Impacts of Water Level Management Decisions on Overwintering Turtles

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Presentation Overview

- Project origin and need
- Background on overwintering in turtles: What can literature tell us?
- Methods: Tracking, tagging, visual surveys, and GIS modeling
- Results
- Key Takeaways

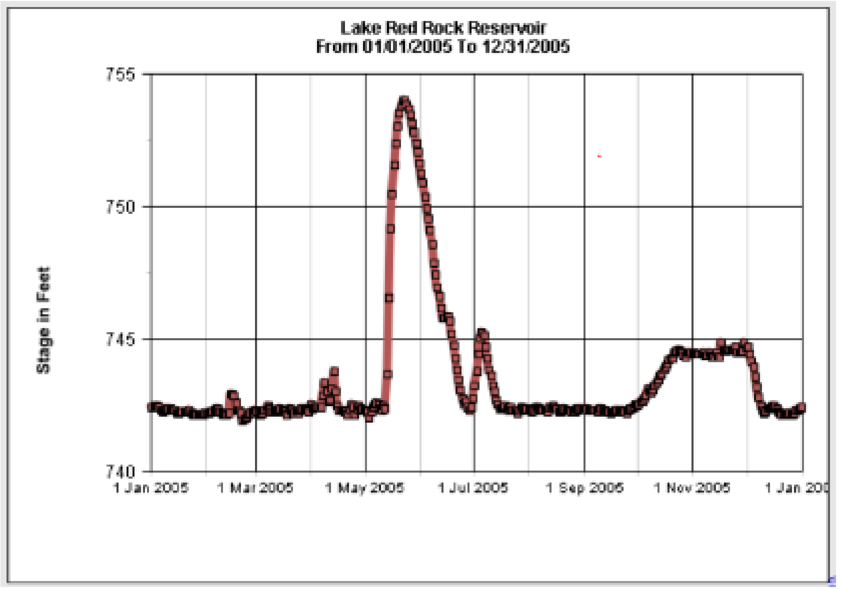
Original Statement of Need

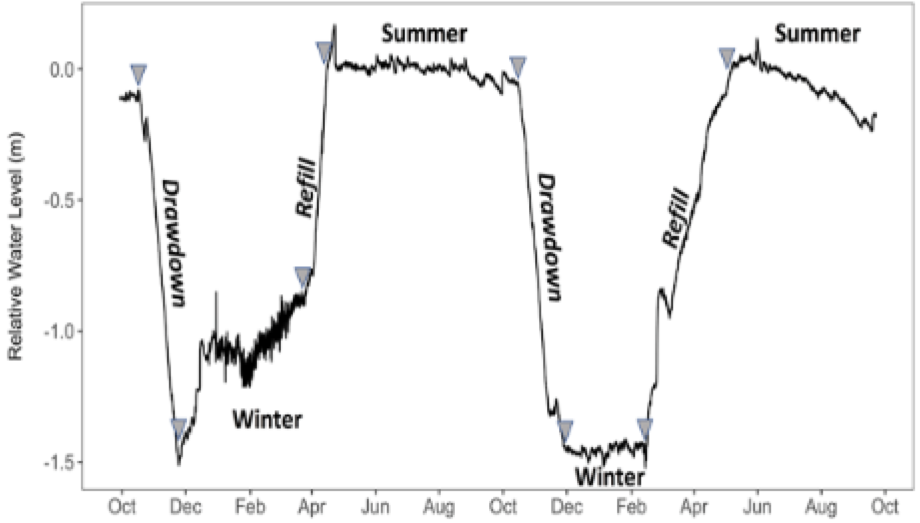
- SON: 2019-1365, “Impacts of Water Level Management on Overwintering Reptiles and Amphibians”

- Need: Determine the overwintering habitat use of reptiles and to assess the potential impacts of lake level management decisions may have on turtle populations in USACE reservoirs.

Winter Water Draw-downs

- A popular reservoir management practice where pool levels are lowered during the winter months. Can provide benefits such as:
  - **Improved Flood Control-** Creates storage for winter rains and snowmelt to prevent downstream flooding.
  - **Vegetation Management**: Exposes shorelines to control invasive aquatic plants.
  - **Other habitat Benefits**: Enhances habitats for wildlife by exposing mudflats

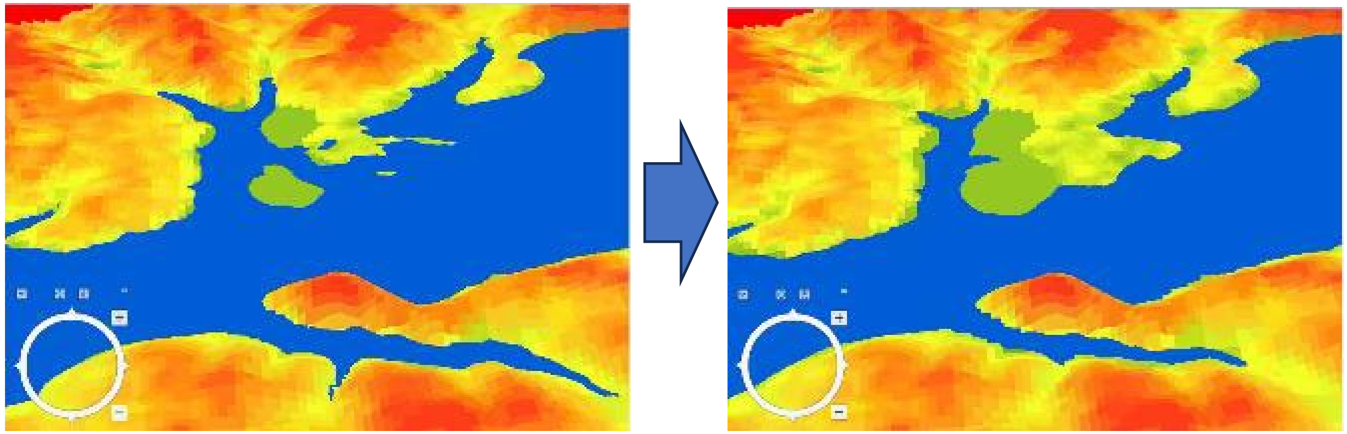




Potential problems with this practice

- **Loss of Habitat**: Potential loss of viable overwintering sites.

- **Interrupted Hibernation**: Species that overwinter in moist environments may be disrupted or die if those habitats dry out.



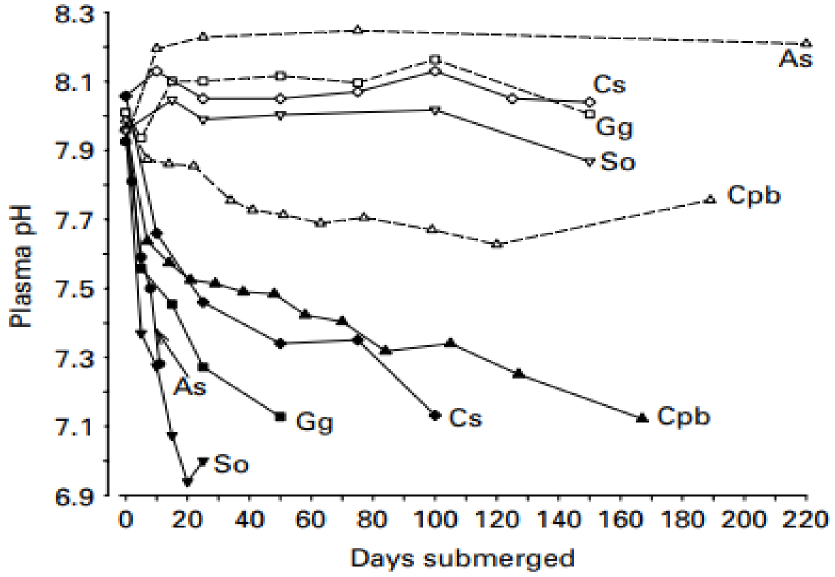


Fig. 2. Changes in plasma pH as a function of time submerged at 3 °C in normoxic (open symbols) and anoxic (filled symbols) water for several species of turtles. All species in normoxic water accumulated little or no lactate, resulting in minor changes in pH of little physiological significance, and prolonged survival. In anoxic water, only *Chrysemys picta bellii* and *Chelydra serpentina* could survive more than 45 days, by minimizing the change in pH that accompanied the buildup of lactate. Abbreviations are Gg (*Graptemys geographica*); As (*Apalone spinifera*); So (*Sternotherus odoratus*); Cs (*Chelydra serpentina*); Cpb (*Chrysemys picta bellii*). (Data compiled from Ultsch & Jackson, 1982*a*; Ultsch, 1988; Ultsch & Cochran, 1994; Reese *et al.*, 2001, 2002, 2003, 2004*a*; G. R. Ultsch & S. A. Reese, unpublished data.)

Potential problems with this practice

- **Exposure to Predators**: Reptiles may be forced into open areas, increasing vulnerability to predators

- Adult turtles may be unable to move or too slow moving to avoid predators
- Though not the primary concern, under the right conditions predation over winter can be devastating (Bulte et al.)
- Small turtles such as bog turtles, musk turtles, painted turtles, and hatchlings overwintering in the nest are most at risk

So where do turtles overwinter?

Well… that's a complicated question.

