Fish Community and Habitat Assessment of Jordan Creek

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Introduction

Stream ecosystems support a high level of biodiversity by providing various habitats for fish, macroinvertebrates, and other aquatic organisms. Fish and invertebrate species that are sensitive to changes in water quality and habitat alteration can act as bioindicators for the health of an ecosystem. Studying aquatic populations is important because they react to the direct and indirect effects of stressors experienced by the entire stream ecosystem (Faush, 1990). Additionally, understanding how fish populations change in conjunction with ecosystem changes can provide valuable insight for management decisions (Herman, 2015). Long-term monitoring of stream systems provides data on the physical and biological variation over time. These data can reveal trends in temporal and spatial variability which might not be apparent with short-term data collection (Coulihan, 2018). These long-term trends can help researchers understand the drivers of system dynamics and direct future research and management.

Extended monitoring programs have been established for multiple Illinois rivers by the Illinois Natural History Survey (INHS) and Illinois Department of Natural Resources (IDNR) Basin Surveys. However, few projects have focused on the long-term monitoring of Illinois streams. Jordan Creek is valuable because it has been extensively studied since the 1950s and has a well-developed database of historical fish and invertebrate populations. In 1950, Weldon Larimore was the first to compile a list of fish species and habitat conditions in Jordan Creek in his 1952 paper "An inventory of the fishes of Jordan Creek." Jordan Creek monitoring was continued by Ike Schlosser in 1978 when he conducted a fish survey of Jordan Creek using the same electrofishing techniques as Dr. Larimore.

To continue this data collection, we designed a long-term observational monitoring protocol for Jordan Creek. This monitoring program was initiated in Summer 2020 and sampling will be continued every other year into the foreseeable future. Our protocol is based on the fish-collection methods of Larimore et al.'s 1952 paper and the habitat assessment and macroinvertebrate collection protocols used by the INHS. The information gathered from this monitoring program will be used to identify changes in fish populations over the past 70 years and provide information on the current macroinvertebrate communities and stream habitats. The utility of these identified trends extends beyond Jordan Creek and can provide insight for current and future research projects looking at fish populations in nearby rivers and surrounding watersheds. The objective of this report is to compare the fish community composition collected during Summer 2020 to those collected by Larimore et al. in 1950 and Schlosser et al. in 1978.

Methods

Study Site

Jordan Creek is a second-order stream that spans 17 miles and drains a 10.6 square mile area until flowing into the Salt Fork River (Figure 1). As part of the Vermillion watershed, it is a good representation of warm water creeks in the Central Illinois area (Larimore, 1961). From its confluence with the Salt Fork, the creek runs through a predominantly forested area, eventually becoming surrounded by well-established agricultural fields with a narrow riparian zone.

The area of interest is a four-mile stretch of Jordan Creek sourced at the confluence of the Salt Fork and continuing upstream. In 1950, Larimore collected data from eight sites within this reach. By assessing the characteristics of these sites, we were able to categorize them into two distinct habitat types: the downstream forested area and the upstream agricultural area (Table 1). We chose four study sites for our 2020 sampling based on their relation to the habitat characteristics and location of Larimore's sites, as well as the willingness of landowner cooperation and ease of stream access (Figure 1). Sites 1-3 corresponds to Larimore's downstream forested area and site 4 corresponds to the upstream agricultural area. (Figure 2).

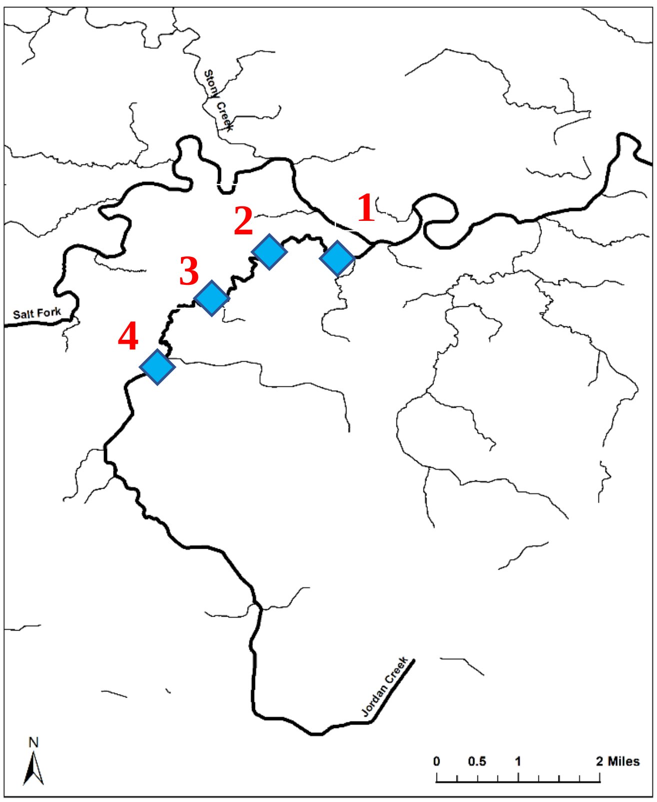

Figure 1: Locations of the 2020 Jordan Creek study sites.

