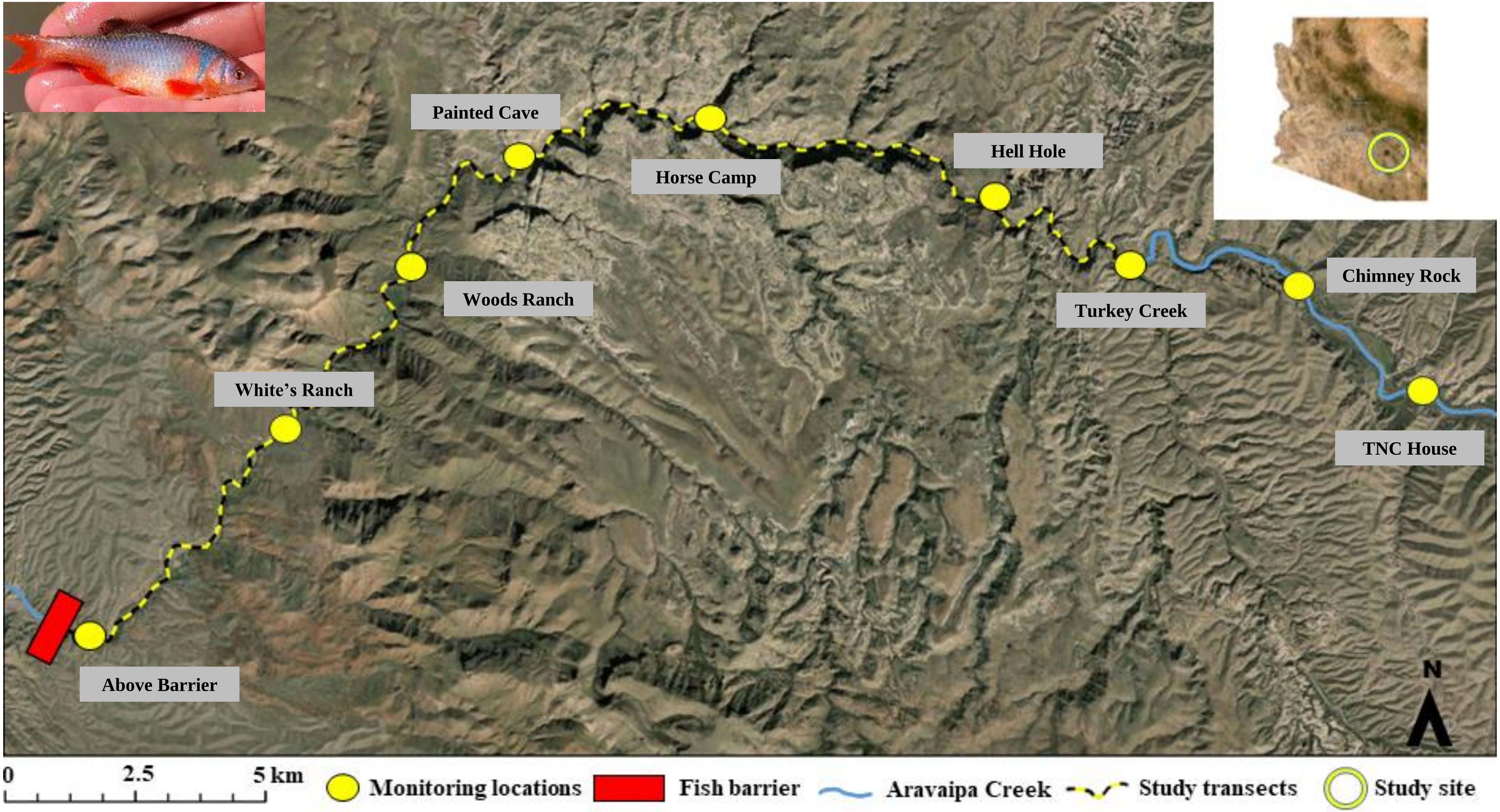


Program CDMetaPOP

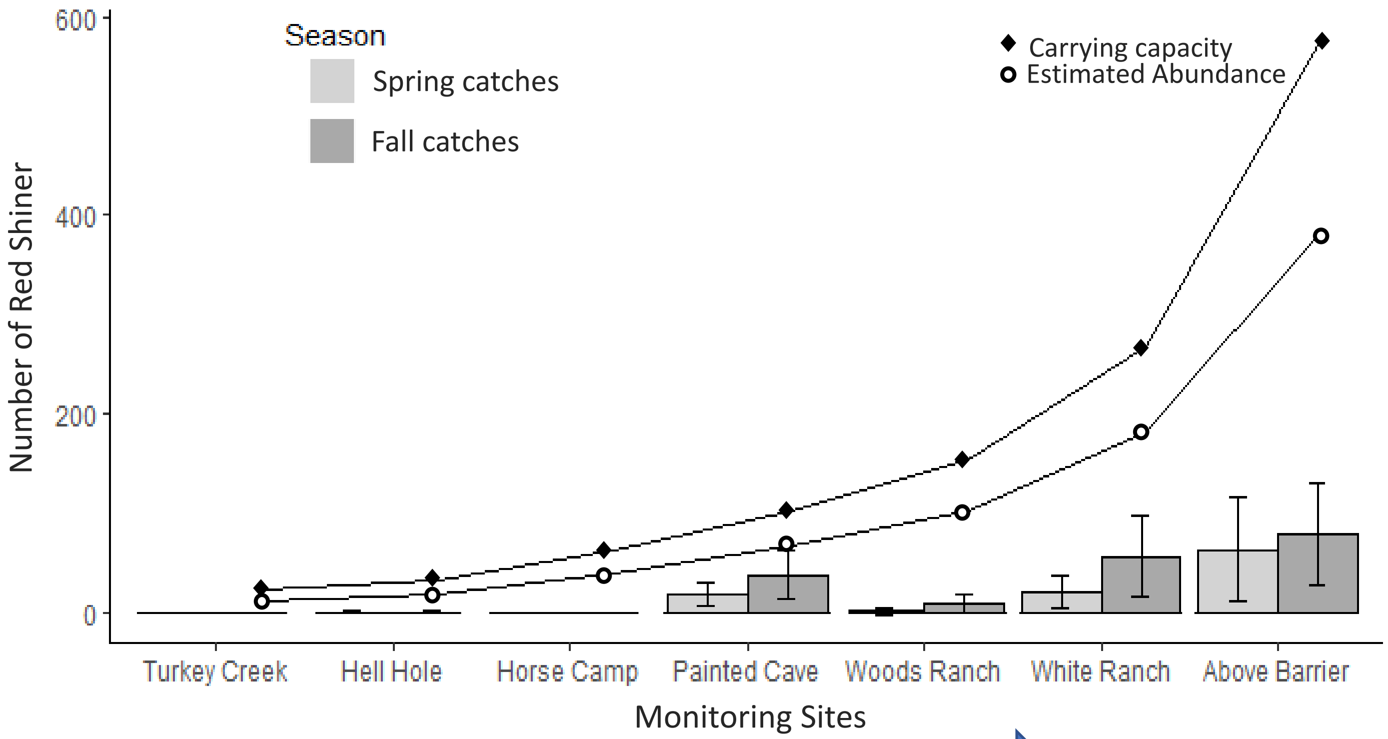
- cost-distance metapopulation
- functions off individual based-movement
- very "data-hungry" modelling
- computationally demanding

	Site 1	Site 2	Site 3	Site 4	Site 5
Site 1	0	180.9828	395.931	634.8965	815.8793
Site 2	180.9828	0	214.9483	453.9138	634.8965
Site 3	395.931	214.9483	0	238.9655	419.9483
Site 4	634.8965	453.9138	238.9655	0	180.9828
Site 5	815.8793	634.8965	419.9483	180.9828	0

Study System- Aravaipa Creek AZ



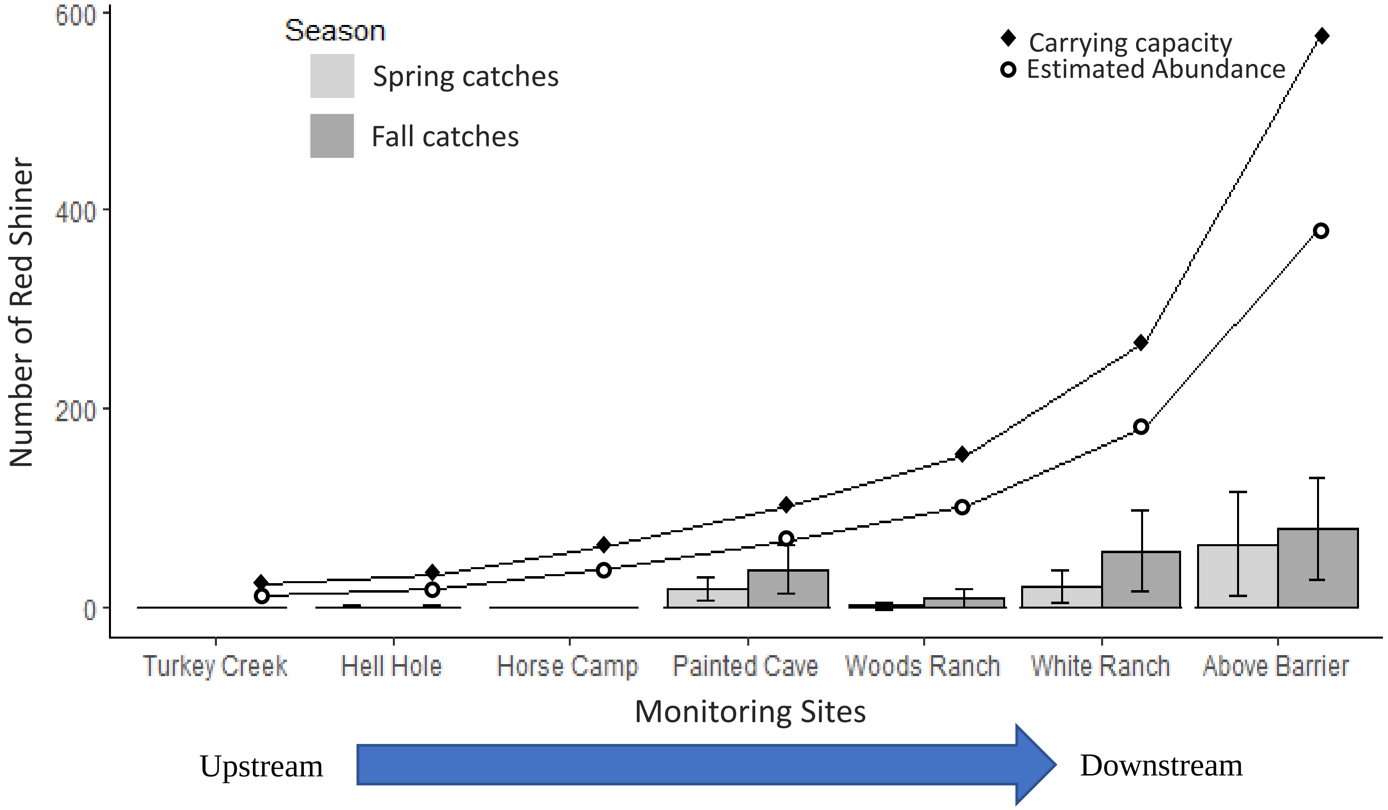
Aravaipa Creek Red Shiner Population Estimates



Upstream → Downstream

Biannual Aravaipa Creek Surveys

Aravaipa Creek Red Shiner Population Estimates



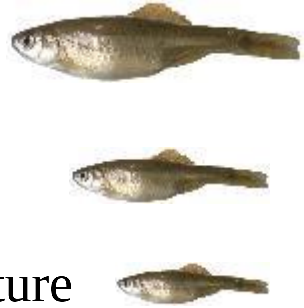
- **Red Shiner spawn Spring to Fall**
- **Used Fall Estimates to represent reproductive potential of population**

Model Parameters- Class Variables

Movement

- *Fishmove*
- 455 m distance
- Archdeacon et al. (2021)

Age Classes



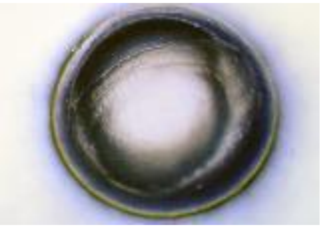
- 0, 1, 2, 3, 4
- 100% mort on age 4
- 60% of age 0 sexually mature

YY Fish in lab exhibited similar performance on growth, fecundity, mating success (Teal et al. 2023)

Mat

- $\bar{X}$ *nu* … *a year*
- 25 m

Fecundity



- 582 eggs/mating event; (SD = 44 eggs/mating event)
- Adjusted to 10 eggs/mating event due to immense abundance of age 0 individuals in the model

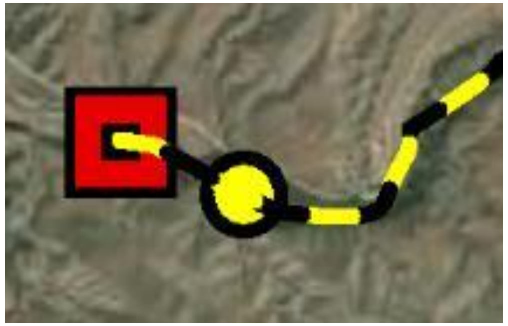
Model Parameters

Population Model

- Density-Dependent Modelling
- Instantaneous mortality rate (*Z*) -1.763 (Yildirim and Peters, 2006)
- High mortality of age 0 (90%), with 82% of pop composed of age 0
- Competition equal among all sexually mature individuals

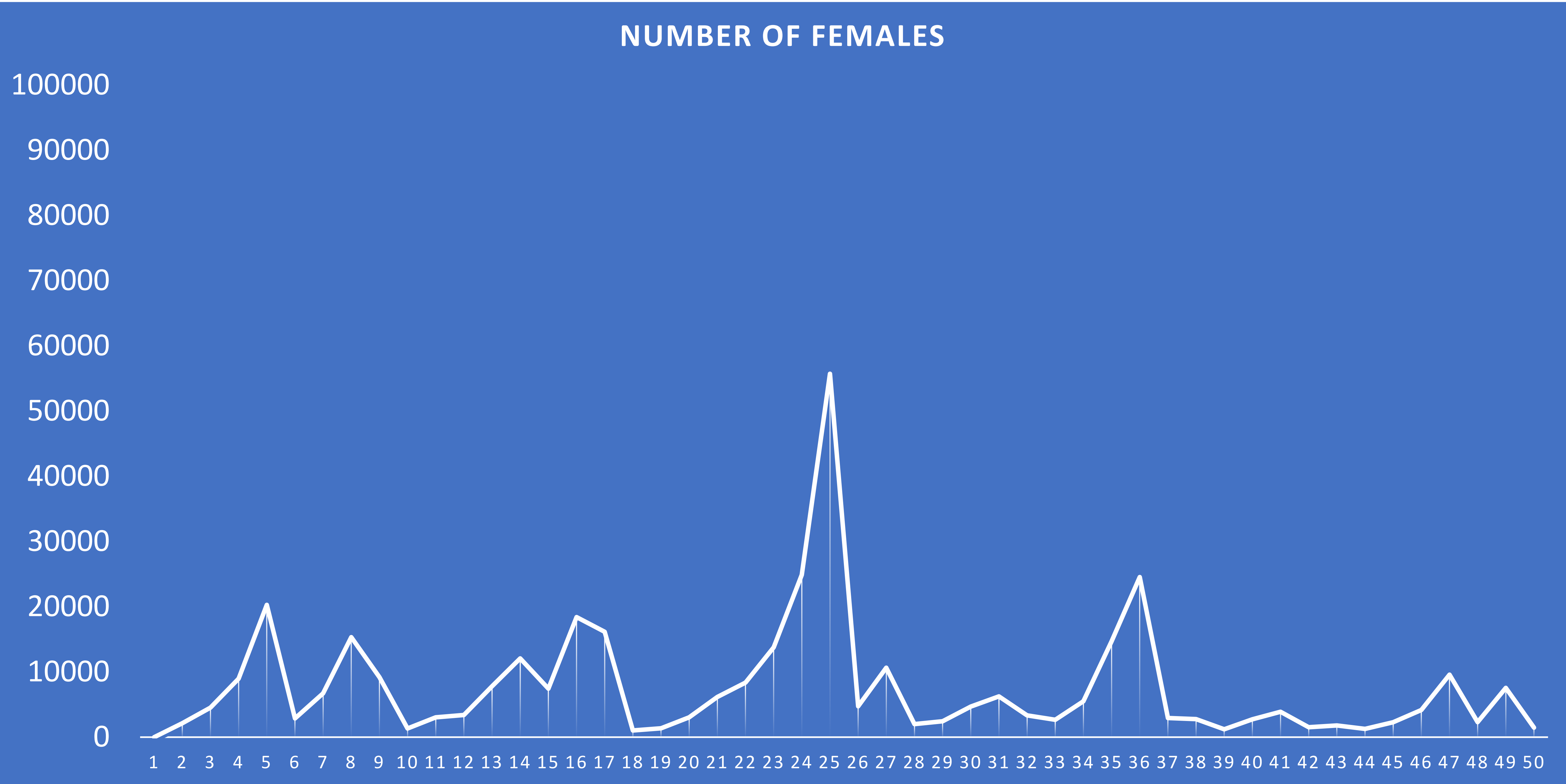
Simulation Parameters

- Initial testing on sample patches
- Testing on 7 furthest downstream sites (most populated)
- 50-year simulations
- 25-year burn in period before adding YY individuals

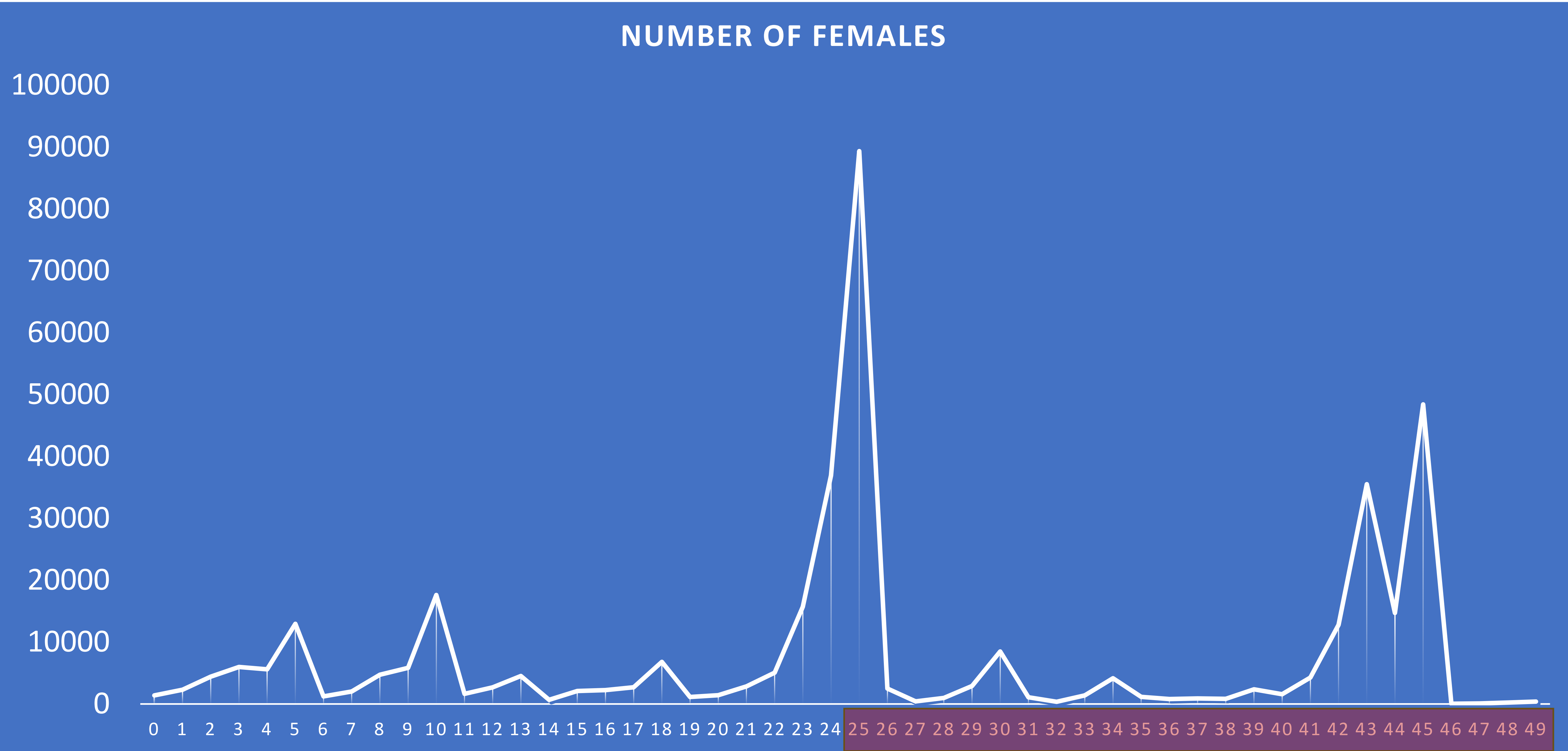


PRELIMINARY Results

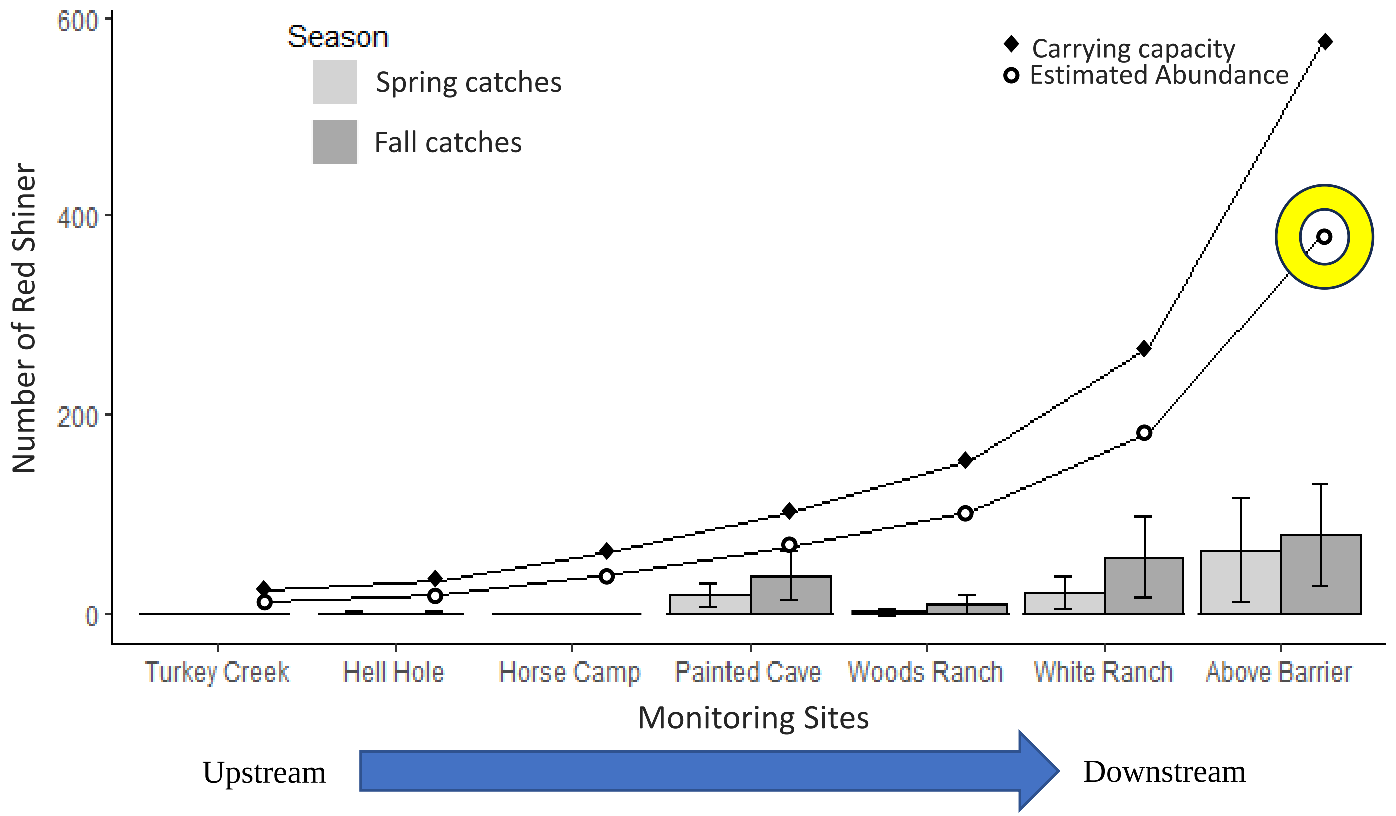
Female Shiner Population Without YY Fish



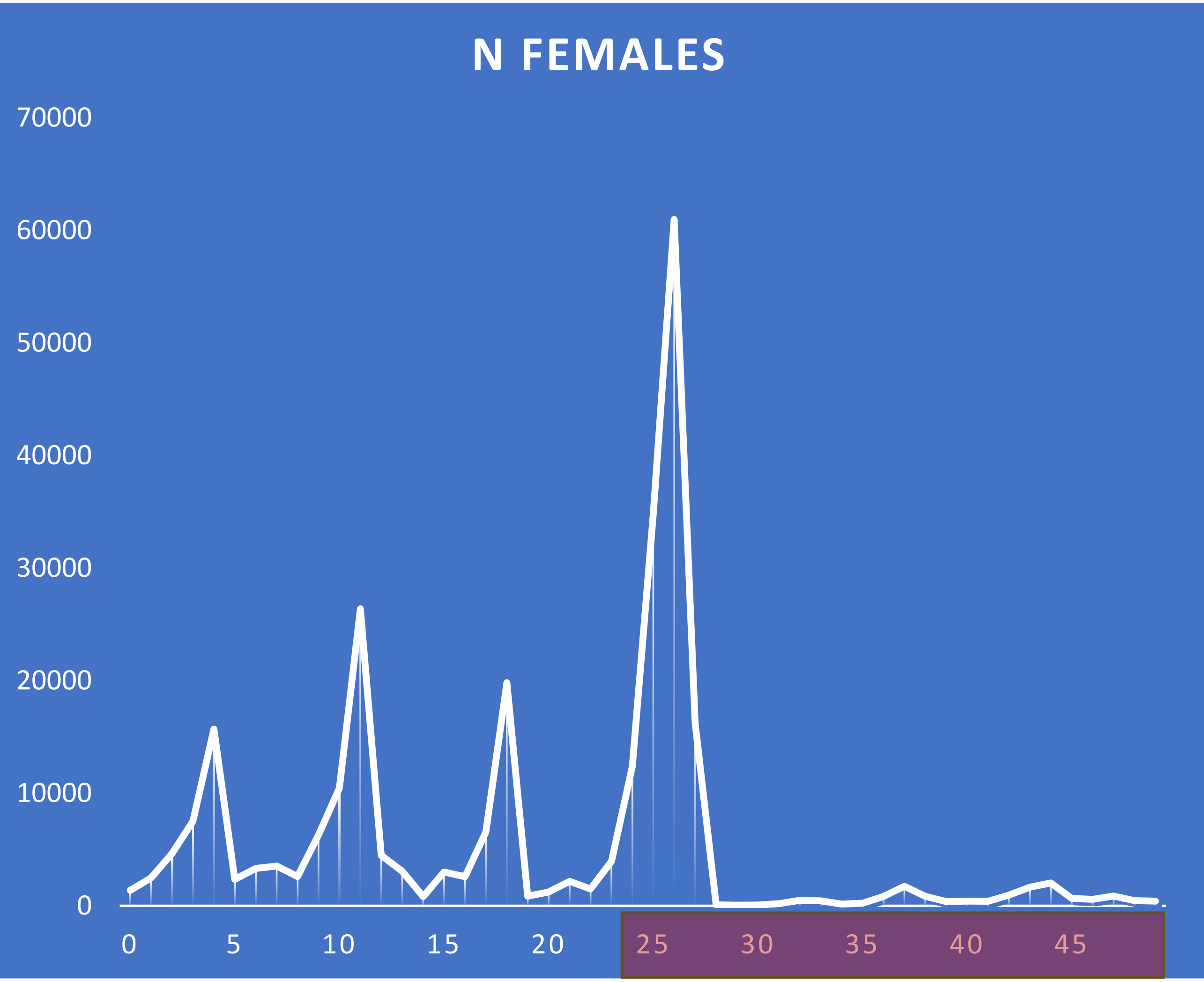
Female Shiner Population With 100 Age 1 YY-Male Introductions per site



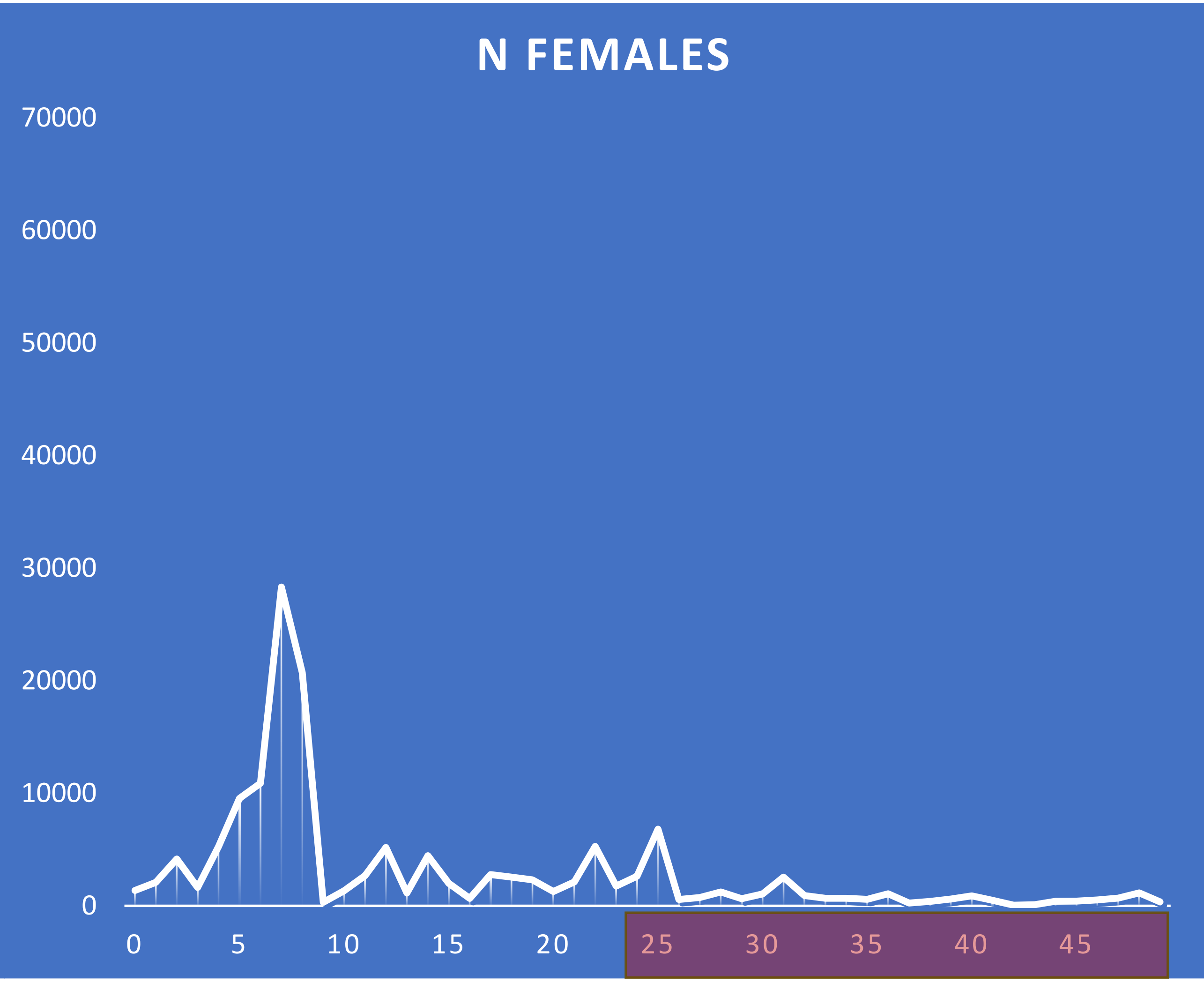
Female Shiner Population With YY-Male Introductions Matching Initial Simulation Population Abundances (~400 YY-males per site)



Female Shiner Population With YY-Male Introductions Matching Initial Simulation Population Abundances (~400 YY-males per site)

