Northern Redbelly Dace Conservation Data Science Project

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Abstract:

With this project, we are attempting to figure out the necessary water quality conditions for breeding and the conservation of the Northern Redbelly Dace. Throughout our research we have been able to find two sites to release the dace and we have successfully done so in both locations. Through this project we have learned a lot about water quality and what good water quality looks like. We have also learned to work and collaborate with peers, as well as graduate students and professionals. We have learned how to work in an aquatic field setting and learn safety parameters. For the future of our project we want to continue to release the Northern Redbelly Dace into new sites so that one day they are able to repopulate the Colorado waterways on their own.

Research Question:

What are the necessary water quality conditions for breeding and the conservation of the Northern Redbelly Dace?

Introduction and Review of Literature:

The Northern Redbelly dace is an endangered species in Colorado. Their populations had been dying out for years but the flood in 2013 had a detrimental impact on their populations by destroying their habitats. This species is largely unknown by the community and it has been our mission not only to start to breed and reintroduce the Northern Redbelly Dace, but also to inform the community about them. These fish are extremely important to our local ecosystem. They are not only important for biodiversity but also because they are indicator species. Indicator species are animals that are extremely sensitive to the environment and the changes within it. This may seem like a bad thing but it actually helps scientists to see if things are going wrong in the ecosystem and hopefully be able to fix the problem before it gets worse. We have been working with wildlife biologists from Colorado Parks and Wildlife and Boulder County Parks and Open Space to learn about this species, as well as the ideal habitats for successful conservation. Our project has been working with breeding and releasing these fish. We have set up and monitored a fish hatchery within our school to breed the Northern Redbelly Dace with the help of biologists from Ocean First Institute. We then continue to work with our community partners to monitor our field locations where we have released the fish, as well as scout out future release sites. We do this by collecting data in the field, as well as collecting samples to test back in the lab.

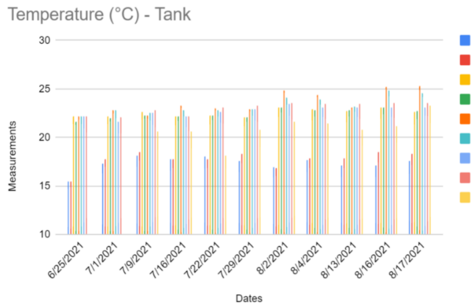
Research Methods and Materials:

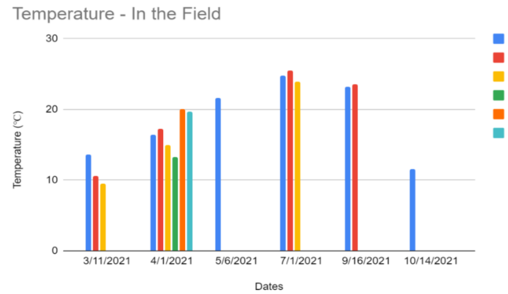
Throughout the different stages of the project we have used many different methods. When doing research on the habitat of the Northern Redbelly Dace we go out into the field and take different data measurements using the different sensors we have access to. These sensors include a YSI sensor, PASCO probe sensors, API Freshwater Master Test Kit (tests pH, High Range pH, Ammonia, Nitrite, Nitrate), and we are working toward building and programing our own Atlas sensors that will be attached to a larger student-drive aquatic robotic project. The data we attempt to measure using the various sensors and chemical tests include: pH, dissolved oxygen, ammonia, nitrate, nitrite, temperature, conductivity and turbidity. When breeding the Northern Redbelly Dace, we increase the light period and temperature of the tanks in order to simulate a natural outside environment. This process allows the Northern Redbelly Dace to lay their eggs in horse hair mats. We use these mats to protect the eggs from the adult fish who will eat the eggs. After the fish hatch we feed them live brine shrimp until they reach adulthood.

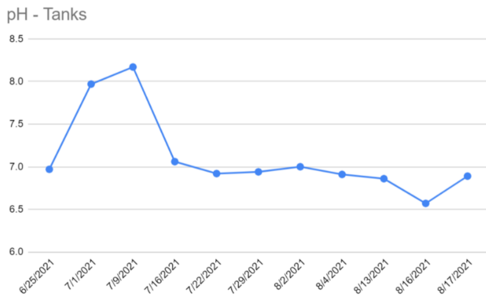
Additional research methods used were the GLOBE Observer app, where we took Cloud Observation and Land Cover data at our fish release field sites. We are using the cloud data, as well as the land cover data to help us understand the water quality data in terms of seasonal fluctuations, as well as isolated storm events. Here is our data that was collected in our field notebooks and then recorded digitally. We then graphed the data to better visualize these seasonal trends from the past year and a half.