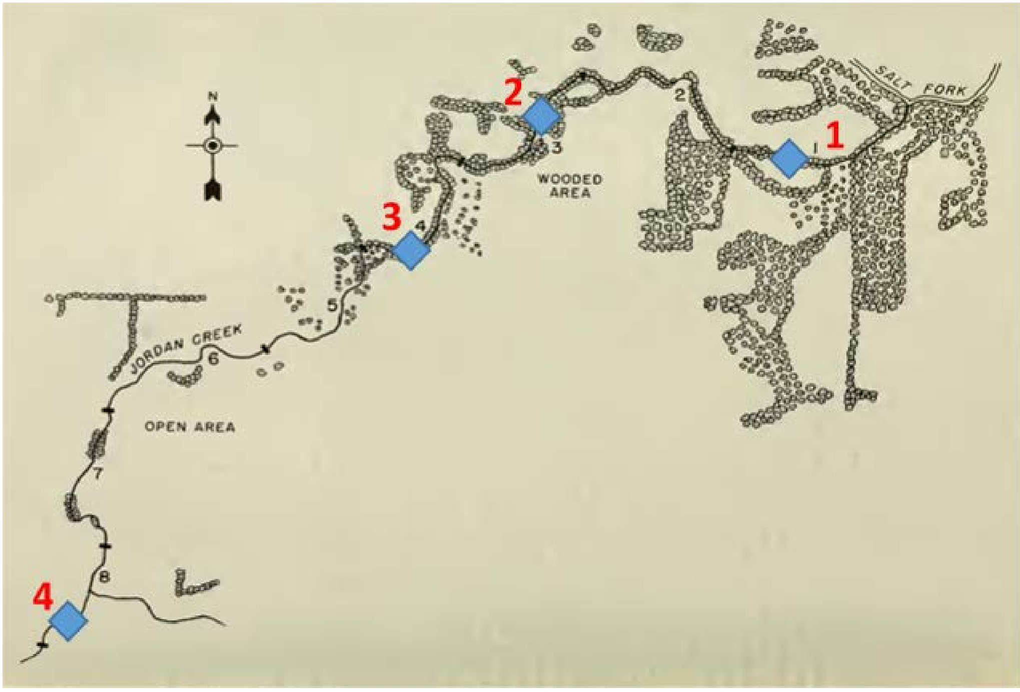

Figure 2: Locations of the 2020 study sites on Larimore's 1950 study site map.

Table 1: Summary of the habitat characteristics of Larimore et al.'s 1950 study divisions.

Characteristics	Downstream Forested Area	Upstream Agricultural Area
1950 Divisions	1-4	5-8
Percent of water shaded (%)	75-85	0-15
Dominant bottom materials	Bedrock, gravel, sand	Sand, gravel, silt
Use of surrounding land	Timber, permanent pasture	Soybeans, permanent pasture

Habitat Assessment

Habitat assessment and macroinvertebrate sampling took place during the last week of July and the first week of August 2020. This sampling time coincided with the peak greenness of the area. Peak greenness is defined by the NEON Riparian Habitat Assessment protocol as "the site-specific period of phenology marking the start of the plant growing season, from spring "green-up" to end of the season plant senescence." Future assessments should continue to take place during peak greenness for an accurate representation of canopy coverage and riparian vegetation structure.

Sites were assessed for wetted width, depth, substrate composition, canopy cover, riparian vegetation composition, and bank angle. Each study site was 100 m in length, and habitat data were collected at nine cross-sectional transects located 10 m apart beginning 10 m from the downstream boundary. Data was not collected at the upper and lower site boundaries. At each transect, wetted width was recorded, then divided by 10 to determine the sampling interval for the depth and substrate sampling points along the stream cross-section. At each depth sampling point, depth was measured with a meter stick and the substrate directly underneath was categorized based on the NEON pebble count protocol. This was repeated for a total of 10 sampling points. Substrate classes were defined as silt (0.02-0.10 mm), sand (0.10-2 mm), pebble (2-65 mm), cobble (65-250 mm), bedrock, and hardpan. Canopy cover was approximated at each transect by the percent of stream shaded along the cross-section. The extent of canopy coverage was categorized as none, low, intermediate, high, and almost total coverage. Riparian vegetation was measured on each bank in a 10 m x 10 m section centered at the transect bank location and extending towards the riparian zone. Vegetation was classified as trees, woody/shrub, and herbaceous plants, and the abundance was categorized based on the percent of transect coverage. Bank angles were broken down into primary and secondary angles and visually assessed in broad categories.

Macroinvertebrate Sampling

Macroinvertebrates were collected following the INHS Macroinvertebrate-Multihabitat Sampling Protocol (INHS, 2018). A D-frame net and jab approach was used to collect 20 samples starting at the downstream boundary and continuing upstream in 5 m increments. Samples were preserved in 99% ethanol for a final concentration of at least 50% ethanol.

Fish Sampling

Sampling was done with a four-person crew at the same 100 m sites used for habitat and macroinvertebrate sampling. Before sampling began, block nets were placed across the upstream and downstream boundaries and secured to the stream bed to ensure no fish entered or exited the site during sampling. Fish were sampled using an AC electric seine beginning at the downstream boundary. From the downstream boundary, the seine was pulled upstream with the probes focused along the bank. The fish were collected by large nets and placed into coolers fitted with aerators for identification.

Conductivity, dissolved oxygen, water temperature, and velocity were recorded at each site before sampling. Electrofishing occurred during the last week of July through the last week in September. Fish sampling was spread out temporally due to low rainfall and complications from the COVID-19 pandemic.

Data Analysis

In 1950, Larimore et al. sampled continuously upstream for 4.02 miles from the confluence with the Salt Fork, while four 100 m sites were sampled in 2020. To compare the 2020 data to the 1950 data, one of Larimore et al.'s eight divisions was compared to one 2020 site using rarified species richness curves. To determine which divisions were representative of the 2020 sites, historical maps identifying Larimore's locations were compared to Google Earth images to identify the best match in geographic location and similarities in habitat type (Table 2). To account for the differences in sampling effort between the 2020 and 1950 survey, the 1950 data were rarefied to produce a species richness which assumed the total fish caught were the same as the 2020 collection (Table 7).