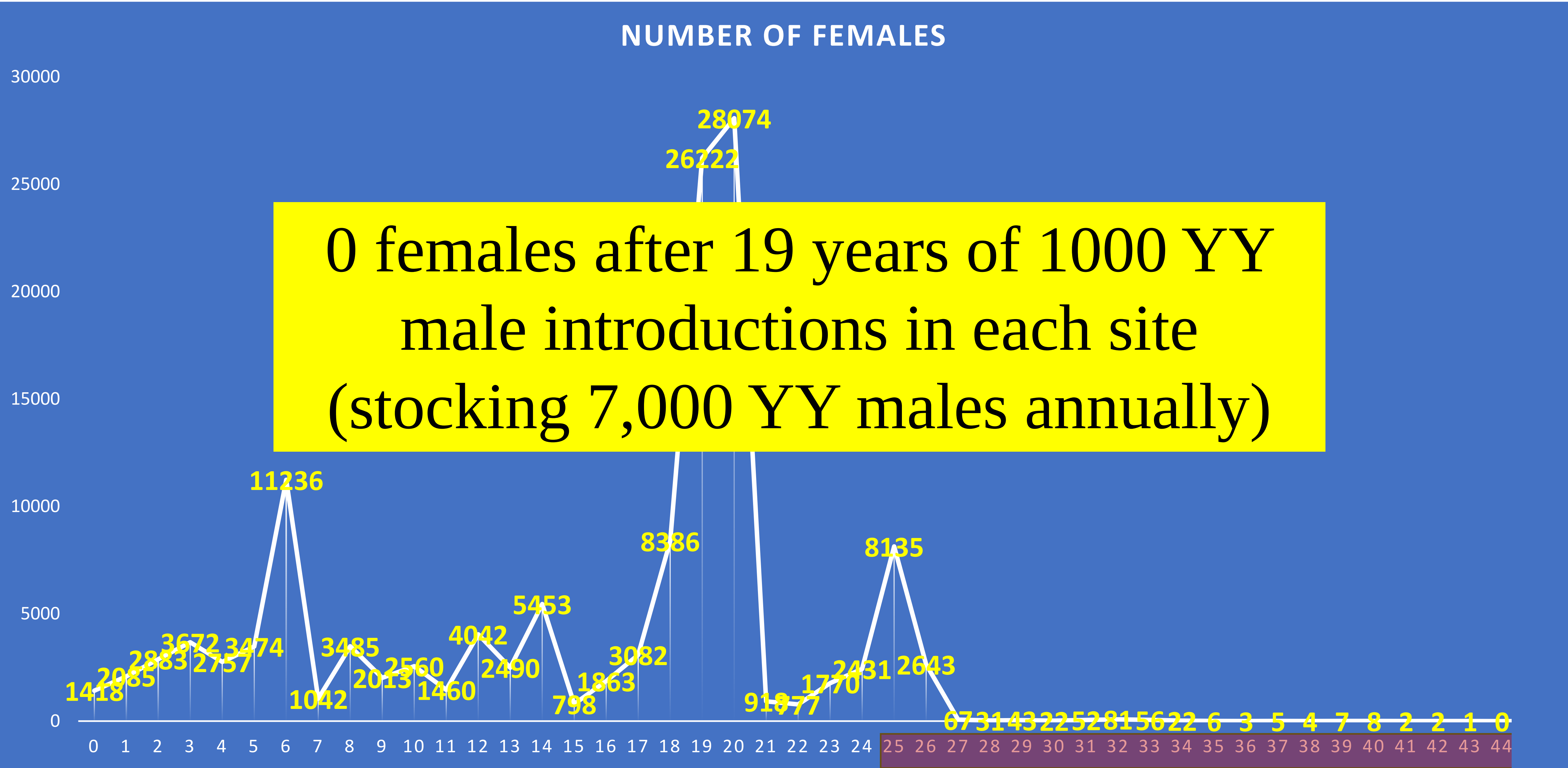


Age 0 introductions



Age 1 introductions

Female Shiner Population With 1000 YY Males Introduced in Each Site

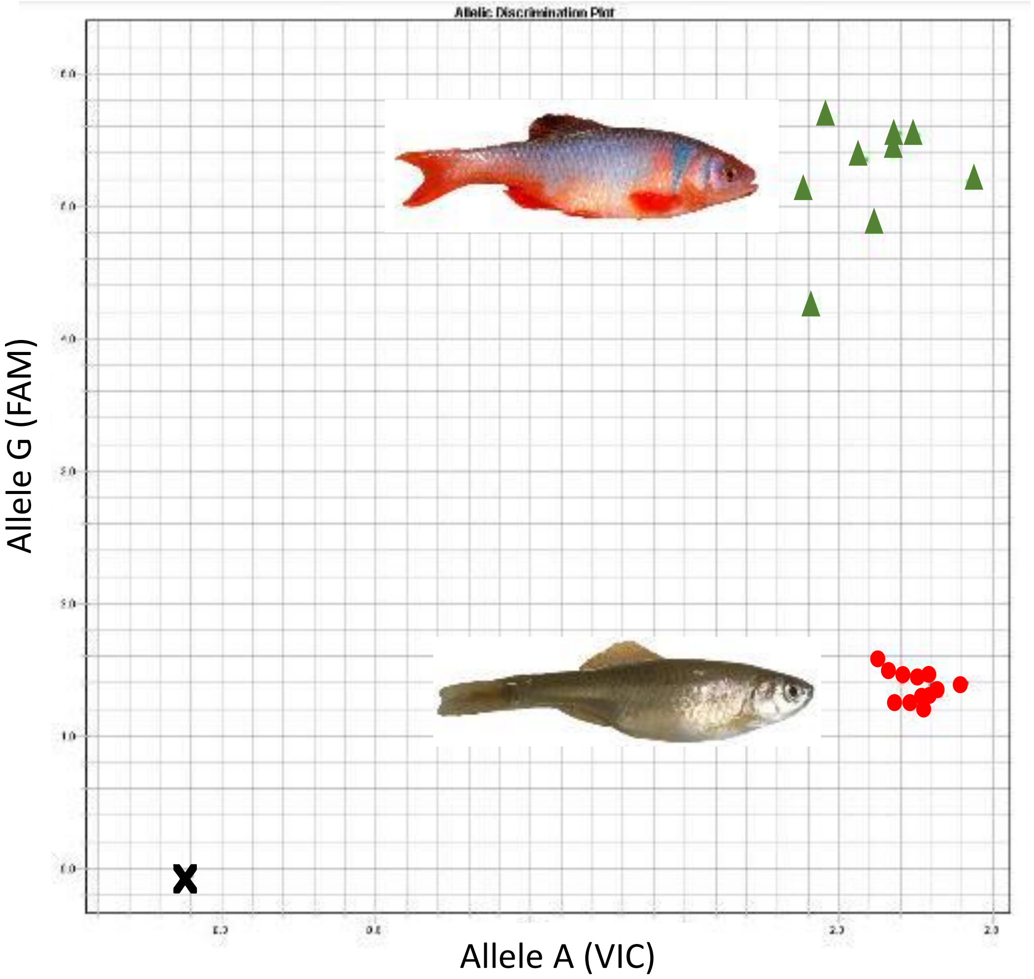


0 females after 19 years of 1000 YY male introductions in each site (stocking 7,000 YY males annually)

Discussion and Next Steps

- Based on catch data, immense amount of inherent variability in the Aravaipa Creek Red Shiner population numbers and/or movements in the system
    - ie 0 caught in April 2023, 122 caught in Fall 2023
- Will continue modelling various YY-male Red Shiner scenarios
    - Stocking in specific sites- more logistically feasible than in every patch
    - Stocking younger vs older age classes
    - Incorporating indiscriminate suppression (no distinction between removing YY-males and wild-types)
    - Run models on all of Aravaipa Creek instead of sample set
- Currently troubleshooting YY-female introductions
- Compare CDMetaPOP models to non-individual based mix-matrix models

Population Genetics and Feminization Trials for Red Shiner

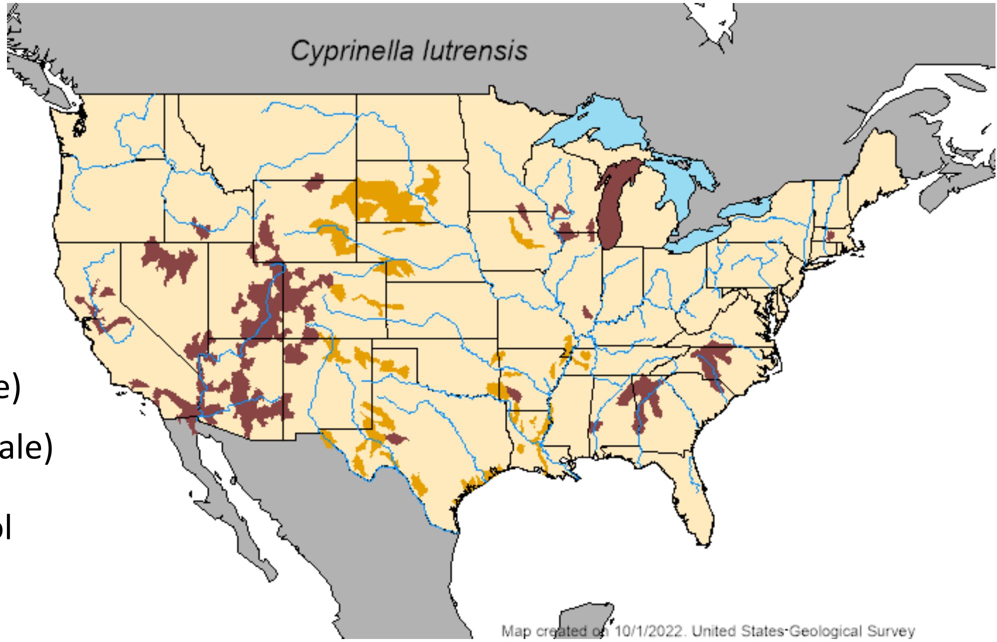


<u>Genotype</u>

▲ AG (Putative XY male)

● AA (Putative XX female)

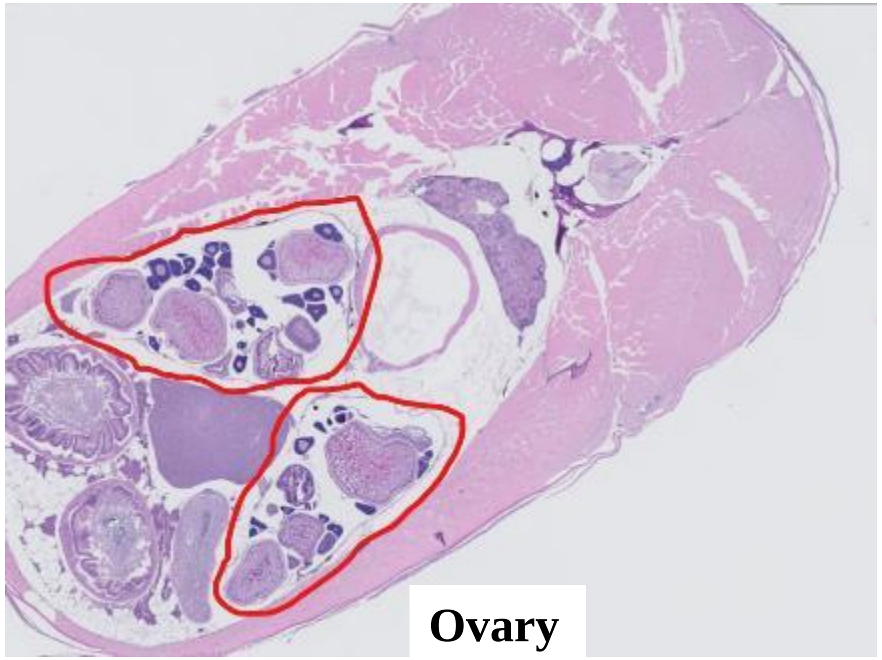
X No Template Control

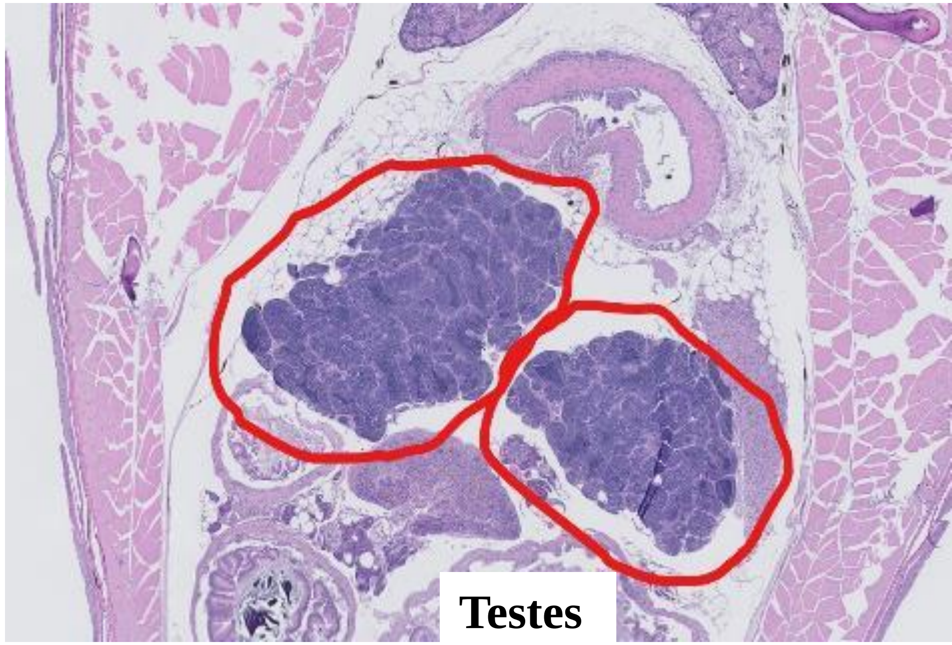


Population Genetics and Feminization Trials for Red Shiner

Effects of Estradiol on Shiner Gonads

Treatment Level (E2 mg/kg of diet)	N	Number of fish	Treatment Duration (DPH)	Mean % Female	95% CI
Control	4	45	2-62	51.11%	36.75% - 65.35%
Control	3	29	2-120	41.38%	24.75% - 59.47%
50	3	33	2-62	90.90%	74.20% - 97.78%
50	3	25	2-120	100.00%	NA
100	4	25	2-62	88.00%	67.33% - 97.03%
100	3	29	2-120	97.54%	87.24% - 99.88%
100	3	23	20-120	100.00%	NA
150	3	31	2-120	97.70%	88.20% - 99.88%





Technical and Experimental Aquatics Lab (TEAL)

YY Fish Overview

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Dept of Watershed Sciences
Utah State University

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Transactions of the American Fisheries Society 147:419–430, 2018

ISSN: 0002-8487 print / 1548-8659 online
DOI: 10.1002/tafs.10060

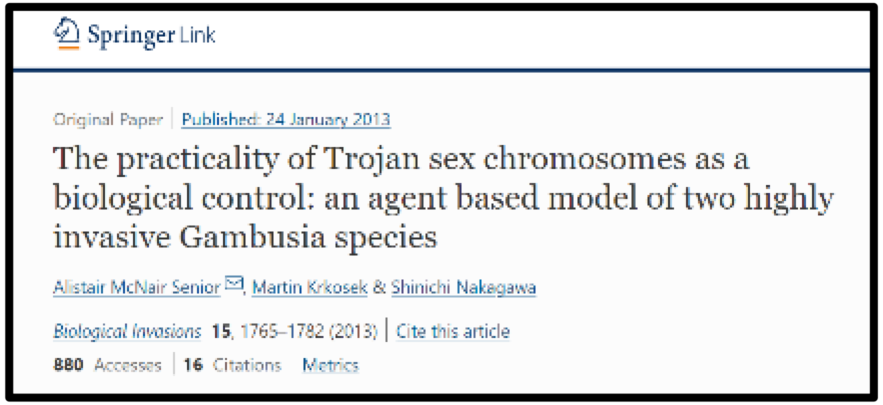
FEATURED PAPER

Survival and Reproductive Success of Hatchery YY Male Brook Trout Stocked in Idaho Streams

Patrick A. Kennedy,* Kevin A. Meyer, and Daniel J. Schill
Idaho Department of Fish and Game, 1414 East Locust Lane, Nampa, Idaho 83686, USA

Matthew R. Campbell and Ninh V. Vu
Idaho Department of Fish and Game, 1800 Trout Road, Eagle, Idaho 83616, USA

YY Fish Research



Springer Link

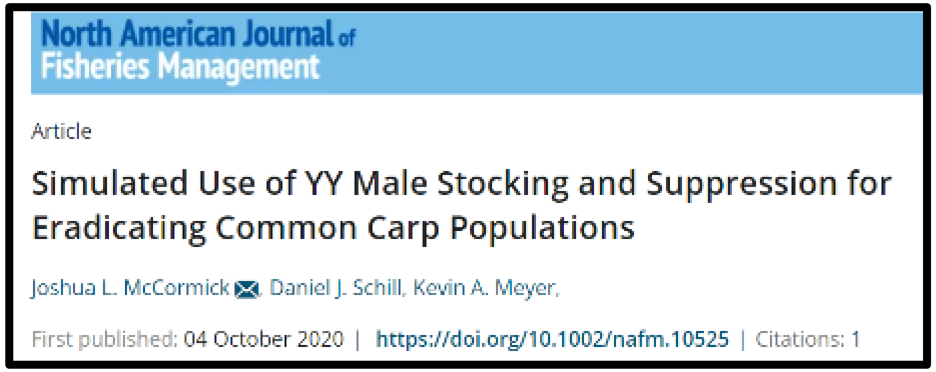
Original Paper | Published: 24 January 2013

The practicality of Trojan sex chromosomes as a biological control: an agent based model of two highly invasive Gambusia species

Alistair McNair Senior, Martin Krkosek & Shinichi Nakagawa

Biological Invasions 15, 1765–1782 (2013) | Cite this article

880 Accesses | 16 Citations | Metrics



North American Journal of Fisheries Management

Article

Simulated Use of YY Male Stocking and Suppression for Eradicating Common Carp Populations

Joshua L. McCormick, Daniel J. Schill, Kevin A. Meyer,

First published: 04 October 2020 | https://doi.org/10.1002/nafm.10525 | Citations: 1

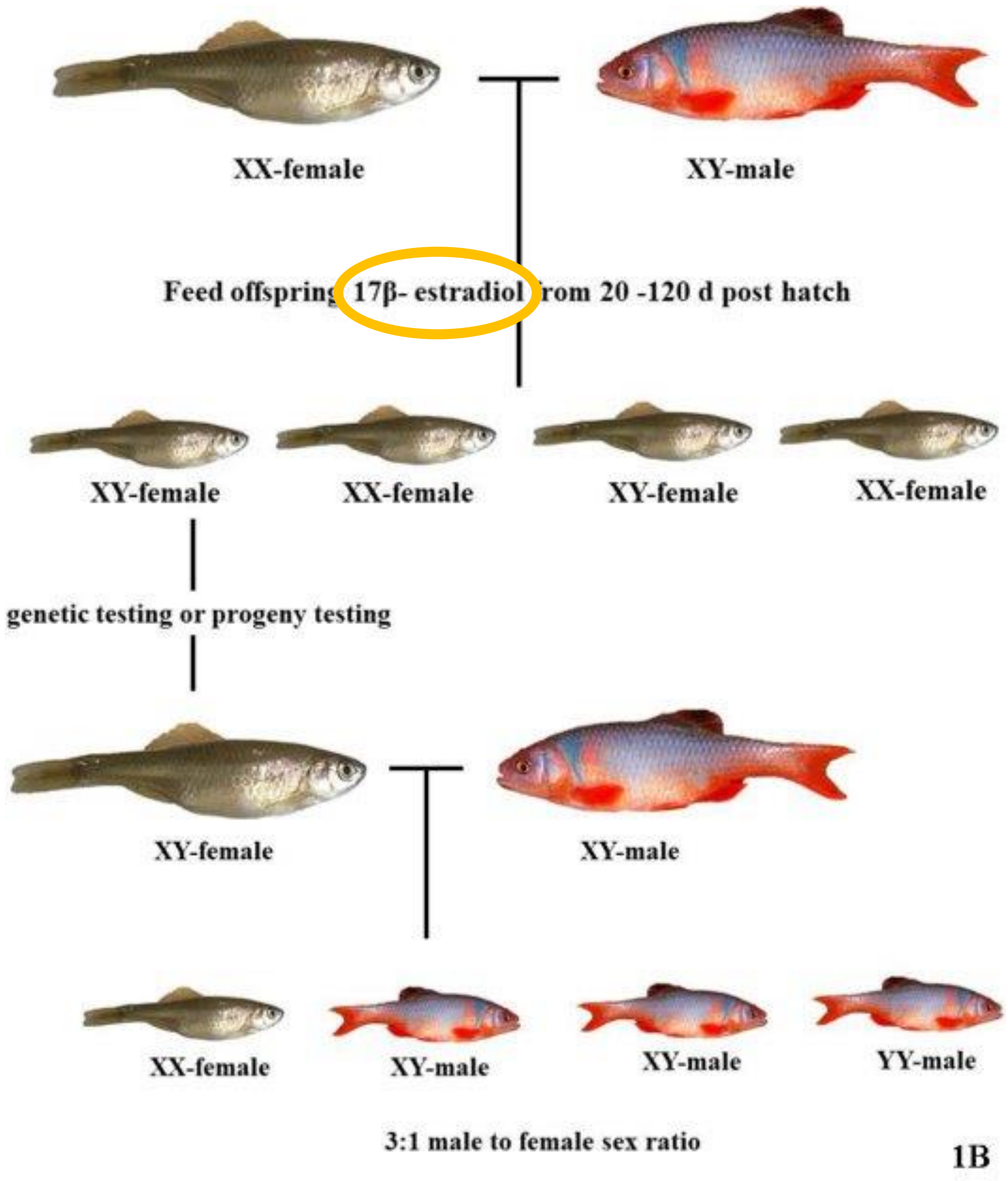
fishes MDPI

Article

17β-Estradiol Can Induce Sex Reversal in Brown Trout

Jill M. Voorhees [1,*], Elizabeth R. J. M. Mamer [2], Daniel J. Schill [3], Mitchel Adams [4], Carlos Martinez [4] and Michael E. Barnes [1]

Why aren't there more field trials with YY fish?


XX-female
XY-male
Feed offspring 17β- estradiol from 20 -120 d post hatch
XY-female
XX-female
XY-female
XX-female
genetic testing or progeny testing
XY-female
XY-male
XX-female
XY-male
XY-male
YY-male
3:1 male to female sex ratio
1B

Need FDA approval to put fish onto the landscape that were produced through the use of a drug

The Brook Trout Model

Opened an Investigational New Animal Drug (INAD) File

- Allows field data to be collected during the drug approval process
  - Requires foundational drug treatment data (eg E2 feminization treatments)
- Typically need a Drug Sponsor to open an INAD (eg Sigma Aldrich)
- Western Association of Fish and Wildlife Agencies (WAFWA) is acting as the "Sponsor" in this instance
- Obtaining official drug approval is a lengthy, expensive, and onerous process
  - Only a couple exist for fish

Our Options For Additional Species

- **Will the FDA allow for more species to follow the Brook Trout INAD model?**
    - USFWS's Aquatic Animal Drug Approval Partnership Program (AADAP) is talking with FDA about this
    - One species at a time approach
    - Would likely require fundamental change to typical INAD process (No drug sponsorship?)




Our Options For Additional Species

Indexing Estradiol

- Allows for extra-label use of drug

- Can be used for non-food species (ie Red Shiner) or non-food life stages of species (ie young fish)

- Can be used for more than one species at a time (ie Salmonids, Cyprinids, or even all finfish)

- Still needs YY fish production data before approval
    - Environmental Assessment or Categorical Exclusion of E2 wastewater
    - Health data (ie data we are collecting on Red Shiner)

- <u>Requires a Chemistry, Manufacturing, and Controls (CMC) Protocol</u> for
  the E2 treated feed (the crux)
    - Expensive and onerous
    - Requires specific lab and manufacturing settings and protocols

Our Options For Additional Species

Indexing Estradiol

- NovaEel, and the feed manufacturer, Precision Science, are developing a CMC for E2 top-coat that is applied to American Eel diets

- WAFWA's YY Fish Consortium and other federal partners might fund NovaEel to ensure accessibility to this top-coat and have access to the CMC protocol
    - $600K to finish their CMC
    - NovaEel anticipates having it done without this funding in 2 years
    - How much money gets them what and by when if they can't get the full $600K ($100K here or there)?

- YY Fish Consortium plans on indexing all Salmonids first
    - What about Red Shiner and other species they're not working on?

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Conclusion

- **We can wait for NovaEel to finish their drug approval process and then we can purchase the diets from them**
  - How long will this take?
  - What will the cost of the approved E2 top-coat and feed be?
  - Incentives for sponsoring NovaEel? There's a lot riding on their success.

- **Still need data for all these prospective species to satisfy the FDA's requirements**
  - Dan Schill is still giving FDA data on Brook Trout feminization results

- **For Red Shiner and Brown Trout, will FDA let us open an INAD without a drug sponsor?**
  - "tap dancing"

Contact Information

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Logan, UT 84322

BUREAU OF RECLAMATION

CONSERVATION & ADAPTATION RESOURCES TOOLBOX

U.S. FISH & WILDLIFE SERVICE

CART’s Non-Native Aquatic Species Community of Practice (CoP):

Progress and Next Steps

GRBNFCP Annual Reporting Meeting 12/11/2023

Purpose of CART

Partners working in resource management wanted a fast and effective platform for peer-to-peer knowledge exchange.

- Case Studies, webinars, workshops, Communities of Practice (CoP), Tool Development
- Improves outcomes of on-the-ground work
- Help get "unstuck" on the most challenging issues — Inspire confidence and action by sharing successful projects
- Issue-based instead of geography-based
- Provide a modular platform for partners to build upon

Non-Native Aquatic Species CoP

195 Members

Issue: Introduced aquatic species are a critical management challenge lacking sufficient cross-agency coordination

Solution: Bring together multiple federal and state agencies, universities, non-profits, and private organization to incorporate best-available science into decision-making.

1. Use Case Studies to inspire and build connections
2. Develop recommended practices based on expertise of members
3. identify knowledge gaps with researchers and managers
4. Co-develop actionable science and tools to address the needs of managers

Non-Native Aquatic Species CoP Accomplishments

- Knowledge exchange
  - 34 case studies, 34 webinars, and 3 workshops
- Tool development
  - Project checklist with the GRBNFCP
  - Project catalog with multiple federal and state partners
  - Regulatory support tool by USFWS Directorate Fellows Program Fellow
  - Non-Native Aquatic Species Toolkit
- Collaborative action
  - Over $900k toward non-native fish, bullfrog, and crayfish research
  - Launched the American Bullfrog Working Group in 2022





Toward Collaborative Action
American Bullfrog Work

- 2022 American Bullfrog Workshop supported three groups exploring bullfrog control (AZ and UT) as test cases. In 2023, we:
  - Co-developed stepwise guidance for initial bullfrog control project scoping
- Documented bullfrog predation of 33 native species through a photo collection of stomach contents.
- Current Working Group Objectives:
  - Conducting a formal literature review of bullfrog impacts of native species in the West.
  - Continued development of a bullfrog control program guidance document

Courtesy of Arizona Game and Fish Department

A West-Wide Need, Now What?

- Consensus that bullfrogs are a west-wide issue
- Building upon CART's foundation and others, the Washington Invasive Species Council submitted an AtBC proposal to provide managing agencies and partners with tools to address invasive frogs.
    - A west-wide hybrid (remote/in-person summit)
    - In-person field trainings and workshops in six Western states
    - Development of a Western Invasive Frog Action Plan
- Overwhelming support for a multi-state project to address invasive frogs
    - 25 letters of support from nine states including BC!

Courtesy Matt Morrison, FLNRORD

Research Updates

Assessment of Fish Movement Through the Emerging Pearce Ferry Rapid on the Colorado River

- Research Questions:
  - Are there differences in fish assemblages above and below the rapid?
  - Is the rapid a barrier to native and non-native fish movement?
- Findings:
  - Upstream consists of mostly native fishes, downstream consists of mostly non-native fishes
  - The rapid is a hindrance to upstream fish movement, but m
  - Flow and temperature can cue fish movement

Ammonia as a Tool for Removal of Invasive Crayfish

- Research Questions:
  - What is the lowest effective dose to achieve 100% mortality?
  - Is there a difference in ammonia sensitivity between two crayfish species?
  - Will laboratory dosages of ammonia and additives cause 100% mortality in the field?
- Completed trial results in the lab, found ammonium sulfate, sodium sulfite, and soda ash is the best combination to kill crayfish, refined doses to find lowest ammonia amount to cause 100% mortality
- Conducted escape trials, to see if crayfish would escape the dosed water if given the opportunity
- Compared effectiveness between two crayfish species
- Conducted field trials for red swamp crayfish
- N more field trials to further understanding of the effec

NAU NORTHERN ARIZONA UNIVERSITY FOUNDED 1899

USGS science for a changing world

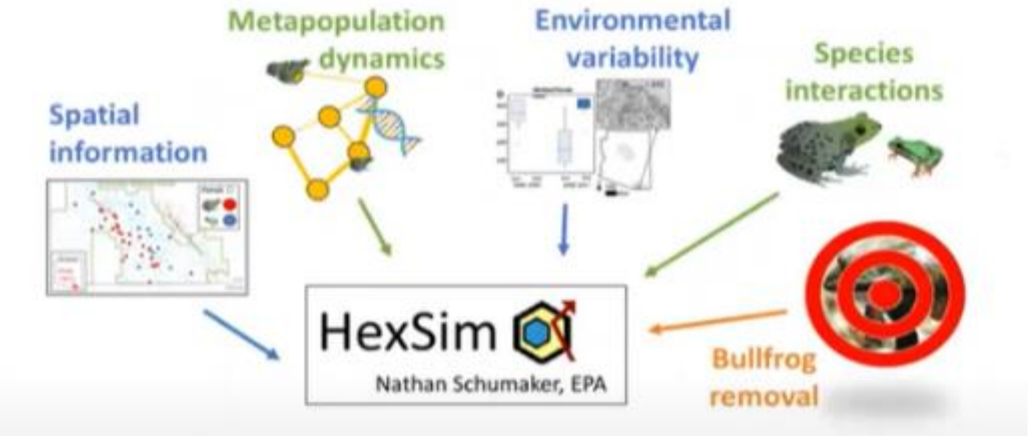
Population Dynamics & Community Interactions of Invasive Crayfish & Protected Fishes & Reptiles in the Gila River Basin

- Goals:
  - Assess population structure and reproductive phenology
  - Identify crayfish food web connections w/suppression reach experiment
  - Quantify magnitudes of crayfish interactions
  - Understand landscape-wide effects of crayfish
- Females average 270 eggs
- No difference in diets of male and female crayfish or by age, no differences in trophic position based on size
- Larger crayfish eat more riparian derived sources
- Removed 896 crayfish in 2020, ~5,000 crayfish in 2021
- Analyzed invertebrate abundance based on crayfish density
- Community structure analysis complete

THE UNIVERSITY OF NEW MEXICO

Integrating Monitoring, Genetic, & Simulation Approaches for Strategic Bullfrog Removal & Control

- Research Question:
  - Does strategic removal and control of bullfrogs work, and what does it take?
- Completed data collection: acoustic recorders to detect bullfrogs and AZ treefrogs and temperature sensors at study sites, landscape genomics to understand metapopulation dynamics, & bullfrog removal
- >700 bullfrog individuals sequenced + exploratory landscape genomics analysis ongoing
- The collected data was input into HexSim simulations to test a myriad of bullfrog management scenarios and effects of climate change in the Huachucas/Canelo Hills
- Hosted a workshop in 2023 to go over findings, limitations, and transferability of this SMARTSIM framework



VIRGINIA TECH

Surveying, Modeling, & Mapping Non-Native Crayfish in the Gila & Little Colorado River Basins

- Objectives: Survey crayfish in the Gila and Little Colorado River basins, use results to map presence/absence across inter-confluence stream reachers, better understand environmental correlates of detection and occupancy
- Surveyed 109 sites in Arizona and New Mexico (2021 , 2022, 2023)
- Conducting modeling to determine virile crayfish distribution and what habitat variables are linked to their presence/absence
- Next steps: add additional models, incorporate additional predictor variables, test different variable combinations

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Non-Native Aquatic Species CoP Next Steps

- Continued development of American Bullfrog Working Group Objectives
  - Consider opportunities to move forward invasive frog work outlined in the WSC's AtBC proposal
- Support a full-time Americorps member in 2024 to development web products synthesizing management, goals, and objectives for Reclamation fish barriers in the Gila River Basin including:
  - Case studies
  - A public-facing, interactive web product

Thank you!

- Join the NNA Species CoP mailing list for meetings, webinars, & workshops
- Submit ideas for Case Studies or webinars: we do (almost) all the work

Contact Karlee: (karlee_jewell@fws.gov)

BUREAU OF RECLAMATION

CONSERVATION & ADAPTATION RESOURCES TOOLBOX

U.S. FISH & WILDLIFE SERVICE

CART’s Non-Native Aquatic Species Community of Practice (CoP):

Progress and Next Steps

GRBNFCP Annual Reporting Meeting 12/11/2023

Purpose of CART

Partners working in resource management wanted a
fast and effective platform for peer-to-peer knowledge exchange.

- Case Studies, webinars, workshops, Communities of Practice (CoP), Tool Development
- Improves outcomes of on-the-ground work
- Help get "unstuck" on the most challenging issues — Inspire confidence and action by sharing successful projects
- Issue-based instead of geography-based
- Provide a modular platform for partners to build upon

Non-Native Aquatic Species CoP

195 Members

Issue: Introduced aquatic species are a critical management challenge lacking sufficient cross-agency coordination

Solution: Bring together multiple federal and state agencies, universities, non-profits, and private organization to incorporate best-available science into decision-making.

1. Use Case Studies to inspire and build connections
2. Develop recommended practices based on expertise of members
3. identify knowledge gaps with researchers and managers
4. Co-develop actionable science and tools to address the needs of managers

Non-Native Aquatic Species CoP Accomplishments

- Knowledge exchange
  - 34 case studies, 34 webinars, and 3 workshops
- Tool development
  - Project checklist with the GRBNFCP
  - Project catalog with multiple federal and state partners
  - Regulatory support tool by USFWS Directorate Fellows Program Fellow
  - Non-Native Aquatic Species Toolkit
- Collaborative action
  - Over $900k toward non-native fish, bullfrog, and crayfish research
  - Launched the American Bullfrog Working Group in 2022





Toward Collaborative Action

American Bullfrog Work

- 2022 American Bullfrog Workshop supported three groups exploring bullfrog control (AZ and UT) as test cases. In 2023, we:
    - Co-developed stepwise guidance for initial bullfrog control project scoping
- Documented bullfrog predation of 33 native species through a photo collection of stomach contents.
- Current Working Group Objectives:
    - Conducting a formal literature review of bullfrog impacts of native species in the West.
    - Continued development of a bullfrog control program guidance document

Courtesy of Arizona Game and Fish Department

A West-Wide Need, Now What?

- Consensus that bullfrogs are a west-wide issue
- Building upon CART's foundation and others, the Washington Invasive Species Council submitted an AtBC proposal to provide managing agencies and partners with tools to address invasive frogs.
    - A west-wide hybrid (remote/in-person summit)
    - In-person field trainings and workshops in six Western states
    - Development of a Western Invasive Frog Action Plan
- Overwhelming support for a multi-state project to address invasive frogs
    - 25 letters of support from nine states including BC!

Courtesy Matt Morrison, FLNRORD

Research Updates

Integrating Monitoring, Genetic, and Simulation Approaches For Strategic Bullfrog Removal and Control

Surveying, modeling, and mapping non-native crayfish in the Gila and Little Colorado River basins

Matthew Troia (PI), Anthony Javiya (MS student), Jennifer Smith (PI)

Ammonia as a Tool for Removal of Invasive Crayfish

...