A Few Things to Consider:

- Your project's latitude and number of warm winter days
- Freeze window length
- Species present and their respective freeze/anoxia tolerances

Brumation/Hibernation/Overwintering

•Brumation is a state of dormancy in reptiles, including turtles, during cold weather

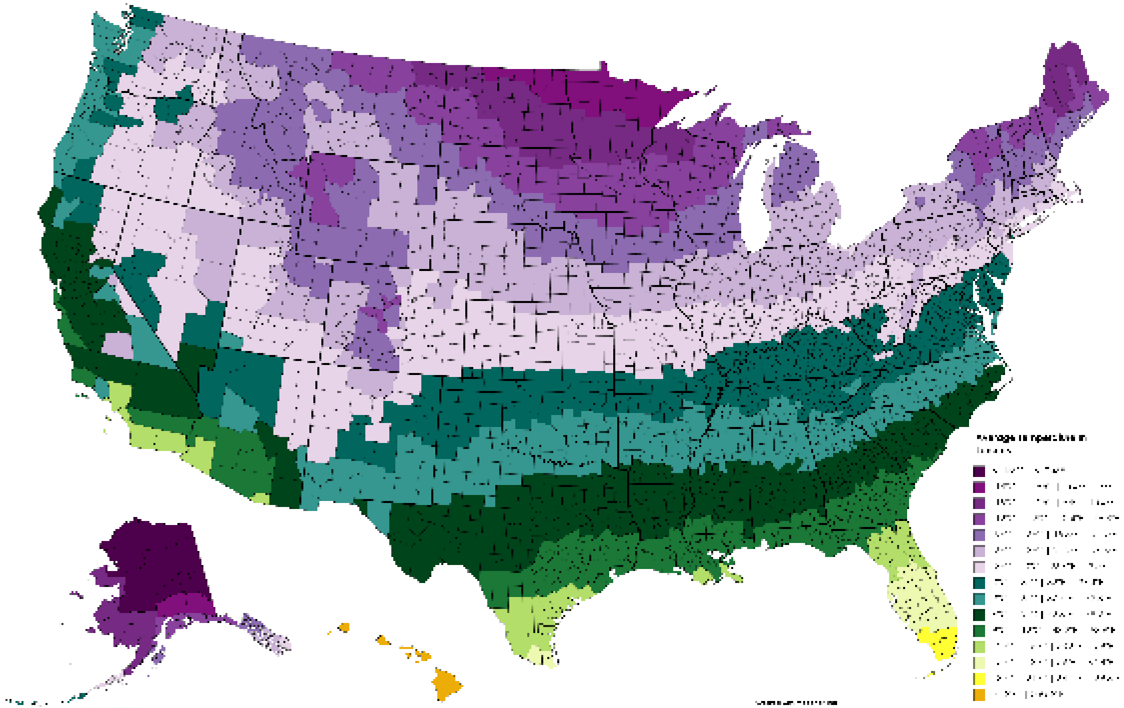
•Turtles become lethargic, stop eating, and seek shelter in burrows, mud, or under submerged debris to conserve energy.

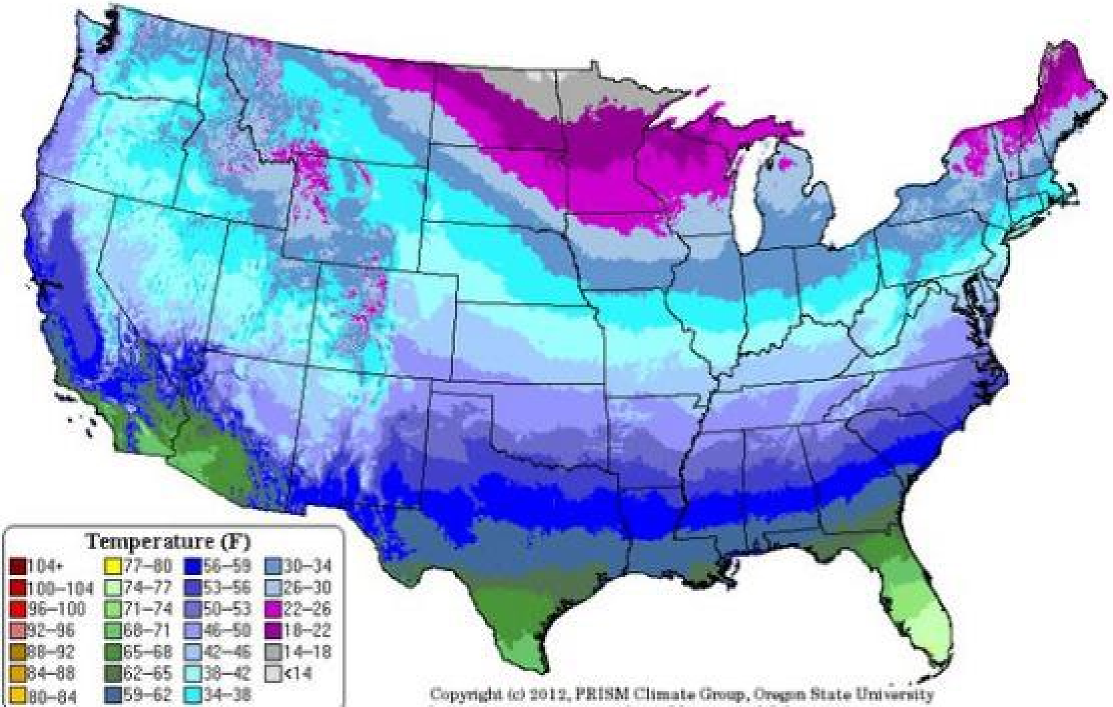
•Their metabolism slows significantly (with the heart rate of some species dropping to a single beat per minute), allowing them to survive for months
•the winter months.

Oxygen Uptake

- Brumating turtles can acquire oxygen in a few ways
  - Through highly vascularized tissues while submerged
  - Breathing air when possible
  - Specialized behaviors
  - Only very anoxia tolerant species can remain buried for extended periods of time

Latitude and Freeze Period Length

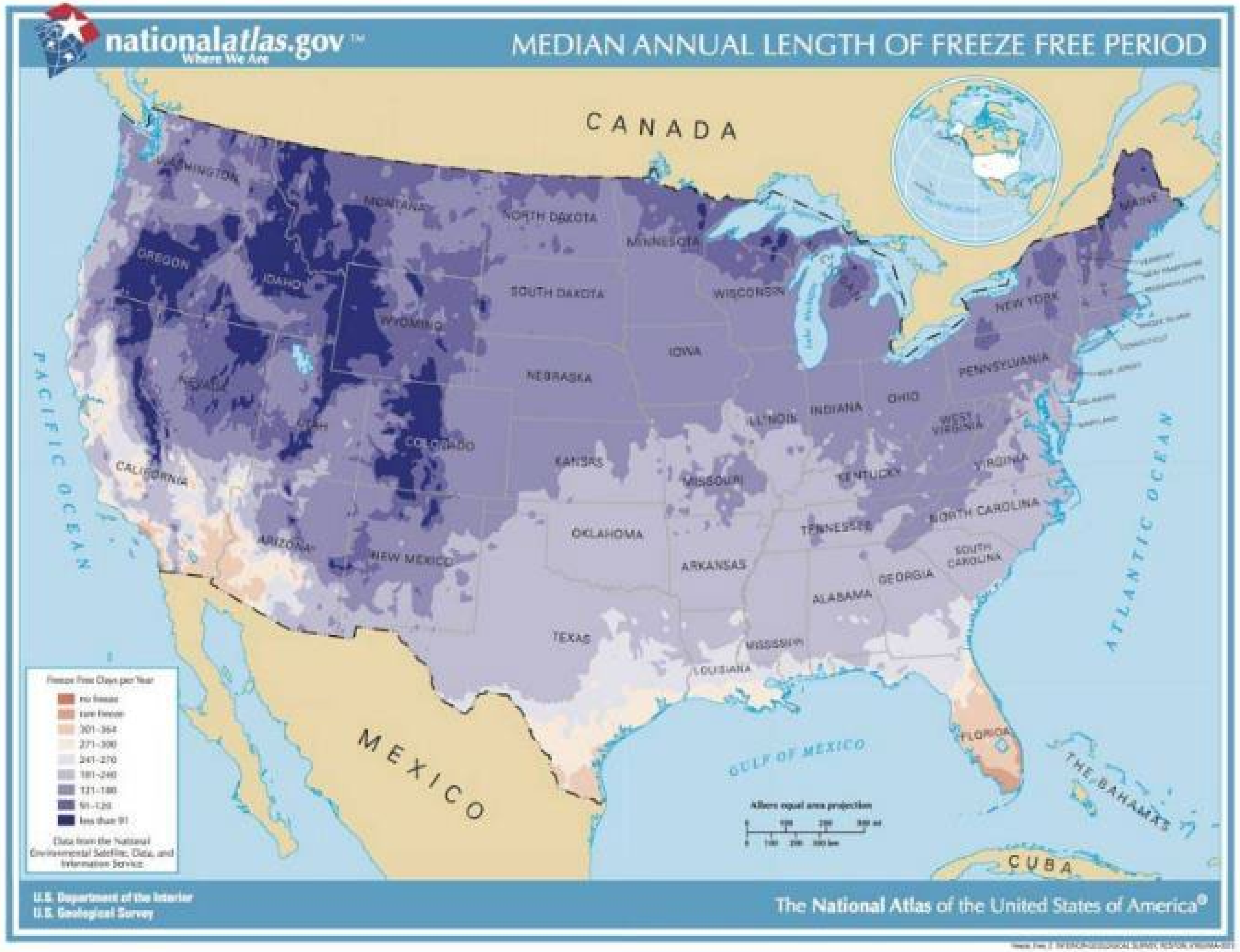




- Top: Average temperature in January
- Bottom: Maximum temperature in January (1981-2010)
- Lake Red Rock has average temperatures well below freezing in January, and the maximum temp rarely exceeds freezing
- Kansas as a comparison

How long is the duration of freezing?

- Median annual length of freeze period across the continental U.S.