Schlosser et al. performed a fish survey of Jordan Creek in 1978, starting from the confluence with the Salt Fork and moving upstream. Four distinct regions were identified and broken down into a total of 14 study stations 100 m in length. We compared the physical locations of the 1978 stations to our 2020 sites using Google Earth to determine the corresponding study sites. Schlosser used an electric seine to sample region 4 and a minnow drag seine to sample region 3. Further experimentation showed that there was no significant difference between the number of fish caught using a drag seine versus an electric seine (Schlosser, 1982).

Larimore's data included in this report includes only the fish caught in the initial census, not the entire number of individuals collected during the repeated census in the fall. It should also be noted that Larimore does not provide data for all the fish that were caught. He included data on the 10 most abundant minnow species but did not identify or quantify the other minnow species which were collected.

We tested to see if species tolerance to disturbance explained the variation in species relative abundance changes using a t-test assuming unequal variances. Species tolerance data was taken from the I-Fish database and tolerances were based on the Biological Stream Characterization Index of Biotic Integrity (IBI) intolerance to silt and large river IBI tolerance.

Table 2: The 1950 divisions and 1978 stations corresponding to the 2020 study sites.

2020 Site	1950 Division	1978 Station
1	1	4E
2	3	4C
3	4	4B
4	8	3A

Results and Discussion

2020 sites 1-3 were surrounded by a thick band of forested areas whose canopy has high to almost total coverage of the water (Table 3). These sites had similar riparian vegetation compositions with intermediate levels of trees, woody shrubs, and herbaceous plants (Table 4). At site 2, approximately 30 m of the left bank was a sheer bluff, and therefore, no riparian vegetation was recorded for those transects. Sites 1-3 had a gradual to moderate shoreline followed by a steep secondary bank angle. At each of these sites, at least one undercut bank was present (Table 5). The stream beds of these sites were predominantly pebble, cobble, and bedrock. Site 2 was uniquely dominated by bedrock as it made up 46% of the sampled substrate.

Sites 1 and 3 were dominated by pebble and cobble. The mean wetted width of sites 1-3 ranged from 7.8-8.5 m with the maximum widths similar throughout all of the sites (Table 6). There were multiple pools and riffles in each site with areas of slow and moderate flow velocities.

2020 site 4 was surrounded by agricultural corn fields and had low to no canopy coverage (Table 3). The site ran underneath a bridge for approximately 10 m, but this bridge coverage was not considered in canopy cover or riparian vegetation assessments. The riparian vegetation was dominated by herbaceous plants with very low levels of trees and woody shrubs present (Table 4). There was a moderate shoreline throughout followed by a steep secondary bank, though in some areas the transition to a secondary bank was not detectable. No undercut banks were found on the site (Table 5). Site 4 was the only site with silt substrate. Silt was the dominant bed material making up 44% of the streambed composition, the rest was composed of sand and pebble. The stream bed was noticeably less stable compared to sites 1-3 and sinking occurred if pressure was applied to the streambed. The wetted width of site 4 was narrower (5.0 m) and less variable than sites 1-3, indicating a more uniform stream geometry. The mean depth was the highest of all sites at 27 cm (Table 6). Unlike sites 1-3, site 4 did not have any discernable pools or riffles and instead was a straight, deep channel, with a uniform slow flow velocity. This site has been subjected to dredging of the stream bed in recent years. However, once an area has been dredged and converted to an agricultural ditch, the continued maintenance of the ditch may not be notably detrimental to the fish community (Ward-Campbell, 2017).

Table 3: Canopy coverage of 2020 sites. Coverage categorized based on the percent of water shaded: none (0-10%), low (25%), intermediate (50%), high (75%), and almost total coverage (90-100%).

Site	**Average Canopy Cover**
1	High
2	Almost total coverage
3	High
4	Low

Table 4: 2020 site riparian vegetation composition. Vegetation abundance was categorized by the percent of coverage in the transect as absent (0%), sparse (<20%), intermediate (20-40%), abundant (>40%).

Site	**Trees**	**Woody**	**Herbaceous**
1	Intermediate	Intermediate	Intermediate
2	Intermediate	Intermediate	Intermediate
3	Intermediate	Intermediate	Intermediate
4	Sparse	Sparse	Abundant

Table 5: Average bank angles and undercut banks of the 2020 sites. Bank angles were categorized as gradual shoreline (0-30□), moderate shoreline (30-60□), steep bank (60-90□), vertical bank (90□), undercut bank (>90□).

Site	Average Primary Bank Angle	Average Secondary Bank Angle	Undercut Banks
1	Gradual shoreline	Steep bank	2
2	Gradual shoreline	Steep bank	2
3	Moderate shoreline	Steep bank	1
4	Moderate shoreline	Steep bank	0

Table 6: Mean wetted width, mean depth, and substrate composition of 2020 sites. Parenthetical indicate the minimum and maximum values at that site.

Site	Mean Wetted Width (m)	Mean Depth (cm)	Silt (%)	Sand (%)	Pebble (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Hardpan (%)
1	8.0 (5.2-11.4)	19 (0-73)	0	13	40	32	6	4	5
2	7.8 (5.9-9.8)	9 (0-30)	0	11	25	10	4	50	0
3	8.5 (1.3-11.8)	10 (0-24)	0	10	68	20	2	0	0
4	5.0 (4.0-6.2)	27 (6-63)	44	17	36	3	0	0	0

Across all four sites, we captured 2,679 fish representing 33 species. Site 3 had the highest richness at 24 species, which was 60% higher than the lowest richness at site 2 which had 15 species. At all sites, the raw data showed lower species richness than Larimore et al. (1952). The 1978 species richness was also lower than the 1950 values. The 1950 species richness was very similar across all sites, ranging from 27—28 (Table 7). However, after rarefaction using the 2020 sample sizes, the 1950 species richness decreased to 23.6—24.7 (Table 8). The 1978 species richness remained very consistent at each site with species richness of 18 at three sites and 21 at the fourth. The 2020 species richness was more varied between the sites compared to the 1950 values, with site 2 experiencing a decrease in species richness from 22.8 in 1950 to 15 in 2020 (Table 7).

