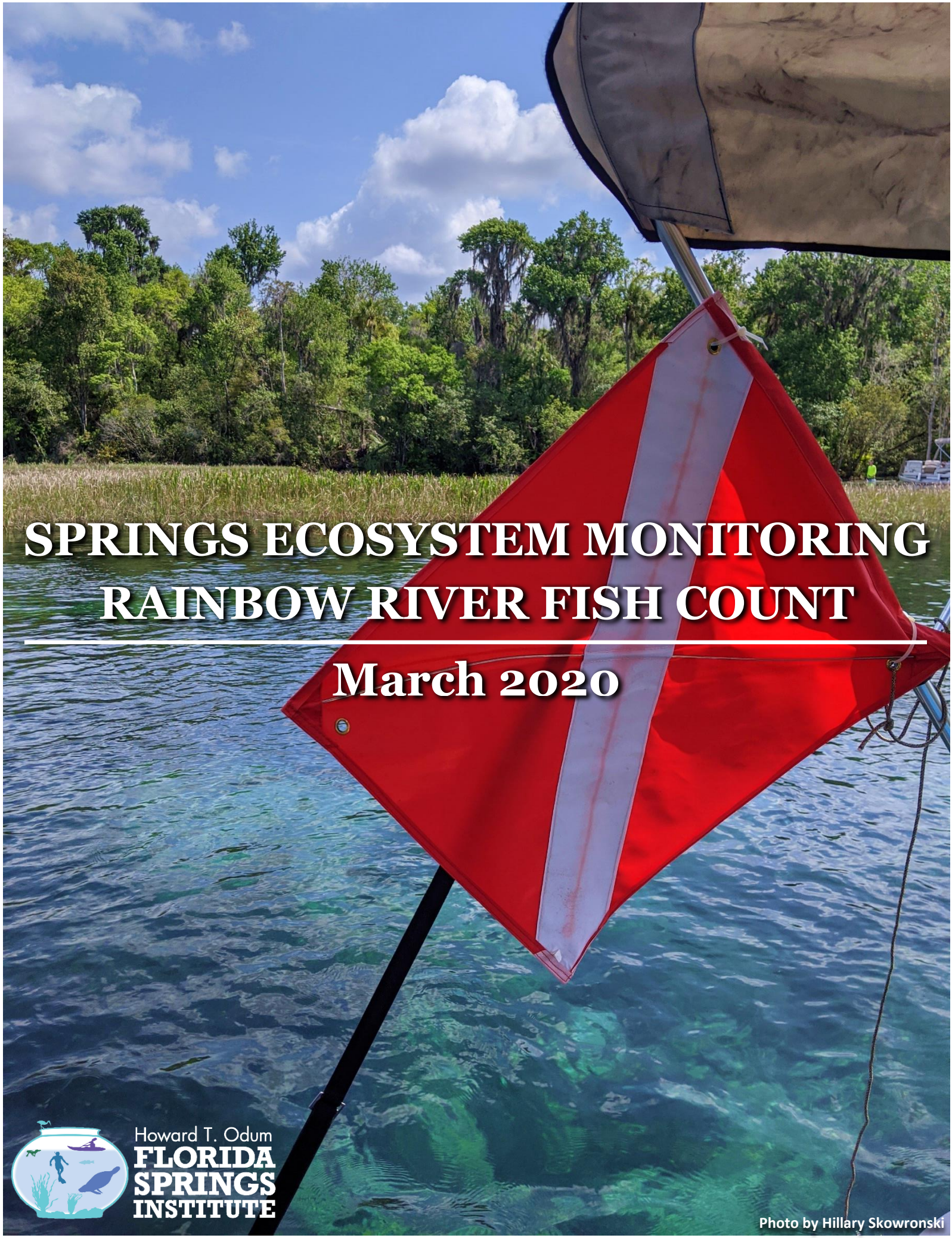

SPRINGS ECOSYSTEM MONITORING
RAINBOW RIVER FISH COUNT

March 2020

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FLORIDA SPRINGS INSTITUTE

Photo by Hillary Skowronski

Acknowledgements

The Florida Springs Institute (FSI) would like to acknowledge Rainbow River State Park for allowing us to access the river for our 2020 fish count. We would also like to recognize Hillary Skowronski (FSI), Zoey Hendrickson (FSI), Bob Knight (FSI), Steve Walsh (USGS), Brenda Wells (FSC) Jessica Millburn (FSI intern) and Erica Ballow (FSI intern) for being our observers, Haley Moody (FSI) for recording the data, and Terry Cake and Bill Vibbert (RRC) for captaining to the support the boats.