Widespread Northern Species

Fig. 1. The approximate northern limits of distribution of eight species of freshwater turtles (after Ernst *et al.*, 1994) that range into Canada (a ninth, *Clemmys* [*Actinemys*] *marmorata*, historically reached into the southern part of British Columbia, but it is not included here because of its present uncertain status in Canada). 1 = *Chelydra serpentina*; 2 = *Chrysemys picta*; 3 = *Clemmys guttata*; 4 = *Clemmys* (*Glyptemys*) *insculpta*; 5 = *Emydoidea blandingii*; 6 = *Graptemys geographica*; 7 = *Sternotherus odoratus*; 8 = *Apalone spinifera*. The southern limits (not shown) of the ranges vary much more among these species than do their northern limits.








Hibernation Preferences

Species	Scientific	Prefered Depth (M)	Prefered Hibernacula	Lactic Acid	Notes
Common Snapping Turtle	*Chelydra serpentina*	<1	In shallow water on top of sediment. Sites with flow or high disolved oxygen are preferable when available.	High	Studies show a preference for high disolved oxygen
Painted Turtle	*Chrysemys picta*	1-2.5	Shallow water, typically on top of sedament unless predation or ice forces burial (1-2.5 M)	High	Offspring overwinter in nest and can tolerate
Spotted Turtle	*Clemmys guttata*	<.5	Underwater typically (rarely on land). Will relocate to overwinter, with swamp	High	
Wood Turtle	*Clemmys*	0-1	Exposed, buried, or partially buried	Low	
Blanding's Turtle	*Emydoidea blandingii*	<1	In shallow water or buried in mud if ice forms down to the substrate	Likely High but	Hatchling overwintering has
Northern Map Turtle	*Graptemys geographica*	<1	Shallow water, typically on top of substrate. Can only survive burial for around 45 days	Low	
Common Musk Turtle	*Sternotheru s odoratus*	0.5	Aquatic in the northern portion of their range, and potentially terrestrial in the southern portion. Utilize burrows underwater and bury themselves shallowly, where the water column can still be easily	Low	
Spiny Softshell Turtle	*Apalone spinifera*	0.5	On top of substrate in shallow water. Can not survive long periods burrowed in substrate and must remain mobile.	Low	Utilize deeper hibernacula in northern extent of

Our Approach

- **Task 1: Initial scouting visit and literature compilation**
  - Obtain permits, file IACUC approved protocol, complete a literature review
  - Confirm species presence at Brown Lake and at Lake Red Rock in
- **Task 2: Local field demonstration**
  - Initial effort at Brown Lake to perfect transmitter attachment techniques and identify any issues with equipment/tracking.
- **Task 3: Large-scale field testing at Lake Red Rock**
  - Overwinter tracking/relocation of turtles and snakes in Iowa
- **Task 5: Desktop Studies**
  - 3D mapping, water removal modeling, characterization of coves, and general mapping
- **Task 6: Result Write-ups**

Trapping

- We utilized swim in and basking traps to capture turtles in Lake Red Rock, IA in the summers of 2022 and 2023 (½ in Memphis Net and Twine, **Fig 1**).
- Traps were checked 1-2 times daily and rebaited when necessary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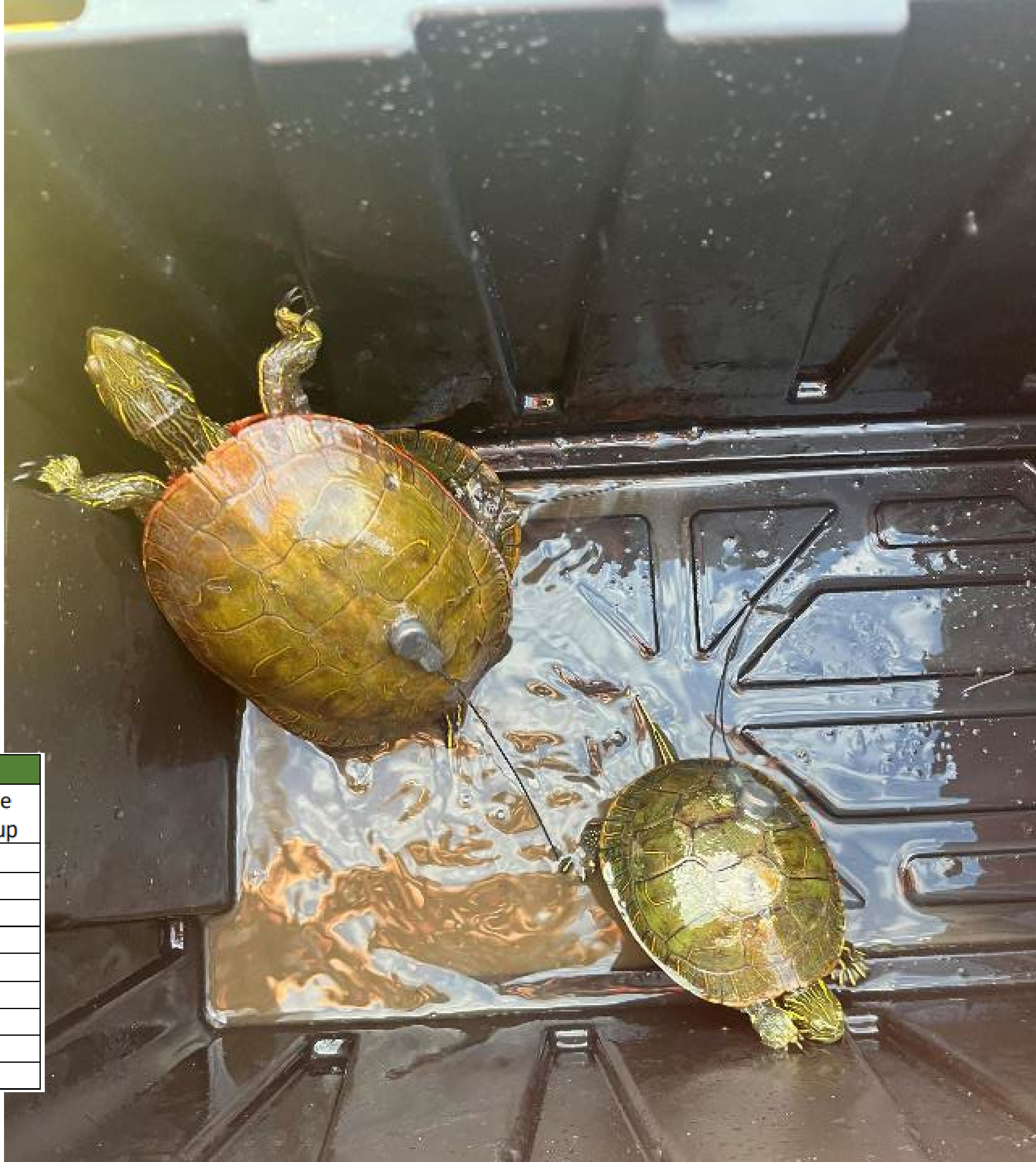
Tagging

- Turtles captured were then weighed and fitted with telemetry transmitters (Advanced Telemetry Solutions, R-1680 models).
- Transmitter weight did not exceed 5% of bodyweight (minimum 72 grams)
- Transmitters were affixed immediately after capture using water-proof epoxy with a one hour curing time. Tagged turtles then returned to their site of capture.

MODEL SPECIFICATIONS												
Model	Battery	Battery Capacity (days)			Dimensions (mm)					Weight (grams)	Price Group
	1.5V	30 ppm*	40 ppm	55 ppm	A	B	C	D	E		
R1610	379	34	20	14	7	18	5	5	9	1.0	A
R1620	377	58	34	25	8	19	5	5	9	1.3	A
R1630	392	94	55	40	9	20	6	6	9	1.7	A
R1640	394	164	96	70	11	22	5	5	9	2.0	A
R1650	393	158	93	68	9	20	7	5	9	2.2	A
R1660	389	198	116	85	13	24	5	5	9	2.5	A
R1670	386	257†	150	110	13	24	6	5	9	3.1	A
R1680	357H	441†	258	189	13	24	7	5	9	3.6	A



Relocating

- Turtles were relocated during winter as closely to ice over as possible (to limit difficulties interpreting signal direction) using biangulation techniques from the shoreline.
- Depth of overwintering sites was approximated in 2023 from nautical maps and confirmed by measurement in 2024.

(Note* early ice-over prevented relocation in winter 2021-2022, so relocation data exists only for the winter of 2022-2023)