The similar species richness found across the four sites in the 1950 sampling effort could be due to the thoroughness of the sampling. The 1950 study reaches range from approximately 500-850 m in length while the 2020 sampling was confined to 100 m reaches. The significantly larger sampling areas in 1950 resulted in more microhabitats sampled across all study sites. This likely increased and evened out the number of species collected in 1950 as some species require specific habitat characteristics which can be present sporadically along a stream. The notable decrease in species richness and increase in variability between the 2020 sites suggests that 100 m is not long enough to capture all microhabitats present. Due to this smaller study site, habitats present in one site potentially were not found in others, leading to the higher species richness variability.

Table 7: Site and entire reach Total Abundance and Species Richness of fish collected in Jordan Creek in 2020, 1950, and 1978 surveys.

Site	2020 Abundance	2020 Species Richness	1978 Abundance	1978 Species Richness	1950 Abundance	1950 Species Richness
1	553	22	433	21	3463	28
2	480	15	234	18	3239	27
3	818	24	190	18	3124	28
4	828	19	1198	18	7472	28
Reach Total	**2,679**	**33**	**2,055**	**25**	**41,231**	**35**

Table 8: Rarefied Species Richness of fish captured in Jordan Creek. Rarefaction analysis was performed to standardize catch. For this, the sample size of Larimore's 1950 data was set to the abundance of fish captured at the 2020 sites within Larimore's corresponding divisions.

Site	2020 Rarefaction Sample Size	1950 Rarified Species Richness with 2020 Sample Size
1	553	23.6
2	480	22.8
3	818	24.7
4	828	24.1

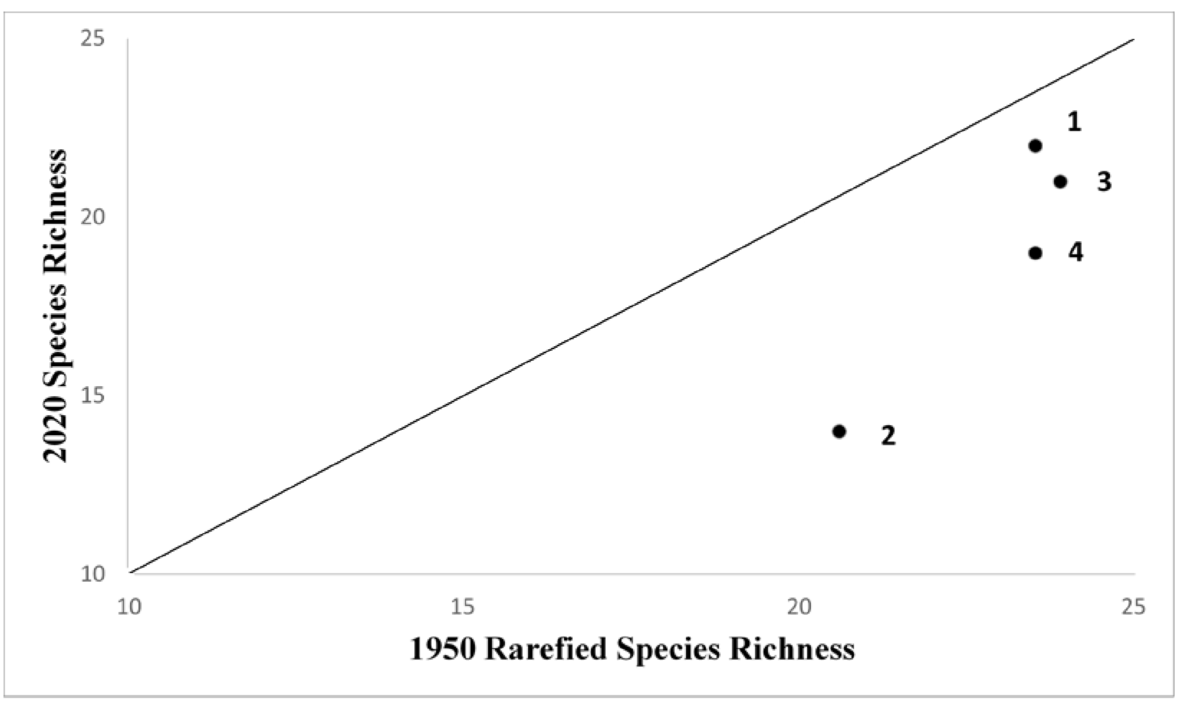

Figure 3: Rarefaction of 1950 species richness compared to 2020 species richness. The solid line indicates a 1:1 relationship.

Table 9: Total abundance of species caught at the 2020 sites and the 1978 and 1950 surveys.