Contents

Table of Exhibits

Tables

Introduction

The Rainbow River, one of Florida's Outstanding Waters and located in western Marion County, Florida, is formed by numerous submarine springs, creating a first magnitude spring group. Since 2017 the Florida Springs Institute (FSI) has conducted ongoing ecological studies in the Rainbow River for comparison to a prior ecosystem level study of the river and springs by Wetland Solutions, Inc. (WSI 2010). In 2008-2009 WSI assessed the Rainbow River among other springs and spring fed rivers during an ecosystem-level study of twelve Florida springs. WSI (2010) reported that the Rainbow River had an average of 8.17 mg/L dissolved oxygen, 1.06 mg/L nitrate nitrogen, and 263 uS/cm specific conductance (WSI 2010). FSI conducted an ecosystem assessment at Rainbow in 2017 and since that time has worked with citizen scientists through a SpringsWatch project to provide routine ecological data for the system. FSI periodically helps the SpringsWatch volunteers conduct an evaluation of fish populations in the river to compare to the earlier work of WSI.

Methods

The study area was replicated from WSI's 2009 study conducted (WSI 2010). Fish were visually surveyed using snorkel gear in two segments: RS-1 to RS-2 and RS-2 to RS-3 (Figure 1). The head spring was included in the RS-1 to RS-2 count. Six to seven observers were in the water during the counts and would tell the data recorder the species observed, followed by the quantity. Zones were defined by the observers in order to reduce the chance of double counting fish. At each station, water quality parameters were recorded, and a water sample was collected for nitrate nitrogen testing.

Figure 1. Rainbow River fish survey study area. (Replicated from a study by Wetland Solutions, Inc. 2008-2009)

Results

Water Quality

FSI collected water quality parameters at each of the three stations: RS1, RS2 and RS3. The following graphs compare data by year and segment. During our 2020 survey, the measured water temperature ranged from 23-23.2°C, with no variation between stations and years except for our furthest downstream station which was 0.3°C cooler than last year (Figure *2*) As for DO (mg/L), our measurements ranged from 6.37 to 6.81 mg/L with all stations having lower DO than the 2019 study (Figure 4). The highest DO was recorded at our RS1 station, closest to the headspring, the opposite of last year where the furthest downstream station had the highest DO. Higher DO downstream is expected due to the abundance of submerged aquatic vegetation in the run and the diffusion of atmospheric oxygen. Hydrogen ion (pH) ranged from 7.6 to 7.8 s.u. (Figure 5) with RS1 and RS3 measuring more acidic than 2019, and RS2 more basic. Our RS2 station has consistently had the highest recorded specific conductance at 285 uS/com, just slightly lower than RS2 in 2019. This portion of the river may have a higher number of unknown springs and spring boils contributing to this value and the lower DO values. Nitrate levels have continued to increase with RS2 at 2.44 mg/L NOx-N and RS3 at 2.09 mg/L, an average increase of 8% since 2019. The 2020 nitrate values are double WSI's reported concentration of 1.06 mg/L. All stations exceed the FDEP spring standard of 0.35 mg/L, represented by a dotted line in Figure 7.

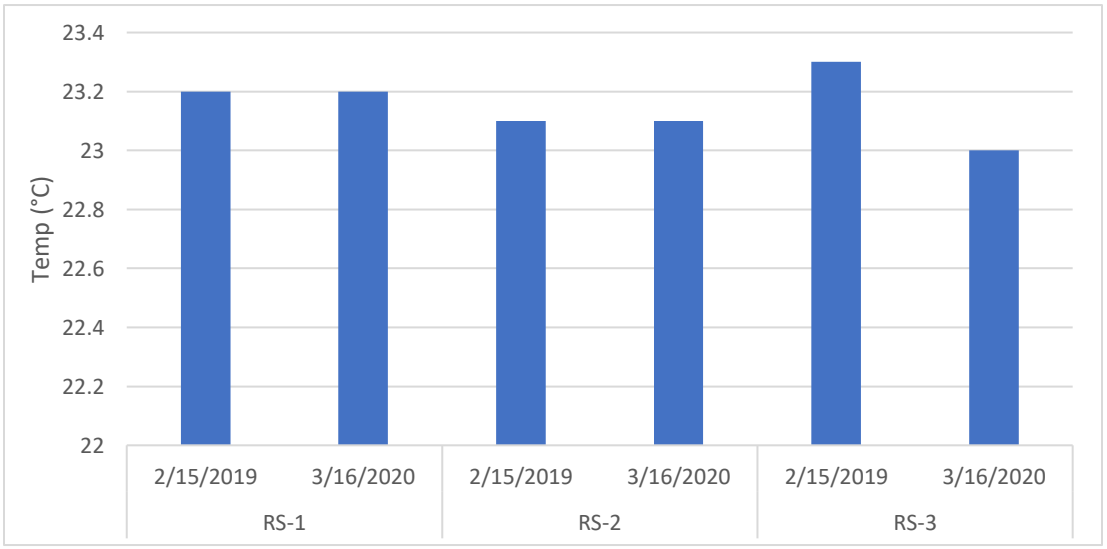


Figure 2. Recorded temperatures for the three FSI study stations for 2019 and 2020.