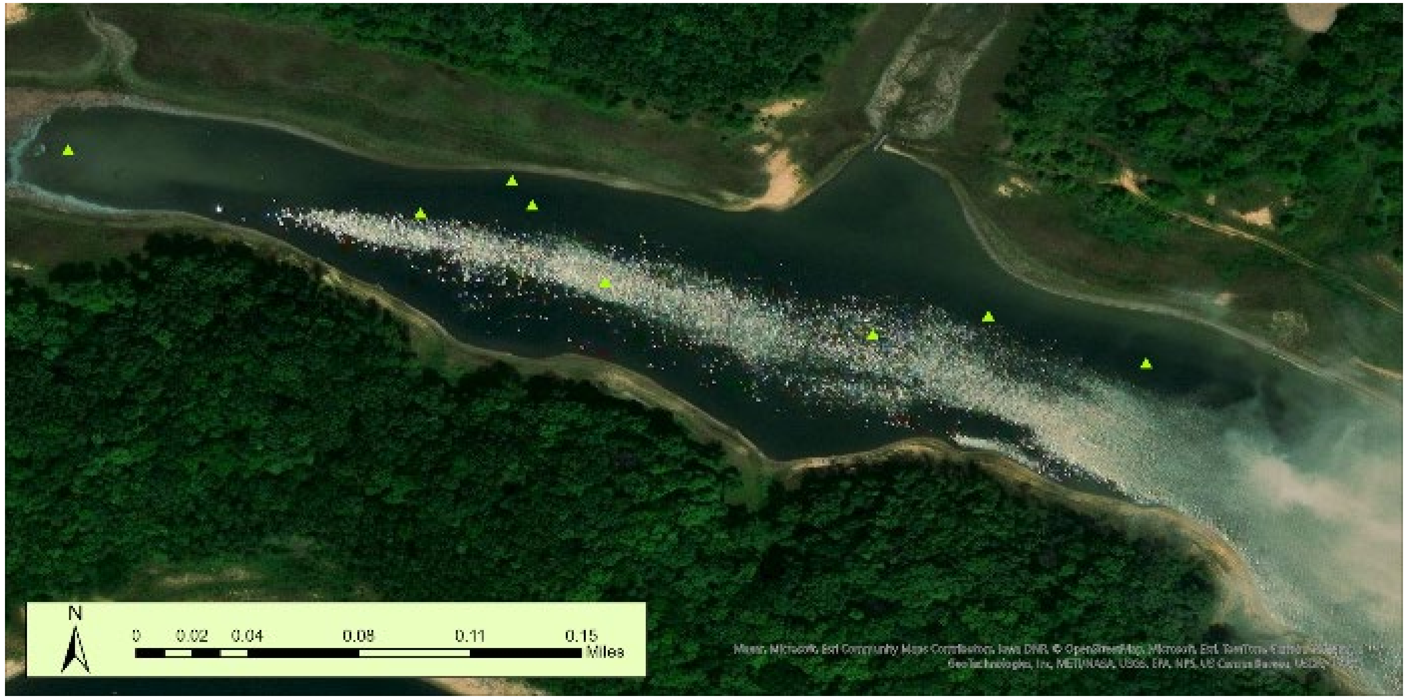
Visual Surveys

- In the summer of 2024, we conducted trapping and visual presence/absence surveys in coves across Lake Red Rock.
- Eight coves were trapped and visually surveyed for three consecutive days by a group of researchers.
- Habitat data were either collected in the field or calculated for each cove using ArcGIS.

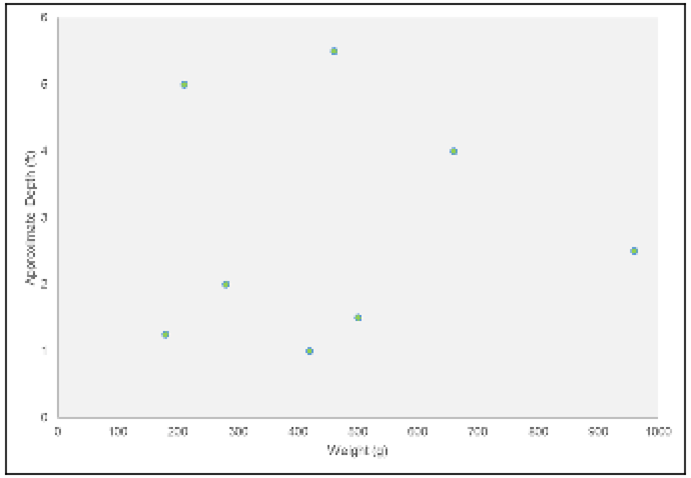
- The data included the number of basking objects, average cove depth, deepest point, shoreline complexity, substrate type, average elevation, minimum and maximum elevation within each cove, and distance from the dam.

Tracking Results

- In year 1, 9 turtles of tracking size were trapped. Unfortunately, early ice prevented accurate relocation. In year 2, 8 turtles were tagged and successfully tracked to overwintering sites.

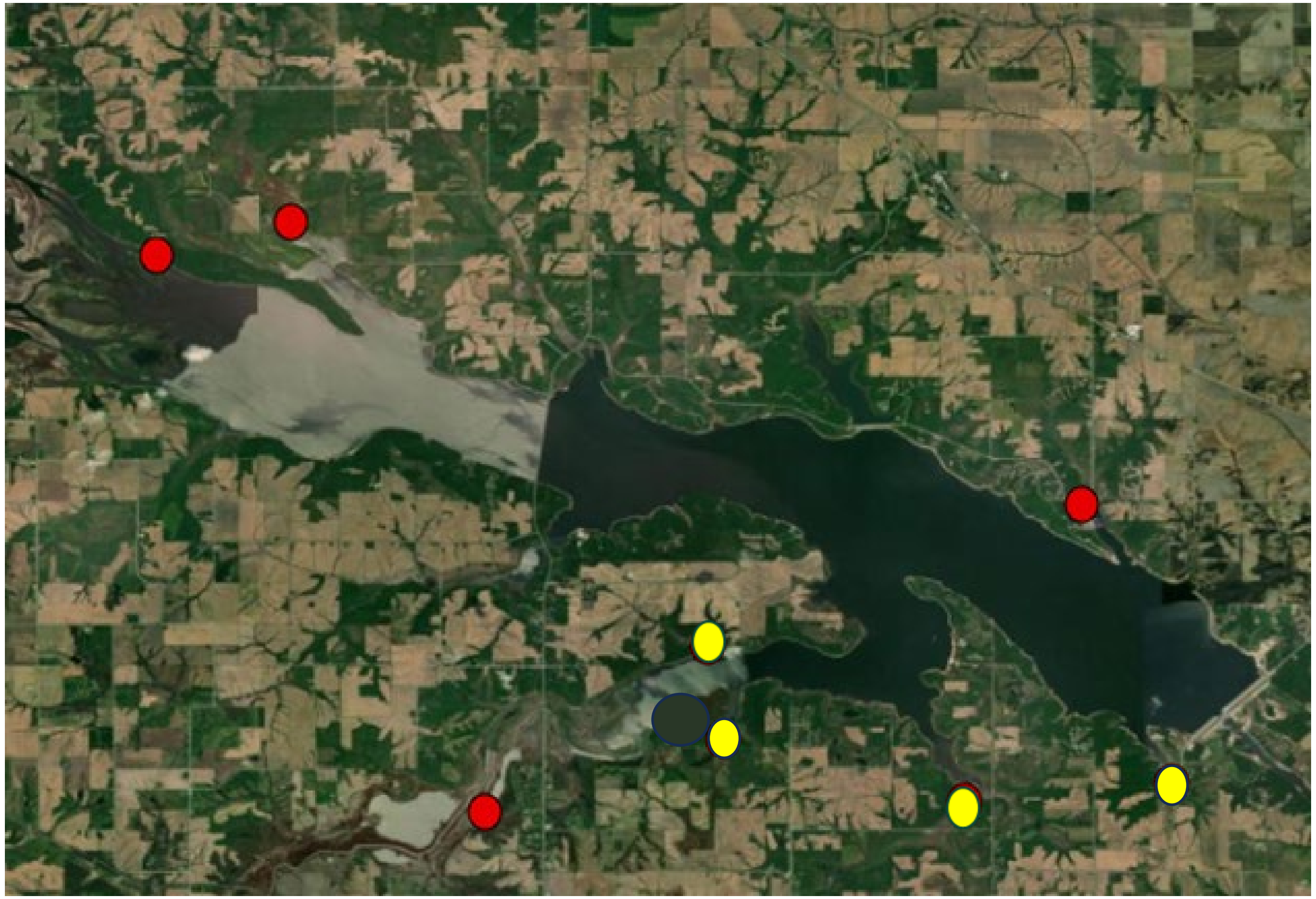


- All turtles tagged overwintered in their original cove of capture (Fig 4). The mean depth of overwintering sites was 2.84 ft (range= 4.5 ft).



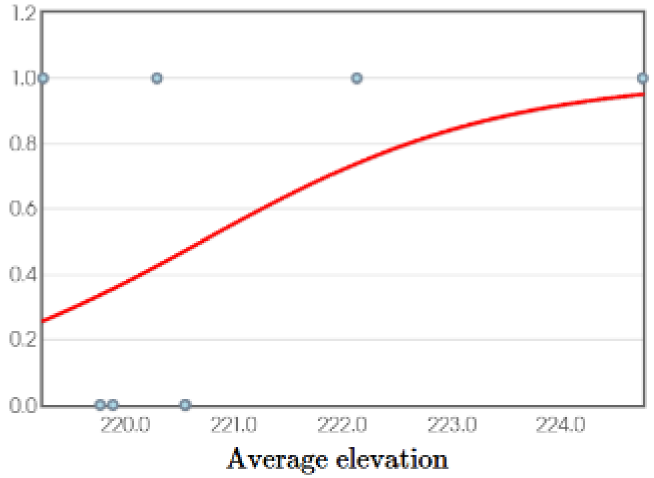
There was no relationship was found between weight in grams and approximate depth of overwintering site (r= 0.0436, p-value=

Presence/Absence Results

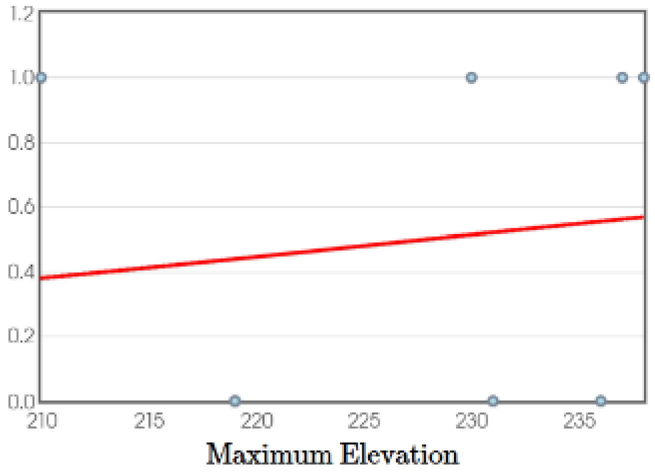


- Of the eight coves surveyed, four were positive for turtle presence.
- Multiple binary logit regression models were used to explore the relationships between presence/absence and the recorded habitat metrics

