Big Spring (Kitch-iti-kipi)
Schoolcraft County, T42N/R17W/S25
Manistique River Watershed, last surveyed 2023

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Environment

The Big Spring (Kitch-iti-kipi) is a half-acre natural spring located in Thompson Township of southwest Schoolcraft County in Michigan's Upper Peninsula (Figure 1). The Big Spring is located within Palms Book State Park approximately 100 miles west of St. Ignace and 52 miles east of Escanaba. The Big Spring is Michigan's largest freshwater inland spring and is a popular destination that provides year-round viewing opportunities for approximately 200,000 annual visitors. The Michigan Department of Natural Resources (MDNR) Thompson State Fish Hatchery is located approximately 8 miles south of the Big Spring. The Seney National Wildlife Refuge, known locally as a "birders paradise", is in Germfask, Michigan approximately 45 miles to the northeast.

The geological formations underlying the Big Spring include Burnt Bluff and the Cabot Head Shale (Cataract formation) groups containing bedrock materials comprised of Silurian-era dolomite and gypsum (MDNR 2001). The Big Spring and other smaller springs in the area are known as `karst' features, formed in carbonate bedrock and eroded over time producing ridges, fissures, sinkholes, and other landforms. Organic matter and fine sands, settled on top of course-and medium-textured materials, exist on the bottom of the Big Spring and are visible through the water column at depths ranging from 30 to 50 feet. As gravity provides hydrostatic pressure to the surrounding watershed, cold groundwater is forced up through the bottom of the Big Spring at a rate exceeding 10,000 gallons per minute. For comparison, another nearby spring has a discharge rate of nearly 1,400 gallons per minute and provides enough cool water to operate the Thompson State Fish Hatchery that produces Steelhead, Chinook Salmon, Walleye and Muskellunge annually. Landcover immediately adjacent the Big Spring is comprised of forest (74.0%), wetland (12.6%), urban (6.4%), grassland (6.0%), and agriculture (1.0%) types.

The Big Spring meanders less than a half mile southeast before entering Langes Bay on the northwest shore of Indian Lake. Indian Lake is an 8,000-acre natural lake with several inlets and outlets. Inlets to Indian Lake include Dufour Creek, Iron Creek, Silver Creek, Gray Duck Creek, Smith Creek, and most notably the Indian River. The Indian River is the sole outflow of Indian Lake and serves as a tributary to the Manistique River approximately 4.2 miles downstream of Indian Lake. The Indian Lake watershed encompasses 145,234 surface acres with land cover types that include forest (45.9%), wetland (34.5%), grassland (3.3%), water (8.7%), urban (4.2%), and other (3.3%). Approximately 18.1% of the Indian Lake watershed remains unprotected and is vulnerable to future residential or agricultural development.

Due to high groundwater inputs, the chemical and physical characteristics of the Big Spring vary little from the bottom to the surface of the water column. For example, year-round bottom to surface temperatures range from 45 to 46 °F degrees (Table 2, Table 3), respectively. Dissolved oxygen concentrations also have a narrow range from the bottom to the surface, and values tend to be slightly

hypoxic (Table 2, Table 3). Water transparency in the Big Spring is exceptionally high from 28 to 39 feet deep, indicating low nutrient levels.

During the 1950s there was interest on behalf of several agencies to quantify the discharge of the Big Spring. Present day signage suggests that the total discharge of the Big Spring is more than 10,000 gallons per minute. Interoffice communications, archived from the 1950s, suggest that the discharge of the Big Spring is often higher than 10,000 gallons per minute. Discharge was quantified nine times from 1950 to 1952 (Table 4). The average discharge from these nine measurements was 14,833 gallons per minutes with a range in discharge from 12,200 to 16,700 gallons per minute. Discharge reportedly was higher during the spring and summer months compared to the fall. These discharge estimates would suggest that, based on an estimated volume of 8 to 14 acre-feet, the Big Spring has a complete turnover rate of approximately once every three to six hours.