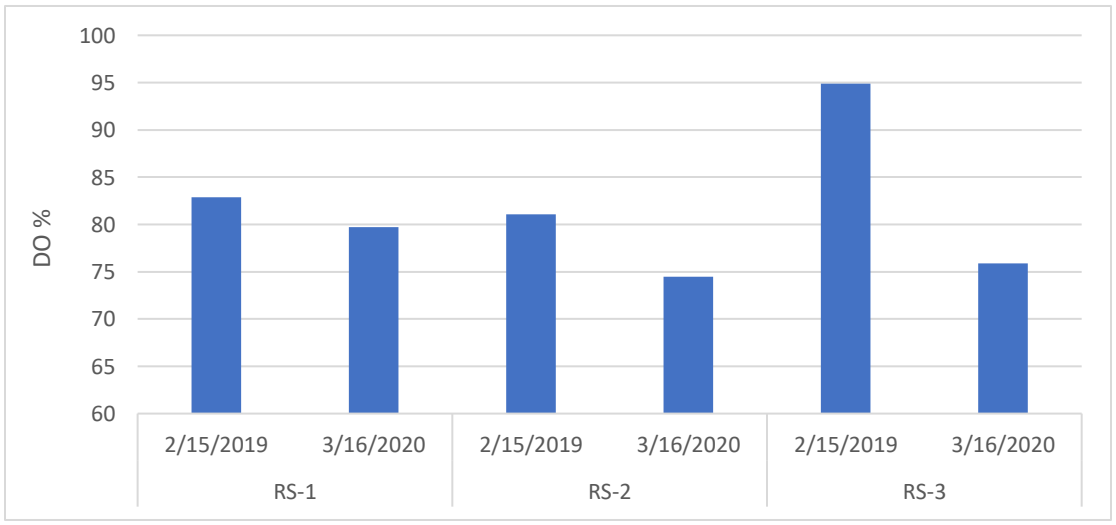


Figure 3. Recorded DO saturation for the three FSI study stations for 2019 and 2020.

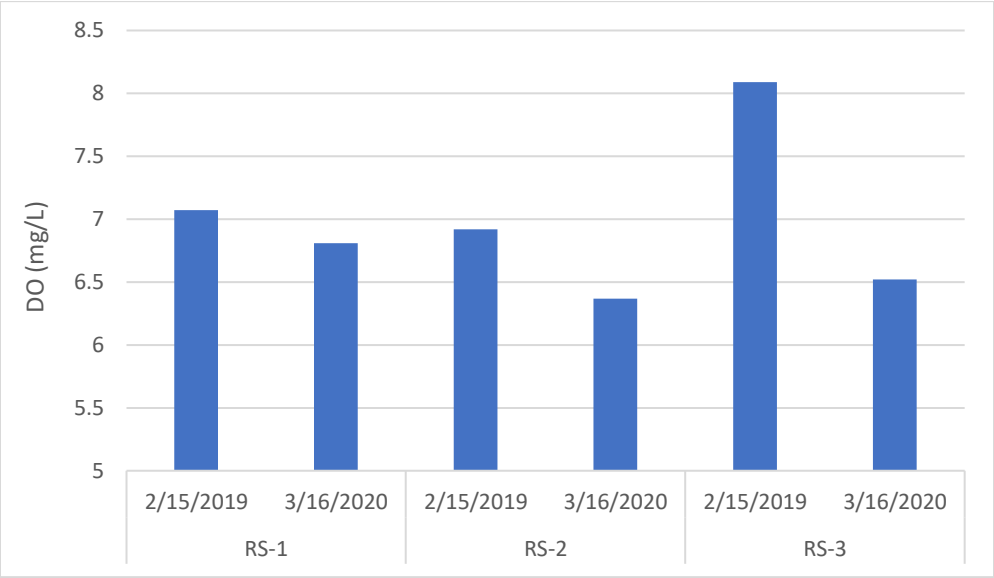


Figure 4. Recorded dissolved oxygen (mg/L) for the three FSI study stations for 2019 and 2020.