	Sites						
Species	**1**	**2**	**3**	**4**	**2020 Total**	**1978 Total**	**1950 Total**
Bluegill	8	1	6	7	**22**	**3**	**101**
Bluntnose Minnow	64	53	135	94	**346**	**709**	**7098**
Blackstripe Topminnow	0	0	0	39	**39**	**54**	**0**
Central Stoneroller	3	30	1	5	**39**	**65**	**9830**
Creek Chub	10	45	55	1	**111**	**30**	**2960**
Emerald Shiner	0	4	11	0	**15**	**0**	**0**
Fantail Darter	15	8	64	0	**87**	**141**	**951**
Golden Redhorse	0	0	1	0	**1**	**5**	**1024**
Greenside Darter	20	29	19	0	**68**	**22**	**748**
Grass Pickerel	1	0	0	1	**2**	**29**	**16**
Green Sunfish	2	0	0	1	**3**	**0**	**318**
Hornyhead Chub	22	44	87	31	**184**	**340**	**2071**
Johnny Darter	1	2	13	0	**16**	**15**	**40**
Largemouth Bass	0	0	0	3	**3**	**0**	**41**
Longear Sunfish	10	0	10	12	**32**	**51**	**2015**
Western Mosquitofish	2	0	21	60	**83**	**0**	**0**
Northern Hogsucker	3	0	0	0	**3**	**44**	**2358**
Orangethroat Darter	0	0	6	0	**6**	**31**	**740**
Orange Spotted Sunfish	0	0	0	16	**16**	**0**	***N/A***
Rainbow Darter	70	22	92	0	**184**	**117**	**574**
Redfin Shiner	1	0	2	0	**3**	**44**	**136**
Rock Bass	2	0	1	1	**4**	**55**	**30**
Roseyface Shiner	0	0	0	8	**8**	**0**	***N/A***
Sand Shiner	0	0	11	0	**11**	**0**	**2344**
Spotfin Shiner	131	76	124	70	**401**	**1**	**273**
Silverjaw Minnow	0	3	3	3	**9**	**0**	**5159**
Smallmouth Bass	4	2	4	0	**10**	**28**	**369**
Stonecat	35	5	7	0	**47**	**8**	**45**
Striped Shiner	142	152	140	474	**908**	**205**	**0**
Unidentified	1	4	4	0	**3**	**0**	**0**
Warmouth	1	0	0	0	**1**	**0**	**0**
White Sucker	5	0	1	1	**7**	**27**	**413**
Yellow Bullhead	0	0	0	1	**1**	**27**	**155**

Black Bullhead	0	0	0	0	**0**	**0**	**4**
Blackside Darter	0	0	0	0	**0**	**2**	**6**
Brindled Madtom	0	0	0	0	**0**	**0**	**18**
Common Shiner	0	0	0	0	**0**	**0**	**826**
Creek Chubsucker	0	0	0	0	**0**	**2**	**22**
Quillback	0	0	0	0	**0**	**0**	**167**
Starhead Topminnow	0	0	0	0	**0**	**0**	**44**
Suckermouth Minnow	0	0	0	0	**0**	**0**	**335**
Sampling Total	**553**	**480**	**818**	**828**	**2,679**	**2,055**	**41,231**

Notably, many species had similar relative abundances over the past 70 years. However, there was a marked change in several species. The relative abundance of the Central Stoneroller, Northern Hogsucker, Silverjaw Minnow, Sand Shiner, and Bluntnose Minnow noticeably decreased from 1950 to 2020. On the other hand, there was an increase in the relative abundance of Spotfin Shiner and Rainbow Darter.

Table 10: Species relative abundance in 2020, 1978, and 1950 collections.

Species	**1950 Relative Abundance (%)**	**1978 Relative Abundance (%)**	**2020 Relative Abundance (%)**
Bluegill	0.24	0.15	0.82
Bluntnose Minnow	17.22	34.50	12.92
Blackstripe Topminnow	*None Collected*	2.63	1.46
Central Stoneroller	22.84	3.16	1.46
Creek Chub	7.18	1.46	4.14
Emerald Shiner	*None Collected*	*None Collected*	0.56
Fantail Darter	2.31	6.86	3.25
Golden Redhorse	2.48	0.24	0.04
Greenside Darter	1.81	1.07	2.54
Grass Pickerel	0.04	1.41	0.07
Green Sunfish	0.77	*None Collected*	0.11
Hornyhead Chub	5.02	16.55	6.87
Johnny Darter	0.10	0.73	0.60
Largemouth Bass	0.10	*None Collected*	0.11
Longear Sunfish	4.89	2.48	1.19
Western Mosquitofish	*None Collected*	*None Collected*	3.10
Northern Hogsucker	5.72	2.14	0.11
Orangethroat Darter	1.79	1.51	0.22
Orange Spotted Sunfish	*N/A*	*None Collected*	0.60
Rainbow Darter	1.39	5.69	6.87
Redfin Shiner	0.33	2.14	0.11

Rock Bass	0.07	2.68	0.15
Roseyface Shiner	*N/A*	*None Collected*	0.30
Sand Shiner	5.69	*None Collected*	0.41
Spotfin Shiner	0.66	0.05	14.97
Silverjaw Minnow	12.51	*None Collected*	0.34
Smallmouth Bass	0.89	1.36	0.37
Stonecat	*None Collected*	0.39	1.75
Striped Shiner	*None Collected*	9.98	33.89
Warmouth	*None Collected*	*None Collected*	0.04
White Sucker	1.00	1.31	0.26
Yellow Bullhead	0.38	1.31	0.04
Black Bullhead	0.01	*None Collected*	*None Collected*
Blackside Darter	0.01	0.10	*None Collected*
Brindled Madtom	0.04	*None Collected*	*None Collected*
Common Shiner	2.00	*None Collected*	*None Collected*
Creek Chubsucker	0.05	0.10	*None Collected*
Quillback	0.41	*None Collected*	*None Collected*
Starhead Topminnow	0.11	*None Collected*	*None Collected*
Suckermouth Minnow	0.81	*None Collected*	*None Collected*

We found that species tolerance did not significantly impact the change in relative abundance from 1950 to 2020 ($t_{(37)} = -0.65$, $P = 0.26$). The average change in relative abundance for all "tolerant" species was -0.42 %, while the average change in "intolerant" species was 0.93 %.