Assessment of Fish Movement through the Emerging Pearce Ferry Rapid on the Colorado River

Assessment of Fish Movement Through the Emerging Pearce Ferry Rapid on the Colorado River

- Research Questions:
  - Are there differences in fish assemblages above and below the rapid?
  - Is the rapid a barrier to native and non-native fish movement?
- Findings:
  - Upstream consists of mostly native fishes, downstream consists of mostly non-native fishes
  - The rapid is a hindrance to upstream fish movement, but m
  - Flow and temperature can cue fish movement

BIO-WEST

Ammonia as a Tool for Removal of Invasive Crayfish

- Research Questions:
  - What is the lowest effective dose to achieve 100% mortality?
  - Is there a difference in ammonia sensitivity between two crayfish species?
  - Will laboratory dosages of ammonia and additives cause 100% mortality in the field?
- Completed trial results in the lab, found ammonium sulfate, sodium sulfite, and soda ash is the best combination to kill crayfish, refined doses to find lowest ammonia amount to cause 100% mortality
- Conducted escape trials, to see if crayfish would escape the dosed water if given the opportunity
- Compared effectiveness between two crayfish species
- Conducted field trials for red swamp crayfish
- N ... more field trials to further understanding of the effe

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USGS science for a changing world

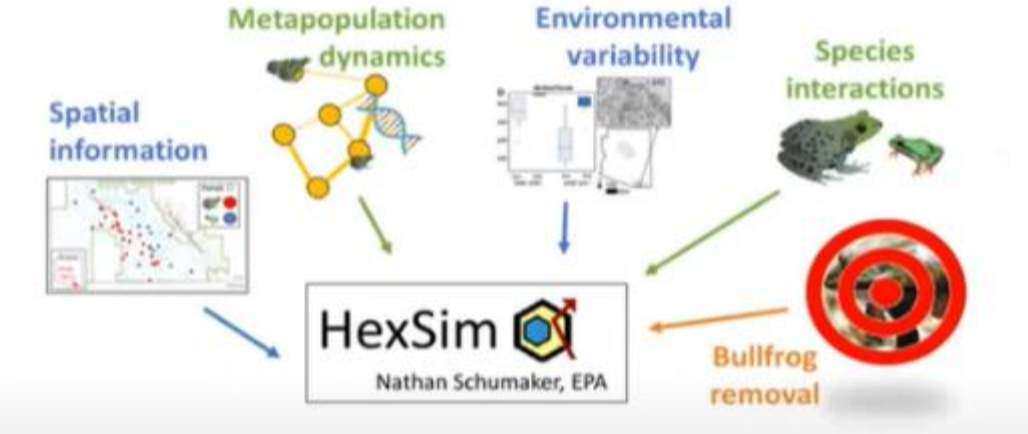
Population Dynamics & Community Interactions of Invasive Crayfish & Protected Fishes & Reptiles in the Gila River Basin

- Goals:
  - Assess population structure and reproductive phenology
  - Identify crayfish food web connections w/suppression reach experiment
  - Quantify magnitudes of crayfish interactions
  - Understand landscape-wide effects of crayfish
- Females average 270 eggs
- No difference in diets of male and female crayfish or by age, no differences in trophic position based on size
- Larger crayfish eat more riparian derived sources
- Removed 896 crayfish in 2020, ~5,000 crayfish in 2021
- Analyzed invertebrate abundance based on crayfish density
- Community structure analysis complete

THE UNIVERSITY OF NEW MEXICO

Integrating Monitoring, Genetic, & Simulation Approaches for Strategic Bullfrog Removal & Control

- Research Question:
  - Does strategic removal and control of bullfrogs work, and what does it take?
- Completed data collection: acoustic recorders to detect bullfrogs and AZ treefrogs and temperature sensors at study sites, landscape genomics to understand metapopulation dynamics, & bullfrog removal
- >700 bullfrog individuals sequenced + exploratory landscape genomics analysis ongoing
- The collected data was input into HexSim simulations to test a myriad of bullfrog management scenarios and effects of climate change in the Huachucas/Canelo Hills
- Hosted a workshop in 2023 to go over findings, limitations, and transferability of this SMARTSIM framework



VIRGINIA TECH

Surveying, Modeling, & Mapping Non-Native Crayfish in the Gila & Little Colorado River Basins

- Objectives: Survey crayfish in the Gila and Little Colorado River basins, use results to map presence/absence across inter-confluence stream reachers, better understand environmental correlates of detection and occupancy
- Surveyed 109 sites in Arizona and New Mexico (2021 , 2022, 2023)
- Conducting modeling to determine virile crayfish distribution and what habitat variables are linked to their presence/absence
- Next steps: add additional models, incorporate additional predictor variables, test different variable combinations

UTSA The University of Texas at San Antonio™

Non-Native Aquatic Species CoP Next Steps

- Continued development of American Bullfrog Working Group Objectives
  - Consider opportunities to move forward invasive frog work outlined in the WSC's AtBC proposal
- Support a full-time Americorps member in 2024 to development web products synthesizing management, goals, and objectives for Reclamation fish barriers in the Gila River Basin including:
  - Case studies
  - A public-facing, interactive web product





Thank you!

- Join the NNA Species CoP mailing list for meetings, webinars, & workshops
- Submit ideas for Case Studies or webinars: we do (almost) all the work

Contact Karlee: (karlee_jewell@fws.gov)

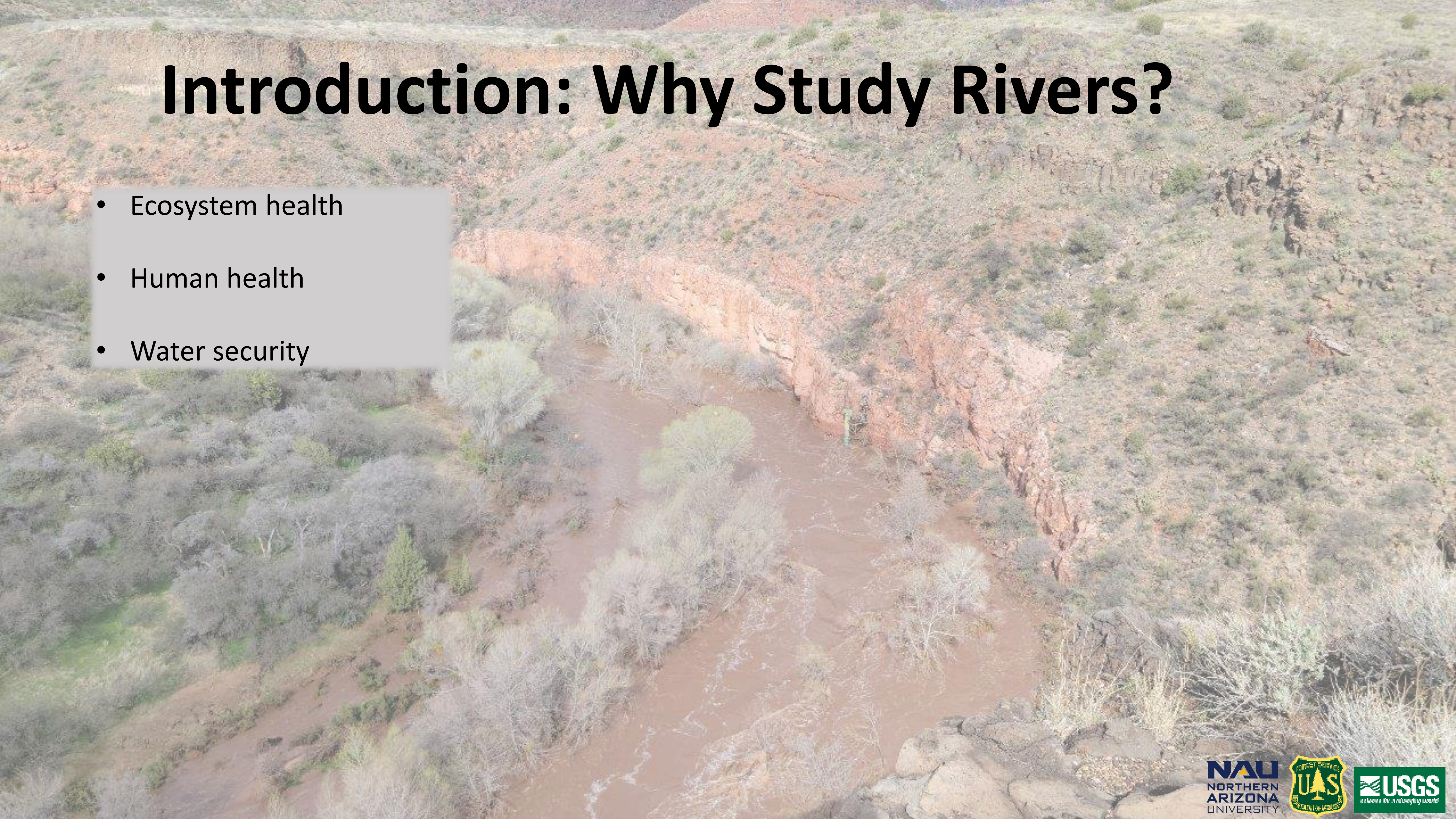
Combining terrestrial lidar with traditional cross-sections to investigate geomorphic change: a case study on the Upper Verde River, Arizona

Lauren Tango[1,*3], Temuulen Sankey[1], Jackson Leonard[2], Joel Sankey[3], Alan Kasprak[4]

[1] Northern Arizona University
[2]U.S. Forest Service (USFS)
[3]U.S. Geological Survey (USGS)
[4] Fort Lewis College
[*]Currently at USGS. LTango@usgs.gov

Introduction: Why Study Rivers?

- Ecosystem health
- Human health
- Water security



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- IPCC: "climate change has already had substantial and increasingly irreversible impacts on terrestrial freshwater ecosystems." (Pörtner et al., 2022)

Introduction: Why Study Rivers?

- Ecosystem health
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Desert Rivers: “Ribbons of Life”


Arizona
N
Flagstaff
Paulden
Cottonwood
Prescott
Phoenix
Verde River
0
100
200 KM

Verde River Ecosystem

Drinking water for 2 million people

Threats

Verde River Ecosystem

Drinking water for 2 million people

A resource that 80% of wildlife in the area depend on

Threats

Verde River Ecosystem

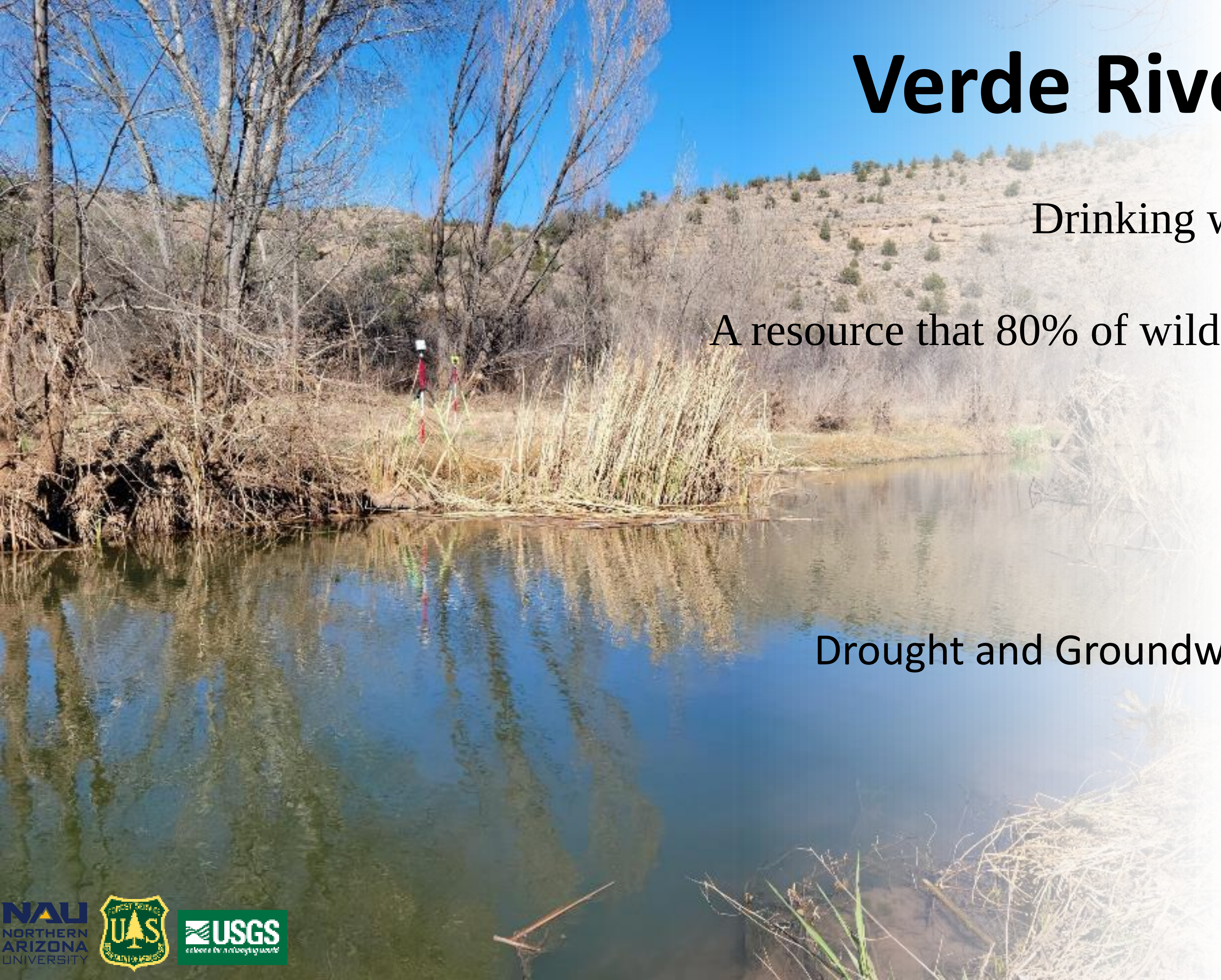
Drinking water for 2 million people

A resource that 80% of wildlife in the area depend on

Irrigation for agriculture

Threats

Verde River Ecosystem



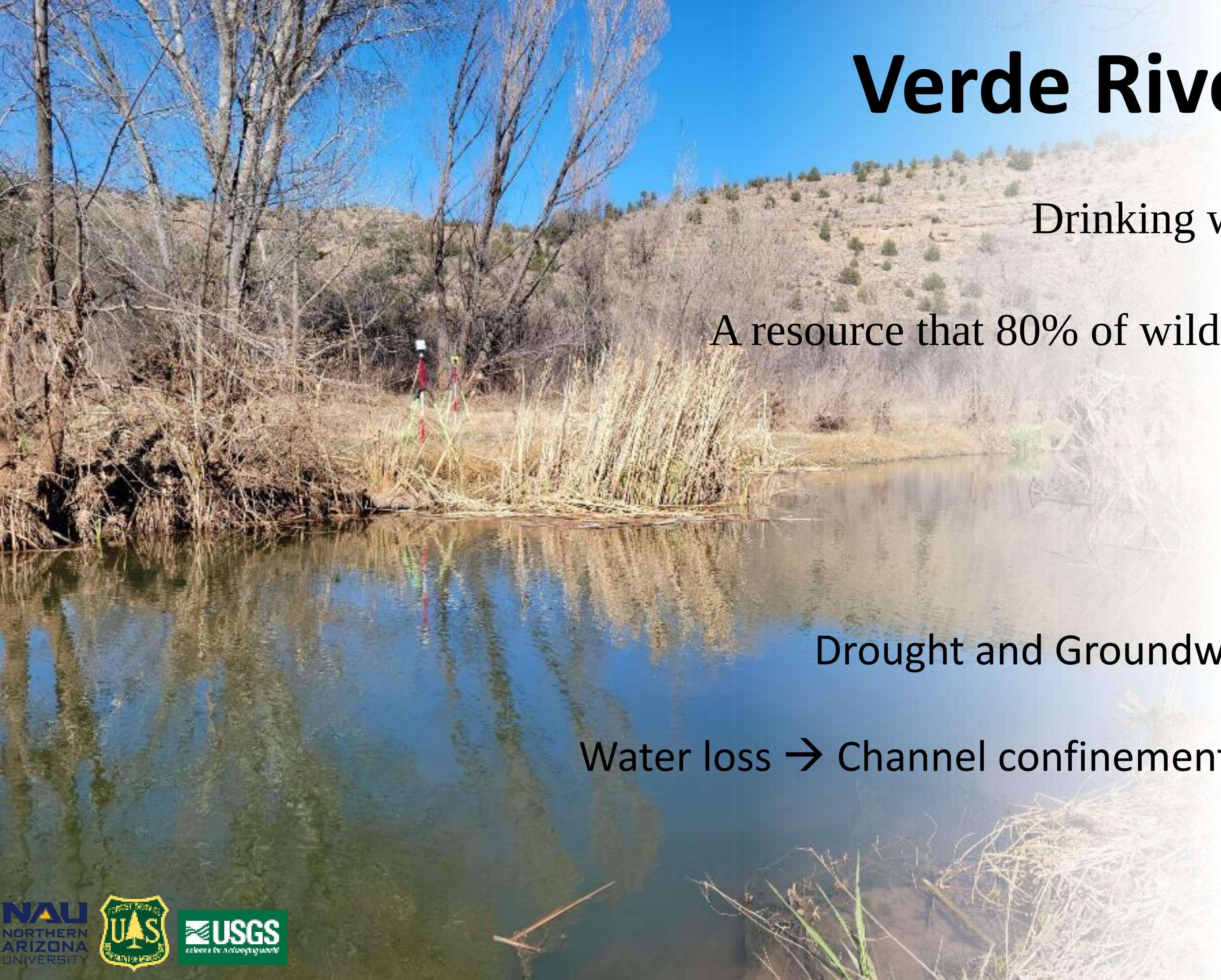
Drinking water for 2 million people

A resource that 80% of wildlife in the area depend on

Irrigation for agriculture

Threats

Drought and Groundwater Pumping → Water loss



Verde River Ecosystem

Drinking water for 2 million people

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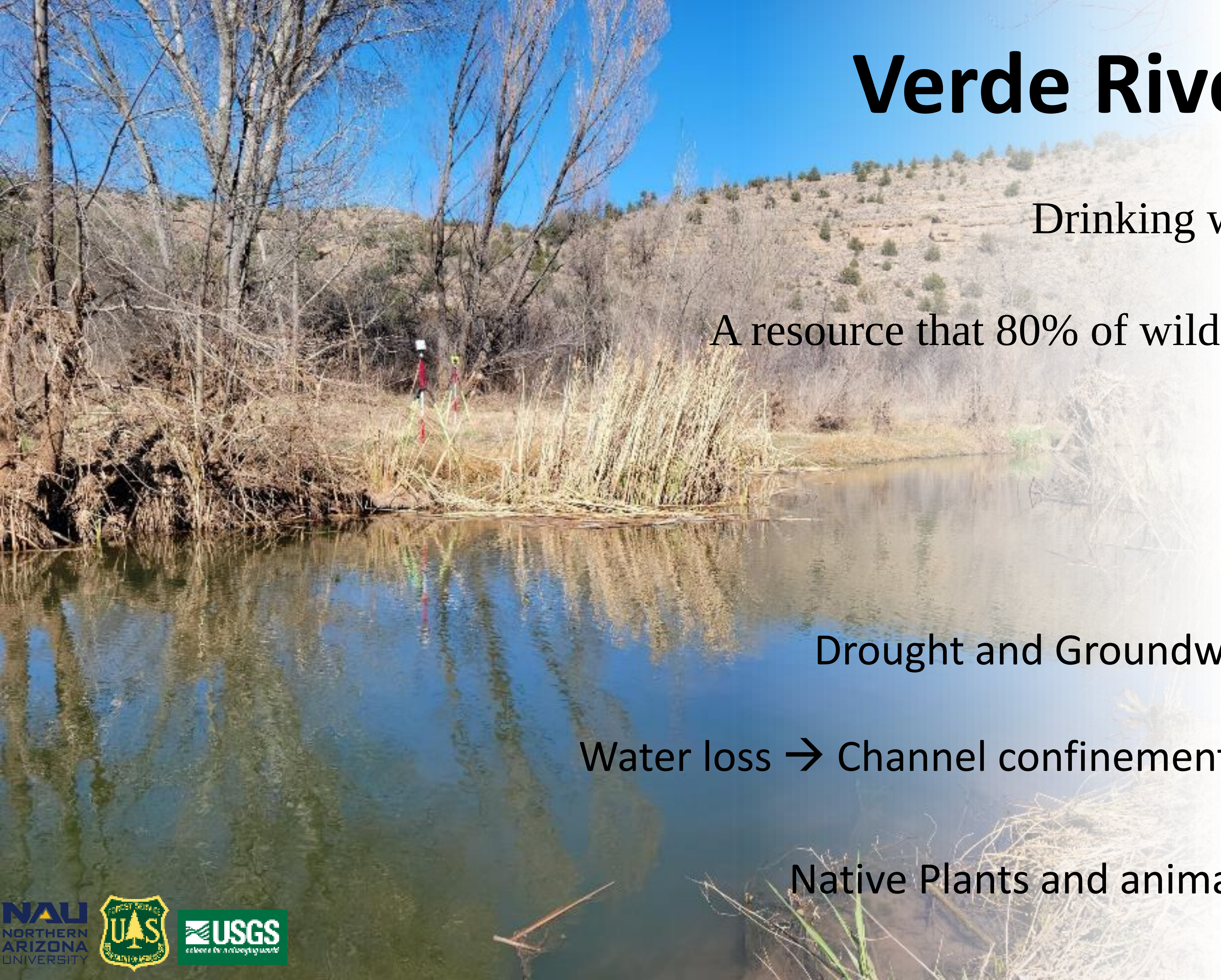
Irrigation for agriculture

Threats

Drought and Groundwater Pumping → Water loss

Water loss → Channel confinement / floodplain disconnection



Verde River Ecosystem

Drinking water for 2 million people

A resource that 80% of wildlife in the area depend on

Irrigation for agriculture

Threats

Drought and Groundwater Pumping → Water loss

Water loss → Channel confinement / floodplain disconnection

Native Plants and animals replaced by invasives

US Forest Service

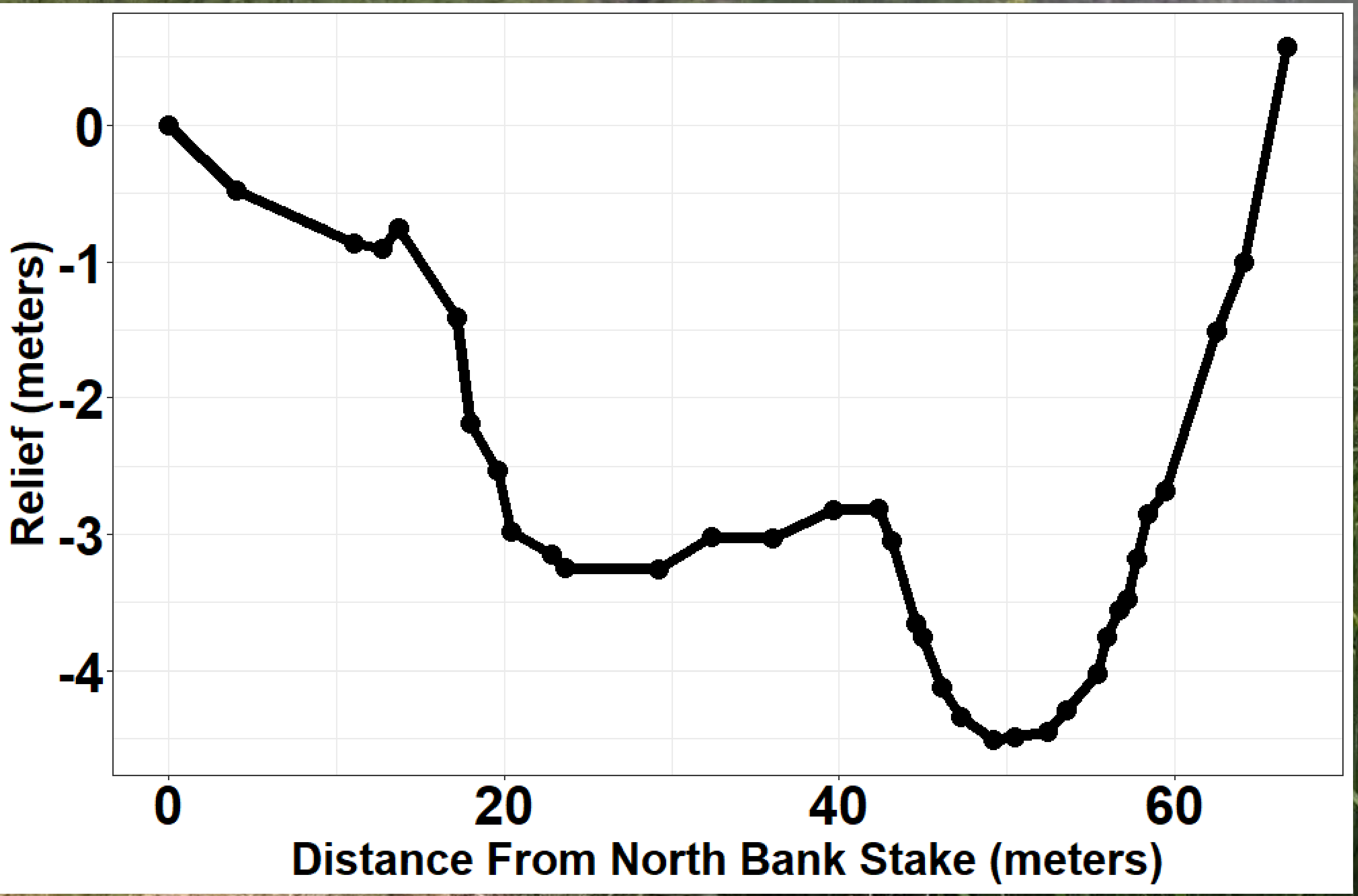
Traditional Channel Cross Sections

US Forest Service

Traditional Channel Cross Sections

US Forest Service

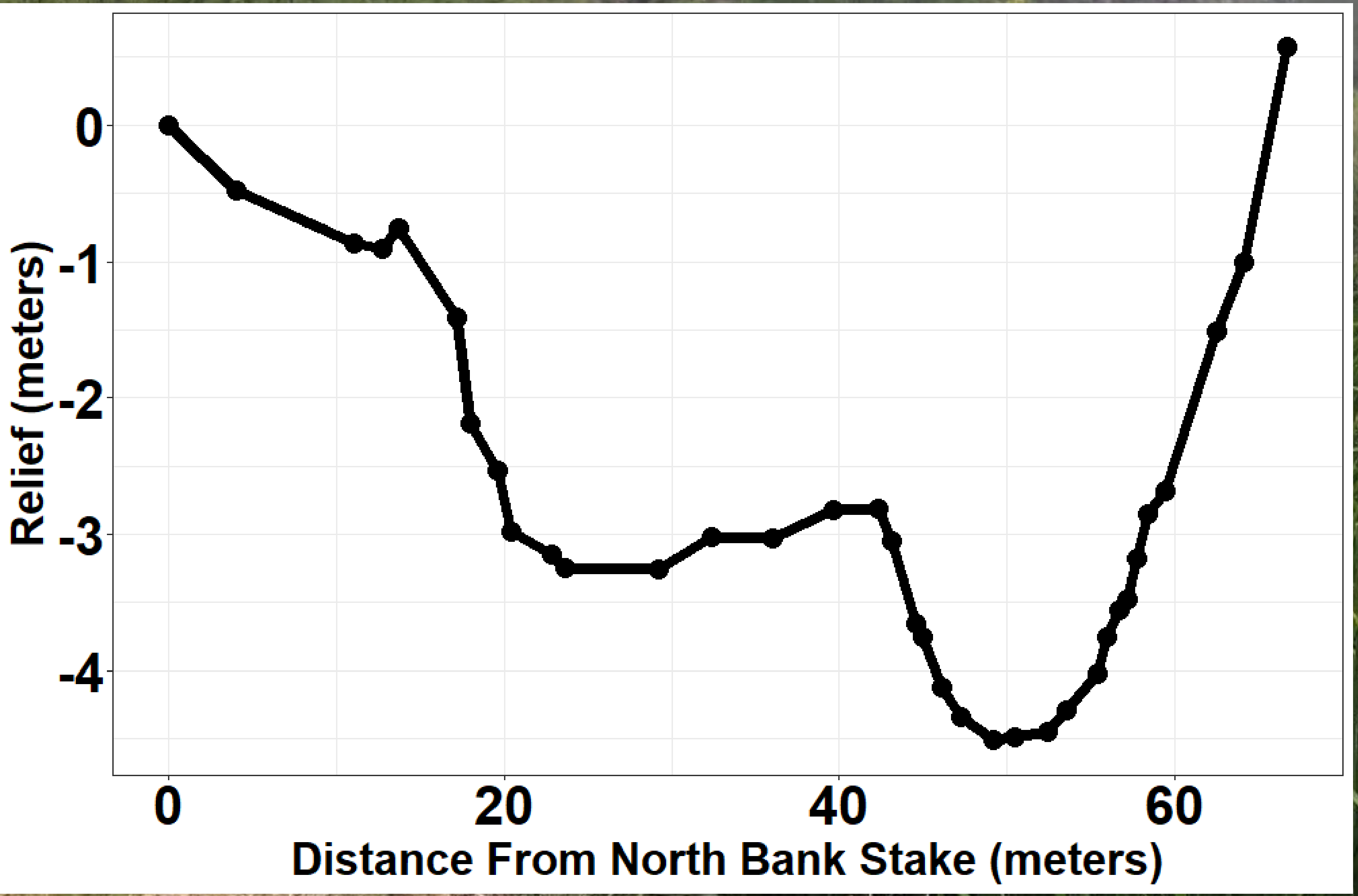
Traditional Channel Cross Sections



Preliminary data, subject to change, do not cite.

US Forest Service

Traditional Channel Cross Sections



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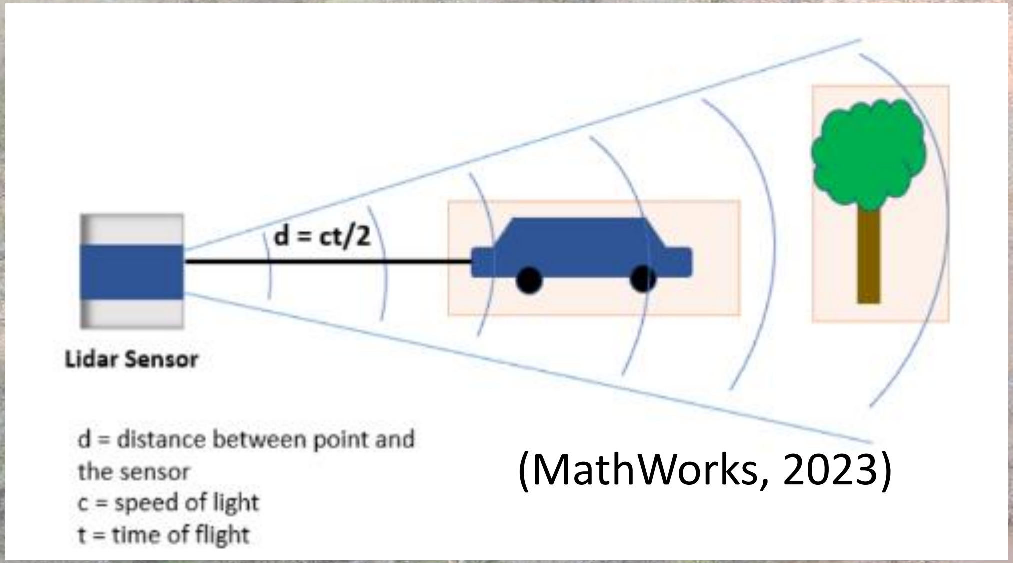
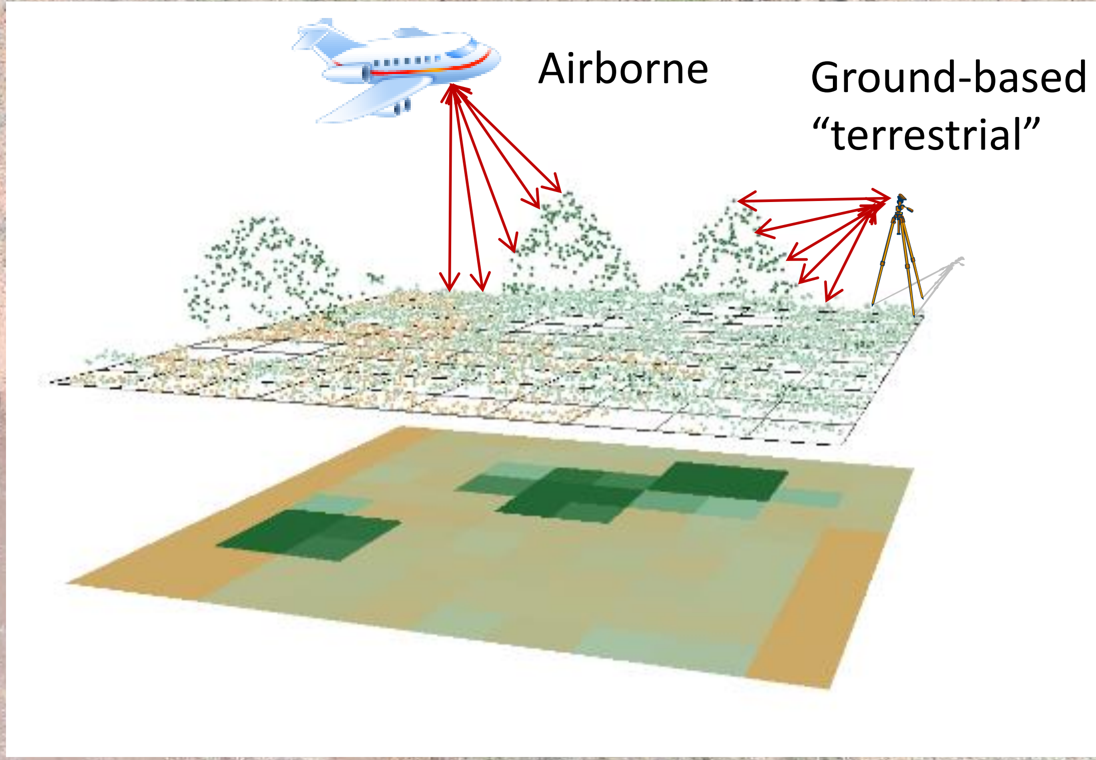
What is Lidar?