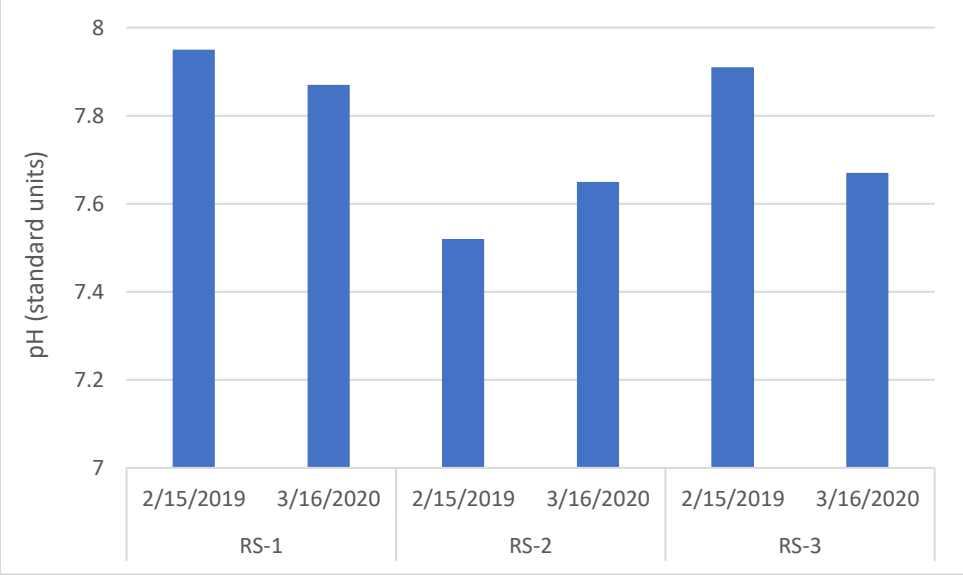


Figure 5. Recorded pH measurements for the three FSI study stations for 2019 and 2020.

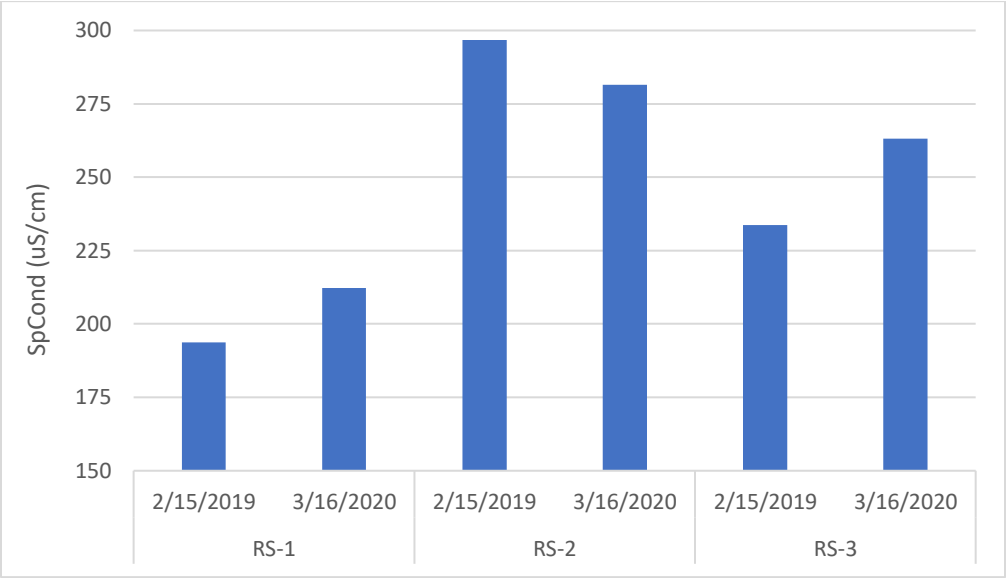


Figure 6. Recorded specific conductance measurements for the three FSI study stations for 2019 and 2020.