Table 11: List of top 10 species with the greatest change in relative abundance from 1950 in either 1978 or 2020. The change in relative abundance was calculated using 1950 as a baseline.

Species	**1978**	**2020**
Striped Shiner	9.98	33.89
Spotfin Shiner	-0.61	14.31
Rainbow Darter	4.3	5.48
Hornyhead Chub	11.53	1.85
Creek Chub	-5.72	-3.04
Bluntnose Minnow	17.28	-4.3
Sand Shiner	-5.69	-5.28
Northern Hogsucker	-3.58	-5.61
Silverjaw Minnow	-12.51	-12.17
Central Stoneroller	-19.68	-21.38

The functional dispersion of 2020 sites 1-3 was similar to both the 1950 and 1978 corresponding sites. Site 4 showed a decrease in functional dispersion from 1950 to 1978 but remained stable from 1978 to 2020 (Table 12).

Table 12: Functional dispersion of fish collected in 2020, 1978, and 1950.

Site	2020 Functional Dispersion	1978 Functional Dispersion	1950 Functional Dispersion
1	0.2319	0.2427	0.2056
2	0.2293	0.2783	0.2551
3	0.2470	0.2726	0.2695
4	0.1612	0.1685	0.2657

Stream Habitat Characteristics

The increased depth at site 1 was at least partially attributable to the increased flow during sampling (Figure 4), however, at the downstream site 4, there were noticeably deeper and more frequent pools.

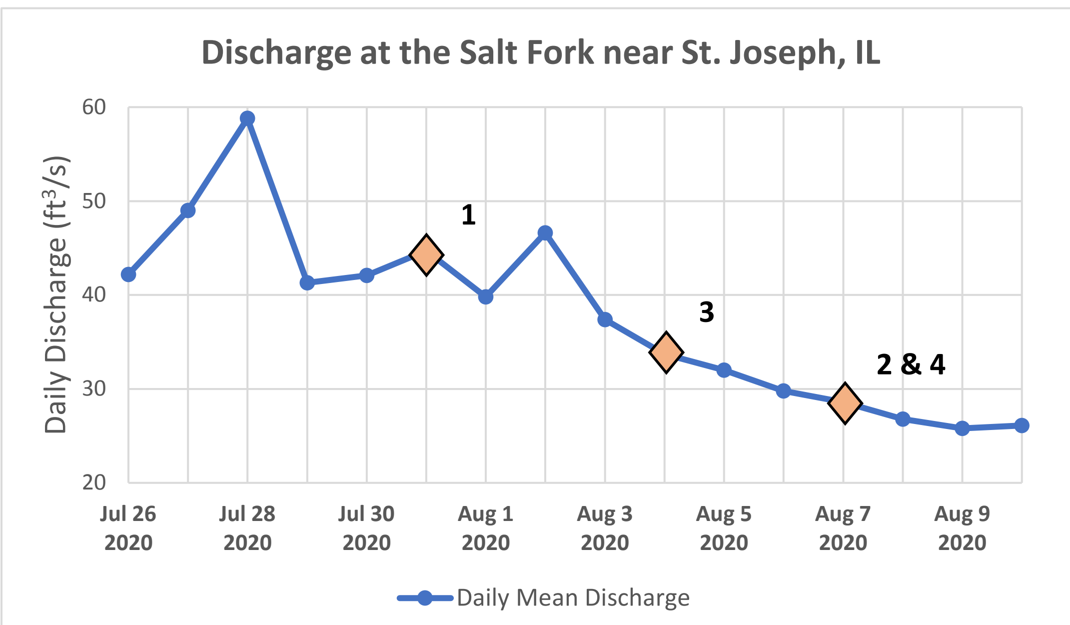

Figure 4: Daily mean discharge of the Salt Fork River during 2020 Jordan Creek habitat sampling time points as measured by a USGS station roughly 16 miles from the Jordan Creek study area. Study sites are labeled next to their corresponding sampling date.

Sampling Efforts

This project was carried out during the COVID-19 pandemic which resulted in sampling delays. As a result, habitat surveys were conducted several weeks before fish sampling which was pushed back later into the summer. The sampling period occurred while water levels were declining, so discharge was noticeably lower during the habitat assessments occurring later in the summer compared to the initial assessments (Figure 4).

Species Composition

Bluntnose Minnow, Spotfin Shiner, and Striped Shiner were by far the most common, making up 61.78% of the total abundance. The relative abundance of the Striped Shiner was over two times greater than the Spotfin Shiner and Striped Shiner, making up 33.89% of all the fish collected. Several species were found in low numbers and had a relative abundance of 0.5% or less. These include the Golden Redhorse, Grass Pickerel, Green Sunfish, Largemouth Bass, Northern Hogsucker, Orangethroat Darter, Redfin Shiner, Rock Bass, Roseyface Shiner, Sand Shiner, Silverjaw Minnow, Smallmouth Bass, Warmouth, White Sucker, and Yellow Bullhead. Together these species make up only 2.28% of the total relative abundance.