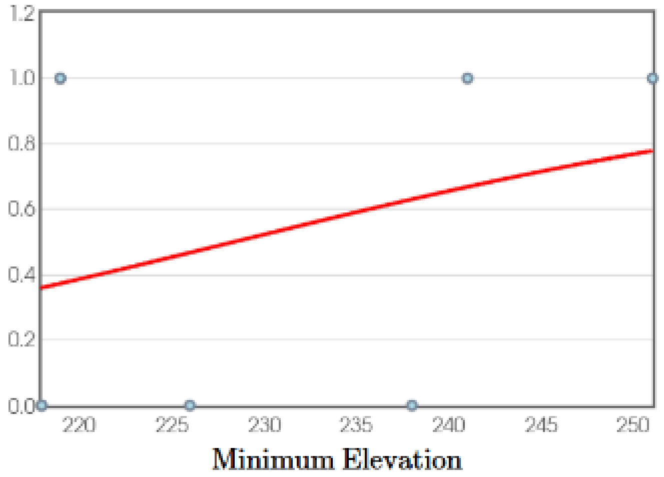
Habitat Metrics for Coves



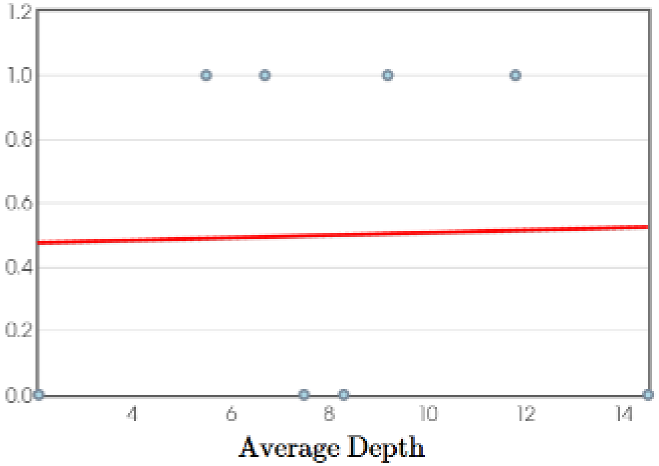
Chi-Square = 1.6976 $df = 1$ p-value = 0.1926



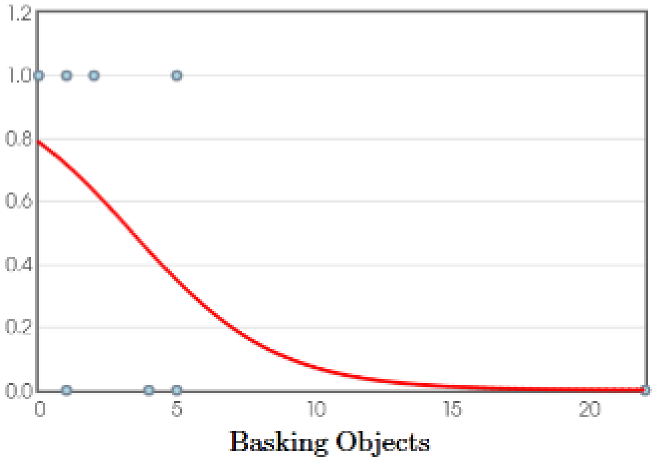
Chi-Square = 0.1355 $df = 1$ p-value = 0.7128



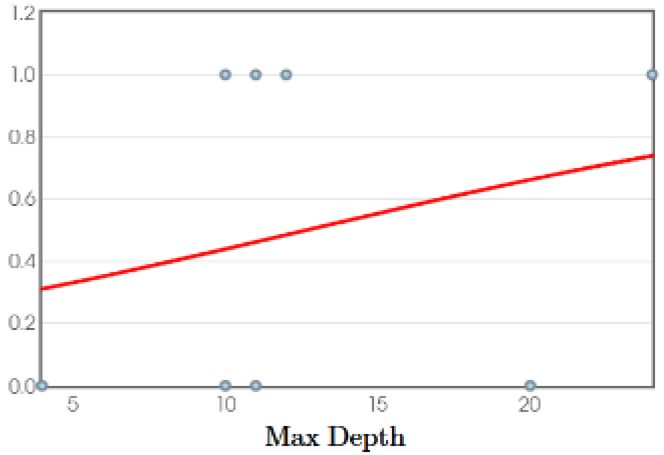
Chi-Square = 0.8018 $df = 1$ p-value = 0.3706



Chi-Square = 0.0063 $df = 1$ p-value = 0.9365



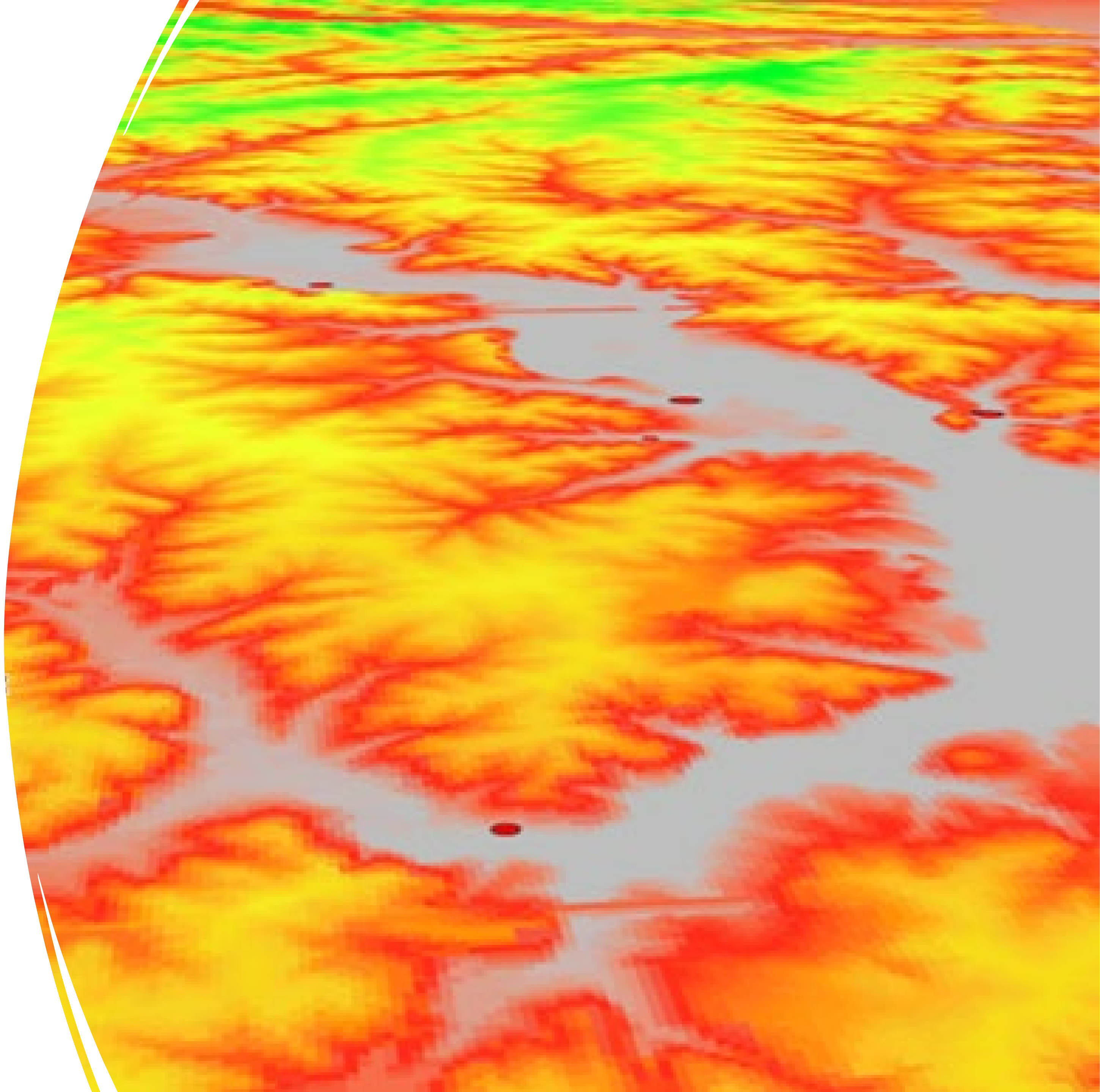
Chi-Square = 2.3785 $df = 1$ p-value = 0.1230