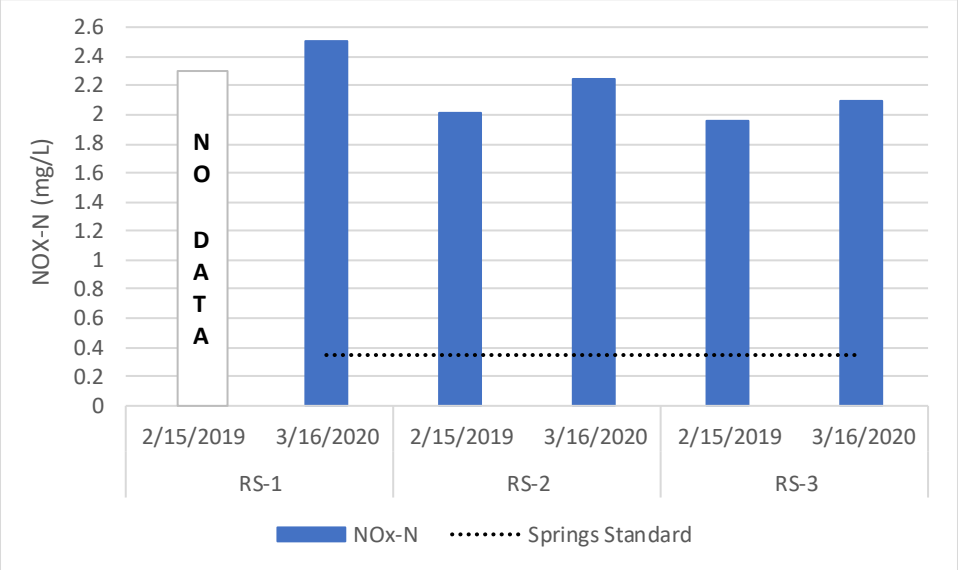


Figure 7. Recorded nitrate-nitrogen for the three FSI study stations for 2019 and 2020.

Fish Surveys

During the March 16, 2020 Rainbow River fish counts, a total of 7,161 fish (1,908 in segment 1 and 5,253 in segment 2) comprising 21 species were observed. The most common species were sunfish (bluegill, spotted, red-breasted), shiners (redeye chub, and metallic and coastal shiners), largemouth bass and redear sunfish, while the least common species were Atlantic needlefish, chain pickerel, sailfin catfish and gar. In comparison to previous studies (Table 2), FSI 2020 observed 7 more species than WSI in 2009 study and 2 more species than the FSI 2019 study. Figure 8 and Figure 9 display the comparison of the number of fishes observed within the two segments, with 10 species graphed separately due to their high abundance.

Table 1 and Figure 10 provide a quantitative comparison of upstream Rainbow River fish population composition and biomass between 2009 and 2020. For the same count area, fish density was highest during the 2020 study at 1,422 fish/hectare and estimated fish biomass was 18% lower than 2009 and 31% lower than 2019. When compared to other springs fish populations sampled and reported previously, the 2020 Rainbow River fish biomass estimate of 54.9 kg/ha is borderline failing with a letter grade of D- (Figure 10). A factor that may have affected the number of fishes observed in the 2020 fish count is the increased flow. During the 2020 study, the flow rate was 697 cfs, however, the 2019 flow rate was 853 cfs. Observers along the edge may have had more time to observe the smaller fishes, while snorkelers in the middle may have missed the larger fish in the vegetation. The reported flow in 2009 (USGS) was 560 cfs.

Table 1 presents data collected by WSI in 2015 and 2016 in the Lower portion of the Rainbow River (sample area = 11.1 hectares). Although the fish counts cannot be directly compared, the data show that fewer species were observed downstream from the head spring. Table 2 provides counts, number of species, density and biomass data for all mentioned fish counts.