The Big Spring is located within Palms Book State Park, a 388-acre park that encompasses the spring and a large portion of land surrounding the outflow stream. The shoreline of the Big Spring is largely undeveloped (except an access walkway) and is protected in public ownership. More broadly, the immediate shoreland surrounding Indian Lake encompasses 689 acres with land cover types that include forest (15%), wetland (47%), grassland (3%), urban (24%), water (11%), and agriculture (1%). Approximately 67% of the shoreland surrounding Indian Lake remains unprotected and is vulnerable to future residential or agricultural development (MGLP 2023). Residential or urban (21%) areas surrounding Indian Lake make up most of these unprotected areas.

History

As early as the late-1800s, the Big Spring was reportedly visited by area residents curious to view the deep clear spring. At this time, Manistique was an established `mill town' and area residents would travel across Indian Lake and hike upstream through the woods to visit the Big Spring. Later, area transportation improved, and visitors reportedly began constructing rafts and other small vessels to float themselves out on to the Big Spring.

By the early 1900s, larger rafts had been constructed to provide viewing opportunities for more visitors. However, by the 1920s, the Big Spring was reportedly full of pieces of lumber and trash from area workers. This prompted a local businessman to clean up the spring and protect it by brokering a deal between the Palm Book Land Company and the State of Michigan. In the late 1920s, the Palms Book Land Company sold 90 acres of land surrounding the Big Spring to the State of Michigan for ten dollars, equivalent to $173.90 in 2023 dollars (CPI 2023). The deed, finalized in 1928, stipulated that the land be "forever used as a public park." and now the park bears the name "Palms Book State Park".

During the 1930s, the Michigan Department of Conservation (now the Department of Natural Resources) initiated fisheries management by requesting that the Institute of Fisheries Research conduct a limnological survey of the Big Spring. The purpose of the survey was to measure temperature and dissolved oxygen and confirm that the spring held suitable oxythermal habitat for trout stocking. The limnological survey was completed in 1937 and trout stocking began in 1948 (Table 1). Stocking trout in the Big Spring was done for the sole purpose of providing fisheries viewing opportunities for the public.

Throughout the 1940s and 1950s there were several species of fish stocked in the Big Spring including Brown Trout, Brook Trout, and Rainbow Trout. Aside from trout stocking, there were three large Lake Sturgeon stocked in the Big Spring in 1954. There is no documentation of where these Lake Sturgeon originated from, however they were likely transferred from Indian Lake. Indian Lake is one of only a few waterbodies that support a remnant population of the State Threatened Lake Sturgeon. By the mid- to late-1950s, increased visitation to the Big Spring prompted several public inquiries about the spring's biology and physical characteristics.

Many visitors to the Big Spring were interested to know what species of fish inhabited the spring, aside from stocked trout. Michigan Department of Natural Resources interoffice communications report that Yellow Perch, Common White Sucker, and a variety of minnow species utilized the spring seasonally. Of note, a local hatchery superintendent documented seasonal minnow migrations in the Big Spring that were "in great numbers, sometimes filling the spring to such an extent that it is impossible to see more than five feet down". This mass minnow migration, of what were reported to be spot-tail shiners, occurred in 1949. However, there is no documentation to suggest this has occurred since.

During this period, visitors were also curious to know what the discharge rate of the Big Spring was. Over time, there were several conflicting reports stating Big Spring discharge rates ranged from 2,000 to 17,500 gallons per minute. However, the discharge rate of the Big Spring was indeed quantified several times from 1950 to 1952 and ranged from 12,200 to 17,700 gallons per minute (Table 4) according to the United States Geological Survey (Houghton, MI interoffice communication 1953).

During the 1960s there were numerous complaints and growing concerns that area residents were illegally harvesting minnows from the Big Spring. Interoffice communications report that individuals "swarmed into the spring" as "an attractive means of dipping [minnows] from the raft". Following these complaints, a Director's Order was posted at the Big Spring stating that it is unlawful to use the spring for the purposes of swimming, bathing, skin diving, fishing, or boating and that the raft provided at the Big Spring by the MDNR was to be used only for the purpose of viewing.