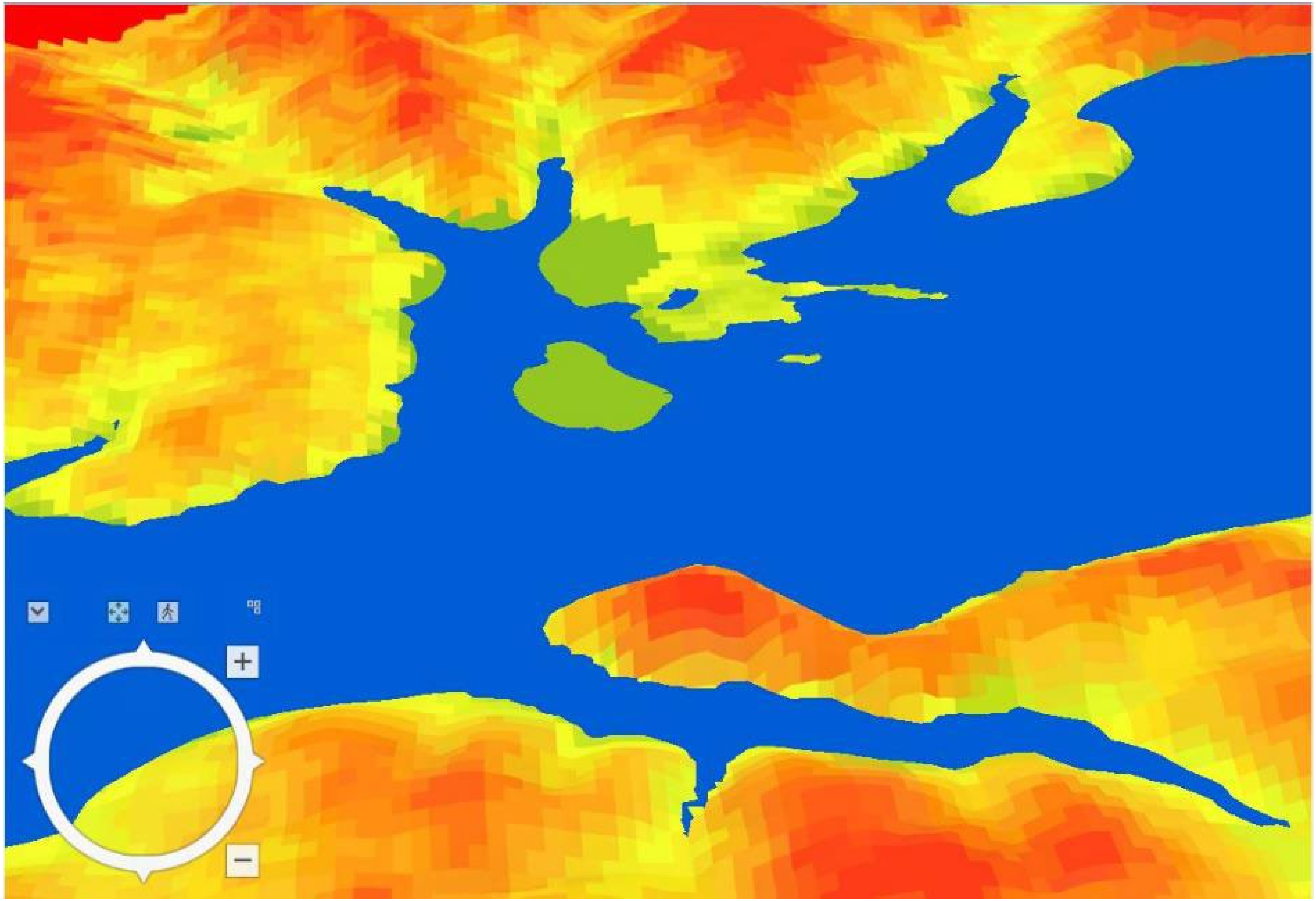


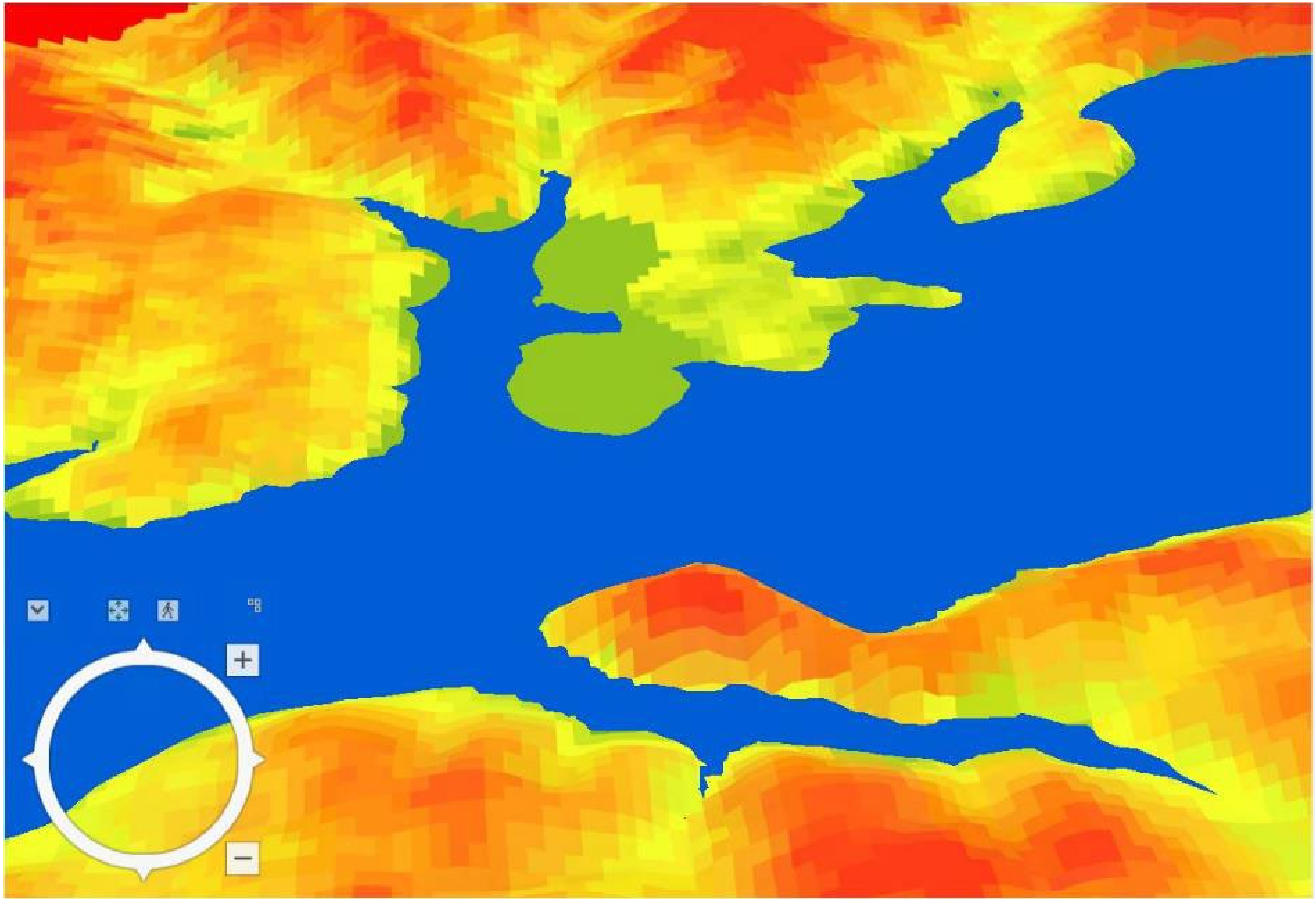
Chi-Square = 0.5344 $df = 1$ p-value = 0.4648