(MathWorks, 2023)



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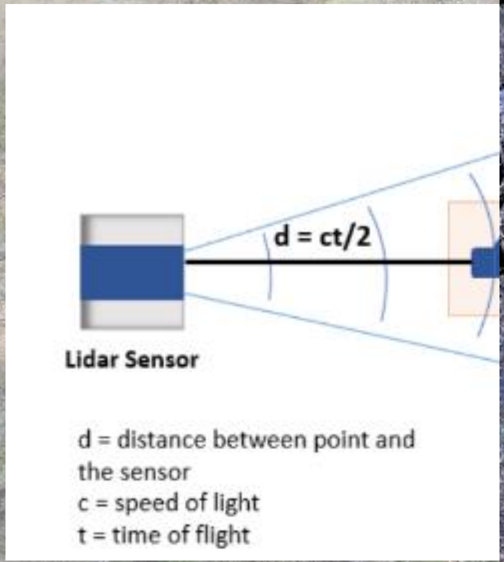
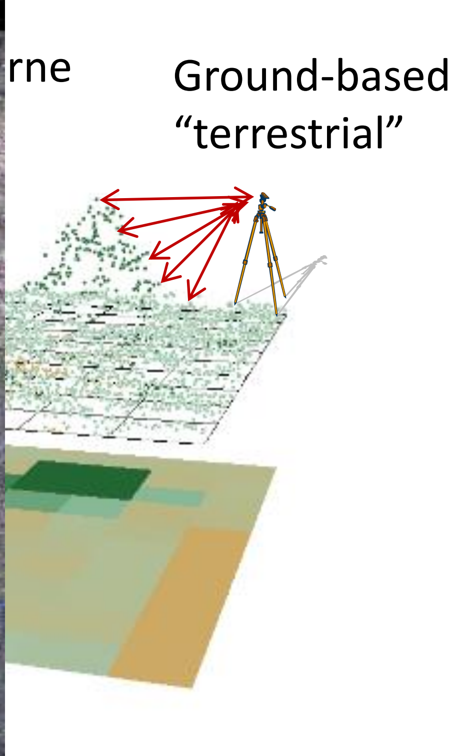
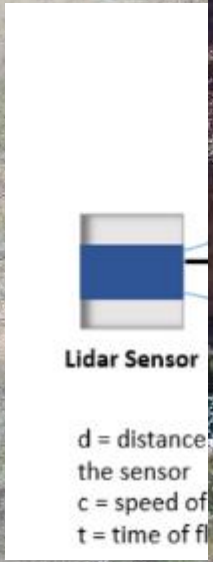
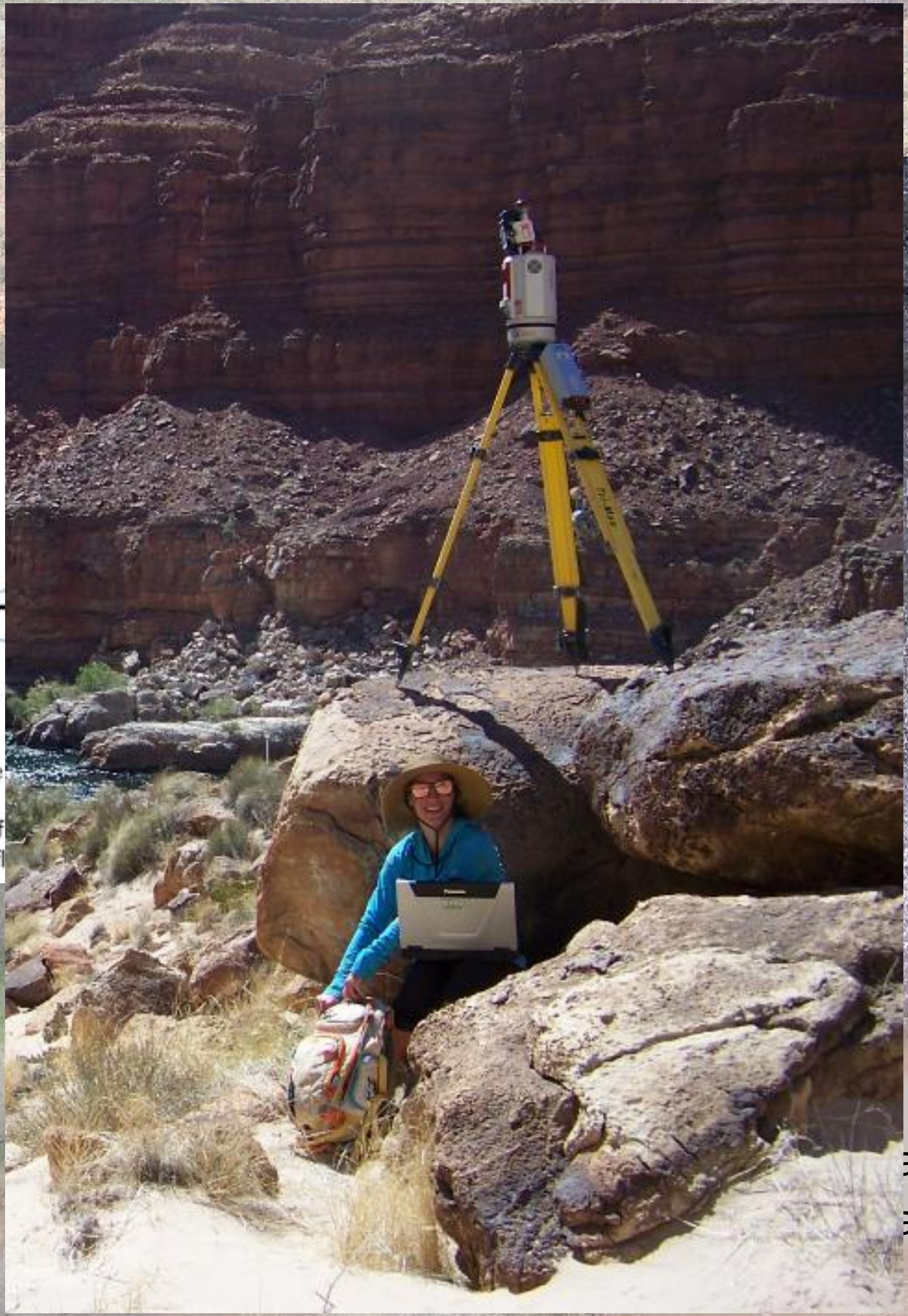




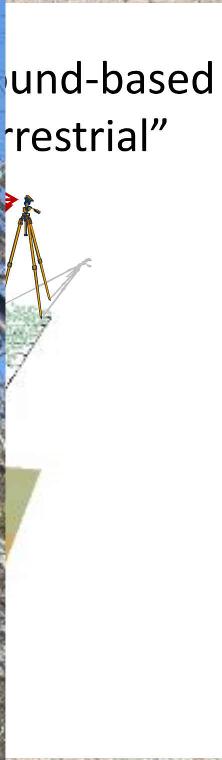
- High Resolution (5mm at 10m)
- Accurate (7mm at 20m)
- Three Dimensional – every point has X, Y, and Z

Preliminary data, subject to change, do not cite.


Lidar Sensor
d = distance
the sensor
c = speed of
t = time of fl




Leica BLK360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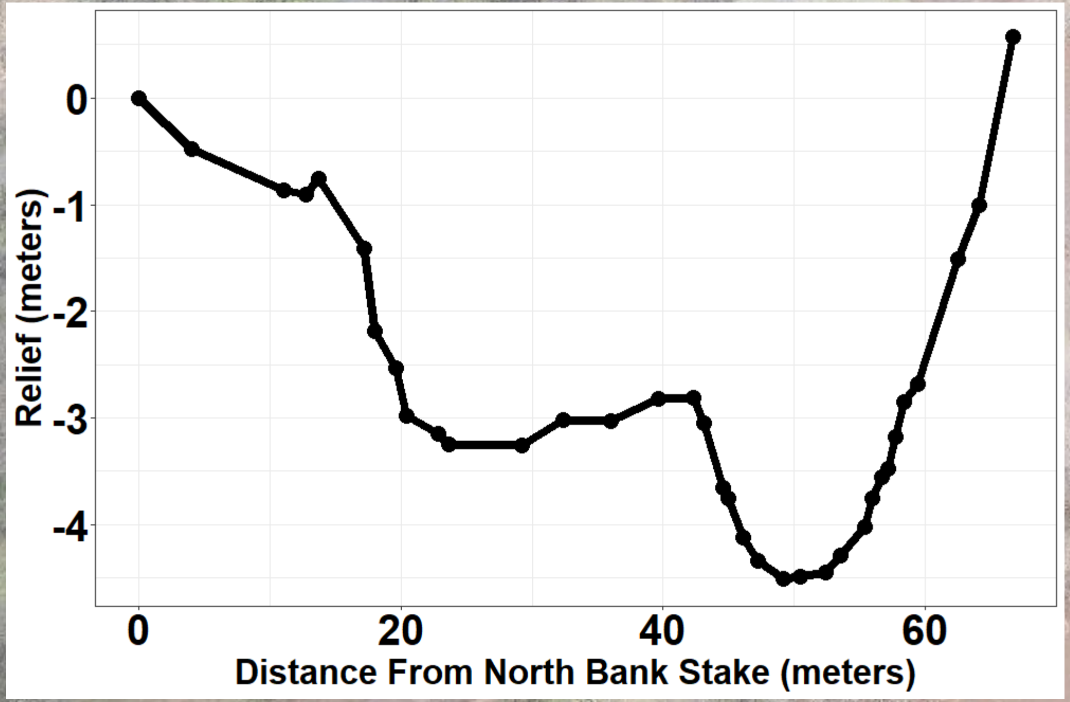
Objectives:

1. Combine 2009 USFS data and 2021 TLS data to produce quantifiable and statistically testable change detection results.

2. Estimate geomorphic changes from those results.



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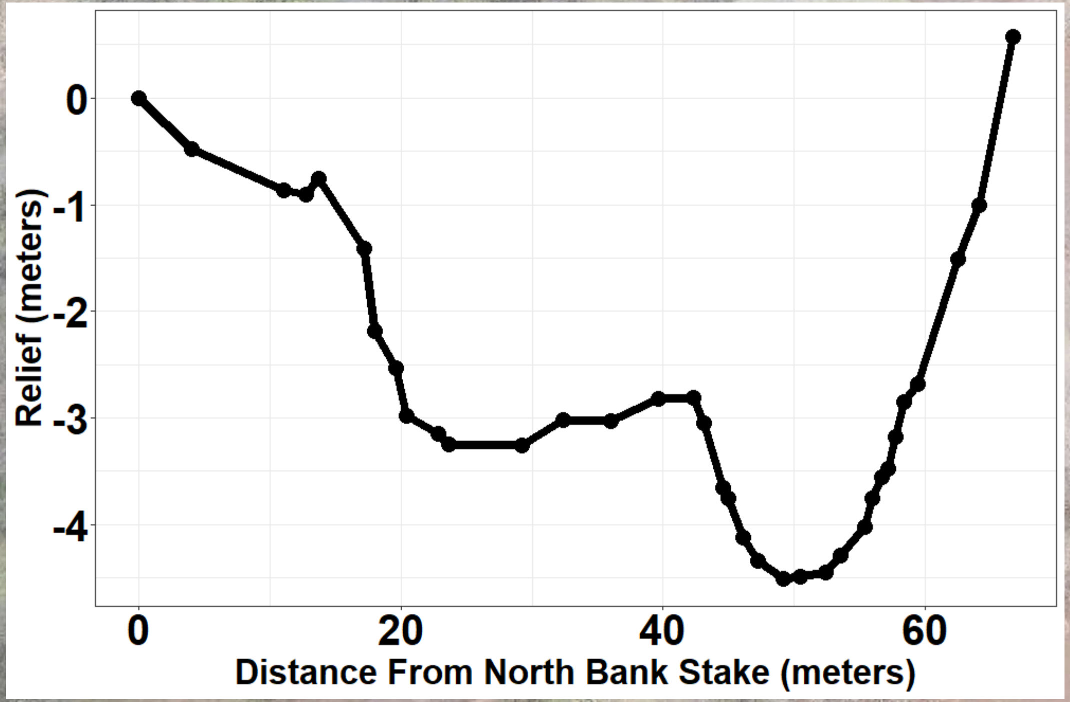

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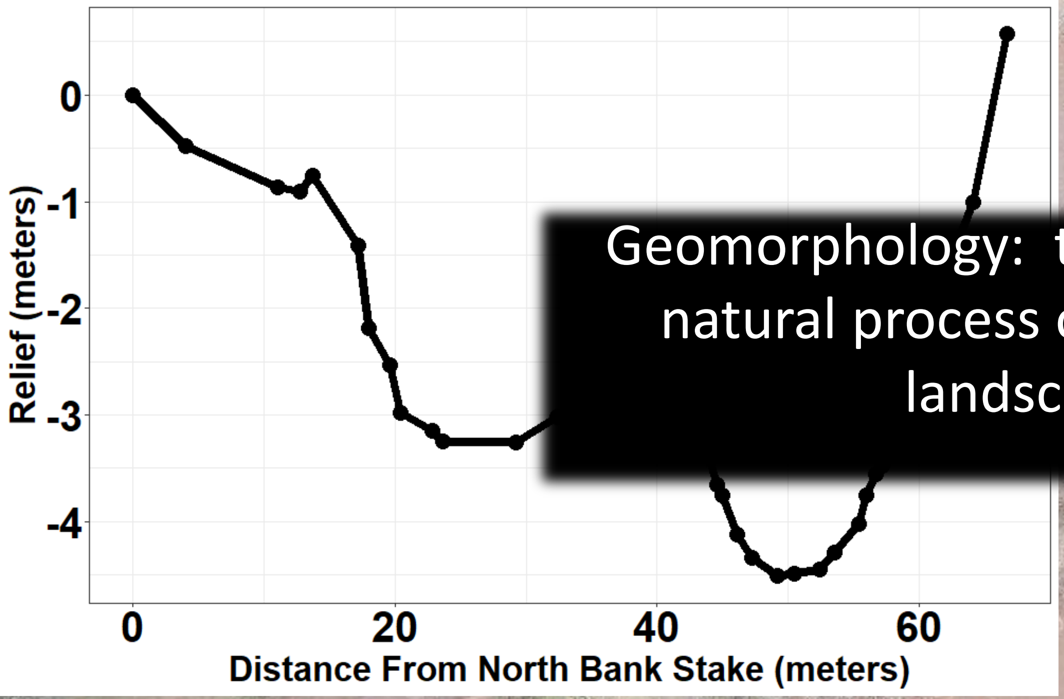
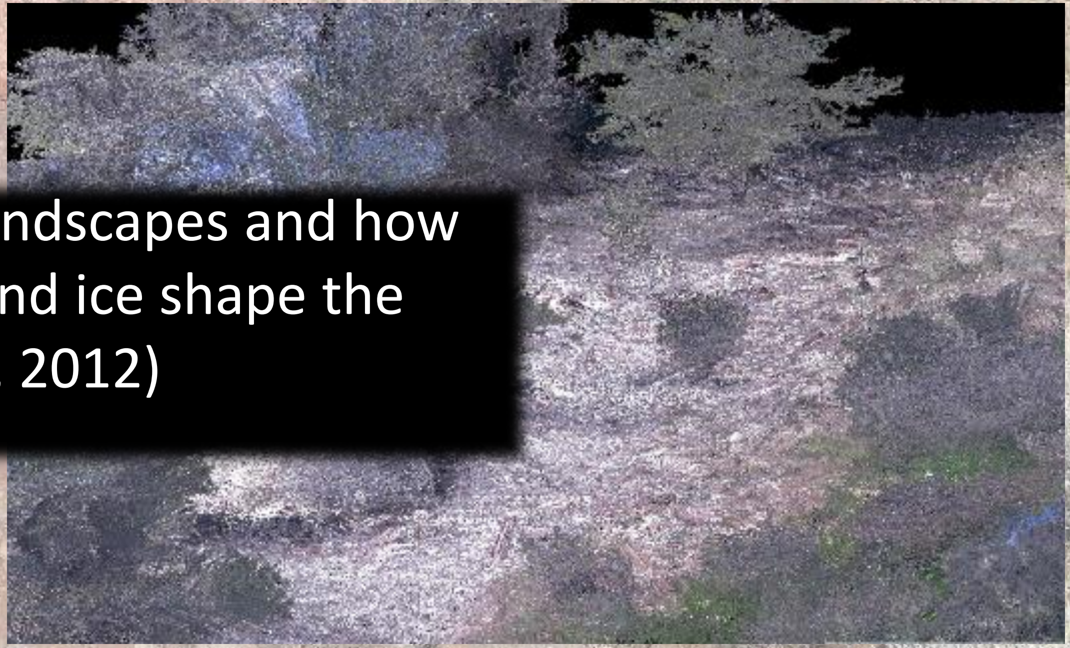


Geomorphology: the study of landscapes and how natural process of air, water, and ice shape the landscape (Williams, 2012)



Preliminary data, subject to change, do not cite.

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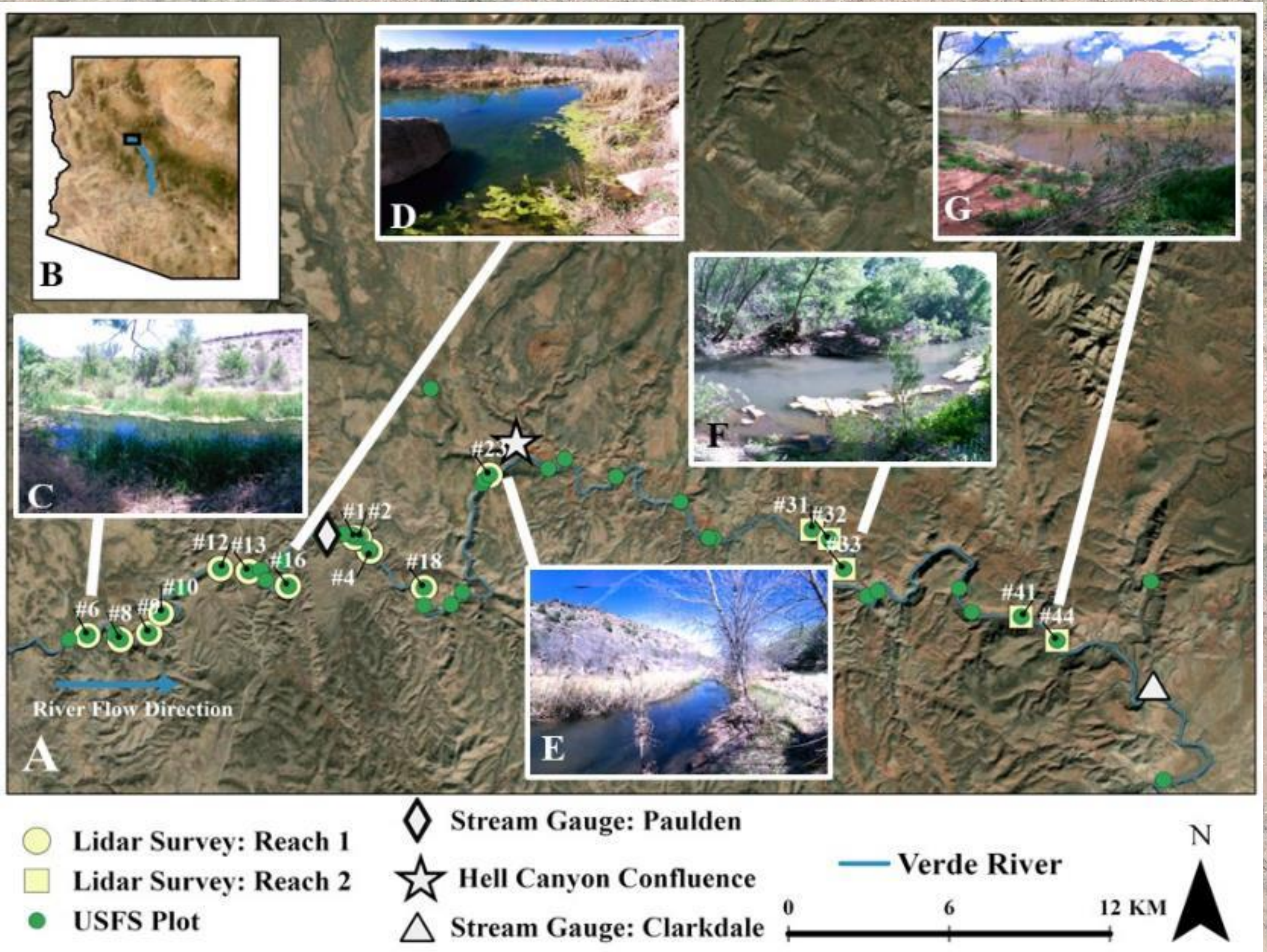
USGS

Study Site



Verde

Salt

Gila

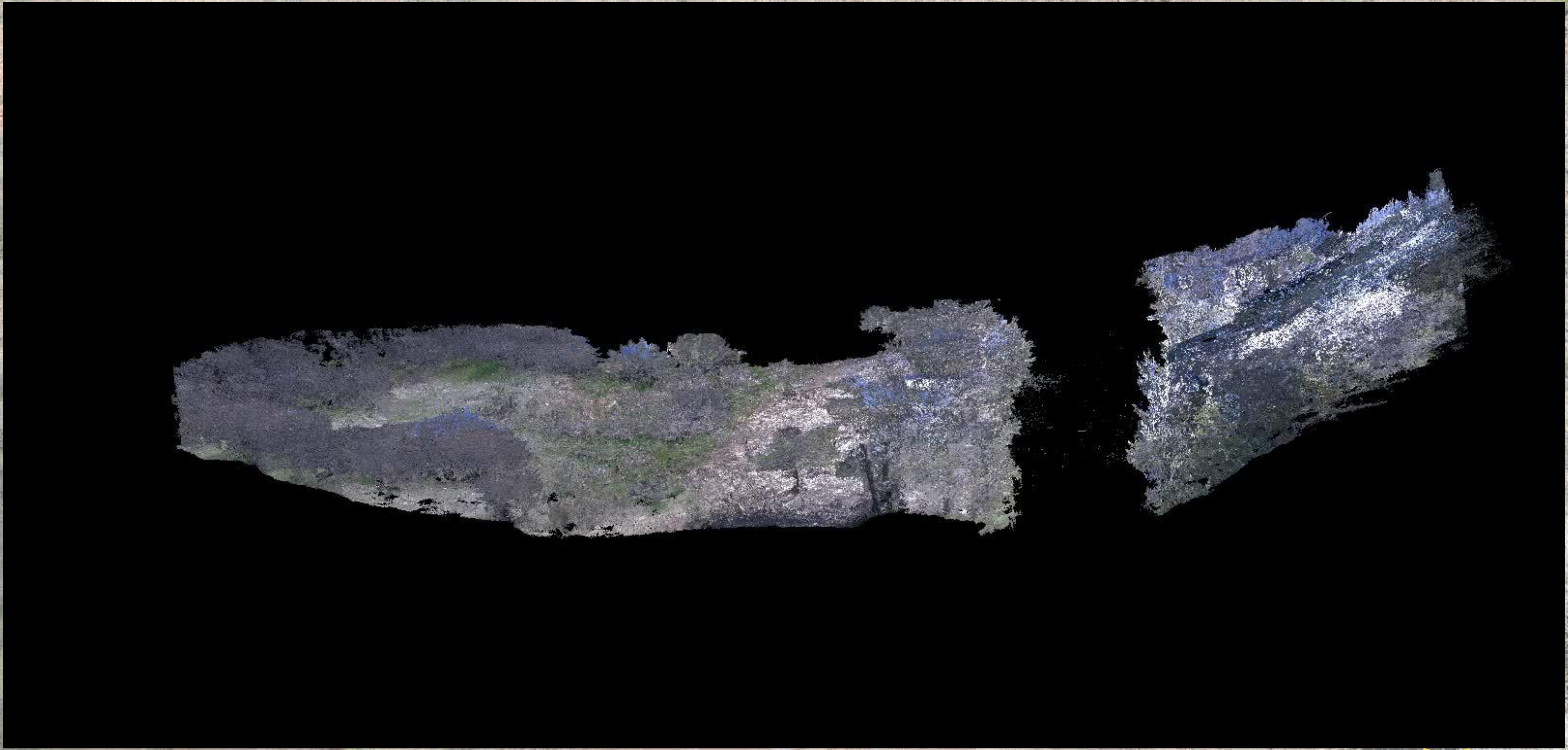
Colorado

Project Timeline:

Collect Lidar Data → Process Lidar Data → Change Detection with USFS Data

Preliminary data, subject to change, do not cite.

Lidar Point Cloud Data



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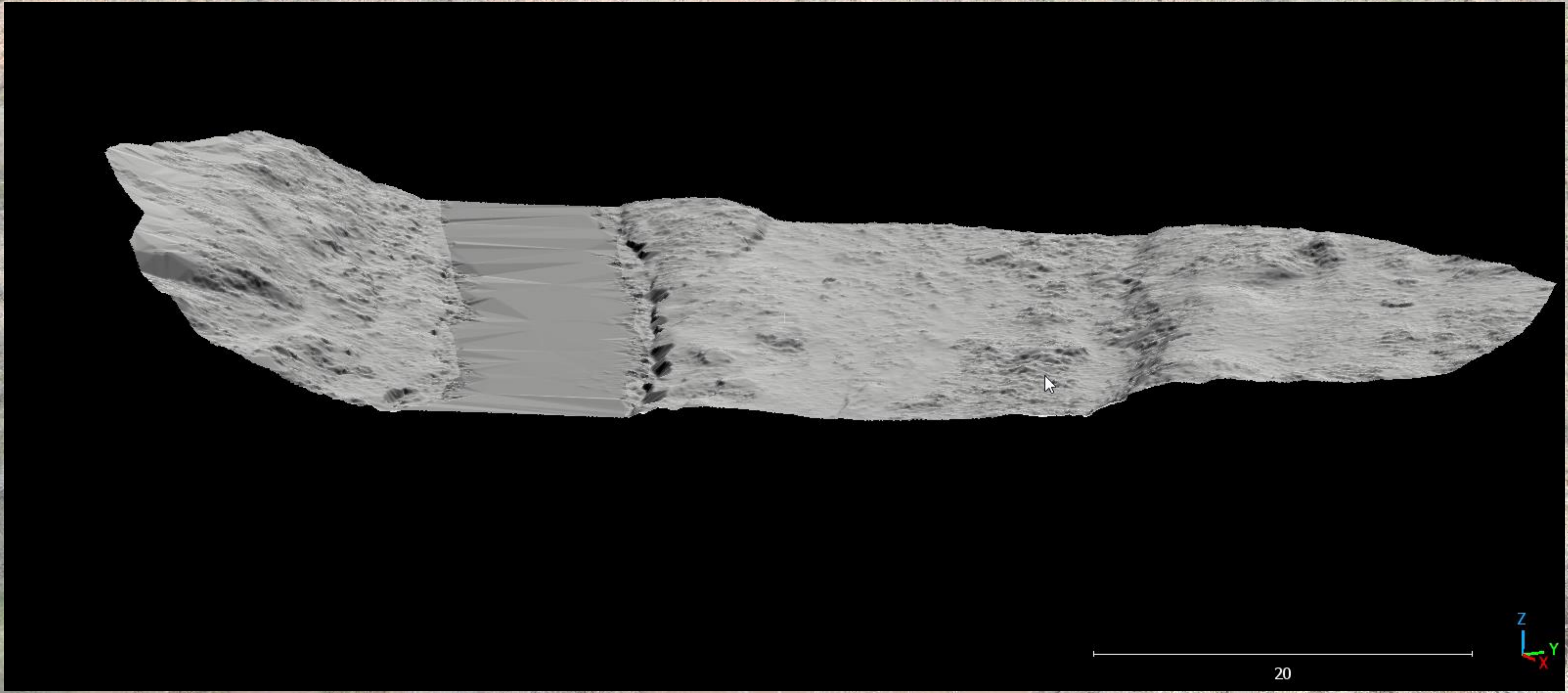
Digital Elevation Model (DEM)



10cm Resolution

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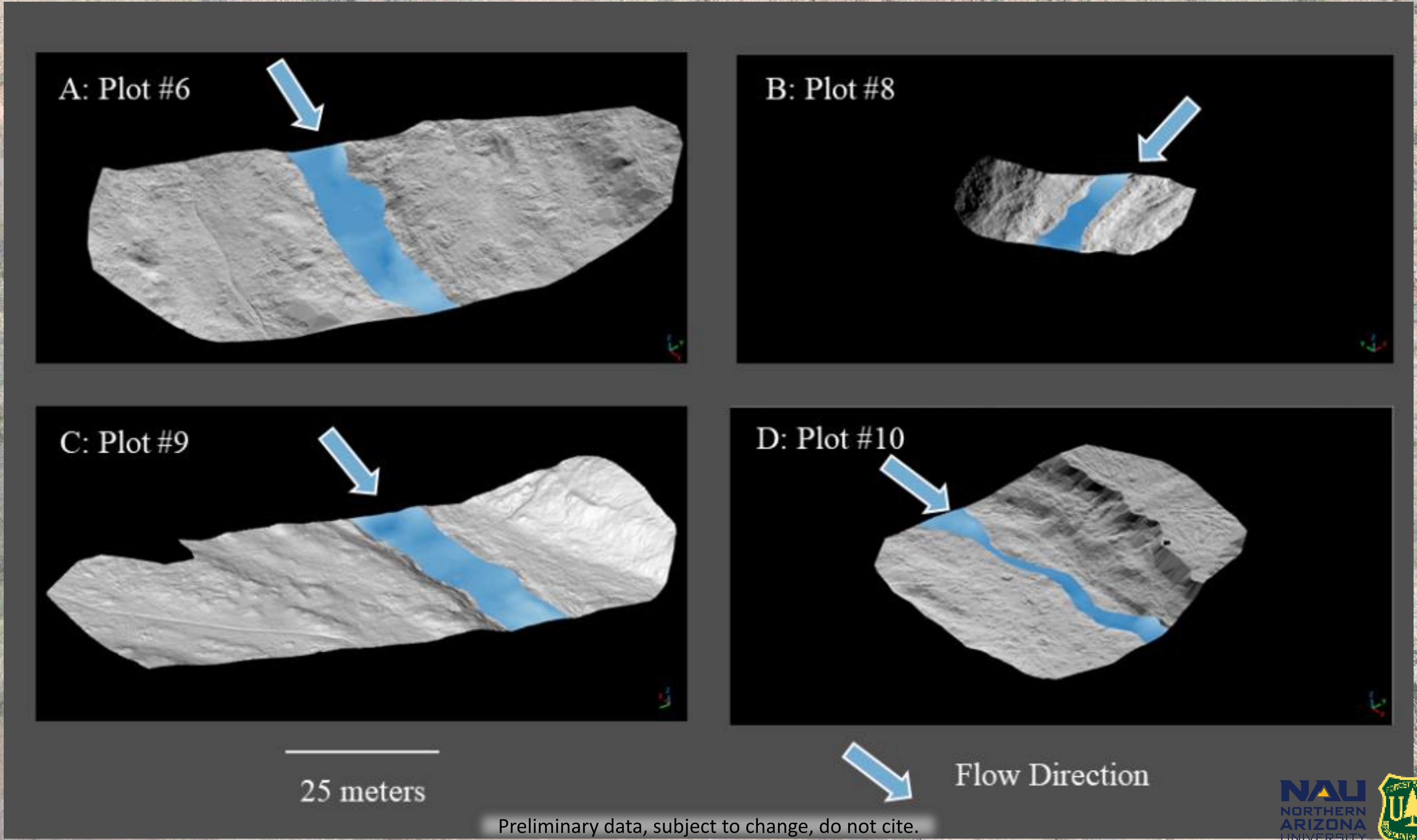
Result



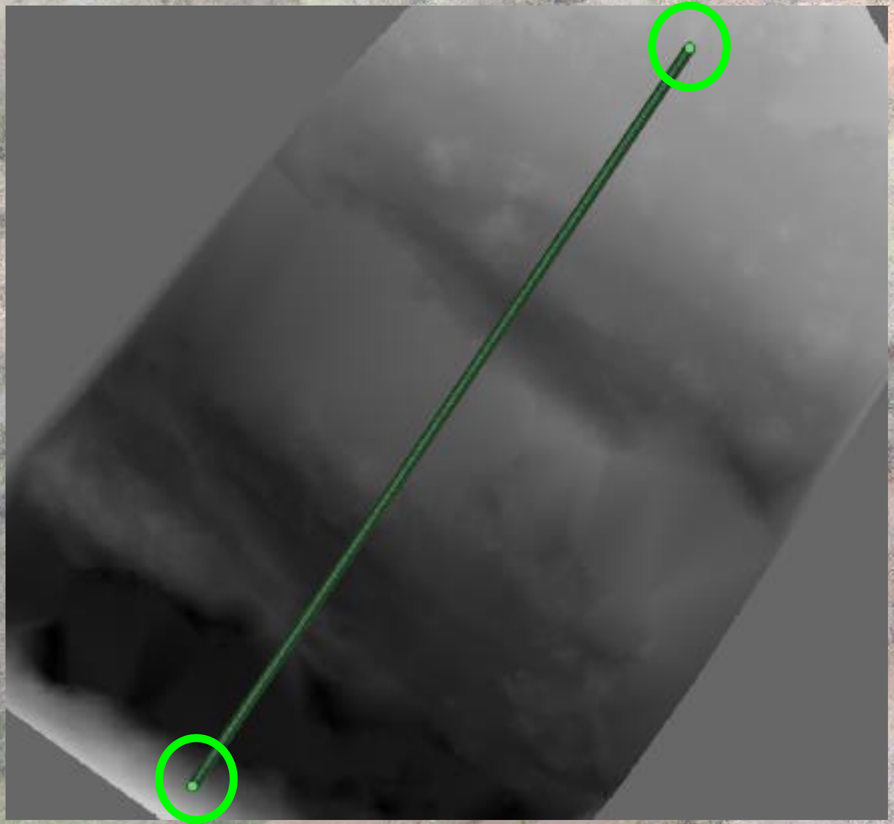
Preliminary data, subject to change, do not cite.