Brown Trout and Rainbow Trout continued to be stocked through the 1960s, however stocking ceased for these species in 1973 and 1975, respectively. Raising legal- or adult-sized Brown Trout and Rainbow Trout was limited at this time as hatchery space was then devoted to the expansion of the Great Lakes Pacific Salmon stocking program. By the early 1970s, large Lake Trout and Brook Trout began to be stocked, however, Lake Trout were stocked more routinely. Brook Trout were last stocked in 2003 and Lake Trout have been stocked semi-annually since the late 1970s and early 1980s.

Currently, a stocking prescription exists to continue stocking adult Lake Trout in the Big Spring each year for the purpose of providing large trout viewing opportunities in Michigan. Stocked Lake Trout are provided by a federally operated hatchery and often have clipped pectoral fins for hatchery identification purposes.

Aside from continuing to support trout viewing opportunities, there is growing interest on behalf of Fisheries Division to understand the extent to which the Big Spring, and similar karst areas, serves as a nursery or spawning ground for various minnow (forage) species. It is also worth noting that annual migrations of native forage species may provide additional viewing opportunities that have not been

previously considered as something to provide the public. These interests prompted the recent limnological and visual surveys of the Big Spring, conducted in March of 2023.

Current Status

Two surveys were used to provide general information about the Big Spring. The first consisted of a limnological survey, conducted 15 March 2023 to provide baseline winter oxythermal habitat data. The second consisted of a semi-quantitative observational survey, conducted 25 March 2023. The purpose of the observational survey was to document the presence of forage species utilizing the Big Spring and determine methods for identifying species present.

Limnological data collected included temperature, dissolved oxygen, pH, conductivity (Table 3), and water transparency. Except for water transparency, all parameters were measured nearly every three feet beginning at 3.0 feet deep down to 28.4 feet. Temperature ranged from 45.7 °F at the water surface to 45.8 °F at the bottom of the spring (Table 3). Dissolved oxygen ranged from 3.8 mg/L at the surface to 2.7 mg/L at the bottom of the spring (Table 3). pH and specific conductance values are reported in Table 3. Based upon the observational survey, there were large numbers of forage minnows present, however there was likely only one species noted to be present. Forage minnows congregating at the spring were consolidated at specific locations near the perimeter.

The immediate area surrounding the Big Spring is largely protected from residential and agricultural development. However, a watershed-scale analysis suggests that shoreland areas of Indian Lake are quite vulnerable to future residential and agriculture development. As reported in the "Environment" section, approximately 67% of the Indian lake shoreland remains unprotected and vulnerable to residential or agriculture development. Based on a shoreland disturbance calculator (MGLP 2023), approximately 23% of the Indian Lake shoreland is currently disturbed suggesting that shoreland conservation measures are necessary (i.e., protection, mitigation, and rehabilitation).

Analysis and Discussion

The recent limnological survey provided baseline information needed to ensure that trout stocking in the Big Spring can continue. Surprisingly, dissolved oxygen levels were relatively low throughout the water column (2.7 to 3.7 mg/L). Most trout are sensitive to low or hypoxic dissolved oxygen levels (less than 4.0 mg/L, Wehrly et al. 2015). Despite these low oxygen levels, adult trout stocked in the spring do survive from one year to the next. These low oxygen values are also surprising given the large numbers of forage fishes that inhabit the spring at certain times of the year. Large congregations of forage fishes have been documented to occur in the Big Spring seasonally. That said, an additional, yet undervalued viewing opportunity for native forage fishes may exist in the Big Spring.

Small Yellow Perch, Common White Sucker, as well as various shiners and minnows have all been reported to utilize the spring to varying degrees at different times of the year. More information is needed about the species of fish that inhabit the spring and the time of year that may be most important to those species. As information is obtained, more outreach and educational material may be incorporated into the Big Spring landscape highlighting the ecological benefits of these undervalued species. While shiners and minnows may not appear that valuable, they are a food source for a variety of gamefish (e.g., Walleye, Yellow Perch, Northern Pike) that inhabit Indian Lake and their diversity is an indicator of overall watershed health.