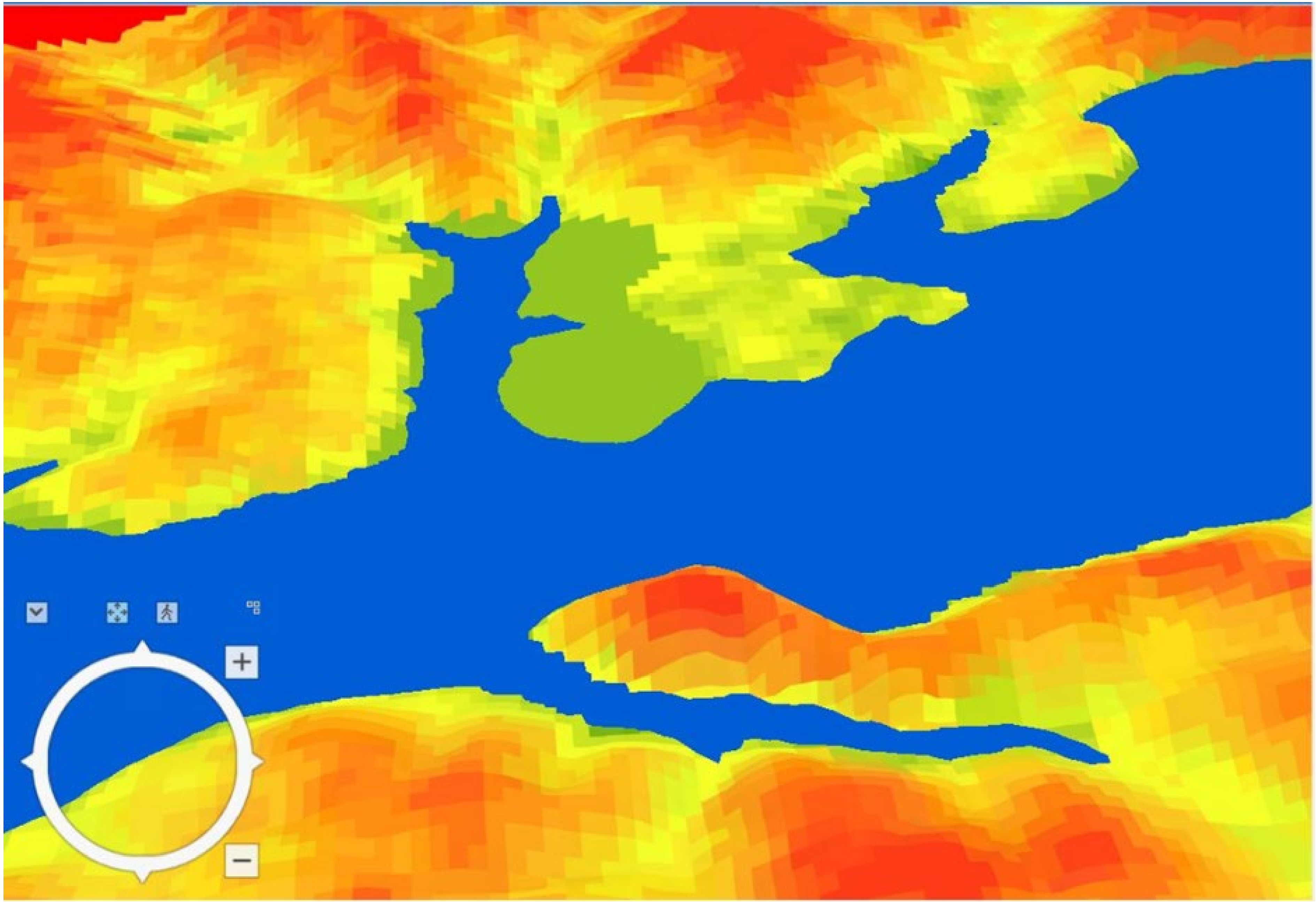
Results: Simulated draw-downs

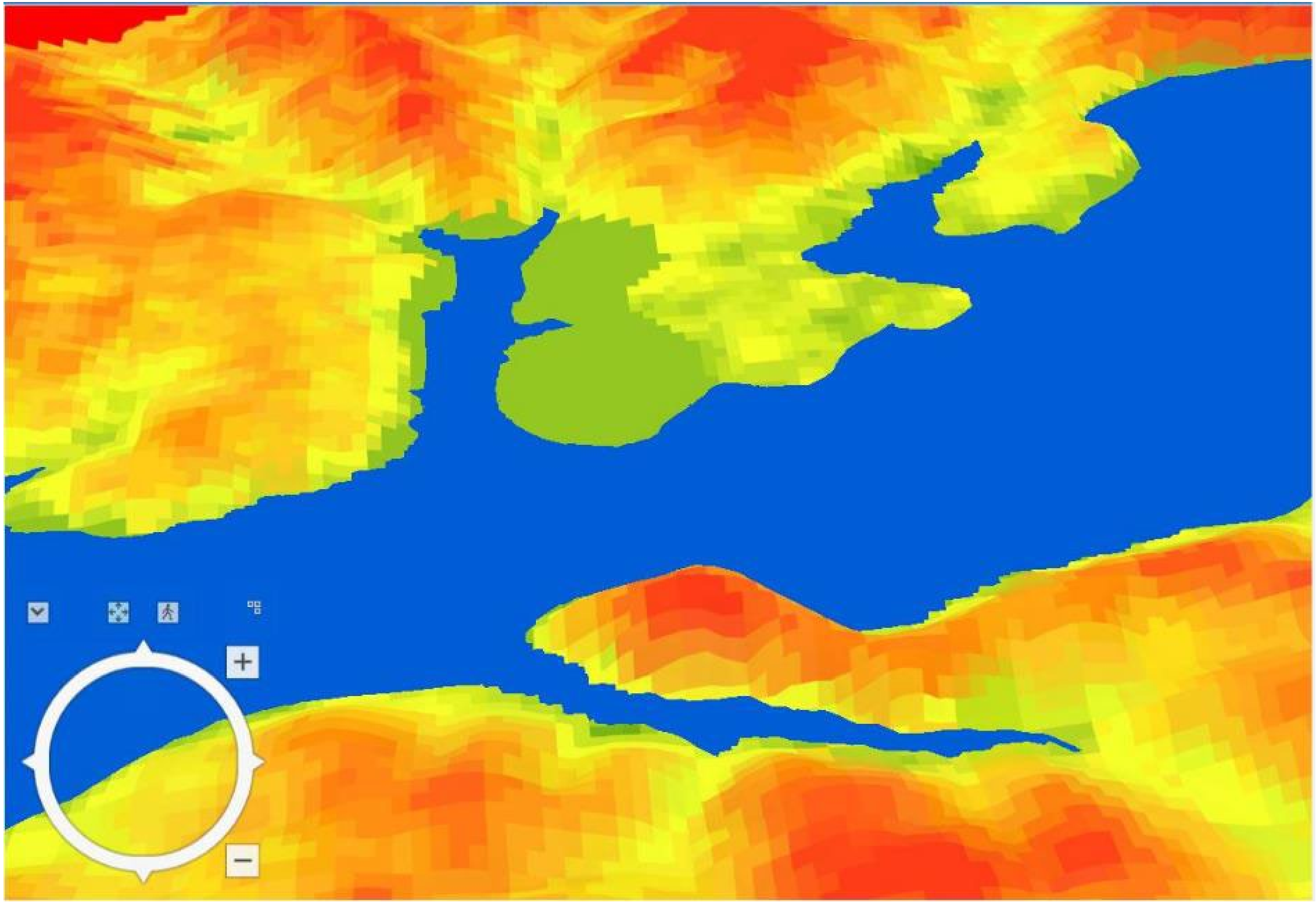
- Elevation data from USGS was plotted and rendered in a 3D map scene in ArcGIS Pro.
- That layer was then inundated at different elevations and drawn back in phases