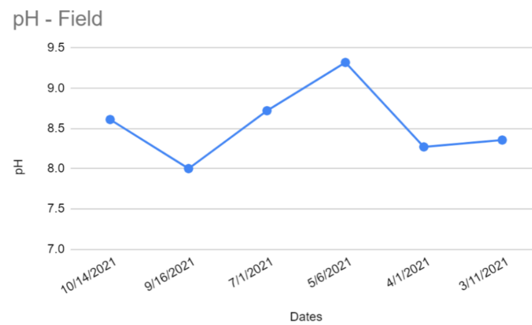
pH	**Ammonia** ppm	**Nitrite** pmm	**Nitrate** ppm	**Temperature** °F	**Dissolved Oxyg** mg/L	**Conductivity** µS/cm	**Turbidity** NTU
				56.57			
8.63				51	9.68	270	103.7
				49.1	9.68	293	102.4
7.5	0	0	0		5.33		
8.4		0					
8.6		0					
8.4		0					
8.6		0					
8.2	0	0	0	16.4°C			
8.4					7.47	337.7	
8.2	0	0	0				
				63, 59, 56, 68, 67.5			
					~6.5		
9.38, 9.5				71	10.38 (144.71%)		
9.08							
8.53, 8.9, 8.74				24.8 C, 25.5C, 2	8.8, 7.23, 10.8	247.2	
8.2	0.0ppm	0.0ppm	0.0ppm	23.6 C	11.23 mg/L	402.7 µS/cm	34.83 NTU
7.8				23.2 C	7.44 mg/L	390.4 µS/cm	
8.61				11.6 C	17 mg/L	343.2 µS/cm	8.57, 7.14, 7.48

Temperature (°C)	16.9	16.8	23.1	23.1	24.8	24.1	23.5	23.6	21.6
pH	6.6	7.2	6.8	6.8	7.2	7	7	7.2	7.2
Ammonia (ppm)	0	0	0	0	0	0	0	0	0
Nitrite (ppm)	0	0	0	0	0	0	0	0	0.25
Nitrate (ppm)	25	10	10	0	10	10	0	10	25









Results:

For this project we have not come up with a definitive answer because this project is still ongoing and we are still learning new things. So far we have decided that safe measurements for the Northern Redbelly Dace is:

- pH: 6.5 - 7.5
- Ammonia: 0
- Nitrate: 0-30
- Nitrite: 0
- Temperature: 10 ℃ - 30 ℃

We do see the normal trends of the pH getting higher in the summer months and then lower in the winter. We have mostly sunny skies in Colorado, which allow for a lot of algae growth and aquatic plant life. These plants are where the Northern Redbelly Dace like to live in the water and help their survival rates. We are hoping to use the land cover data to help us still learn about how local wildfires could affect the water quality because of storms over the burn scars just upstream. Here is a website that we made with CU Boulder graduate students to record our progress and the results of this project as it continues.

Discussion:

Through analysis of the data, our group was able to find multiple sites where Northern Redbelly Dace would have a high chance of survival if bred and released. The first release site that was used was Rooney pond, in which Northern Redbelly Dace were successfully released in October 2020. This pond did not have any pretotaty fish and is a calm groundwater feed pond about 5 meters from the St. Vrain River. This pond was formed as a result of the 2013 floods. The second release site that has been used was Webster Pond at Pella Crossing in Boulder County, which was in August 2021. This open space area used to be gravel pits and was turned into a fishing recreation area. After the 2013 floods, Webster pond was restored to be a completely native pond with native fish and plant species in and around the pond. We hope to continue to release Northern Redbelly Dace at this site, and we have continued to do different data testing to make sure that the water is still healthy for the dace released. Additionally, we are attempting to artificially breed more Northern Redbelly Dace in our school to boost the population of the Dace in the pond.

Conclusion:

There has been one confirmed successful release of the Northern Redbelly Dace at Rooney Pond. We have video coverage of the dace living successfully in this pond. In Webster

Pond, there has been no visual confirmation of the dace since our last release in August. However, we are beginning to use eDNA as a non-invasive technique of tracking the presence of the dace in the pond. To take these eDNA measurements, we can take a boat out to collect water samples and then use a qPCR machine to isolate the Northern Redbelly Dace DNA. We have recently received a grant to purchase this qPCR machine and begin to set up our own eDNA testing lab within our school.

Badge Descriptions/Justifications:

I AM A COLLABORATOR

Our group was a collaborative effort between students all over the St. Vrain Valley School District. Each team member worked together to collect and analyze data in the most efficient and effective ways possible, sectioning off different types of work to best suit each student's talents, while also pairing mutual strengths with each other to get the job done as efficiently as possible. Mateo Bandera, Bethany Lonsinger, Taryn McDermid, Mark Raehal, Sean-Patrick Schmitz, and Jenna Watson all did their part to ensure that every job was done well.

I AM A DATA SCIENTIST

As a group we collected and evaluated data related to the environmental factors that affected water quality including temperature, acidity, and turbidity. We monitored this data weekly, and along with other experiments such as titrating water samples and sifting through others for specific strands of DNA, we gathered information to better understand the aquatic conditions of our analyzed lakes and apply the data to a much larger multi-team conservation project involving the Northern Red-Belly Dace.

I AM A STEM STORYTELLER

We are sharing our data in unique ways using ArcGIS story maps and designing complex power points to better convey our discovered information across a broader audience of readers and listeners. We have also utilized the Innovation Center's Mobile Lab and held verbal conferences to tell our story, and our creative data visualization methods have helped to distinguish our observation projects from others.