The watershed and shoreland areas that encompass the Big Spring and Indian Lake are vulnerable to development and the introduction of invasive species. Given the current levels of disturbance, approximately 75% and 25% of conservation efforts are recommended to be devoted to protection and rehabilitation, respectively. Protection measures include additional land acquisitions, conservation easements, zoning, and invasive species prevention. Rehabilitation measures might include incorporating bioengineered shorelines, establishing `no-mow' zones, sewage management, and erosion control.

Management Direction

Currently, the Big Spring offers year-round fish viewing opportunities, and a growing number of people are traveling to the spring to take advantage of this unique opportunity. Recent visitation numbers suggest that more people visit the Big Spring each year than all State hatchery facilities combined. This increase in attendance provides great opportunities to build upon current natural resource outreach and education curriculum consistent with Fisheries Division's Strategic Plan. Large trout have been stocked since the 1940s and will continue to be stocked in the future to maintain these unique viewing opportunities.

Moving forward there are strategies that may be adopted to continue or building upon the success of the Big Spring fishery.

1). Continue to annually stock from 75 to 150 adult Lake Trout annually into the Big Spring.

2). Gather forage fish community information from the Big Spring to build upon current viewing, education, and outreach opportunities.

3). Additional winter and summer limnological surveys should be conducted to build upon the current volume of baseline information.

4). Discharge measurements should be collected at the outflow of the spring, upstream of the Indian Lake confluence to compliment recent limnological data. The last discharge measurement recorded from the Big Spring occurred more than 70 years ago. Given the high value of this resource, routine and seasonal monitoring of the spring should occur for baseline monitoring purposes.

References

CPI (Consumer Price Index). 2022. CPI Inflation Calculator (bls.gov).

MDNR (Michigan Department of Natural Resources). 2001. Bedrock Geology of Michigan. Land and Minerals Division.

MGLP (Midwest Glacial Lakes Partnership Conservation Planner). http://midwestglaciallakes.org Access March 2023.

Wehrly, K. E., D. B. Hayes, and T. C. Wills. 2015. Status and trends of Michigan inland lake resources, 2002-2007. Michigan Department of Natural Resources, Fisheries Report 08, Lansing.

Table 1. Year, species, number (N) planted, and size (TL inches) of fish stocked in Big Spring (Kitch-iti-kipi) for viewing opportunities, Schoolcraft County Michigan.

Year	Species	N	TL (in.)
1948	Brown Trout	30	10.0
1949	Brown Trout	30	9.3
1951	Brown Trout	50	7.3
1954	Brook Trout	4	16.0
1954	Brown Trout	50	28.0
1954	Lake Sturgeon	1	66.0
1954	Lake Sturgeon	2	36.0
1954	Rainbow Trout	100	23.0
1956	Brown Trout	50	
1956	Rainbow Trout	50	
1957	Brown Trout	50	
1959	Brown Trout	50	
1960	Brown Trout	50	
1961	Brown Trout	50	
1962	Brown Trout	50	
1963	Brown Trout	50	
1964	Brown Trout	100	
1965	Brown Trout	100	
1965	Rainbow Trout	50	
1966	Brown Trout	50	
1966	Rainbow Trout	50	
1967	Brown Trout	35	
1967	Rainbow Trout	150	
1968	Brown Trout	50	
1968	Rainbow Trout	50	
1969	Rainbow Trout	50	
1971	Brook Trout	267	
1971	Brown Trout	50	
1971	Rainbow Trout	100	
1972	Brook Trout	50	
1972	Rainbow Trout	47	
1973	Brown Trout	50	
1974	Lake Trout	6	
1975	Lake Trout	6	
1975	Rainbow Trout	50	
1976	Lake Trout	12	
1977	Lake Trout	12	
1977	Lake Trout	15	
1978	Lake Trout	15	

Table 1. Continued.