Larimore listed 38 species in his 1950 survey but provided numerical data for only 35 species. The following analysis will thus be based only on these 35 species. The most common species collected in 1950 were the Bluntnose Minnow, Central Stoneroller, and Silverjaw Minnow. These three fish accounted for 53.57% of the total relative abundance. Unlike the 2020 survey, no single species dominated the total fish population. The species that were the least prevalent, representing 0.5% or less of the relative abundance, include the Bluegill, Grass Pickerel, Johnny Darter, Largemouth Bass, Redfin Shiner, Rock Bass, Stonecat, Yellow Bullhead, Common Shiner, Black Bullhead, Brindled Madtom, Blackside Darter, Starhead Topminnow, and Creek Chubsucker.

Absent Species

There were 13 species collected in the 1950 survey that were not collected in the 2020 sampling: Creek Chubsucker, Quillback, Spotted Sucker, Carp, Common Shiner, Suckermouth Minnow, Flathead Minnow, Black Bullhead, Bridled Madtom, Starhead Topminnow, Blackside Darter, Logperch, and Warmouth. However, Larimore did not provide numerical data for the Spotted Sucker, Carp, or Logperch so it is difficult to assess their prevalence in Jordan Creek.

The three species which Larimore collected in noticeable amounts but were not collected in either 2020 nor 1978 are the Quillback Carpsucker (167 collected), Common Shiner (826 collected), and Suckermouth Minnow (335 collected). The Quillback Carpsucker is currently found throughout the state of Illinois and has been routinely identified in the nearby Kankakee River by the Illinois DNR over the past 20 years (Pescitelli, 2017). The fact that Quillbacks were only found in 1950 can potentially be attributed to their lifestyle. Quillbacks migrate in schools and can occur sporadically in areas where they have previously been prevalent (Larimore, 1996). Therefore, Larimore could have come across a school of Quillbacks during his 1950 survey and recorded data that is not reflective of long-term population dynamics

Common Shiners were abundant in 1950 but were not collected in either the 1978 or 2020 surveys. Information provided by the Illinois DNR shows that the range of the Common Shiner is limited to the top fourth of Illinois and does not extend to Champaign County and Jordan Creek (IDNR, n.d.). It is unclear what conditions of Jordan Creek in 1950 were favorable to Common Shiners, but they were collected in an area that is now considered outside of their habitat range.

The Suckermouth Minnow is another species found in 1950 but at no other collection time points. According to the Illinois DNR, the Suckermouth Minnow is found throughout the state of Illinois, except for the northeast one-fourth of the state in which Champaign County resides (IDNR, n.d.). Jordan Creek is located at the cusp of the current range, this boundary could have potentially shifted in the past 70 years and led to the absence of Suckermouth Minnows.

New Species

There were four species collected during the 2020 survey which were not listed in Larimore's 1950 sampling report. These species are all part of the minnow family and include the Emerald Shiner, Western Mosquitofish, Blackstripe Topminnow, and Striped Shiner.

Both the Emerald Shiner and Western Mosquitofish are unique to the 2020 survey and were not collected in either the 1950 or 1978 sampling events. The Emerald Shiner was only found in sites 2 and 3. The Western Mosquitofish was found in all sites except for site 2, and it was significantly more abundant in site 4 where 60 of the 83 total individuals were collected.

The Blackstripe Topminnow was not collected in 1950 but it was present in the 1978 survey where it made up 2.63% of the relative abundance. In our 2020 survey, the Blackstripe Topminnow had a relative abundance of 1.46%, indicating that the population levels have remained stable.

The most notable species present in the 2020 survey, but absent in the 1950 survey, is the Striped Shiner. The Striped Shiner was prevalent throughout all sites with 100+ individuals collected at each site. Of all the species caught, the Striped Shiner was the most numerous representing 33.89% of the total relative abundance. The number of individuals caught was four times greater at site 4 compared to sites 1-3. The Striped Shiner can inhabit all streambed substrates including muck and clay-silt. As site 4 is the only site that has muck and clay-silt as the dominant substrate, the increased populations could reflect their affinity for those streambed conditions. While they were not collected in 1950, by 1978 the Striped Shiner had begun to populate Jordan Creek and represented 9.98% of the relative abundance. Schlosser's survey showed that the Striped Shiner was predominantly found in his agricultural site which is consistent with our 2020 collection as most of the Striped Shiners were found at the agricultural site 4.

Species Decline

Species that suffered a noticeable decline in their populations from 1950 to 2020 include Central Stoneroller, Silverjaw Minnow, Northern Hogsucker, Sand Shiner, and Bluntnose Minnow.

Central Stonerollers prefer habitats with streambeds composed of gravel and bedrock, a moderate flow rate, and clear water. They avoid areas with high levels of clay-silt and muck and therefore are not found in degraded streams with high bank erosion and high stream turbidity (Post, 1996). The relative abundance of Central Stonerollers dropped from 23.84% (9830 individuals) in 1950 to 3.16% in 1978 (65 individuals) and is now at 1.46% (39 individuals) in 2020. Most of the Central Stonerollers collected in the 2020 survey were found at Site 2. This site is dominated by bedrock and pebbles which is the preferred habitat of Central Stonerollers and can potentially explain their higher populations at this site. Looking at the 1978 data, most individuals were collected at site 4E which correlates to our 2020 site 1, though there are slight differences in exact site locations. In both the 2020 and 1978 surveys, Central Stonerollers were found mostly in the upstream reach and rarely in the downstream area which has higher levels of silt and sand. Because Central Stonerollers are found throughout the entirety of Illinois, it is likely the stream conditions, not the range, which is influencing the change in population levels.