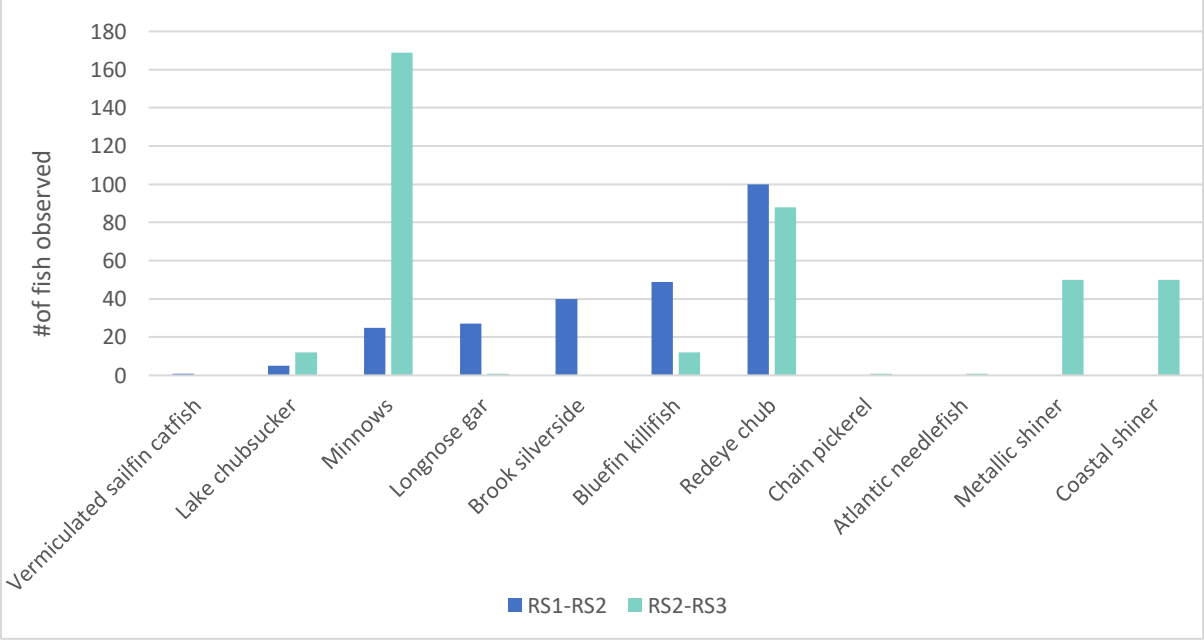


Figure 8. A comparison of number of fishes observed in each segment by FSI in 2020.

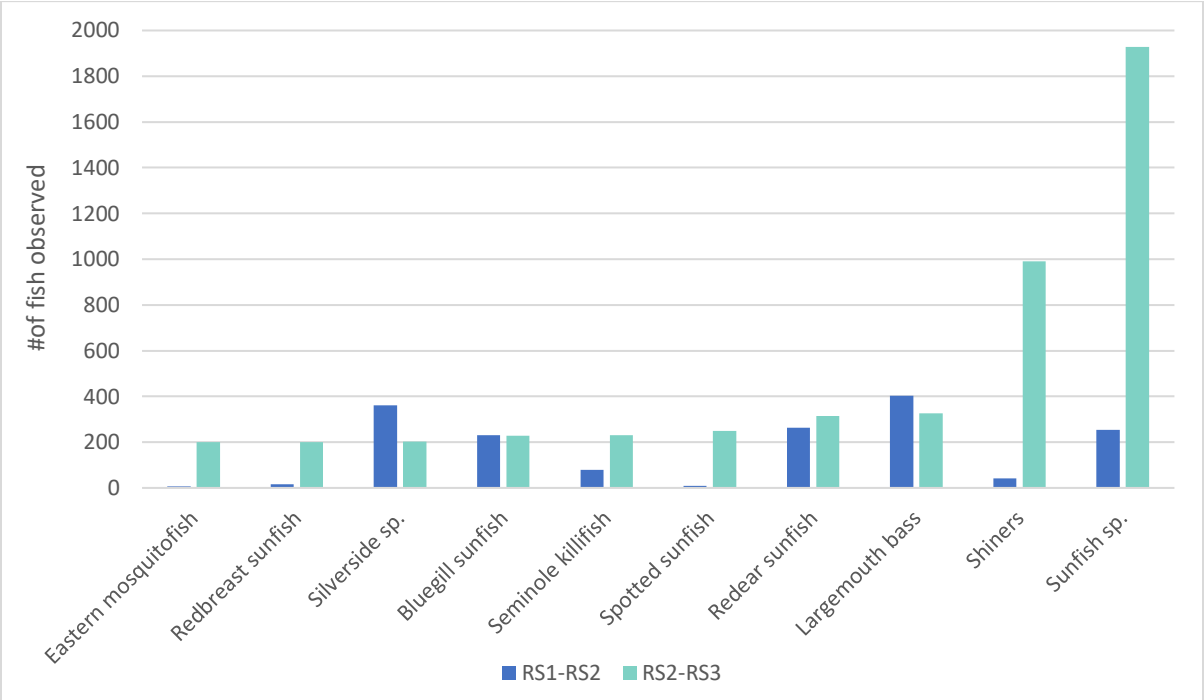


Figure 9. A comparison of the most common species observed by FSI in 2020 in both segments.

Table 1. Baseline assessment data of the Lower Rainbow River fish populations in 2015 and 2016 (FSI 2017).