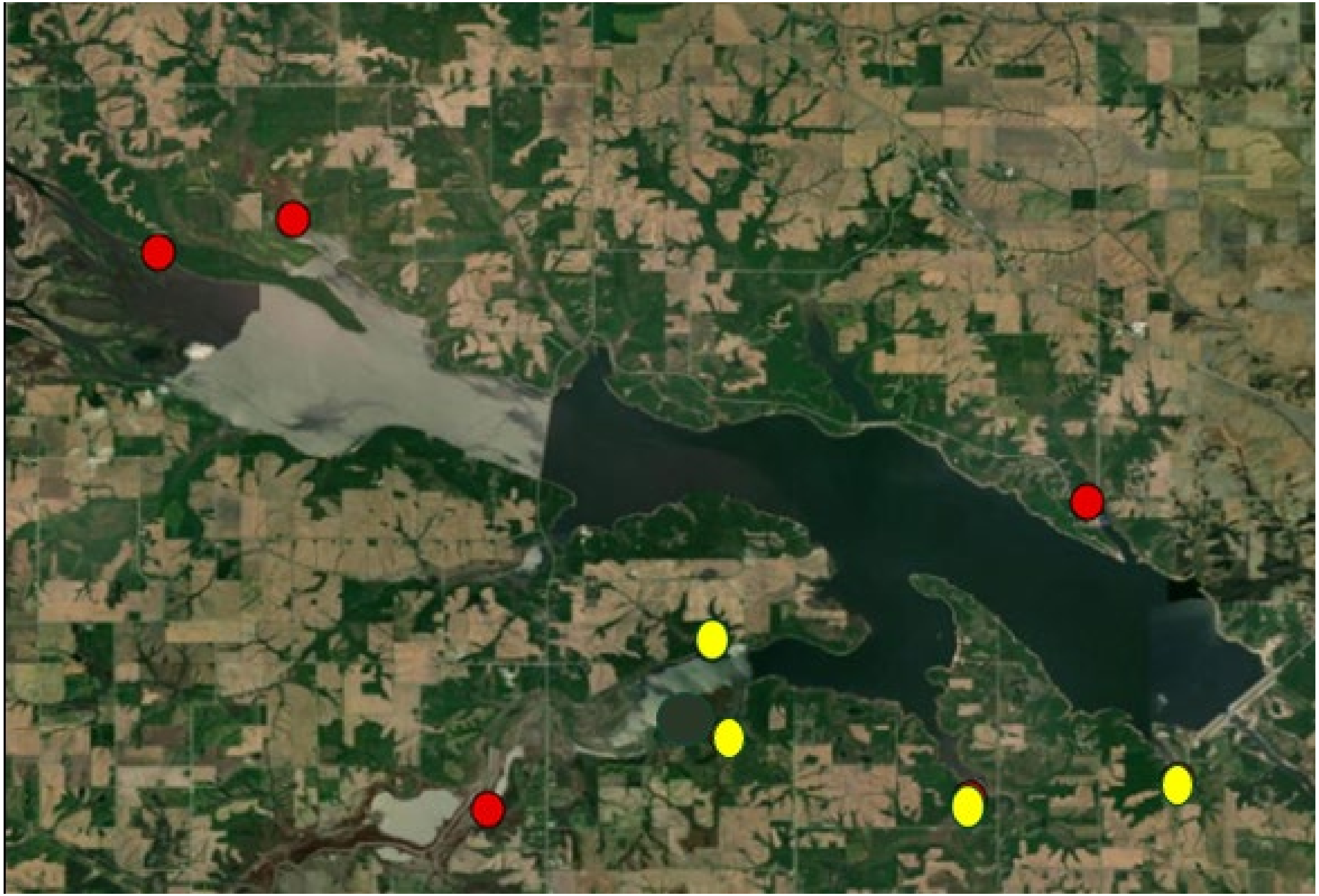


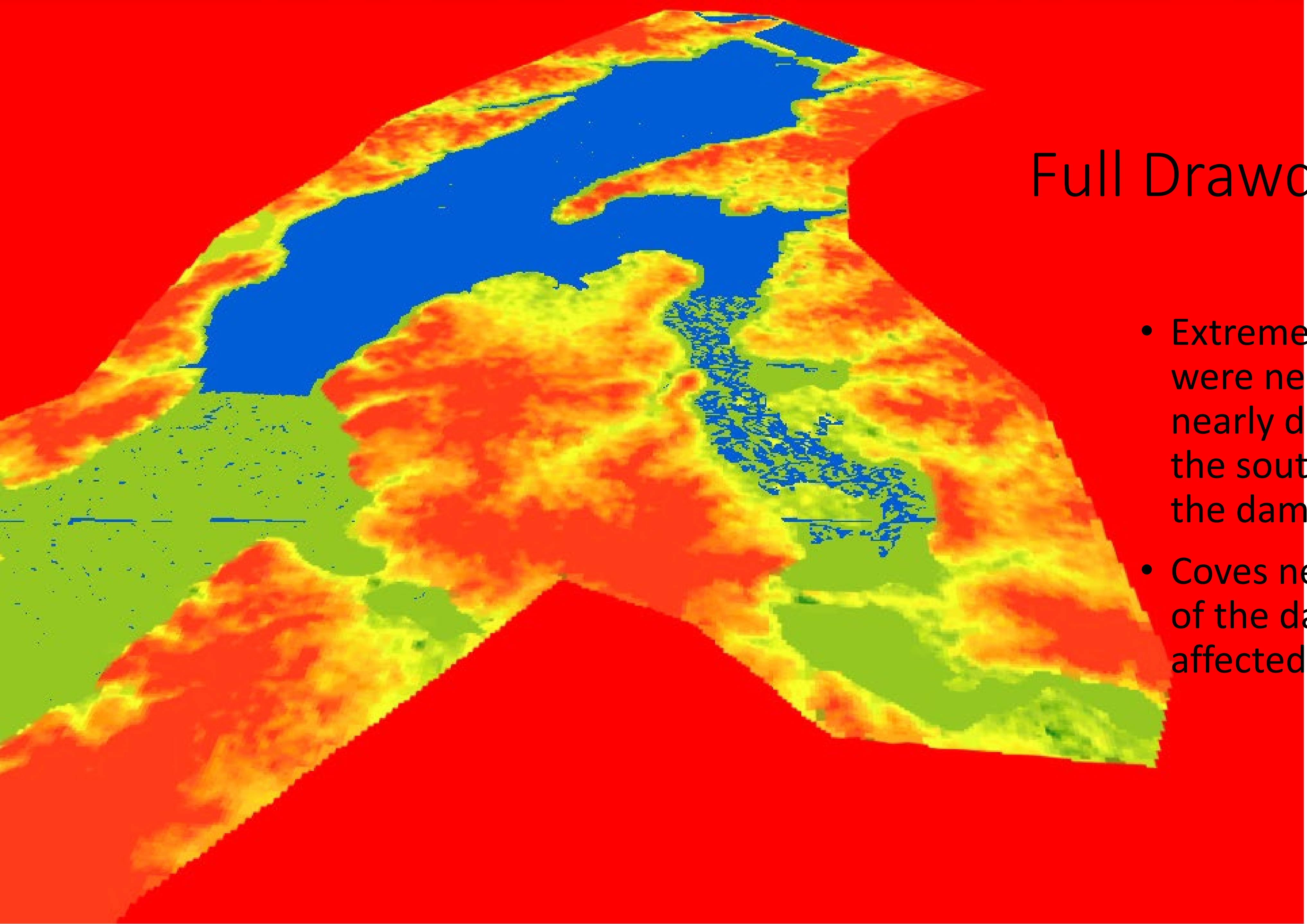












Full Drawdown

- Extreme reductions were necessary to nearly dry coves on the southern side of the dam
- Coves near or south of the dam were affected more slowly

Results for Latitude and Distance to Dam

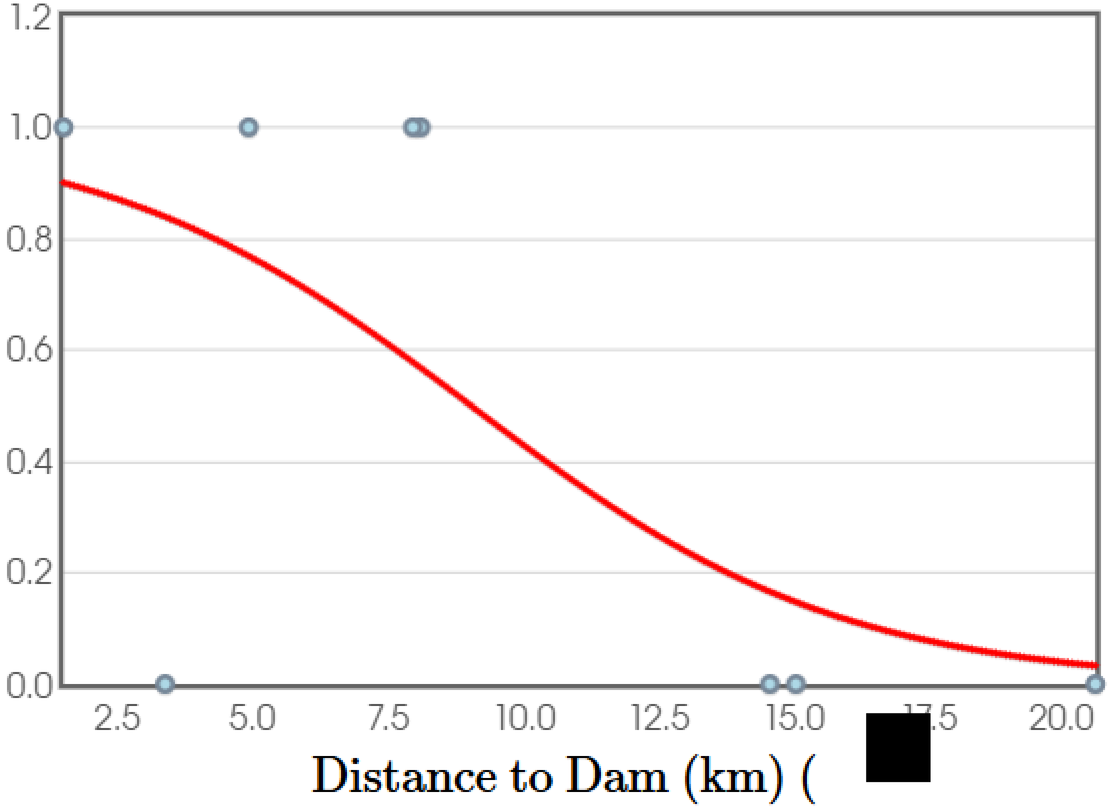
- A multiple binary logit regression considering distance to dam in km and latitude
- Results were significant (p-value= 0.0039)
- These results indicate that the geographical location of coves in relation to water control structures is more important than habitat variables

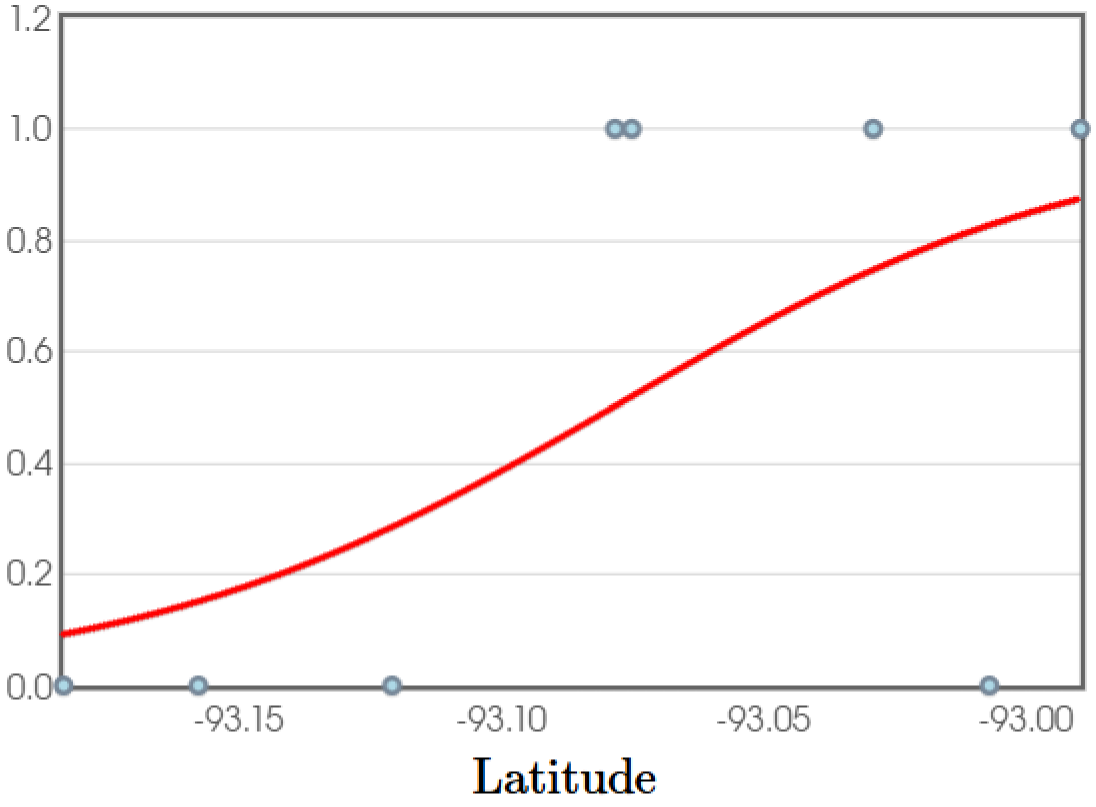
Chi-Square $= 11.0904$ $df = 2$ p-value $= 0.0039$

Model: $$P = \frac{1}{1 + e^{-(56157.0078 - 230.2751x_1 + 17814.9438x_2)}}$$

Distance to Dam (km) (	Latitude	Presence/Absence	P	95% Confidence Interval
4.9450	-93.0295	1	1.0000	(0.0000, 1.0000)
8.1220	-93.0754	1	1.0000	(0.0000, 1.0000)
7.9770	-93.0786	1	1.0000	(0.0000, 1.0000)
14.5700	-93.1210	0	0.0000	(0.0000, 1.0000)
15.0500	-93.1578	0	0.0000	(0.0000, 1.0000)
20.5800	-93.1835	0	0.0000	(0.0000, 1.0000)
3.4020	-93.0074	0	0.0000	(0.0000, 1.0000)
1.5260	-92.9901	1	1.0000	(0.0000, 1.0000)

Visualizations





Cove 5 (Absent) Historical imagery

Cove 2 and 3 (Present) Historical Imagery

Key Takeaways

- All turtles tagged overwintered in their original cove of capture
  - While turtles are likely mobile to some degree after ice over, movements over significant distances were not observed.
- The mean depth of overwintering sites was only 2.84 ft
  - This is important, as reservoir drawdowns can pull water levels down relatively rapidly
- Overall, few of the habitat variables considered seemed to affect presence/absence
  - Number of basking objects present, average elevation, min elevation, max elevation, etc. did not significantly affect presence/absence in coves
  - Location relevant to dam appears to be extremely important
  - This might be due to the speed at which water exits coves further from the dam during drawdowns

Acknowledgements

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