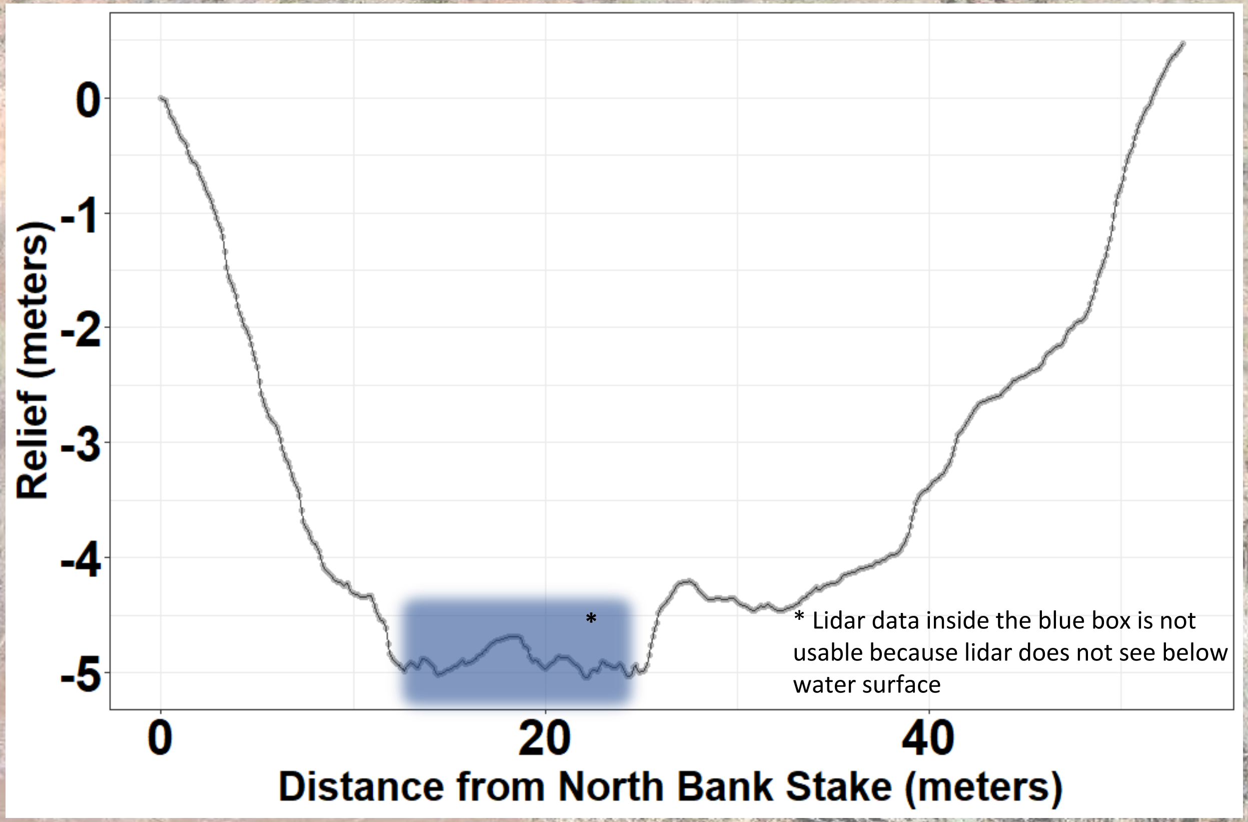
Methods: Statistically Testable Data Fusion and Error Documentation

Extract Channel Profile from DEM

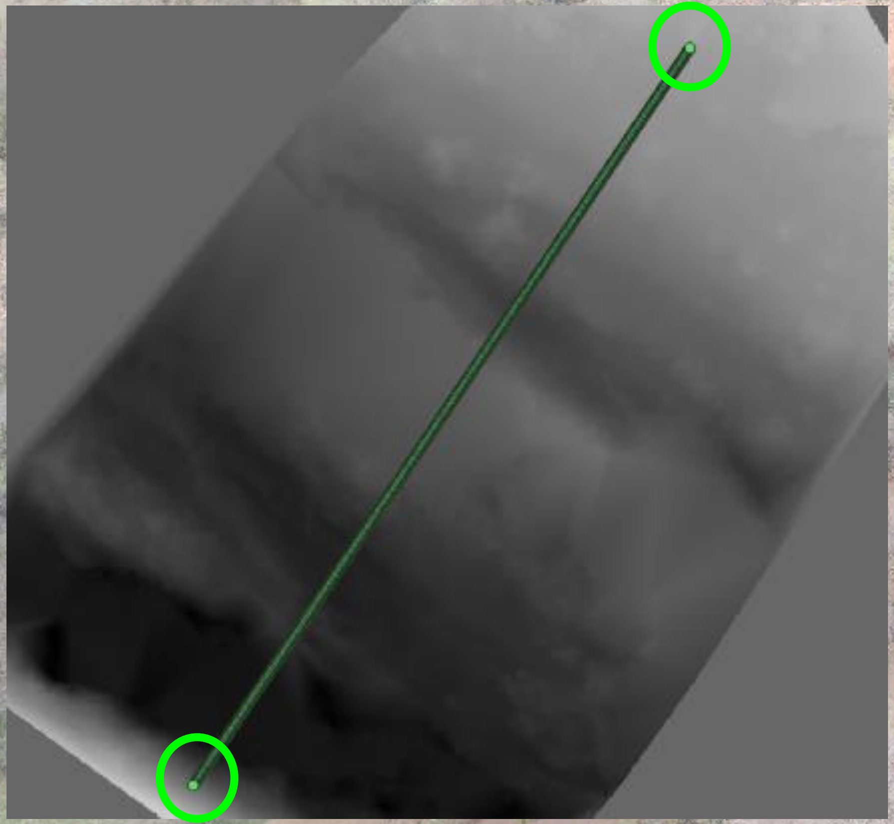
Statistical Analysis

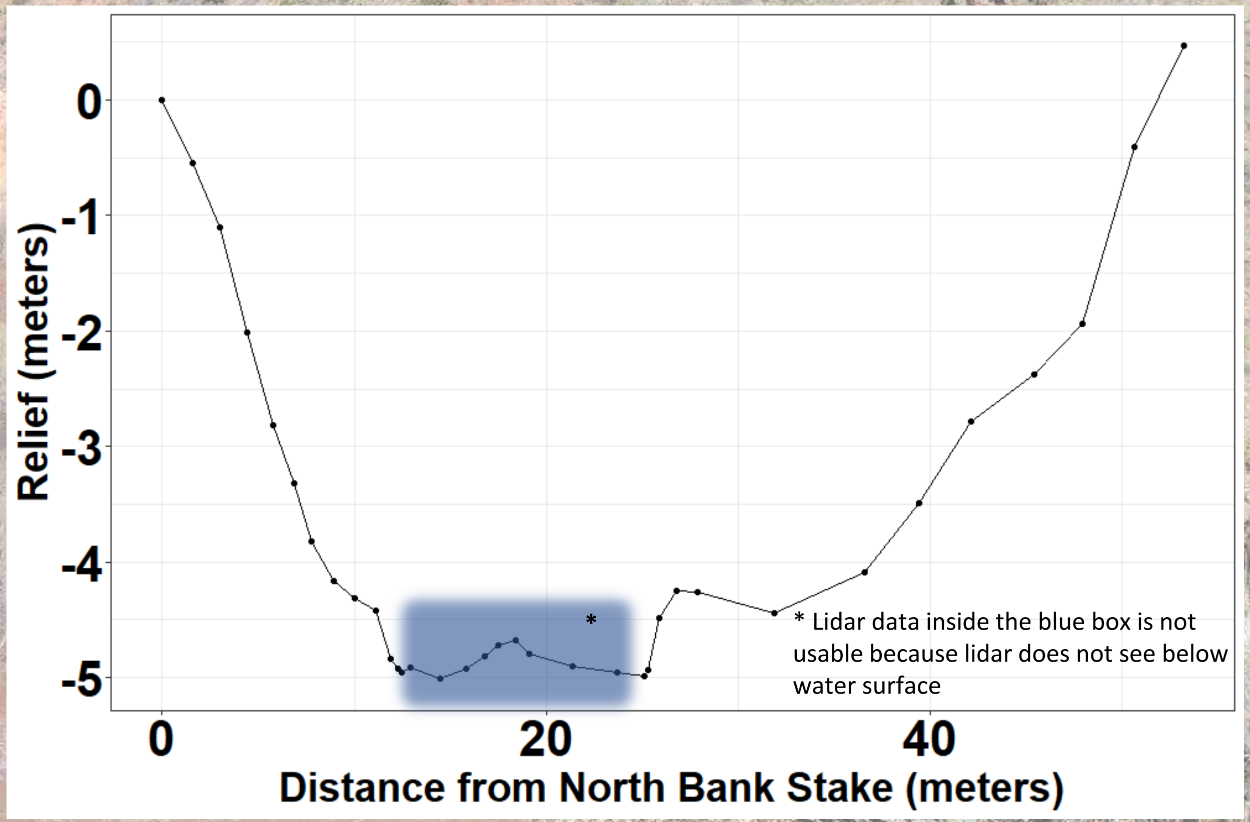
DEM to Channel Profile





DEM to Channel Profile





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Statistical Analysis

1

- Identify Hillslope Points
  - What was expected to have not changed?
  - Assumed change should be 0.

Statistical Analysis

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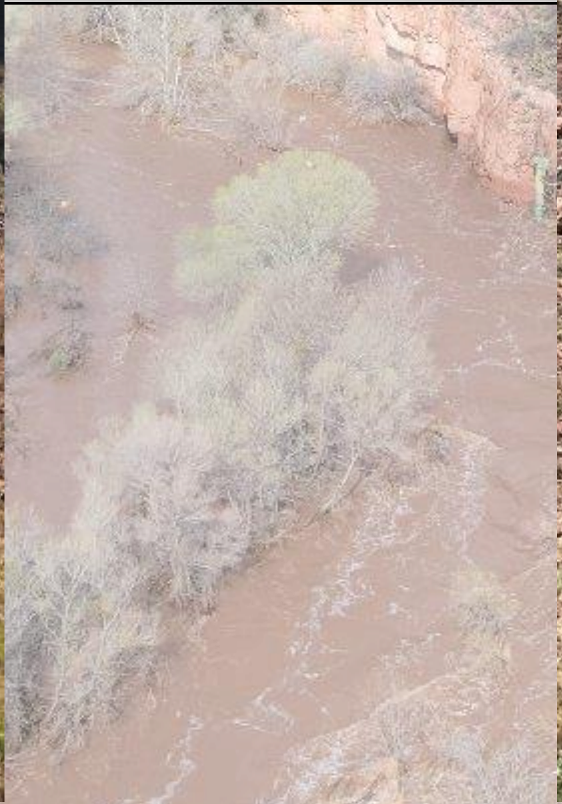
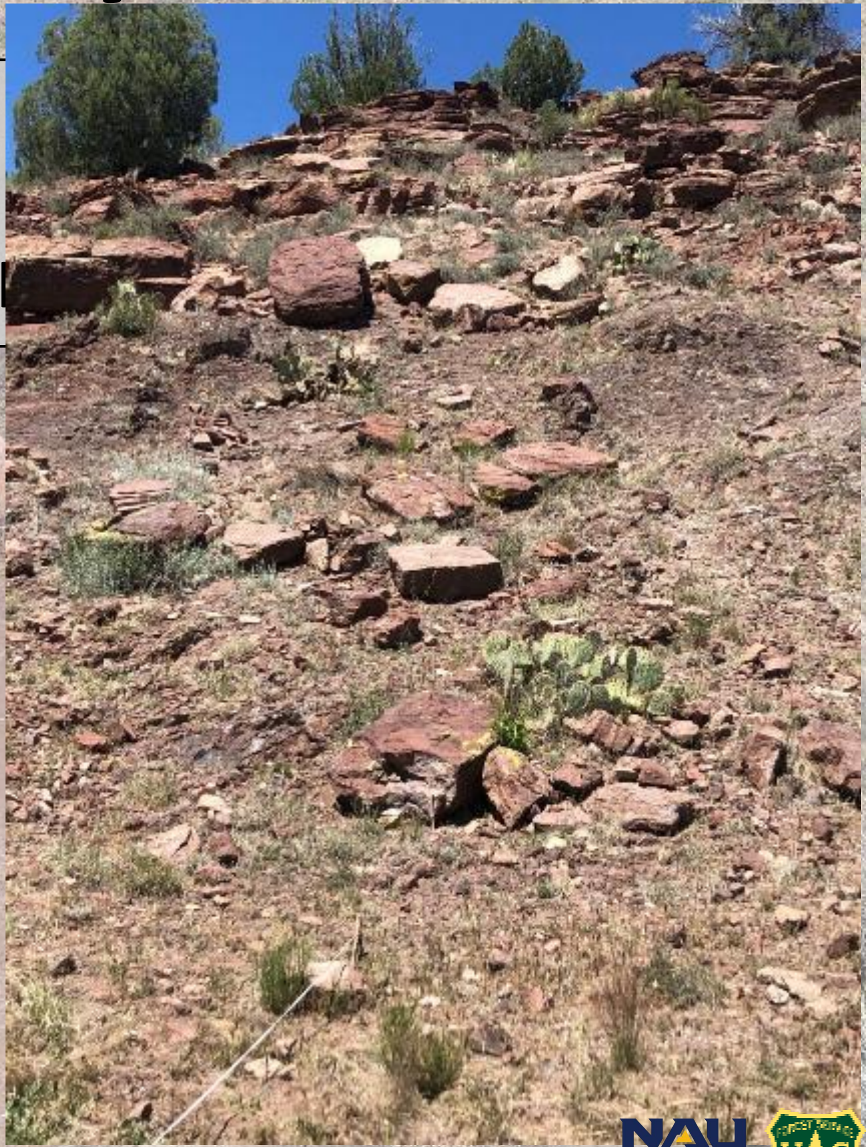
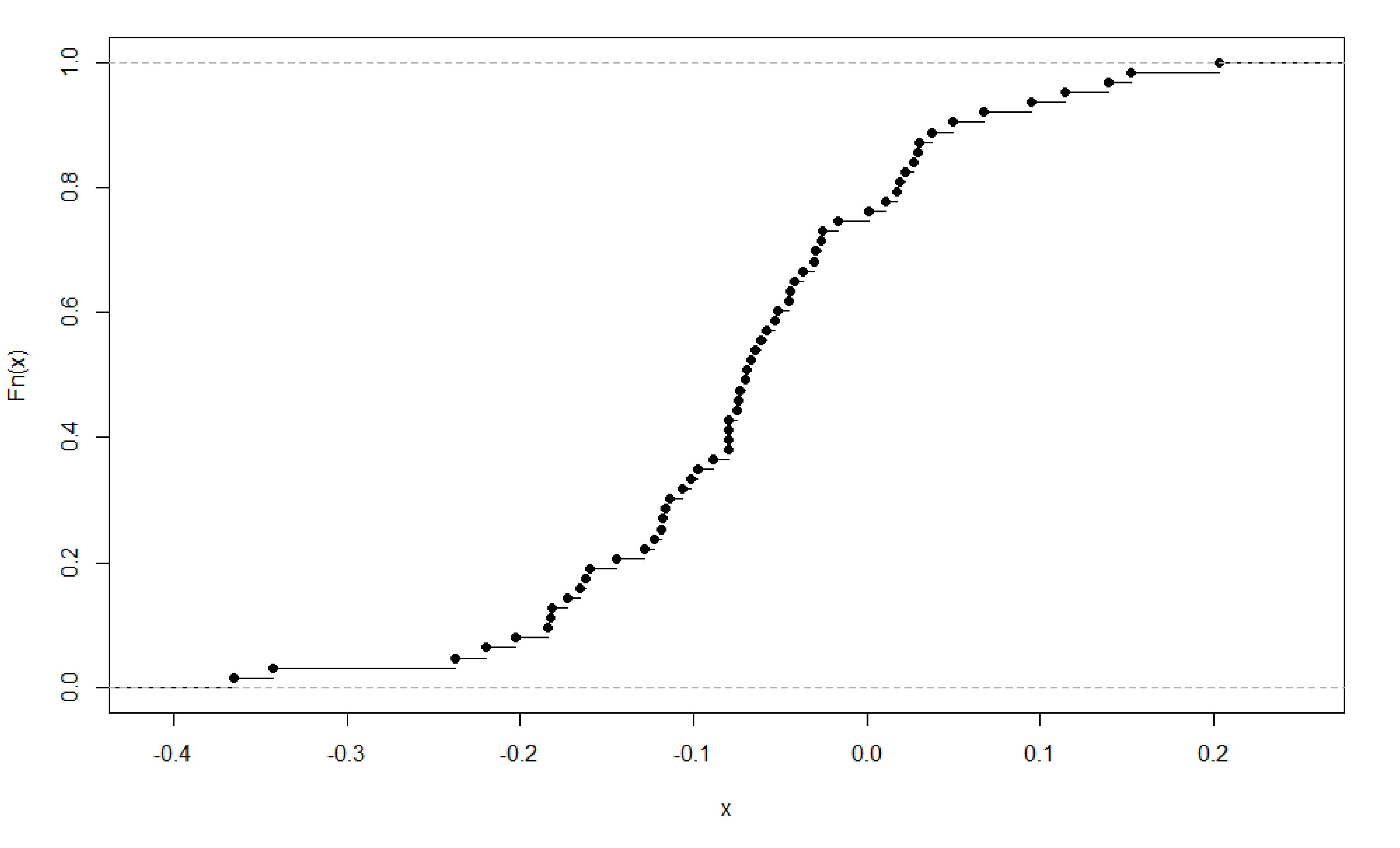




Preliminary data, subject to change, do not cite.

Statistical Analysis

- Create and use Empirical Cumulative Distribution Function
  - Probability the point is a “true” change



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Statistical Analysis

1

- Identify hillslope points
  - What was expected to have not changed?
  - Assumed change should be 0.

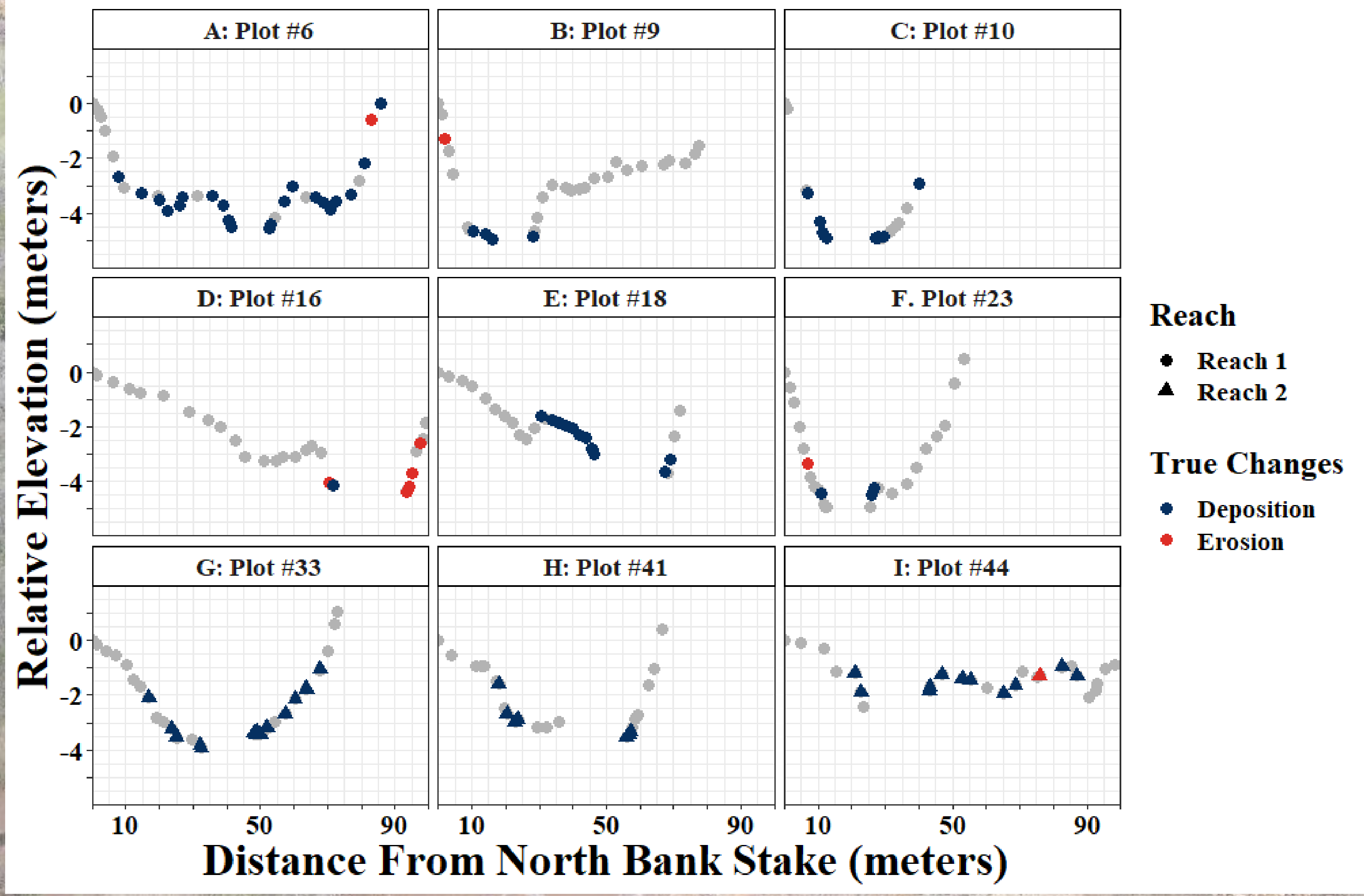
2

- Create and use the Empirical Cumulative Distribution Function
  - Probability the point is a “true” change

3

- Filter out all changes with an effective p-value greater than 0.05

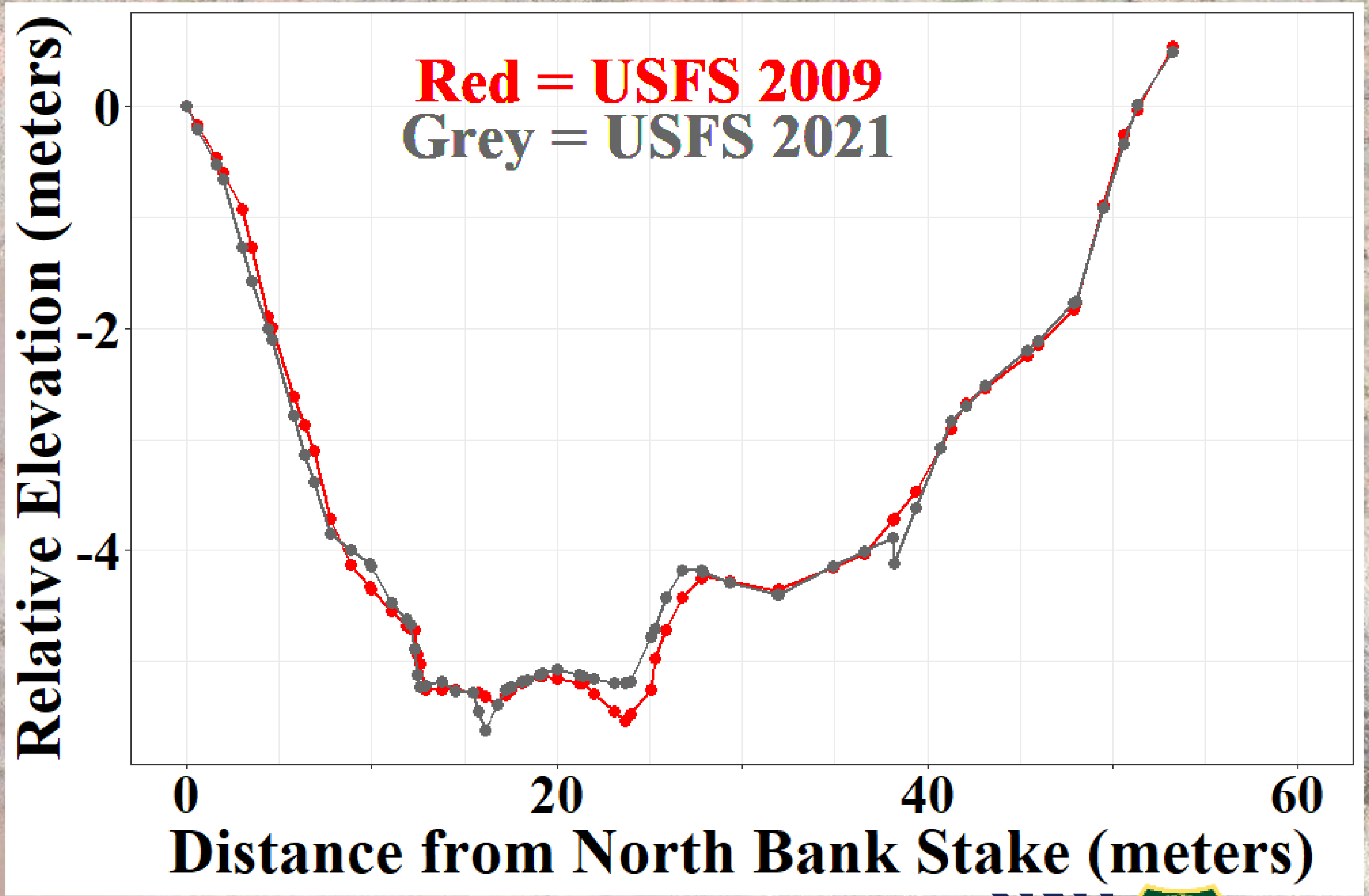
Lidar Results: Statistically Testable Data



Preliminary data, subject to change, do not cite.

Results: 2009 USFS Transects compared to 2023 USFS Transects

- Similar process used to compare these data



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Results: 2009 USFS Transects compared to 2023 USFS Transects

- Lower change detection sensitivity

20% vs. 38%

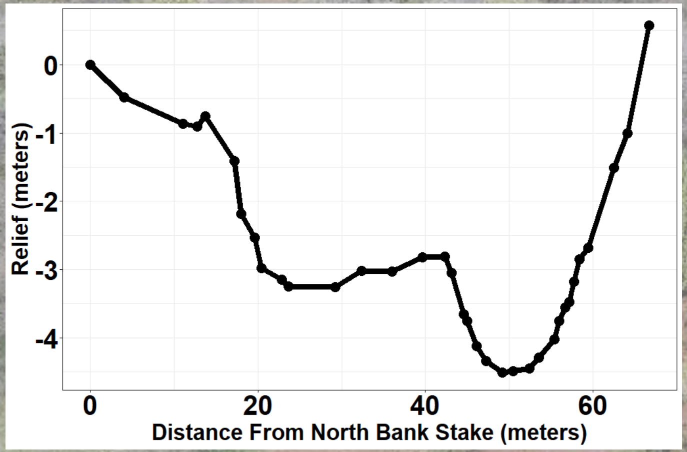
- Lower certainty of results

0.03 vs. 0.01

Key Take-Aways

Is data fusion possible?

- Statistically testable data resulted from a fusion between historical transect data and modern TLS data



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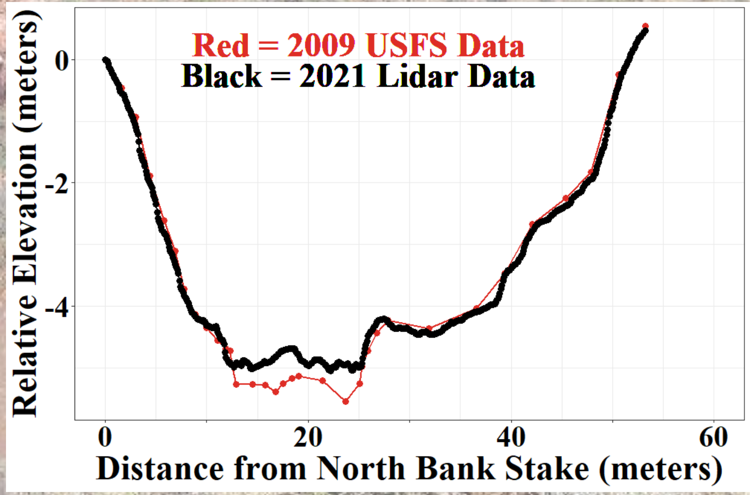

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Key Take-Aways

Is data fusion possible?

- **Statistically testable data resulted from a fusion between historical transect measurements and modern TLS data**

Identify more changes

- **Bridging the gap between traditional methods with new technology results in a higher change detection sensitivity**

Preliminary data, subject to change, do not cite.

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Key Take-Aways

Is data fusion possible?

- **Statistically testable data resulted from a fusion between historical transect measurements and modern TLS data**

Identify more changes

- **Bridging the gap between traditional methods with new technology results in a higher change detection sensitivity**

Be more certain of your results

- **Using these methods provides a higher certainty that the results are accurate**

Preliminary data, subject to change, do not cite.

On March 22, 2023, a 16,000 CFS flood occurred on the Upper Verde River

Plot #1

2021: Approximately 25 CFS

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Plot #1

2021: Approximately 25 CFS

Plot #1

2021: Approximately 25 CFS

2023: Approximately 250 CFS

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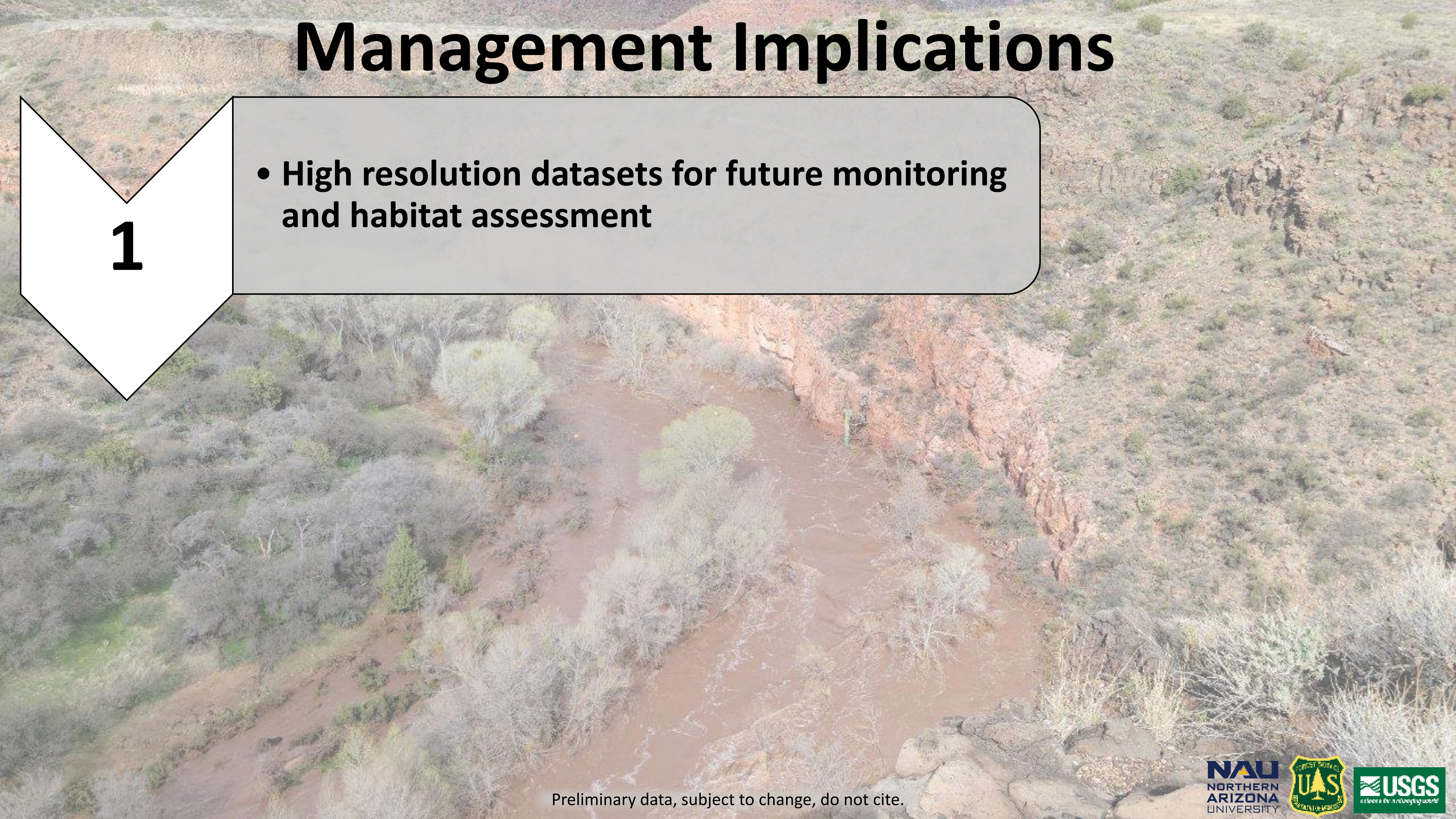

Management Implications

1

- High resolution datasets for future monitoring and habitat assessment

Preliminary data, subject to change, do not cite.

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Management Implications

1

- High resolution datasets for future monitoring and habitat assessment

2

- Quantitative, results you can be certain of

Management Implications

1

- High resolution datasets for future monitoring and habitat assessment

2

- Quantitative, results you can be certain of

3

- Document impacts to the river from a variety of variables

Preliminary data, subject to change, do not cite.

Questions?

LTango@usgs.gov

Thank you to my funding agencies:

US Bureau of Reclamation, US Forest Service, Northern Arizona University (NAU)

- The Geoinformatics lab members at NAU: lidar processing guidance
- Wade Gibson: Vital assistance with field work

BUREAU OF RECLAMATION

REMOTE SENSING AND GEOINFORMATICS LAB

NORTHERN ARIZONA UNIVERSITY

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

And to the USGS Grand Canyon Monitoring and Research Center (my current position):

USGS science for a changing world

Grand Canyon Monitoring and Research Center

Forest Service
U.S. DEPARTMENT OF AGRICULTURE

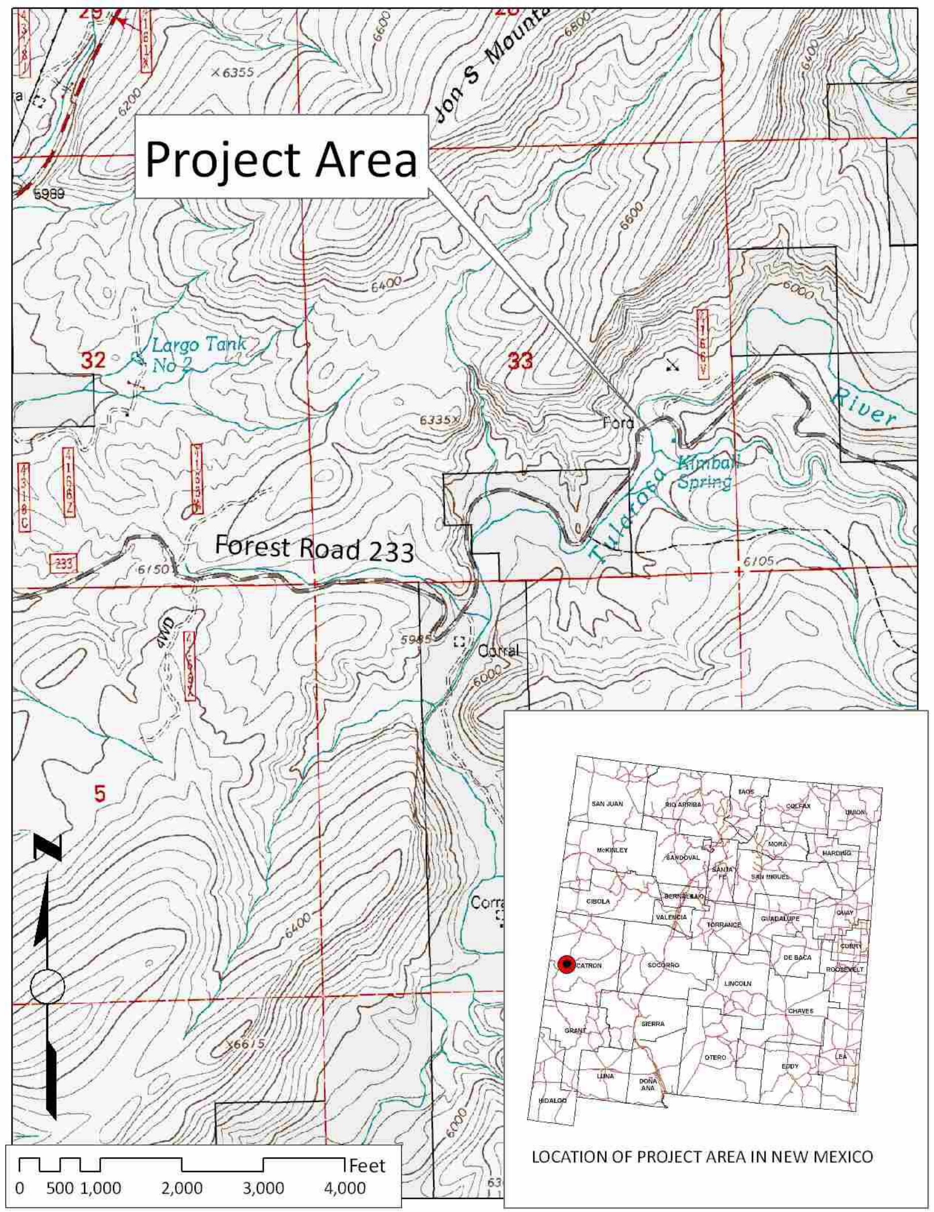
The Tularosa AOP/Wetland Restoration Project

Gila National Forest

Carolyn Koury and Elizabeth Sorells

October 25, 2023

Reserve Ranger District



Background – Forest Road 233

The Slab

Hardened crossing at the intersection of the Tularosa River and NFSR 233

Been in place for several decades

- Road
  - –Only road to access the Eagle Peak Lookout – critical for fire on north end of the Forest
  - –Important hunting and recreation access route

2007 – looking upstream of slab

Background – Tularosa River

- Fish community consists almost entirely of native species, several of which are of conservation concern.
  - Loach minnow
  - Desert sucker
  - Sonora sucker
  - Longfin dace
  - Speckled dace

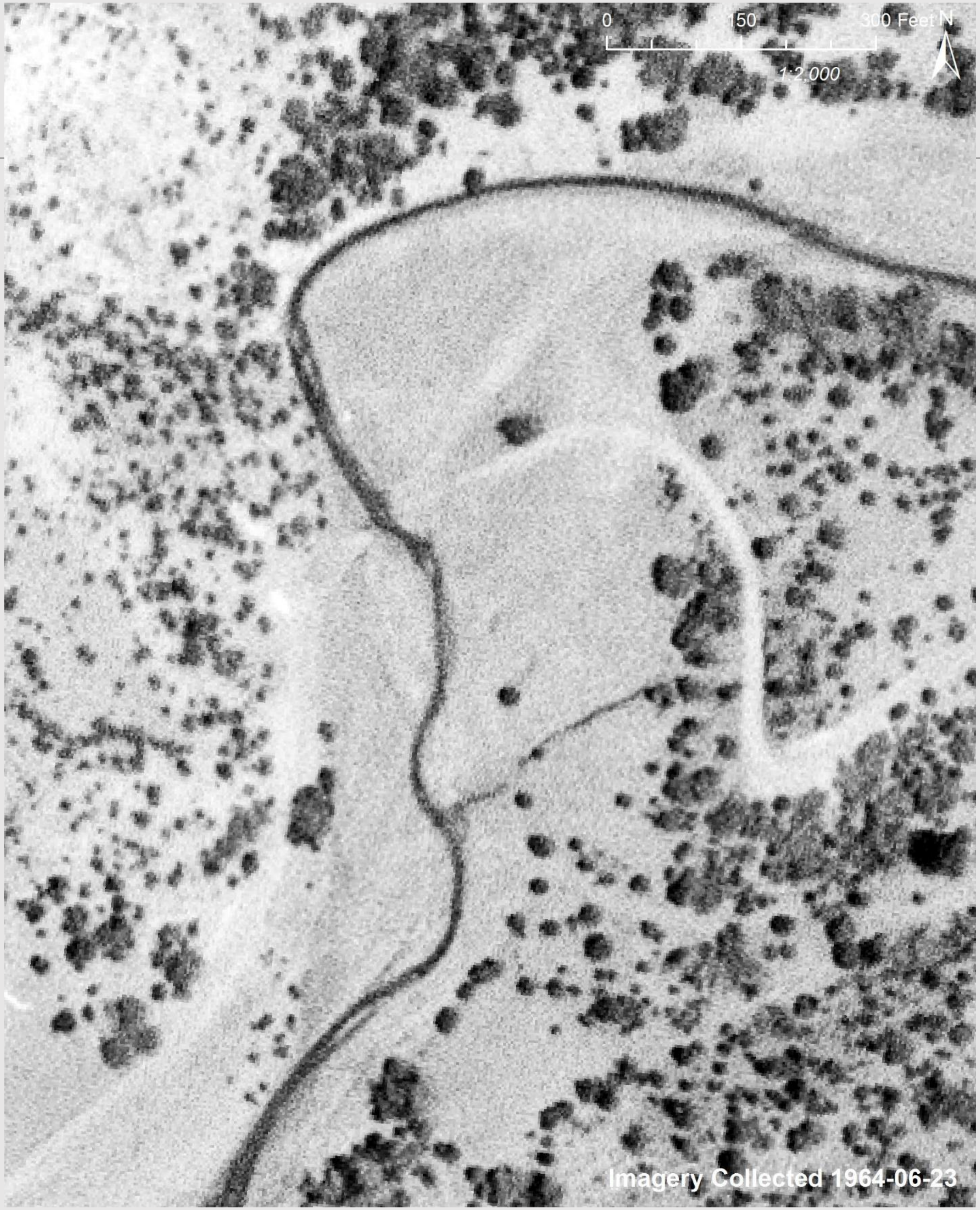
Other aquatic species of conservation concern

- Chiricahua leopard frog
- Arizona toad
- Narrow-headed garter snake - threatened

Left to right:
Sonora sucker,
Desert sucker,
Longfin dace

Fragmentation of aquatic habitat - major threat to persistence of native fishes in the Gila River basin, which includes the Tularosa River.