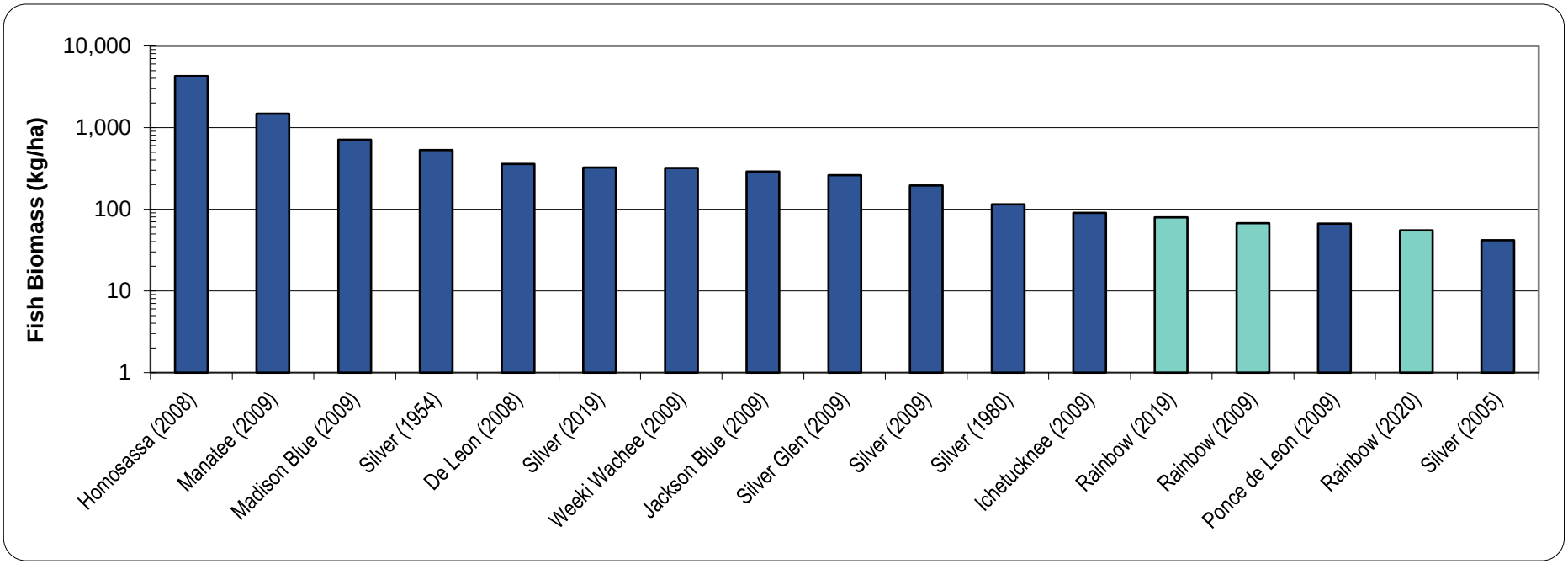
Common Name	Scientific Name	Density (#/ha)		Biomass (kg/ha)	
		Sep-15	Feb-16	Sep-15	Feb-16
Bowfin	*Amia calva*	0.090	0.00	0.197	0.00
Gizzard shad	*Dorosoma cepedianum*	90.2	0.00	79.8	0.00
Lake Chubsucker	*Erimyzon sucetta*	0.942	0.628	1.26	0.839
Killifish sp.	*Fundulus sp.*	10.6	20.6	0.110	0.214
Florida Gar	*Lepisosteus platyrhincus*	1.88	2.87	7.52	11.5
Sunfish sp.	*Lepomis sp.*	399	346	19.6	20.9
Largemouth Bass	*Micropterus salmoides*	70.3	49.0	11.6	3.88
Minnows	*Notropis sp.*	205	69.5	0.338	0.115
Atlantic Needlefish	*Strongylura marina*	7.67	1.17	0.558	0.085
Total		**786**	**490**	**121**	**37.5**

Table 2. Comparison of fish count, number of species, density and biomass data from 2009-2020.

Project Year	Sampled area (ha)	Total Fish	# of Species Observed	Density (#/ha)	Biomass (kg/ha)
WSI 2009	7.94	10,392	14	1,309	67.12
WSI 2015*	11.1	8,756	9	786	121
WSI 2016*	11.1	5,461	7	490	37.5
FSI 2019	7.94	6,771	19	1,344	79.2
FSI 2020	7.94	7,161	21	1,422	54.89

*Baseline assessments in 2015 and 2016 included portions of the lower Rainbow River

RAINBOW RIVER



Fish Biomass	Grade	Rainbow (2020)	A: > 300 B: 200 - 299 C: 100 - 199 D: 50 - 99 F: < 50
	D	54.89 Biomass kg/ha	

Figure 10. Rainbow River fish biomass report card grade.

Table 3. Fishes reported from Rainbow River by study.