Year	Species	N	TL (in.)
1980	Lake trout	25	31.1
1981	Lake trout	25	33.4
1982	Lake trout	30	33.6
1982	Lake trout	25	34.6
1983	Lake trout	35	22.8
1983	Lake trout	20	13.0
1984	Lake trout	30	20.1
1985	Lake trout	35	18.1
1986	Lake trout	35	24.4
1987	Lake trout	25	26.5
1988	Brook trout	10	13.5
1988	Lake trout	10	28.1
1991	Brook trout	35	14.0
1991	Lake trout	24	30.2
1992	Brook trout	30	18.4
1992	Brook trout	30	19.1
1992	Lake trout	30	21.0
1993	Lake trout	30	28.2
1994	Lake trout	35	14.9
1995	Lake trout	40	16.3
1996	Lake trout	30	29.3
1997	Lake trout	30	28.5
1998	Lake trout	30	29.5
1999	Lake trout	20	34.8
2000	Lake trout	30	37.2
2001	Brook trout	50	10.4
2001	Lake trout	40	31.3
2002	Lake trout	18	29.1
2003	Brook trout	35	14.0
2003	Lake trout	118	12.3
2004	Lake trout	35	38.6
2006	Lake trout	78	23.8
2006	Lake trout	50	41.7
2008	Lake trout	50	16.6
2009	Lake trout	40	10.6
2009	Lake trout	115	31.5
2010	Lake trout	30	26.1
2011	Lake trout	80	30.2
2012	Lake trout	84	25.6

Table 1. Continued.

Year	Species	N	TL (in.)
2012	Lake trout	120	26.8
2012	Lake trout	138	24.4
2012	Lake trout	50	26.0
2012	Lake trout	50	27.0
2013	Lake trout	128	36.2
2013	Lake trout	83	31.9
2014	Lake trout	150	18.3
2014	Lake trout	96	36.2
2015	Lake trout	50	30.0
2016	Lake trout	30	29.5
2016	Lake trout	43	29.5
2016	Lake trout	70	29.8
2016	Lake trout	95	28.6
2017	Lake trout	100	35.4
2017	Lake trout	68	35.4
2018	Lake trout	110	28.2
2018	Lake trout	45	29.0
2018	Lake trout	100	27.6
2019	Lake trout	100	29.9
2019	Lake trout	73	36.6
2021	Lake trout	150	27.1
2022	Lake trout	75	27.9

Table 2. Depth in feet (ft), temperature (°F), dissolved oxygen (mg/L), and pH measurements recorded in the Big Spring (Kitch-iti-kipi) by the Institute of Fisheries Research on 30 June 1937.

Depth (ft)	Temp (°F)	Dissolved Oxygen (mg/L)	pH
0 (surface)	46.0		
3	44.8	5.2	7.6
6	45.5		
9	45.3		
12	45.0		
24	44.8		
30		5.4	
36	44.6		
39 (bottom)	44.6		