1964

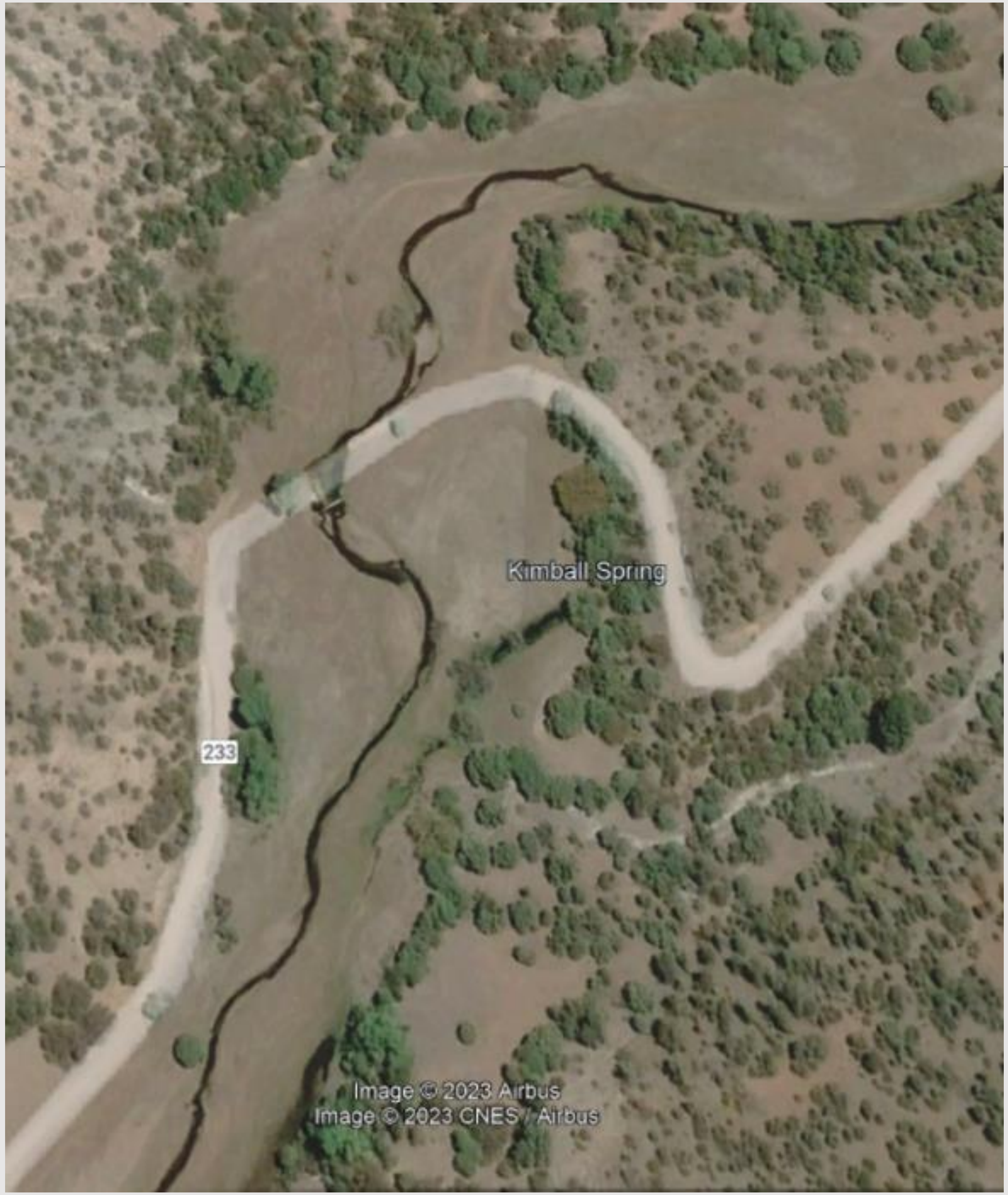


2006

2014

2017

2020


Kimball Spring
233
Image © 2023 Airbus
Image © 2023 CNES / Airbus

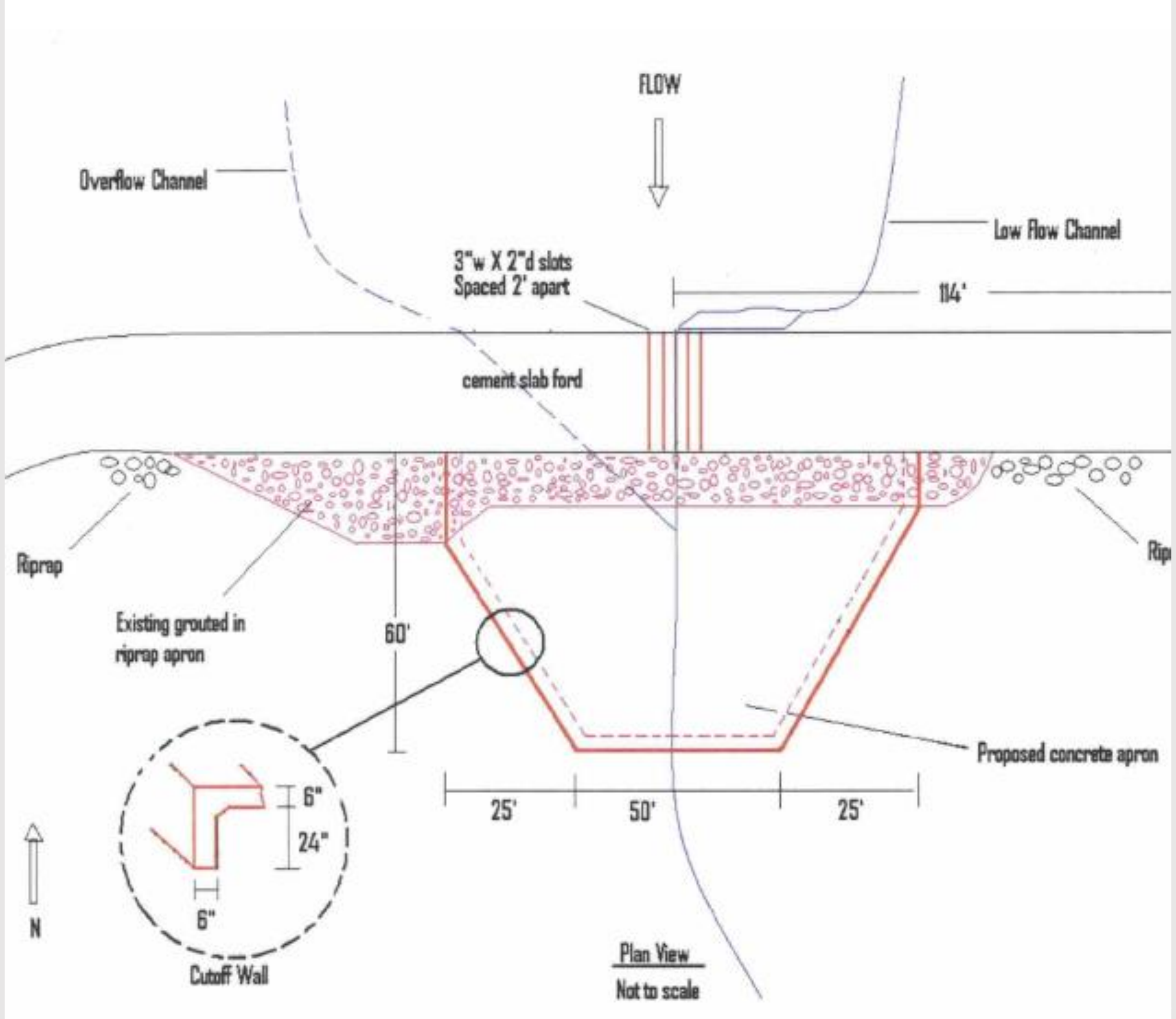
History: Pre-2009

2007 – downstream of slab

- Existing concrete low-water crossing creates barrier to upstream movement of fish and other aquatic fauna
- Crossing prevented upstream movement of fish and other aquatic organism passage
- Threatened and Endangered Species:
  - Loach Minnow (Threatened)
  - Chiricahua Leopard Frog (Threatened)
  - Narrow-headed Garter Snake (Threatened - listed in 2014)

2009

– Forest installs new concrete apron that extended further downstream and was at a gradient necessary for aquatic organism passage
– New concrete apron had 4-6 slots cut into it to allow for fish movement upstream across the slab
– This crossing lasts for several years until high flows began to scour the site – creating a barrier for AOP



2015

- High flows make apron impassable to native fish
- Money set aside from Federal Lands Transportation Program (FLTP) to improve the crossing to restore AOP. ($550,000)
- Project to connect 15 miles upstream habitat
- Central Federal Lands was designated as the lead on the project and agreed to do NEPA for the crossing and wetland restoration.

2015

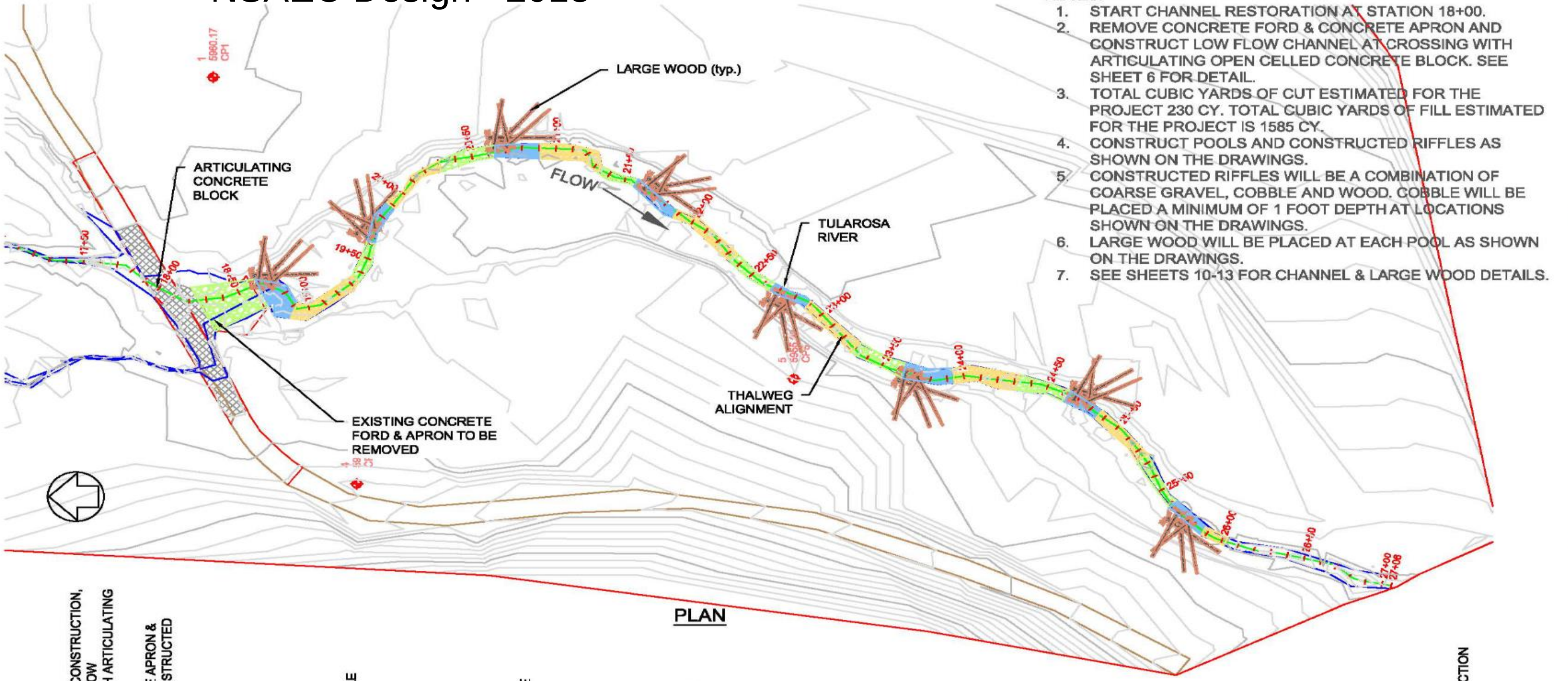
2016-2018

- Continued high flows create even larger AOP barrier and degrade wetlands adjacent to the crossing.
- Project design begins with Federal Highways but had to rework.
- Used USFS National Stream and Aquatic Crews to work with Federal Highways to come up with more natural design and incorporate downstream wetland restoration.
- Project costs were much higher than expected so had to work to find funding.

2016

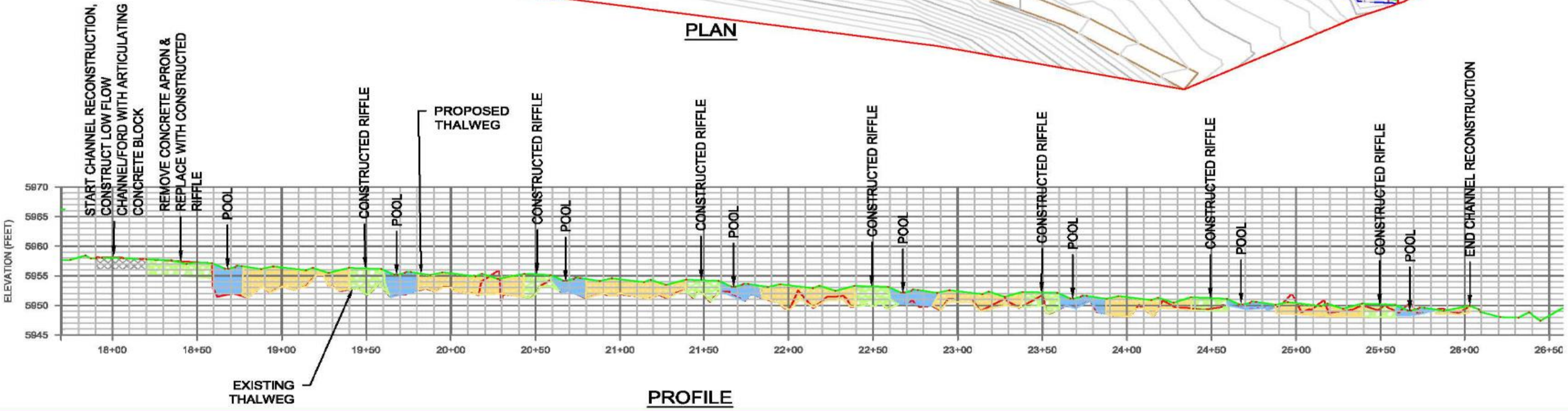
Kimball Spring

NSAEC Design - 2018



NOTES:

1. START CHANNEL RESTORATION AT STATION 18+00.
2. REMOVE CONCRETE FORD & CONCRETE APRON AND CONSTRUCT LOW FLOW CHANNEL AT CROSSING WITH ARTICULATING OPEN CELLED CONCRETE BLOCK. SEE SHEET 6 FOR DETAIL.
3. TOTAL CUBIC YARDS OF CUT ESTIMATED FOR THE PROJECT 230 CY. TOTAL CUBIC YARDS OF FILL ESTIMATED FOR THE PROJECT IS 1585 CY.
4. CONSTRUCT POOLS AND CONSTRUCTED RIFFLES AS SHOWN ON THE DRAWINGS.
5. CONSTRUCTED RIFFLES WILL BE A COMBINATION OF COARSE GRAVEL, COBBLE AND WOOD. COBBLE WILL BE PLACED A MINIMUM OF 1 FOOT DEPTH AT LOCATIONS SHOWN ON THE DRAWINGS.
6. LARGE WOOD WILL BE PLACED AT EACH POOL AS SHOWN ON THE DRAWINGS.
7. SEE SHEETS 10-13 FOR CHANNEL & LARGE WOOD DETAILS.



United States Department of Agriculture
Forest Service

R3
SOUTHWEST REGION

PROJECT NAME

NFSR 233 TULAROSA STREAM CROSSING

GILA NATIONAL FOREST

RESERVE RANGER DISTRICT

DRAWING TITLE

PROJECT PLAN & PROFILE

DATE 9/10/19

ARCHIVE NO.

DESIGNER C. MARZULLO

DRAWN C. MARZULLO

CHECKED X.XXX

PROJECT NO.

DWG SHEET NO. 5

SHEET 5 OF 13

2021 – Large event occurs in October

2021

2022

2022 – Pre Project Conditions

2022


CAT

Placing log jams

Fish Shocking Compromised Sites

Workings of the new channel

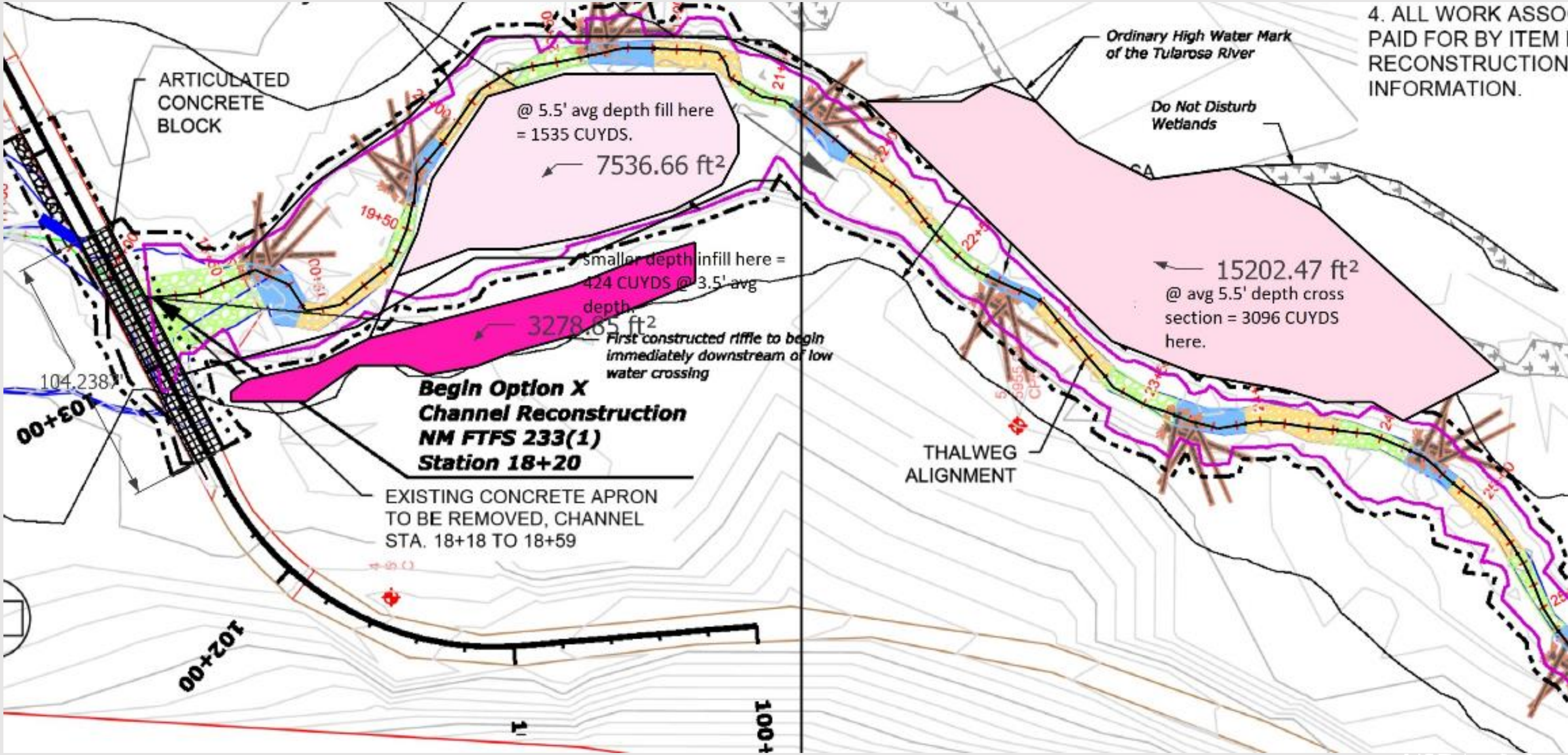
This was an all hands-on deck approach to clear site of fish

Narrow-headed garter snake and Loach minnow on the day of the river flip

Turning the River Back

New Low Water Crossing

Ponding in pink and magenta areas still need to be filled.



Funding

Tularosa AOP Crossing and Wetland Restoration - Funding		
Funding Source	**Amount**	**Comments**
Legacy Roads & Trails (LRT)	$510,000	Initial: $300k + $210k in FY24 to finish
USFWS – Fish Passage	$280,000	Initial: $50k +$180k (BIL) +$50k from year end BIL funding (FY23)
USFWS - Desert Fish Habitat	$40,000	Competitive grant
Federal Land Transportation Program (FLTP)	$1,280,504	Initial: $34k for NEPA + $550k to implement +$696k to completely fund
	Total: $2,110,504	

Lessons Learned

- Wetland Restoration projects are expensive
- Working with Central Federal Lands is expensive and limited our control
- Inspector should be present daily
- Don’t underestimate species presence
- Snakes love places to hide (Including plastic sheeting and rip-rap)
- Have project designer on site to make changes on the fly
- Biologists should be present at all times (Expensive but necessary)
- Expect the unexpected and adapt as needed
- Use local resources
- Interagency agreements with Central Federal Lands require advanced payment
- The RO is our best friend <3

What is Next for the Tularosa AOP

- More fill
  - Biologist will need to be on site
  - Utilize Blanket Purchase Agreement (BPA)
- Boulder placement
- Willow planting day (All are welcome)

Forest Service
U.S. DEPARTMENT OF AGRICULTURE

USDA is an equal opportunity provider, employer, and lender.

Upper Verde River Habitat Analysis Project

Dr. Jackson Leonard

USDA Rocky Mountain Research Station Flagstaff, Arizona

Dr. Temuulen “Teki” Sankey

Lauren Tango

Northern Arizona University, School of Informatics, Computing and Cyber Systems, Flagstaff, Arizona

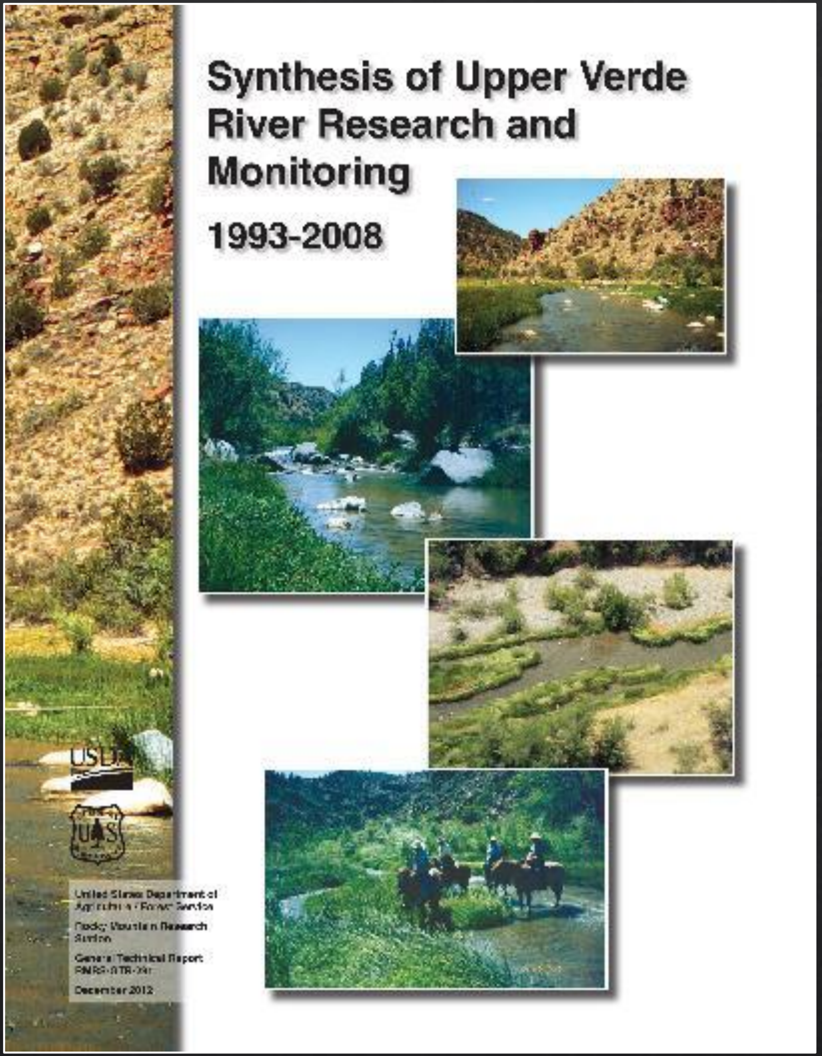
NORTHERN ARIZONA UNIVERSITY

USDA FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

BUREAU OF RECLAMATION

Presentation Objectives

- Quick Overview
- Ground-based lidar and RTK
- Unmanned Aerial Vehicle (UAV)
- Environmental DNA
- Products
- Closing Thoughts



Neary, Daniel G.; Medina, Alvin L.; Rinne, John N., eds. 2012. Synthesis of Upper Verde River research and monitoring 1993-2008. Gen. Tech. Rep. RMRS GTR-291. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 296 p.

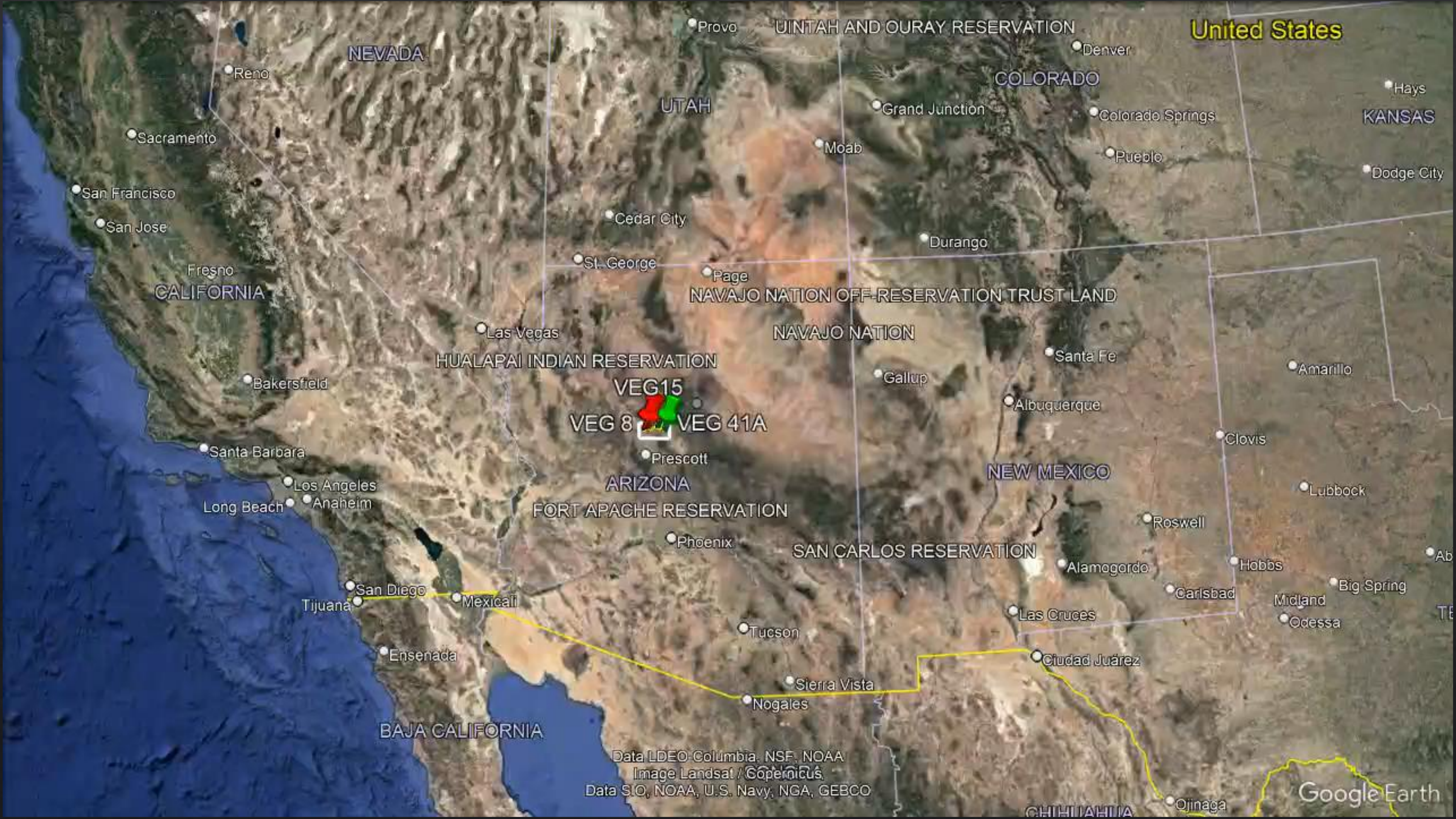
Overview

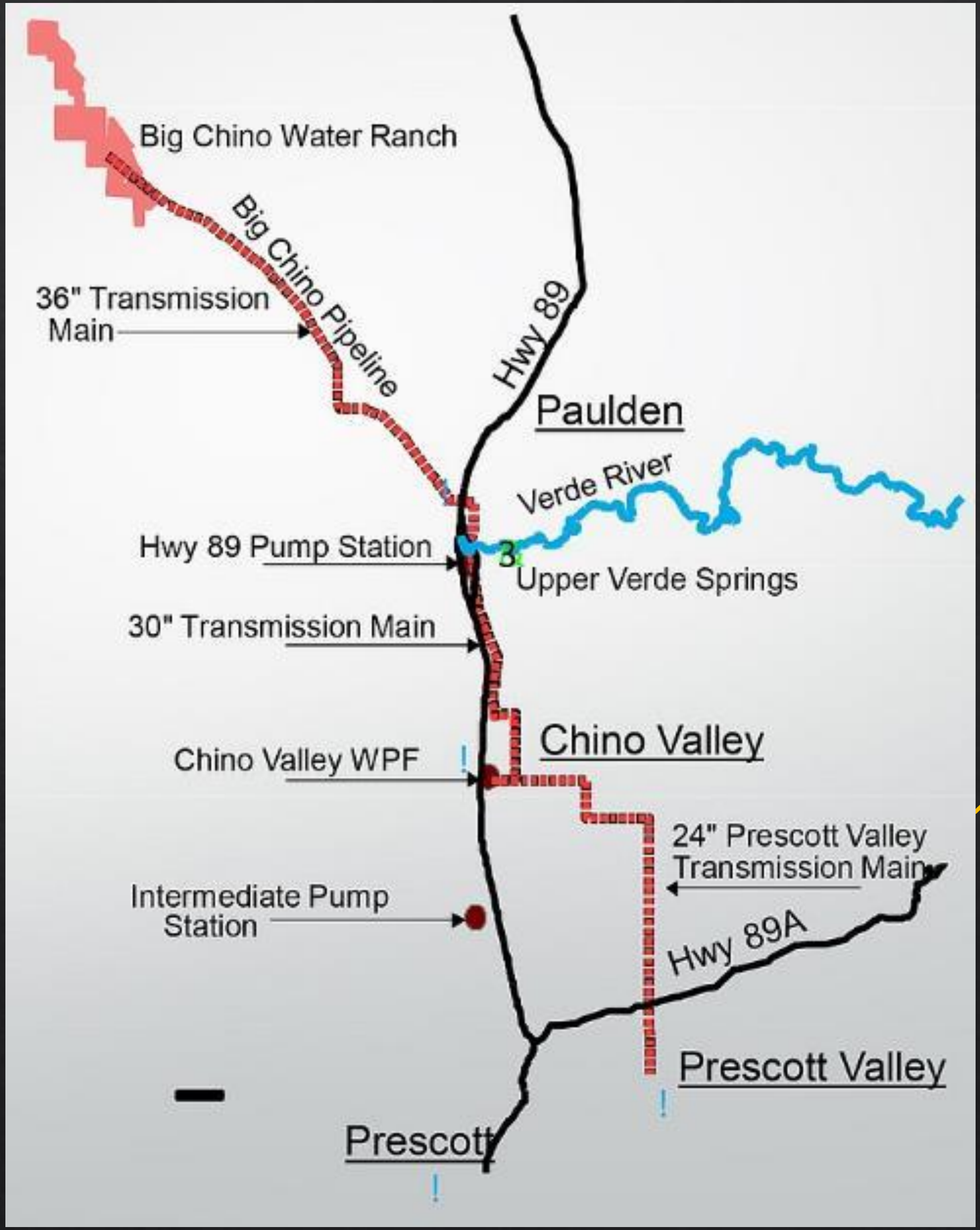
1979

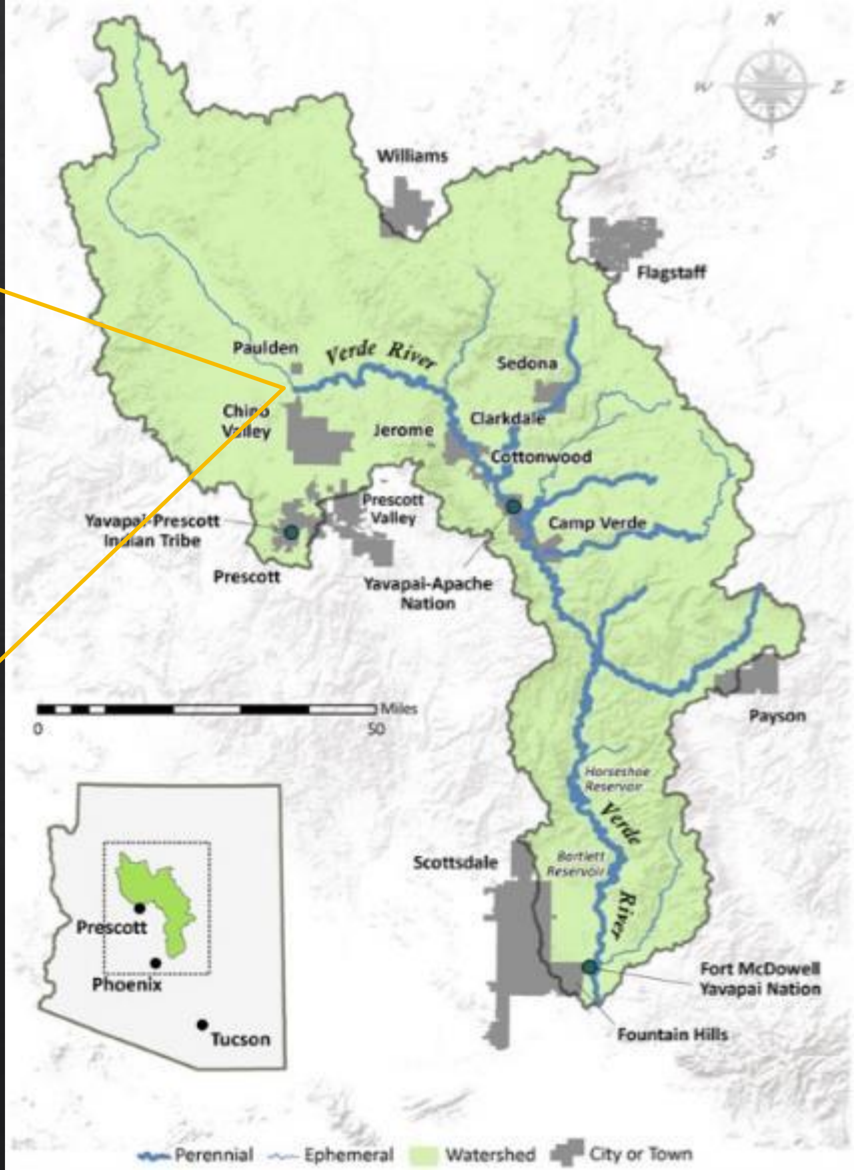
2001

Long-term Trends

- Decline in native fish populations, increased populations of non-native fish
- Conversion of sedge meadows to gallery forests, stream channel confinement
- Non-native woody species (Tamarisk and Russian Olive)