Family	Common Name	Species Name	WSI 2009	FSI 2019	FSI 2020
Amiidae	Bowfin	*Amia calva*	X		
Atherinopsidae	Brook silverside	*Labidesthes sicculus*			X
	Silverside sp.	*Labidesthes sp.*	X		X
	Inland Silverside	*Menidia beryllina*		X	
Belonidae	Atlantic Needlefish	*Strongylura marina*	X	X	X
Catostomidae	Lake Chubsucker	*Erimyzon sucetta*	X	X	X
Centrarchidae	Black Crappie	Pomoxis nigromaculatus		X	
	Bluegill Sunfish	*Lepomis macrochirus*		X	X
	Largemouth Bass	*Micropterus salmoides*	X	X	X
	Redbreast Sunfish	*Lepomis auritus*		X	X
	Redear Sunfish	*Lepomis microlophus*		X	X
	Spotted Sunfish	*Lepomis punctatus*		X	X
	Sunfish Sp.	*Lepomis sp.*	X	X	X
Clupeidae	Gizzard Shad	*Dorosoma cepedianum*	X	X	
Cyprinidae	Coastal Shiner	*Notropis petersoni*		X	X
	Golden Shiner	*Notemigonus crysoleucas*	X	X	
	Metallic Shiner	*Pteronotropis metallicus*		X	X
	Minnows	*Notropis sp.*		X	X
	Redeye Chub	*Notropis harperi*		X	X
	Shiners	*Pteronotropis sp.*	X		X
Esocidae	Chain pickerel	*Esox niger*	X		X
Fundulidae	Bluefin Killifish	*Lucania goodei*	X	X	X
	Seminole Killifish	*Fundulus seminolis*	X	X	X
Lepisosteidae	Longnose gar	*Lepisosteus osseus*	X	X	X
Loricariidae*	Vermiculated sailfin catfish	*Pterygoplichthys disjunctivus*			X
Poeciliidae	Eastern mosquitofish	*Gambusia holbrooki*	X		X
Total			**14**	**19**	**21**

***non-indigenous species

References

Florida Springs Institute (FSI). 2016. Rainbow Spring Baseline Ecosystem Assessment.

Wetland Solutions, Inc. (WSI). 2010. An Ecosystem-Level Study of Florida's Springs. Prepared for the Florida Fish and Wildlife Conservation Commission, Tallahassee, FL. FWC Project Agreement No. 08010.

Appendix A

Detailed count, density and biomass for the March 2020 fish count

Species Name	Common Name	Average Length (cm)	RS1-RS2			RS2-RS3			Total		
			Count	Density (#/ha)	Biomass (kg/ha)	Count	Density (#/ha)	Biomass (kg/ha)	Count	Density (#/ha)	Biomass (kg/ha)
Strongylura marina	Atlantic Needlefish	17.78	---	---	---	1	0	0.002	1	0	0.002
Lucania goodei	Bluefin Killifish	3.81	49	10	0.007	12	2	0.002	61	12	0.01
Lepomis macrochirus	Bluegill Sunfish	12.7	231	46	0.965	228	45	0.952	459	91	1.92
Labidesthes sicculus	Brook Silverside	8.89	40	8	0.060	---	---	---	40	8	0.06
Esox niger	Chain Pickerel	25.4	---	---	---	1	0	0.014	1	0	0.01
Notropis petersoni	Coastal Shiner	8.89	---	---	---	50	10	0.075	50	10	0.08
Gambusia holbrooki	Eastern Mosquitofish	3.81	6	1	0.001	200	40	0.027	206	41	0.03
Erimyzon sucetta	Lake Chubsucker	35.56	5	1	0.879	12	2	2.110	17	3	2.99
Micropterus salmoides	Largemouth Bass	19.05	403	80	7.767	326	65	6.283	729	145	14.05
Lepisosteus osseus	Longnose Gar	91.44	27	5	9.935	1	0	0.368	28	6	10.30
Pteronotropis metallicus	Metallic Shiner	7.62	---	---	---	50	10	0.036	50	10	0.04
Notropis sp.	Minnows	3.81	25	5	0.004	169	34	0.025	194	39	0.03
Lepomis auritus	Redbreast Sunfish	12.7	17	3	0.145	200	40	1.702	217	43	1.85
Lepomis microlophus	Redear Sunfish	17.78	262	52	3.962	314	62	4.749	576	114	8.71
Notropis harperi	Redeye Chub	5.08	100	20	0.033	88	17	0.029	188	37	0.06
Pterygoplichthys disjunctivus	Vermiculated Sailfin Catfish	30.48	1	0	0.095	---	---	---	1	0	0.09
Fundulus seminolis	Seminole Killifish	20.32	78	15	0.248	231	46	0.735	309	61	0.98
Pteronotropis sp.	Shiners	7.62	41	8	0.039	991	197	0.948	1032	205	0.99
Labidesthes sp.	Silverside sp.	6.35	360	71	0.191	203	40	0.108	563	112	0.30
Lepomis punctatus	Spotted Sunfish	12.07	9	2	0.047	248	49	0.931	257	51	0.98
Lepomis sp.	Sunfish Sp.	12.7	254	50	1.329	1928	383	10.089	2182	433	11.42
Total			**1,908**	**379**	**25.71**	**5,253**	**1,043**	**29.18**	**7,161**	**1,422**	**54.89**