The Silverjaw Minnow is a benthic feeder found exclusively in shallow streams with a sandy bottom and no silt content. They have been known to feed with Bluntnose Minnows and Central Stonerollers to take advantage of the benthic invertebrates uncovered by their feeding activities (University of Kentucky, n.d.). In 1950, 5159 Silverjaw Minnows were collected, in 1978 none were captured, and in 2020 only 9 individuals were caught across the entire study area. Larimore collected higher numbers of Silverjaw Minnows in the downstream area which is associated with agricultural activity and correlates with our 2020 site 4. Site 4 had the highest percent of sand composition of all the sites, but it was predominantly silt. As the Silverjaw Minnow is intolerant of silty streambeds, land-use changes associated with increased suspended sediment and silt deposition may be a driving cause of their noticeable decline. A study on Silverjaw Minnow populations in a small freshwater stream showed that accidental discharges of manure and high levels of nutrient runoff entering the water resulted in significant fish kills. These results indicate that Silverjaw Minnows are highly sensitive to these inputs (Toth, 1982). Changes in land use and agricultural activities following 1950 may have resulted in increased nutrient runoff and therefore decreased populations in both 1978 and 2020.

Only three individuals of the Northern Hogsucker were collected in 2020 and 44 individuals were collected in 1978. Comparatively, 2358 Northern Hogsuckers were collected during the 1950 sampling event and they represent 5.72% of the relative abundance. Northern Hogsuckers are highly sensitive to stream channelization and siltation. Their populations have been decreasing in central Illinois due to these processes (IDNR, n.d.). Downstream of the forested area, Jordan Creek is surrounded by agriculture. Farming activities can result in stream channelization and erosion processes which increases the suspended sediment load and fine silt content of waterways. As Northern Hogsuckers are sensitive to both these processes, land-use changes, and agricultural activities may be primary drivers of their disappearance from Jordan Creek.

Sand Shiners were uniformly found across the 1950 study site and made up 5.69% of the relative abundance with 2344 individuals collected. Their population dramatically declined, and no Sand Shiners were found in the entire 1978 sampling event and only 11 were collected during the 2020 sampling. The Sand Shiner is found throughout Illinois except for the bottom southeast of the state which does not include Champaign county. Sand Shiners are found in streams with gravel and pebble substrate (IDNR, n.d.). In the 2020 survey, Sand Shiners were only collected in site 3 which was dominated by pebble and cobble substrate. Potential changes to the prevalence of pebbles in the stream substrate composition following the 1950 sampling effort could contribute to the decline in Sand Shiners.

The Bluntnose Minnow is found throughout the entirety of Illinois (IDNR, n.d.) and is listed as a species of least concern by the IUCN due to their large population sizes and stable population trends (Fishes of Boneyard Creek, n.d.). The Bluntnose Minnow was collected in the 1950, 1978, and 2020 sampling efforts, however, their relative abundance has fluctuated. From 1950 to 1978 the relative abundance increased by 17.28% but fell by 21.58% from 1978 to 2020 with an overall decline of 4.3% compared to their relative abundance in 1950. Despite the decrease in relative abundance in 2020, they represent 12.92% of the total sample with 346 individuals collected throughout the sites. Bluntnose Minnows live in schools and are commonly found midwater or at the bottom of the water column in clear streams with abundant aquatic vegetation, sand and gravel substrate, and a consistent flow (IDNR, n.d.). Their preference of sand and gravel substrate is reflected in our results; the greatest number of individuals were found at site 3 which is the only site dominated by pebble substrate. Because they prefer the mid to deep areas of the water column, low water levels are not favorable conditions. The decline in discharge across sampling points could have caused them to leave Jordan Creek for deeper waters. The decline in Bluntnose Minnow species in 2020 could be a result of both lower water levels and limited pebble-dominated sampling sites.

Conclusion/Recommendations

The 2020 assessment of habitat characteristics and fish community composition provides valuable insight into changes occurring in Jordan Creek. Looking at the historical context when comparing results of 1950, 1978, and 2020 sampling efforts can provide a greater understanding of the observed trends. In 1950 there were few regulations for surface water drainage. 1978 is several years after the Clean Water Act and therefore should reflect the newly imposed regulations. While 2020 represents shifting environmental standards towards fewer regulations on discharge into surface waters.

Continued monitoring of Jordan Creek at more frequent time intervals will help substantiate the 2020 results as it will provide clarification as to whether our data represents continued trends. Because of the short sampling reaches, the 2020 data has the potential of misrepresenting total species abundance. Future sampling can help identify potential species misrepresentation. To account for differing microhabitats between the reaches, a more thorough assessment of the habitat types present in each reach can help support our assertions that the presence, or absence, of microhabitats, is the driving factor of variations in species richness. In conjunction with electrofishing and fish identification, monitoring changes in the surrounding land-use can provide additional insight into potential changes in the fish community of Jordan Creek.

Fish species caught in 1950 and 2020 by family

Sucker Family

White sucker
Hog sucker
Golden redhorse
Creek chubsucker*
Quillback*
Spotted Sucker*

Minnow Family

Creek chub
Hornyhead chub
Rosyface shiner
Spotfin shiner
Sand shiner
Silverjaw minnow
Bluntnose minnow
Stoneroller
Carp*
Common shiner*
Suckermouth minnow*
Flathead minnow*
Blackstripe topminnow**
Striped shiner**
Emerald shiner**
Western mosquitofish**

Catfish Family

Yellow bullhead
Stonecat

Black bullhead*
Bridled madtom*

Killfish Family
Starhead topminnow*

Perch Family
Johnny darter
Rainbow darter
Fantail
Greenside darter
Orangethroat darter
Blackside darter*
Logperch*

Sunfish Family
Smallmouth black bass
Largemouth black bass
Green sunfish
Bluegill
Orangespotted sunfish
Longear sunfish
Rock bass
Warmouth*

*: were not caught in the 2020 sampling
**: were not caught in the 1950 sampling

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