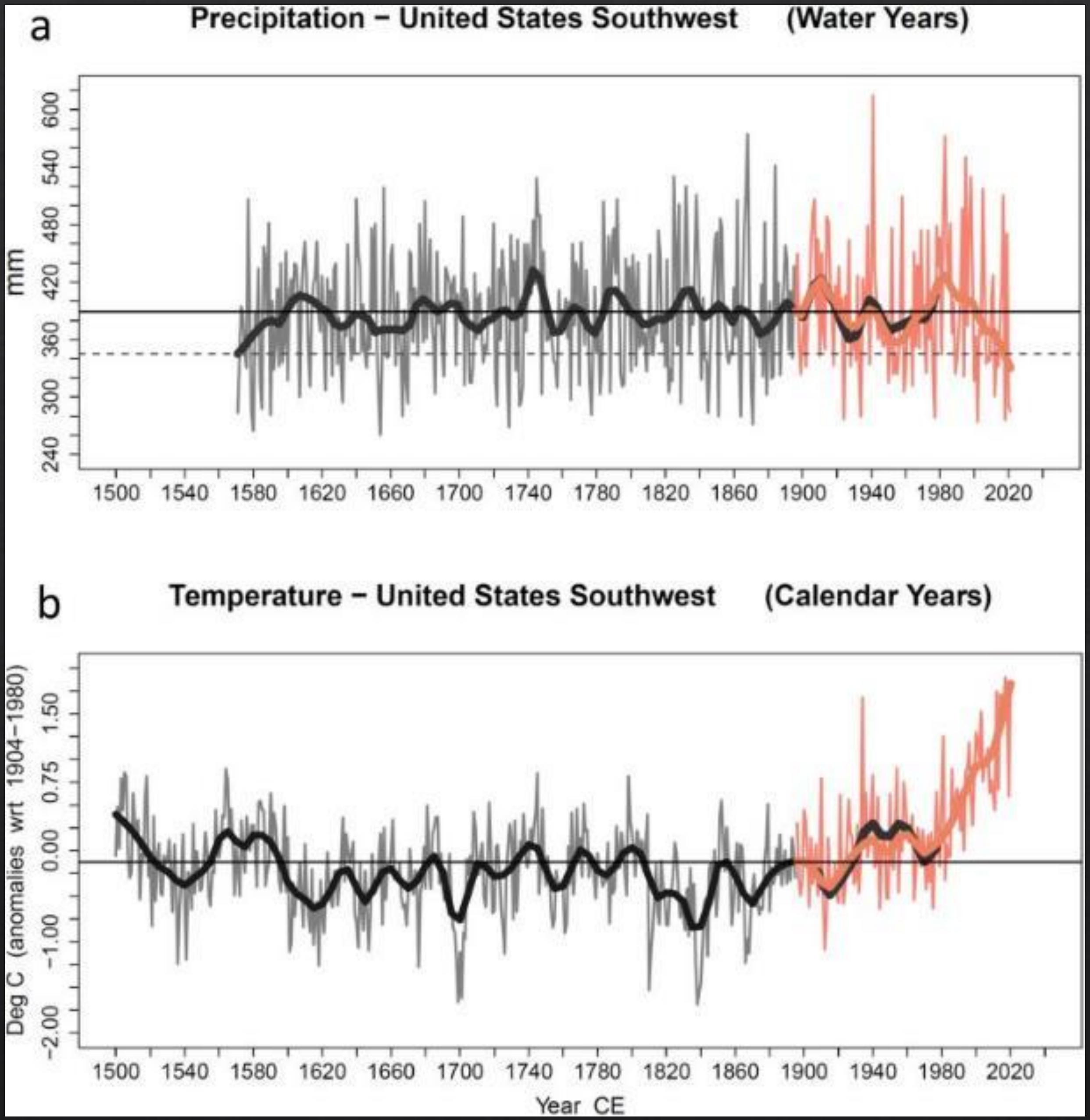

United States
Provo
UINTAH AND OURAY RESERVATION
Denver
NEVADA
Reno
COLORADO
UTAH
Grand Junction
Colorado Springs
Hays
KANSAS
Sacramento
Moab
Pueblo
Dodge City
San Francisco
San Jose
Cedar City
Durango
St. George
Page
Fresno
CALIFORNIA
NAVAJO NATION OFF-RESERVATION TRUST LAND
NAVAJO NATION
Las Vegas
HUALAPAI INDIAN RESERVATION
Santa Fe
Amarillo
Bakersfield
Gallup
VEG15
VEG 8
VEG 41A
Albuquerque
Clovis
Santa Barbara
Prescott
Los Angeles
Anaheim
Long Beach
ARIZONA
NEW MEXICO
Lubbock
FORT APACHE RESERVATION
Roswell
Phoenix
SAN CARLOS RESERVATION
Alamogordo
Hobbs
San Diego
Tijuana
Mexicali
Carlsbad
Big Spring
Midland
Odessa
Las Cruces
Tucson
Ensenada
Ciudad Juárez
Sierra Vista
Nogales
BAJA CALIFORNIA
Data LDEO-Columbia, NSF, NOAA
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Ojinaga
Google Earth





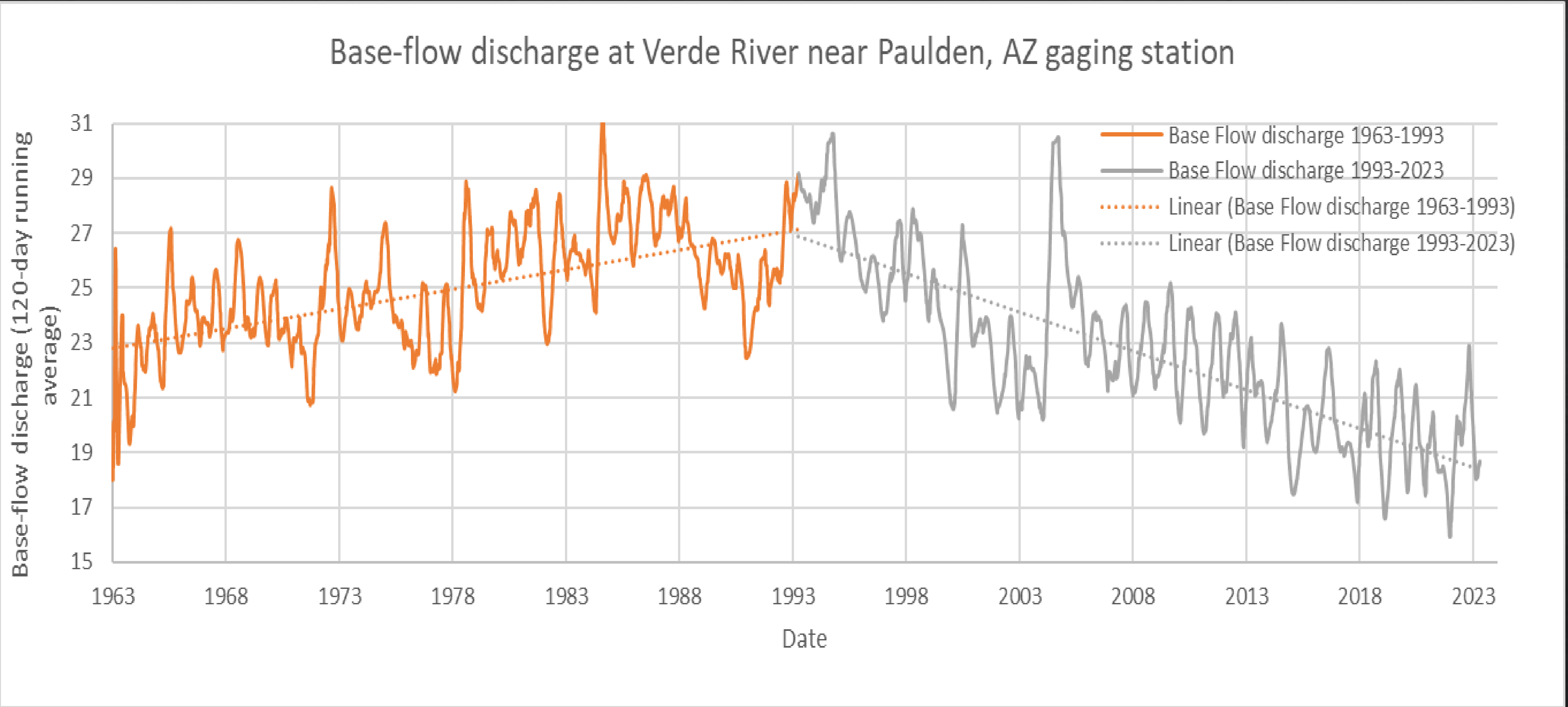
https://verderiver.org/get-involved/watershed-map/

Regional Map



Wahl et al. 2022. *Southwestern United States drought of the 21st century presages drier conditions into the future.* Communications Earth and Environment.

Overview



Overview

USGS URL: https://waterdata.usgs.gov/nwis/monthly?

2009 Upstream

2021 Upstream

2009

- Loss of streamside vegetation diversity
- Narrowing and deepening of main channel

2021

Overview

2009

Vertical banks

Loss of riffle habitat

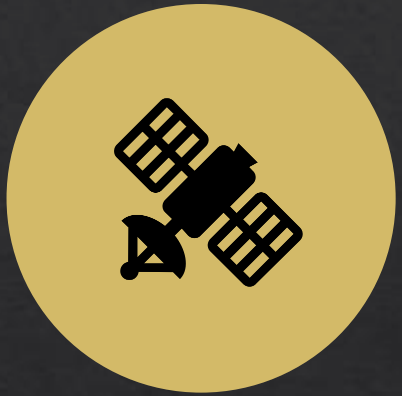
2021

Current Project Objectives

Update monitoring for:

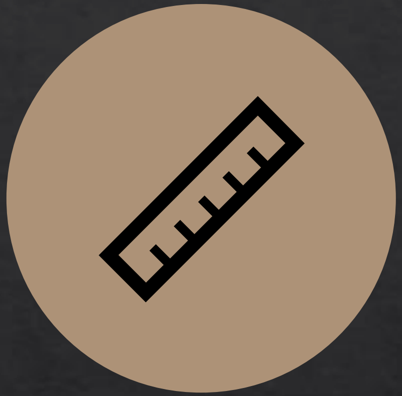
1) Streambank and floodplain woody vegetation
2) Digital elevation mapping
3) Geomorphology
4) Fish communities

Problem with Scale



SATELLITE DATA IS TOO COARSE

AIRBORNE LIDAR IS TOO EXPENSIVE



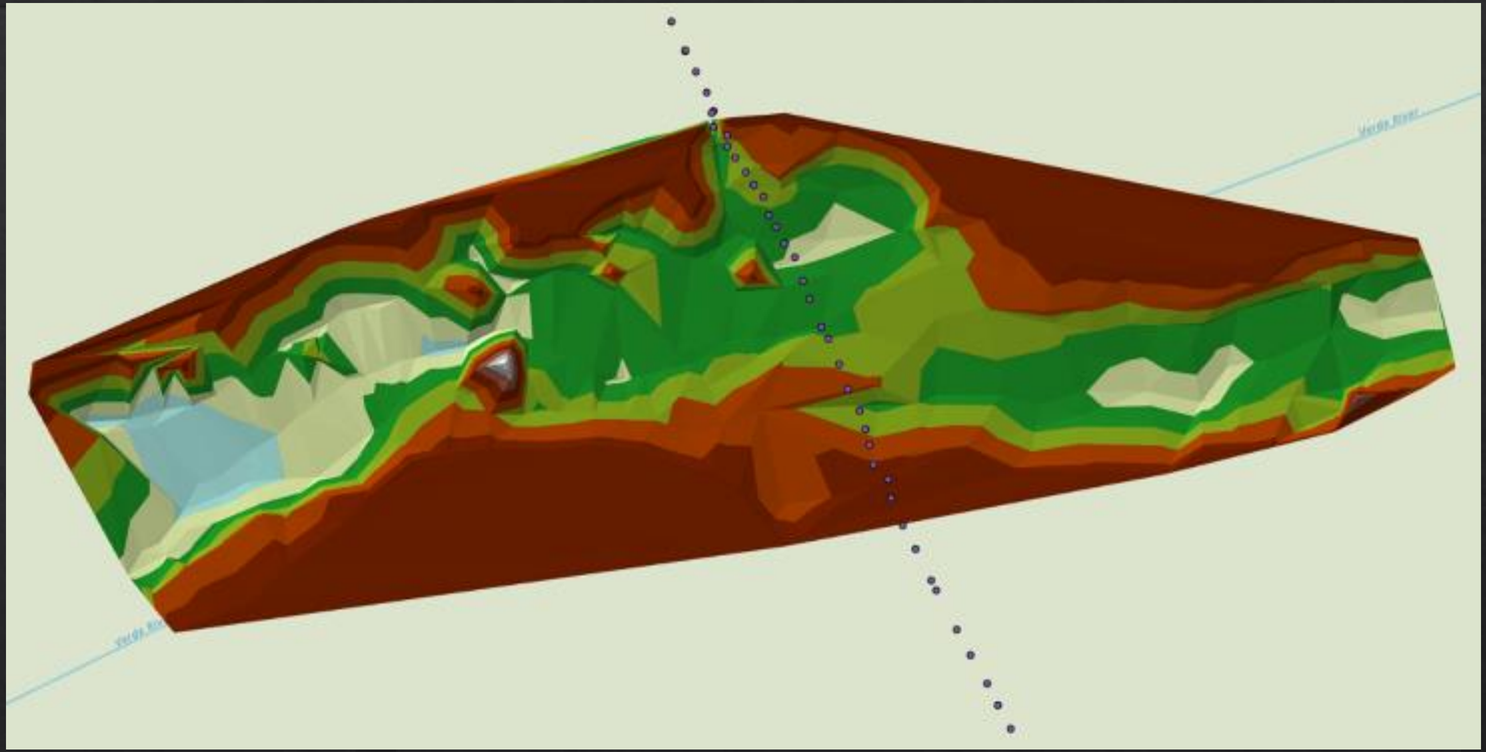
GROUND-BASED MEASUREMENTS ARE TOO LIMITED

New Methods

1) Real-Time Kinematic (RTK)
2) Ground-based LIDAR
3) Aerial UAV survey
4) eDNA Fish Sampling

- More data collected over a larger area in less time
- Repeatable

Bathymetry survey using RTK



New Methods

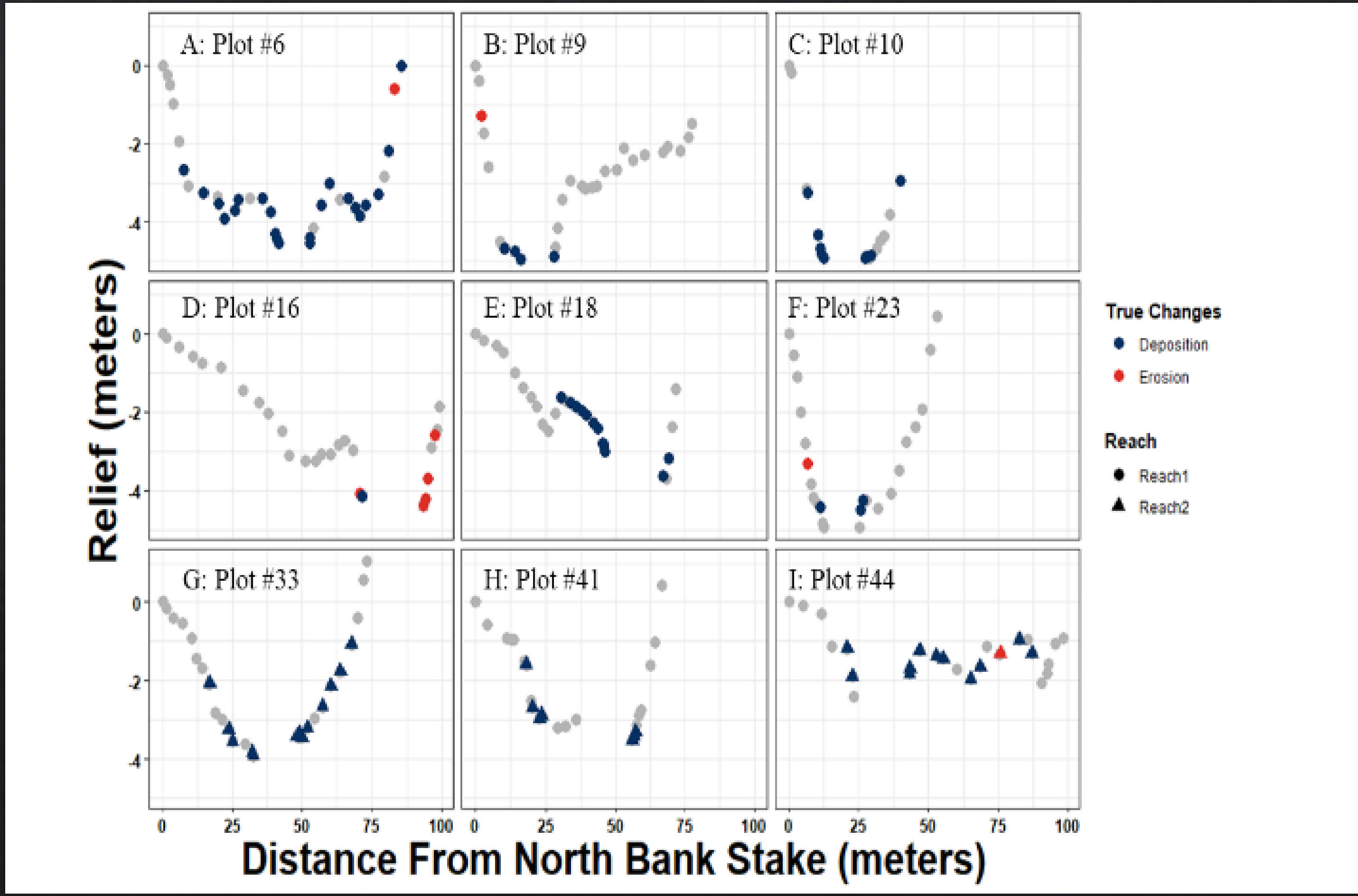
Terrestrial Lidar

Leica BLK360

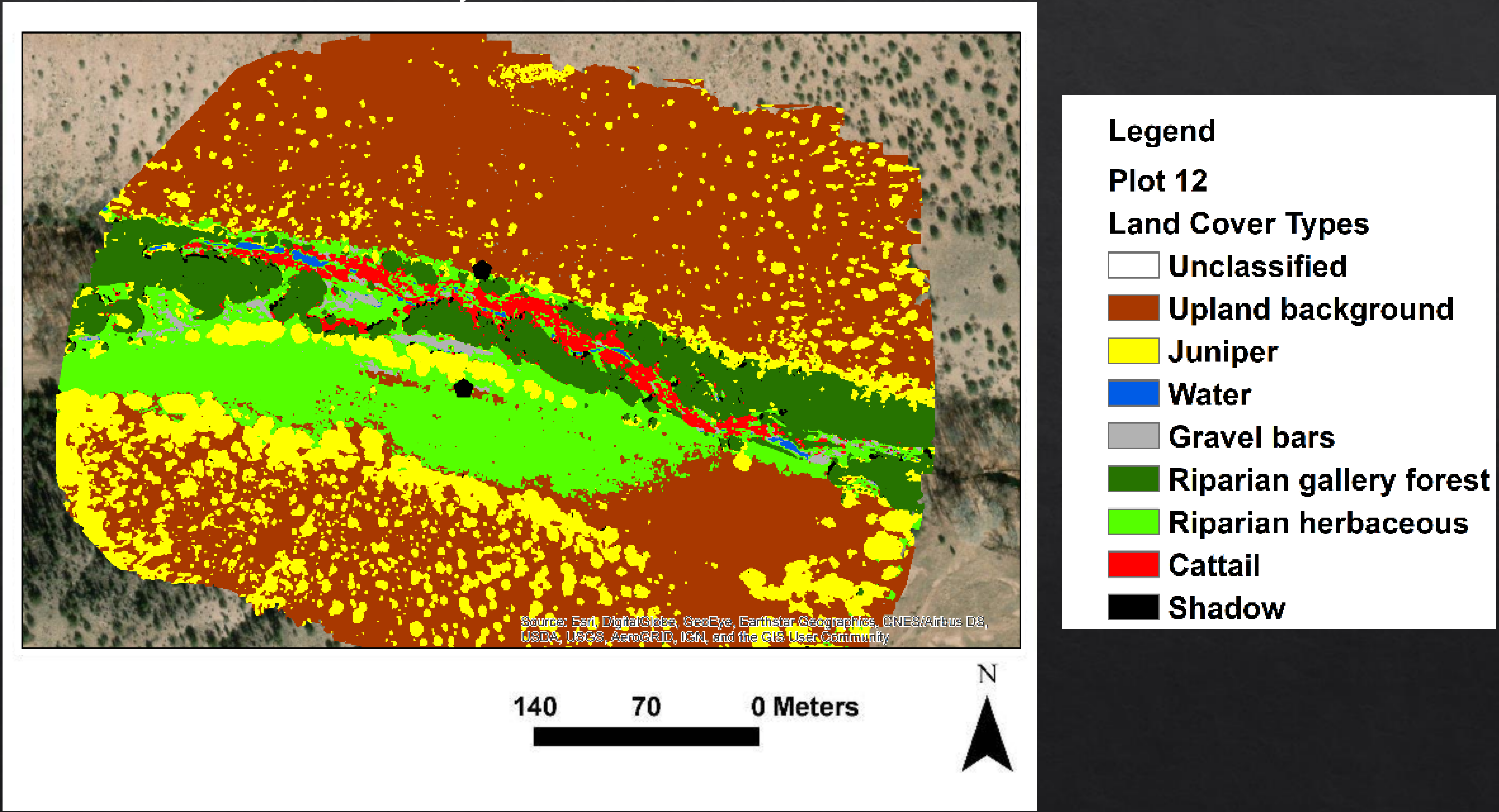
New Methods

Comparison through time

- Since 2009 deposition has mostly occurred immediately adjacent to the channel



Unmanned Aerial Survey



NAIP Imagery

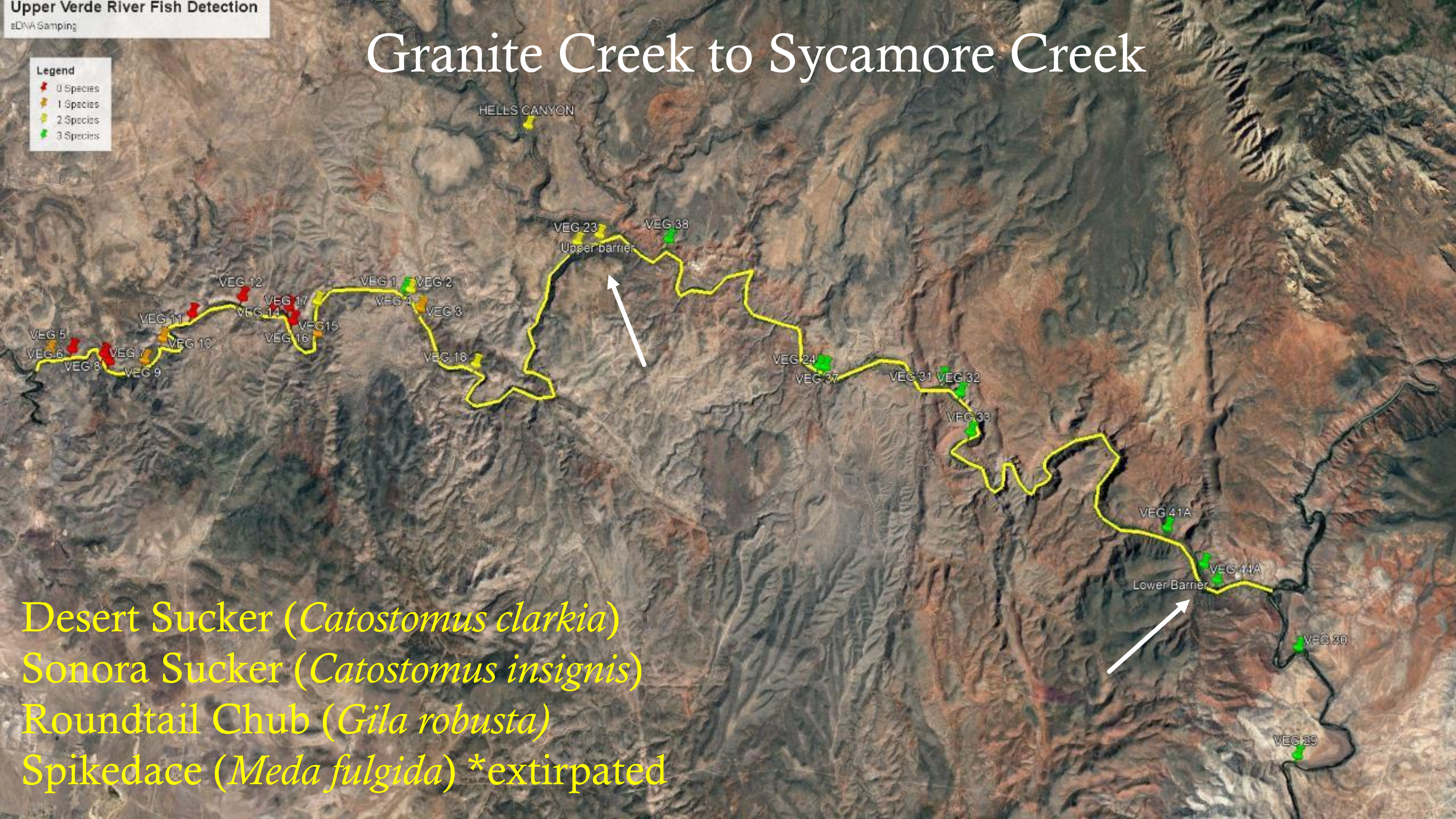
1997 Aerial Survey
vs.
2019 Aerial Survey

National Agricultural Imagery Program

Results

- Riparian woody vegetation increased approximately 35% since 1997
  - Bare ground *decreased* by 6%
  - Open channel *decreased* by 23%
  - Cattail cover *increased* by 10%

Granite Creek to Sycamore Creek



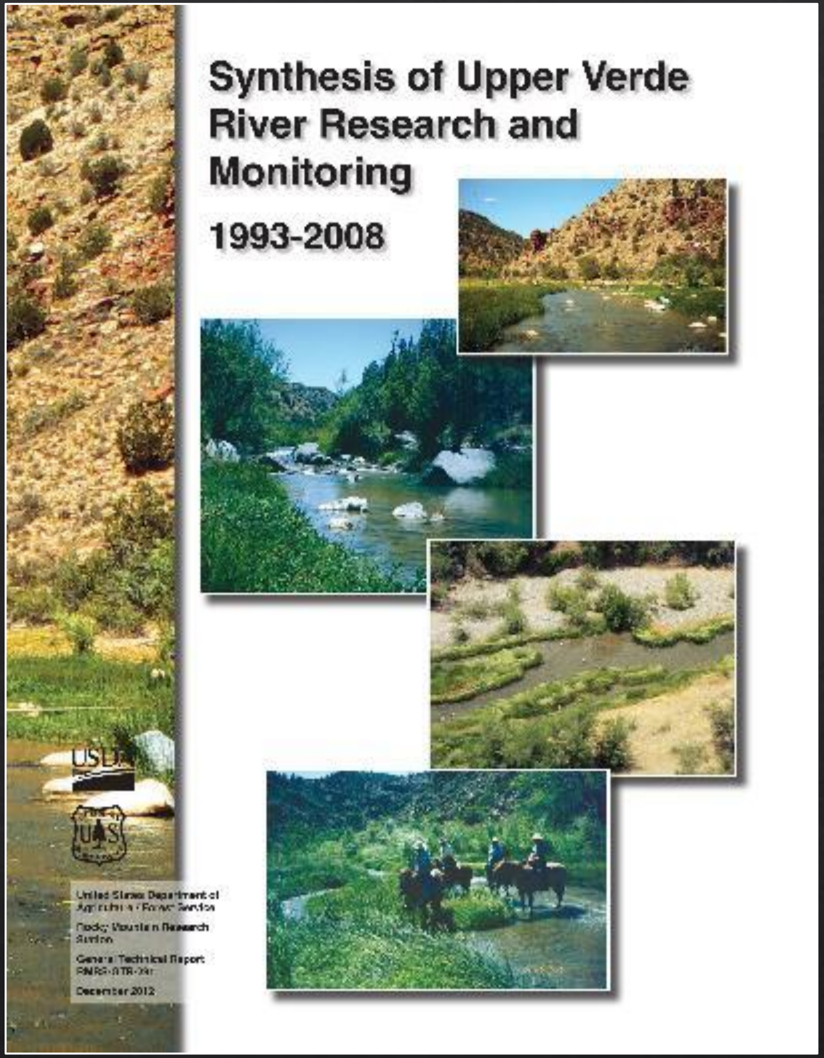
Desert Sucker (*Catostomus clarkia*)
Sonora Sucker (*Catostomus insignis*)
Roundtail Chub (*Gila robusta)*
Spikedace (*Meda fulgida*) *extirpated

Products

- High resolution Digital Elevation Maps of terrestrial LiDAR (20) and UAV (10) sites
- High resolution vegetation data for all UAV sites
- High resolution bathymetry survey (RTK) data for 20 sites
- Traditional laser level geomorphology survey data for 20 sites
- Traditional woody vegetation survey data for 20 sites
- eDNA fish presence/absence data for 20 sites over multiple years
- Repeat photography