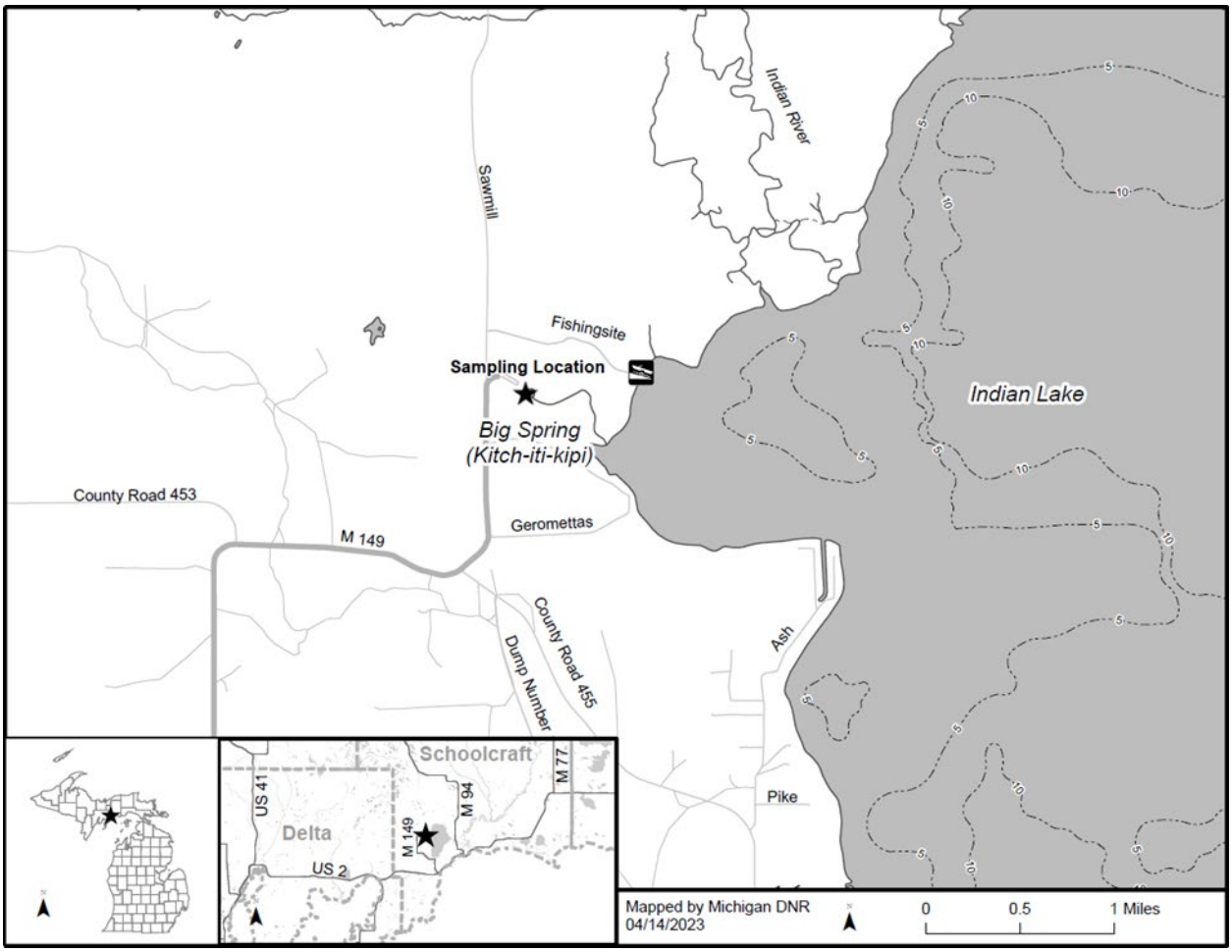
Table 3. Depth in feet (ft), temperature (°F), dissolved oxygen (mg/L), pH, and specific conductance (mS/cm) measurements recorded in the Big Spring (Kitch-iti-kipi) by Fisheries Division on 25 March 2023.

Depth (ft)	Temp (°F)	Dissolved Oxygen (mg/L)	pH	Specific Conductance (mS/cm)
0 (surface)				
3	45.7	3.8	6.4	1.2059
6	45.7	3.7	6.6	1.2088
9	45.7	3.6	6.8	1.2126
12	45.6	3.5	6.9	1.2146
15	45.6	3.5	7.0	1.2171
18	45.6	3.4	7.1	1.2188
21	45.7	3.4	7.1	1.2226
24	45.7	3.4	7.2	1.2376
28	45.8	2.8	7.2	1.3889
28.4 (bottom)	45.8	2.7	7.2	1.3949

Table 4. Measurement number, date of measurement, and discharge in cubic feet per second (CFS) and gallons per minute (GPM) of the Big Spring (Kitch-iti-kipi). Data were reported in an interoffice communication from 1953. Data were reported to have been collected by the United States Geological Survey (Houghton, MI office communication 1953).

Measurement No.	Date	CFS	GPM
1	May 24, 1950	37.1	16,700
2	August 8, 1950	31.2	14,000
3	November 9, 1950	32.2	14,500
4	May 15, 1951	35.5	16,000
5	August 21, 1951	32.6	14,700
6	October 18, 1951	29.1	13,100
7	April 24, 1952	39.4	17,700
8	July 22, 1952	32.5	14,600
9	November 13 1952	27.2	12,200

Figure 1. Map of the Big Spring (Kitch-iti-kipi) located in southwest Schoolcraft County, Michigan (46.004084 -86.382339).



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