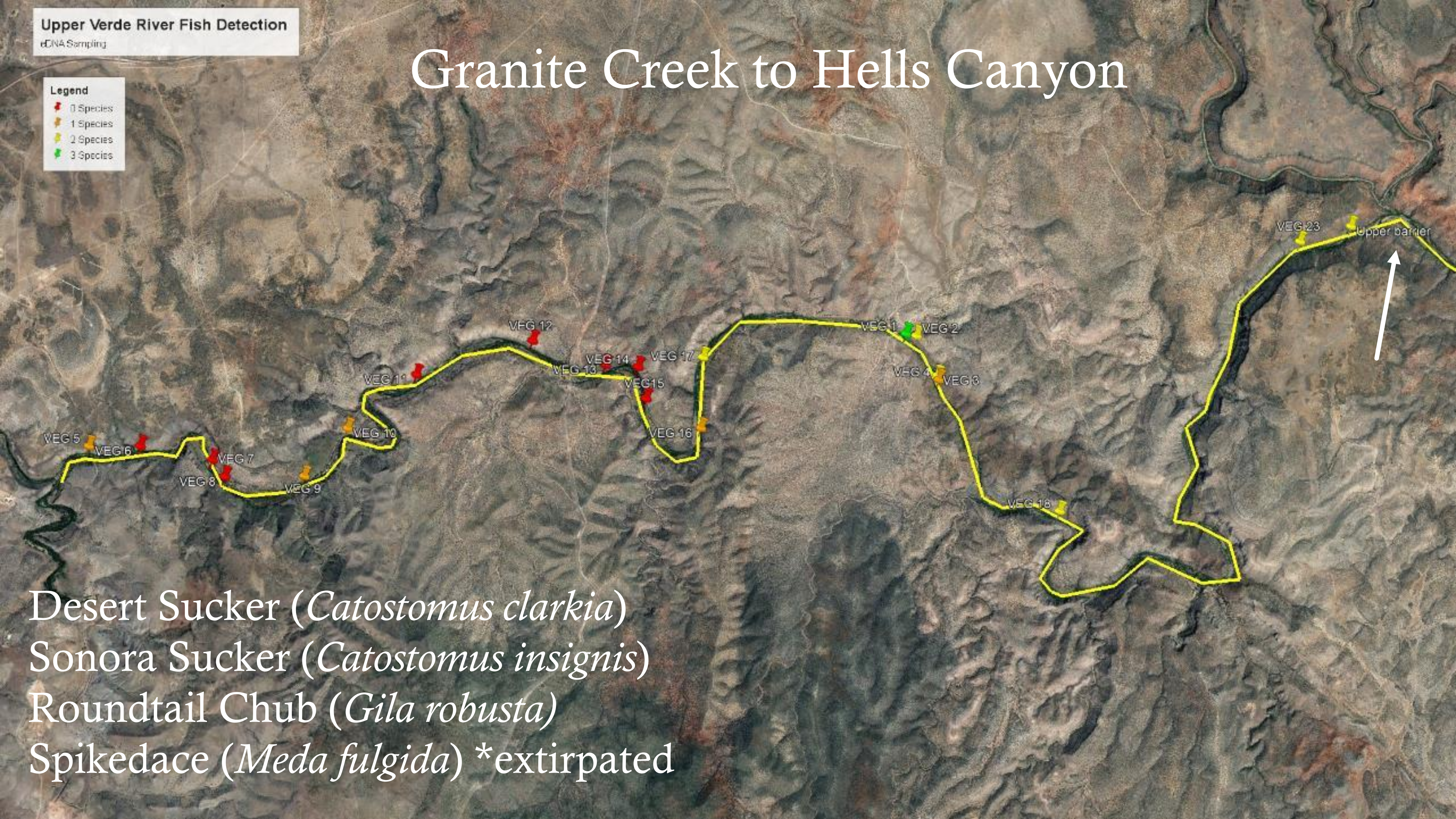
Closing Thoughts

- How do changes in habitat and fish distributions in upper-most reaches influence decision making?
  - Fish barriers
  - Restoration
- How is the ecology of the system changing in response to disturbance?
  - Changes in climate, flow, sediment
- What are the future habitat conditions for species of concern?
  - Fish, reptiles and amphibians



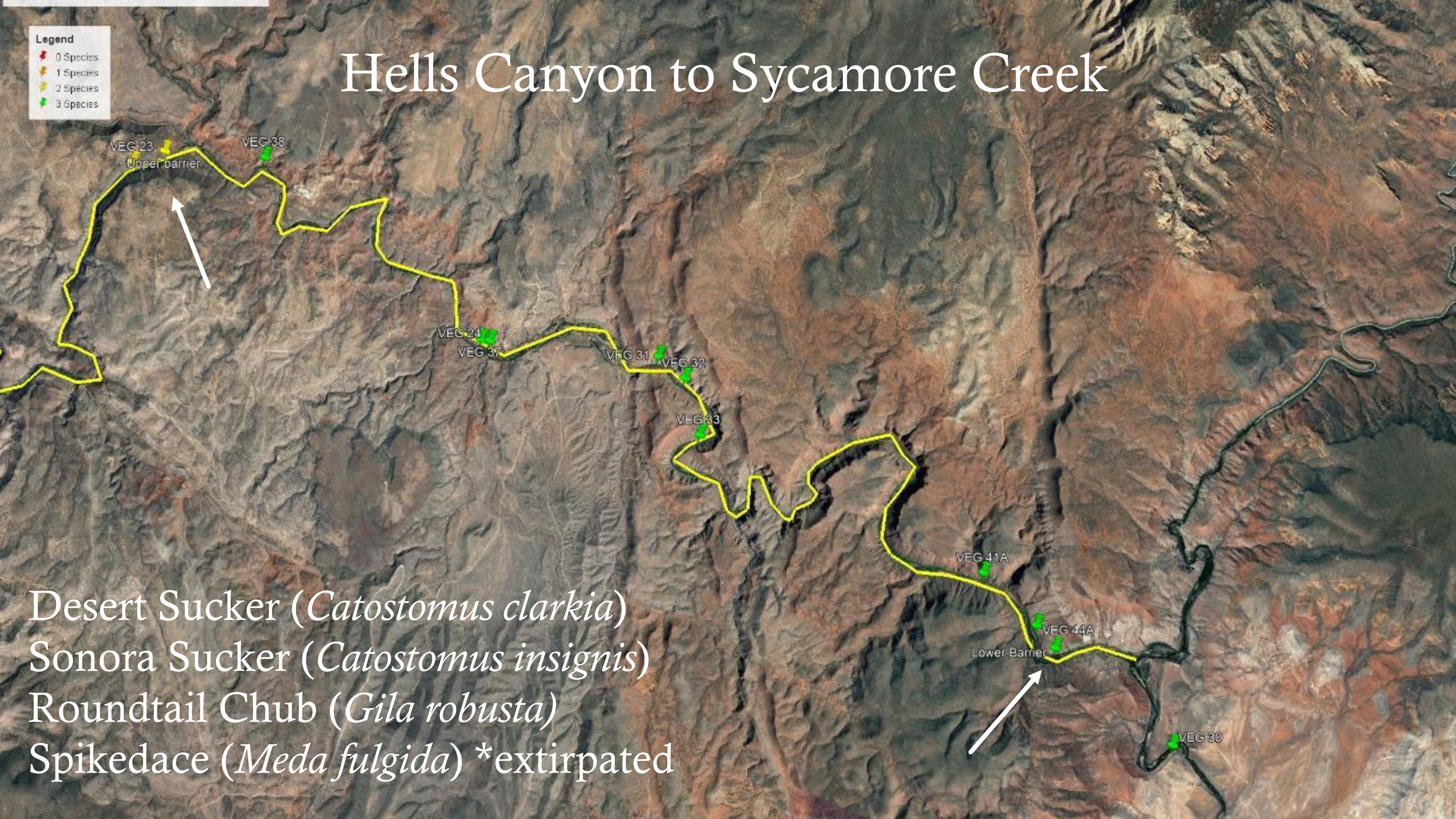
Neary, Daniel G.; Medina, Alvin L.; Rinne, John N., eds. 2012. Synthesis of Upper Verde River research and monitoring 1993-2008. Gen. Tech. Rep. RMRS GTR-291. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 296 p.

Granite Creek to Hells Canyon

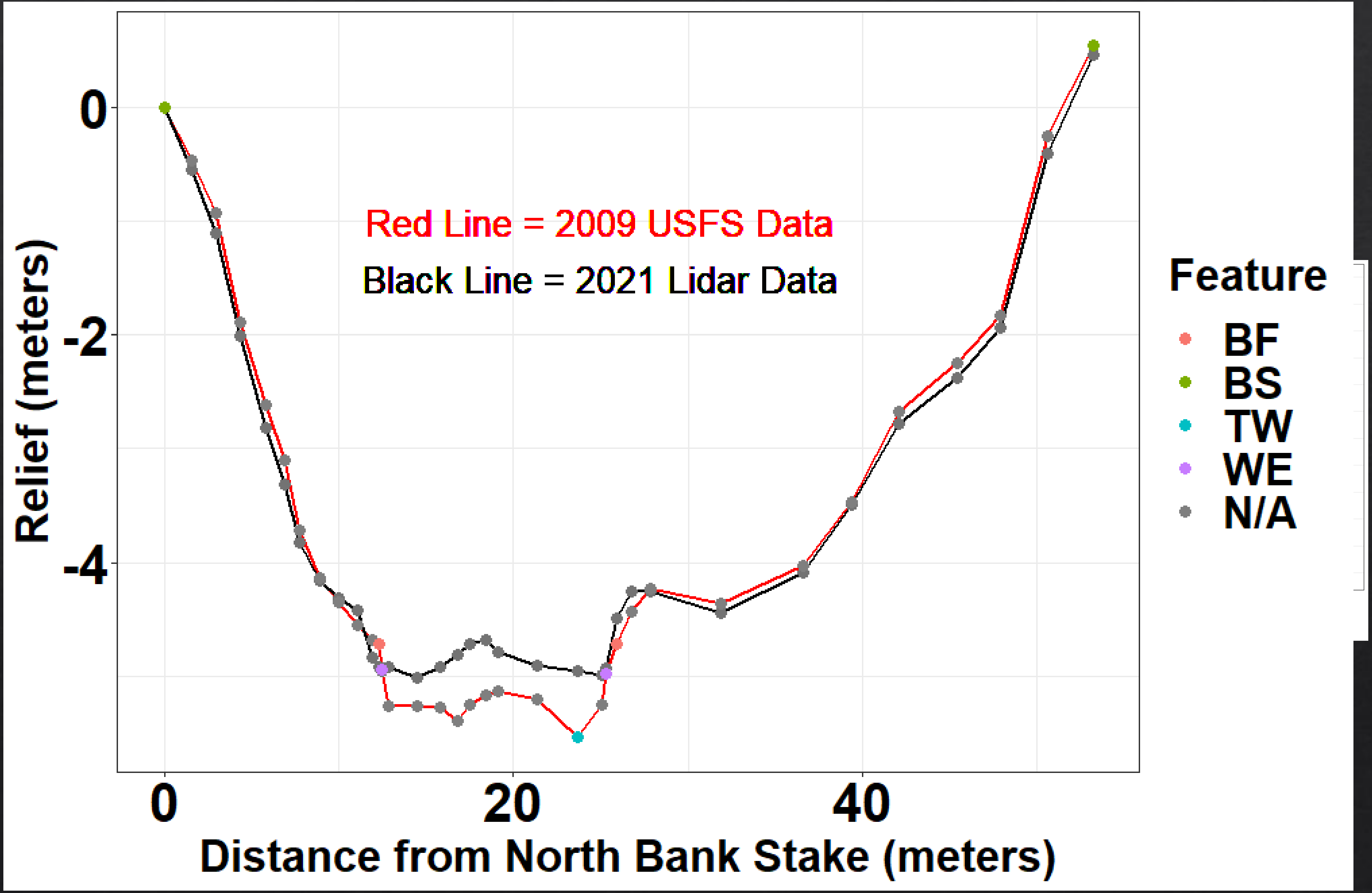


Desert Sucker (*Catostomus clarkia*)
Sonora Sucker (*Catostomus insignis*)
Roundtail Chub (*Gila robusta)*
Spikedace (*Meda fulgida*) *extirpated

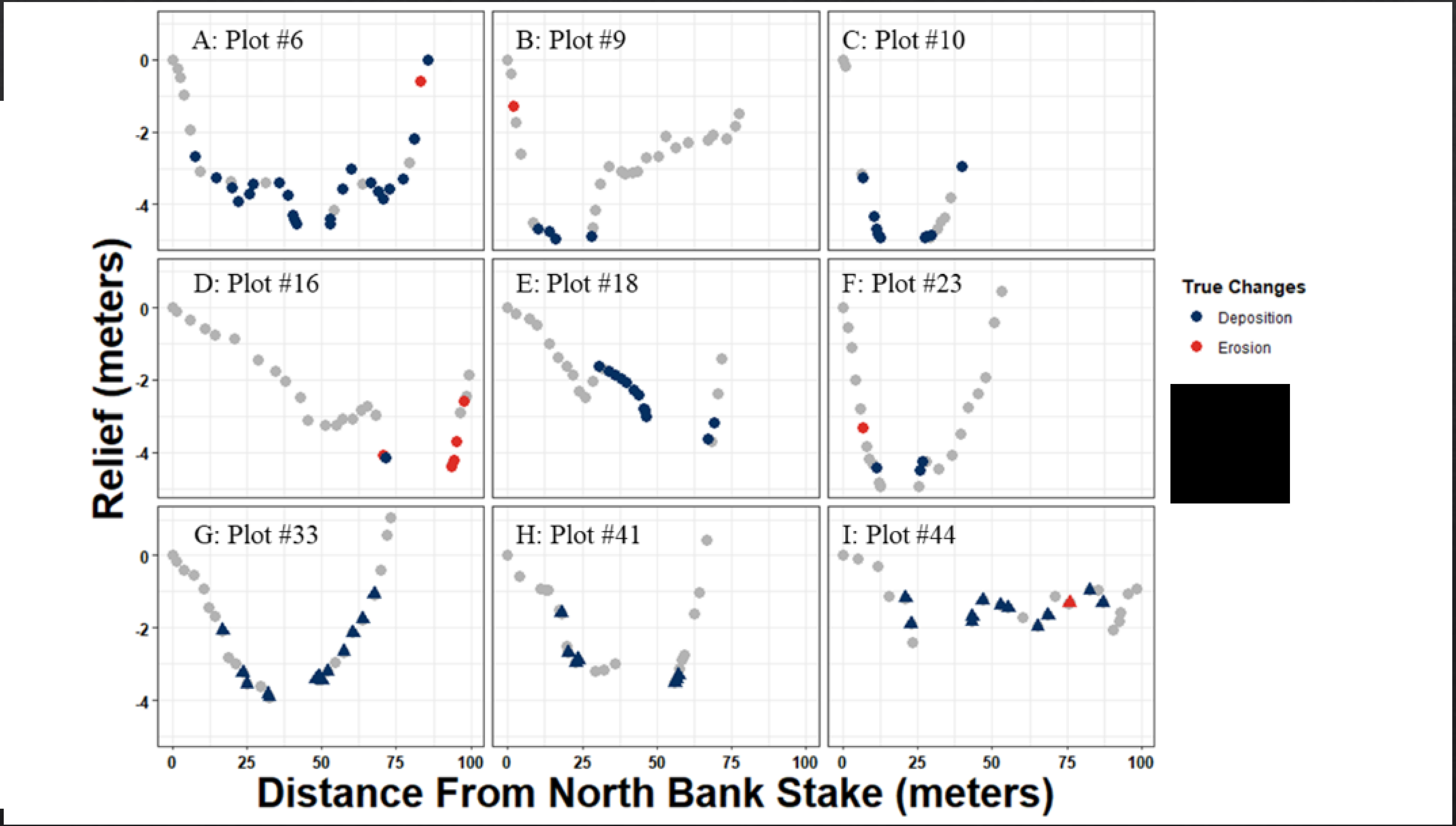
Hells Canyon to Sycamore Creek

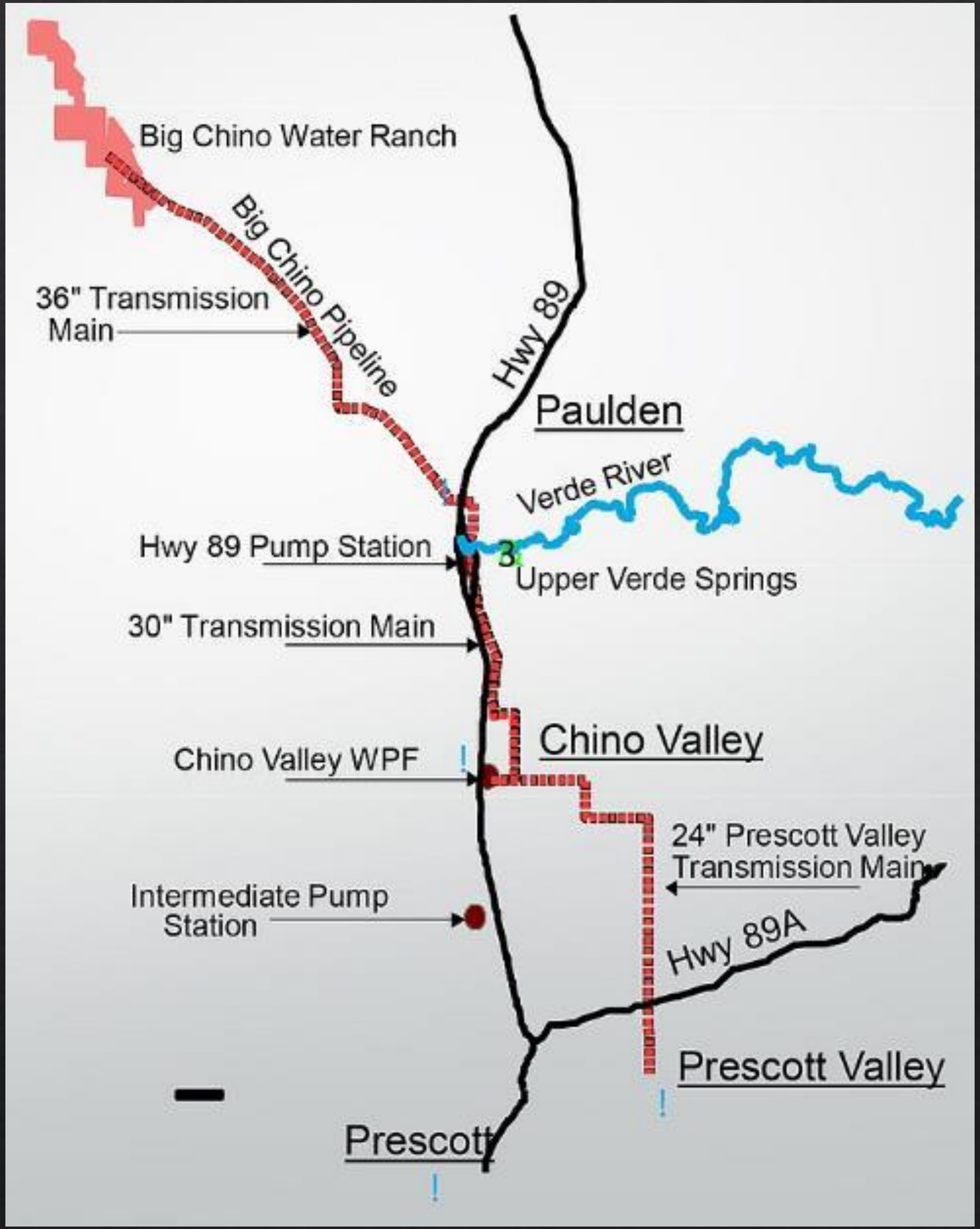


Desert Sucker (*Catostomus clarkia*)
Sonora Sucker (*Catostomus insignis*)
Roundtail Chub (*Gila robusta)*
Spikedace (*Meda fulgida*) *extirpated


Red Line = 2009 USFS Data
Black Line = 2021 Lidar Data
Relief (meters)
0
-2
-4
0
20
40
Distance from North Bank Stake (meters)
Feature
BF
BS
TW
WE
N/A

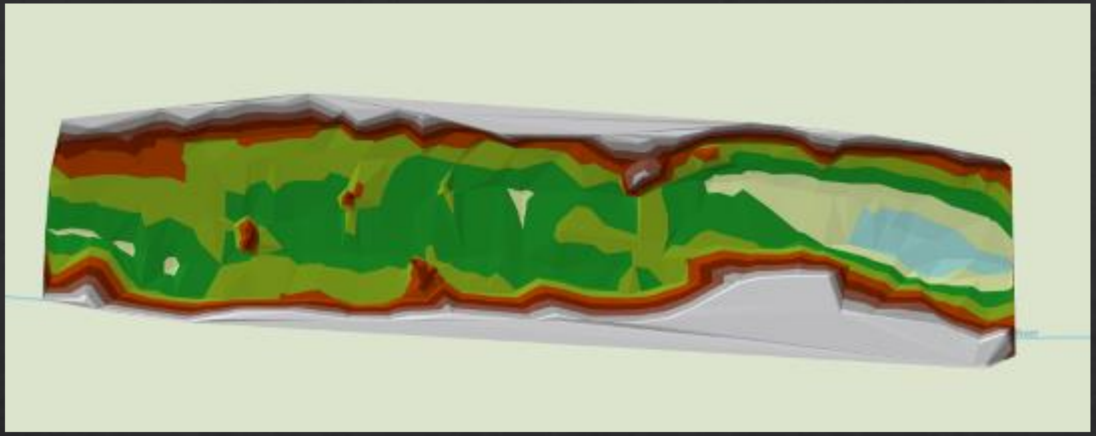
Change Detection Analysis

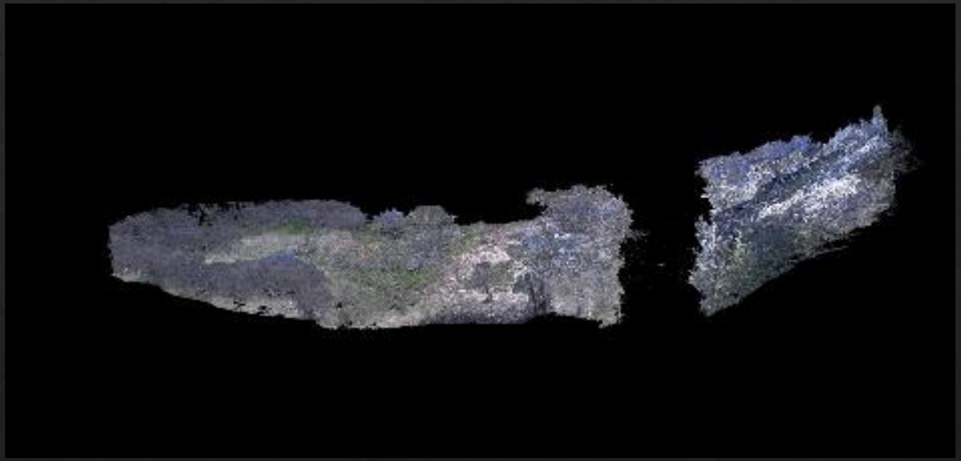


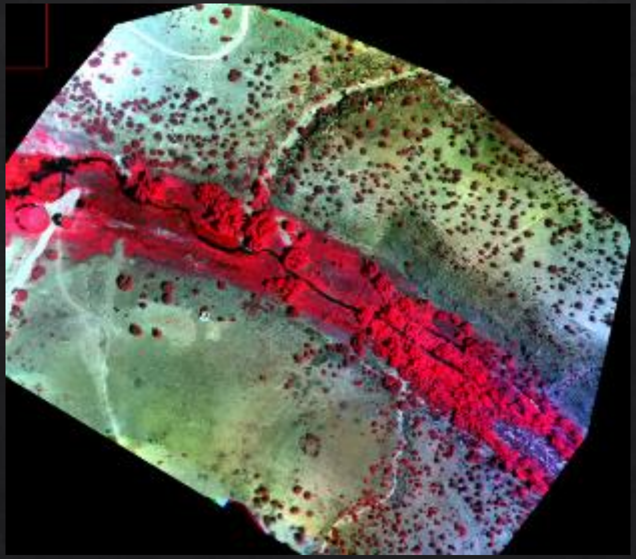

Big Chino Water Ranch
Big Chino Pipeline
36" Transmission Main
Hwy 89
Paulden
Verde River
Hwy 89 Pump Station
3
Upper Verde Springs
30" Transmission Main
Chino Valley
Chino Valley WPF
24" Prescott Valley Transmission Main
Intermediate Pump Station
Hwy 89A
Prescott Valley
Prescott

Upper Verde River
Monitoring site locations
Legend
Upper Verde River
VEG
HELLS CANYON
VEG 38
VEG 40
VEG 22
VEG 36
VEG 51
VEG 2
VEG 24
VEG 37A
VEG 12
VEG 17
VEG 18
VEG 37
VEG 43B
VEG 41A
SYCAMORE CANYON
Paulden
VEG 11
VEG 5
VEG15
VEG 21
VEG 20
VEG 35
VEG 34
VEG 8
VEG 10
VEG 42A
VEG 44A
VEG 30
VEG 29
Chino Valley
Google Earth
89
©2021 Google
89A
Cottonwood
10 mi
260
Cornville
N

New Methods







Project title	Lead agency	Cost	Plan/proposal in place	Need	Notes
~~physical manipulation of substrate to promote spawning of loach minnow~~					
physical thinning of terrestrial riparian vegetation to improve habitat for gila topminnow - habitat restoration			need a proposal		San Pedro preserve
~~coronado national forest - fish/frogs into stock tanks, non-native control forest wide~~					
~~coronado NF - bog hole improvement to hold water for topminnow, pupfish, gila chub~~					
fund FS or contractor for compliance work					project specific, option for the right project
red rock property needs some work (pond maintenance, reconstruction)					
~~pupfish and topminnow habitat maintenance work~~					
sands draw work (fencing?)	BLM AZ				needs more info from Heidi
~~mechanical removal crew~~					
~~Summary of mechanical control efforts~~					
weir at morgan city wash replacement	BOR	50k			
investigate opportuniites for acquiring water rights					
~~survey stock tanks in the Verde watershed~~					AGFD already doing this
~~chub DNA project~~					
factors that determine success or failure of restablished populations					Crosby doing this
year round spawning - hatchery study for loachminnow			concept		
~~Investigate artificial structures and natural habitat to reduce predation on stocked sites~~					
~~T4 springs improvements~~					
Reclamation equipment purchased for lending to other agencies	BOR				list needed of potential equipment needs
Support for regisitration of piscicides: Crayfish biocide/Research on antimyacin feeds					ongoing investigation (re: registration) - CCAST, J. Amberg
~~Habitat restoration~~					
~~How to manage excess hatchery fish~~					discussion only
Pupfish genetics					AGFD working on it, may need more funding
~~Impacts to aquatic inverts on stocking~~					
~~Razorback sucker and desert pupfish interactions~~					
(all/most samples already collected)	BOR		in process		funding analysis of existing samples
Poplation genomics (e.g. low coverage whole genome sequencing) of Gila and Yaqui Topminnow in Arizona			in process		
Mitogenomics of P. monacha-occidentalist in Arizona and neighboring drainages in Mexico			in process		
patterns)	P. Rienthal	<$10,000			hire undergrad
Hatchery - flow training to improve post-stocking persistence	ARCC/other				
Posting tagging survival and movement of fish in Eagle Creek	AGFD				analysis and publication - inform future translocations
FDA approval for using YY Red Shiner					

Arizona Game and Fish Workplan Cost Adjustments

Project Name	Revision	Original Cost	Revised Cost
Project 4 (Muleshoe)	NA	11056.00	NA
Project 5 (Gila Topminnow Stocking)	Translocation of Gila Topminnow to Hidden Water Spring, drop Maternity Wildlife Pond Augmentation, extension of Telegraph Canyon timeline.	50620.00	NA
Project 6 (Spring Creek)	Augmentation of Spikedace Population	6370.00	7070.00
Project 7 (Blue River)	Extension of Middle Blue River timeline one additional year	41645.00	NA
Project 8 (Harden Cienega)	Move up surveys of upper Harden Cienega Creek for isolated populations of Green Sunfish	33277.00	39077.00
Project 9 (Verde River)	Increase number of tributaries to be surveyed and clarify specific tributaries: MC Canyon, Grindstone Wash, Bear Canyon	16944.00	22944.00
Project 10 (Sharp Springs)	Additional translocations of Gila Topminnow. Deployment and maintenance of dissolved oxygen loggers.	12178.00	15580.00
Project 11 (George Wise Spring)	Increase depletion effort on stream section and any stock tanks where nonnative fish are detected	25746.00	29246.00
Project 12 (Eagle Creek)	Limit work to drafting and finalization of monitoring plan. Postpone pre-barrier habitat surveys to FY25.	22403.00	3000.00
Project 13 (Acquire Spikedace and Loach Minnow)	NA	7589.00	NA
Project 13 (ARCC)		135698.00	NA

Muleshoe Ecosystem Stream and Spring Repatriations

Proposed Work

Redfield Canyon:

- Removal trip with multiple passes in May or June

Proposed Cost

$9,641

Gila Topminnow and Gila Chub Stockings

Proposed Work

Aravaipa Creek:
- Post-stocking monitoring
- Genetic augmentation

Telegraph Canyon:
- Post-stocking monitoring
- Genetic augmentation

Rarick Canyon:
- Post-stocking monitoring

Unnamed Drainage 68B:
- Post-stocking monitoring
- Genetic augmentation

Sycamore Canyon:
- Potential translocation

Fish health assessments to support augmentations, habitat assessments as necessary

Proposed Cost

$40,856

Spring Creek (Oak Creek tributary) Repatriations

Proposed Work

Spring Creek:

- Final annual monitoring

Proposed Cost

$6,632

Blue River Native Fish Restoration

Proposed Work

Middle Blue River:

- Final annual monitoring

Upper Blue River:

- Annual monitoring

Augmentations as necessary

Proposed Cost

$36,974

Harden Cienega Creek Native Fish Restoration

Proposed Work

Two removal passes in Harden Cienega Creek (pending sunfish detection in FY24)
or
Verification of eradication in perennial reach with eDNA samples pending three consecutive passes with no Green Sunfish

Removal of Green Sunfish from intermittent portions of Harden Cienega Creek if sunfish are detected in FY24

Proposed Cost

$34,587

Upper Verde River Native Fish Restoration

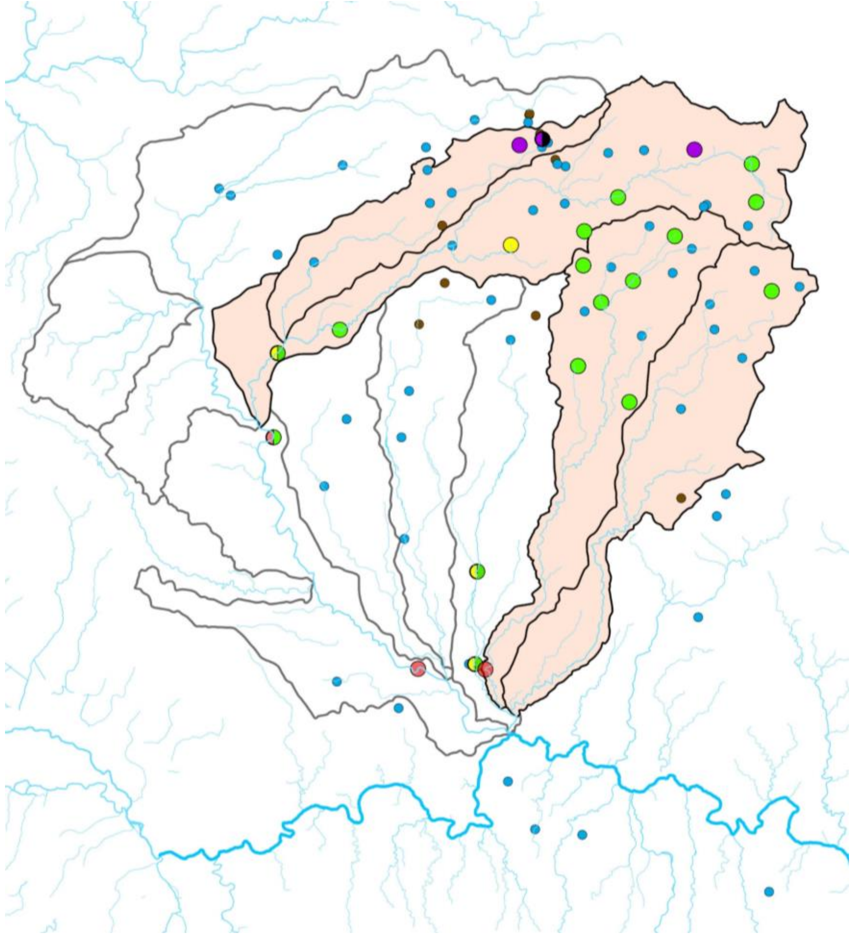
Proposed Work

Survey drainages downstream of stock tanks with nonnative fishes.

- Upper Hell Canyon
- Upper MC Canyon
- Bear Canyon (if not sampled in FY24)

Proposed Cost

$14,806



Sharp Spring Native Fish Restoration

Proposed Work

Annual monitoring of Gila Topminnow

Additional translocation of Gila Topminnow as necessary

Planning and implementation of potential management strategies following DO logger deployment in FY24

Proposed Cost

$15,535

George Wise Spring Nonnative Fish Removals

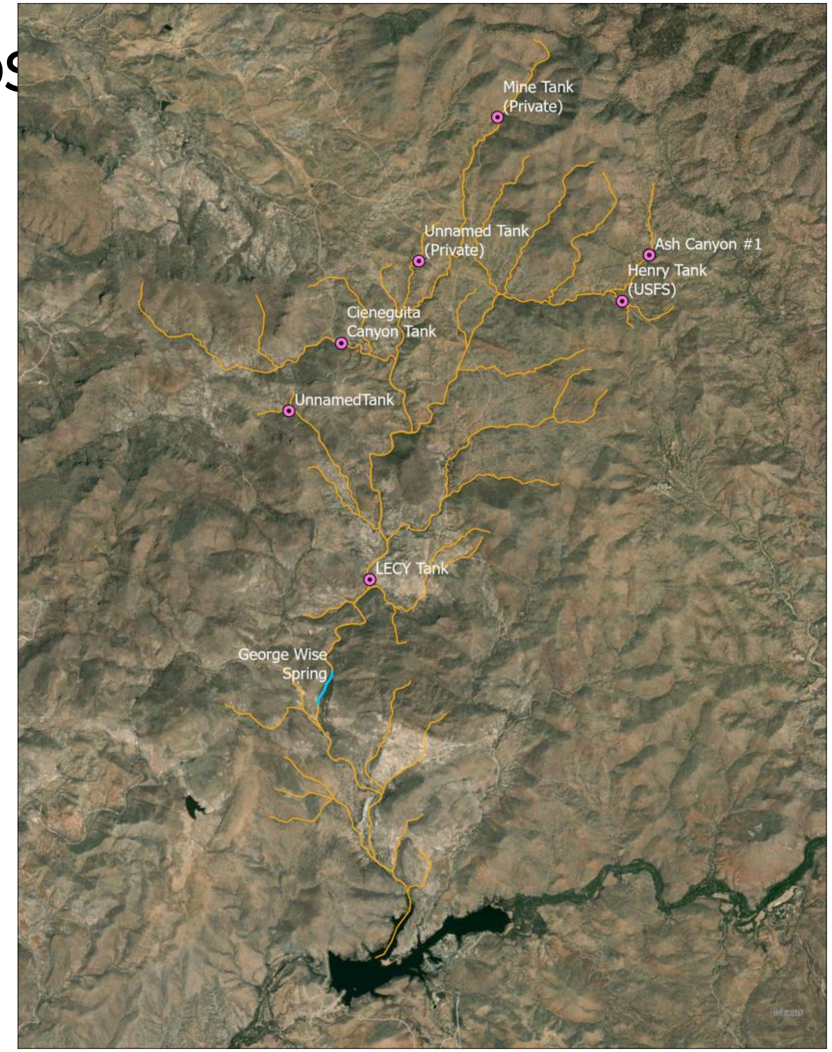
Proposed Work

Eradicate Green Sunfish from any stock tanks and perennial water in the drainage using appropriate techniques (pending FY24 results)

Follow-up surveys to confirm eradication success

Proposed Cos

$49,045



Eagle Creek Spikedace and Loach Minnow Reintroduction

Proposed Work

Initial baseline monitoring and habitat mapping

Proposed Cost

$19,880

Aquatic Research and Conservation Center Populations

Proposed Work

Propagation and maintenance of hatchery stocks

Collection of wild brood stock from the wild, and fish health assessments

Research to improve propagation success

Proposed Cost

$146,471