Fisheries Assessment of the Kickapoo River from the Headwaters to Wilton, Wisconsin

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Abstract

In 2003, the Wisconsin Department of Natural Resources (WiDNR) conducted 5 fisheries surveys on the Kickapoo River between the Kickapoo River headwaters and Wilton, Wisconsin. Habitat surveys were also conducted on 3 of the 5 survey stations. Fisheries and habitat surveys were conducted as a part of the WiDNR baseline monitoring program. The objectives of monitoring the Kickapoo River were: to classify the stream according to aquatic life potential, help determine why this section of stream may not be reaching biotic potential, determine if resource management activities could improve stream conditions, document physical and biological trends, and quantify land and water use factors impacting the stream (WiDNR, 2000).

Fisheries data from these stations were evaluated using the Coldwater Index of Biotic Integrity (IBI) to Measure Environmental Quality and the IBI to Measure Environmental Quality in Warmwater Streams of Wisconsin. Trout per kilometer and biomass in kilograms per kilometer were also calculated based on actual fish caught per one time sampling effort. Brown trout (*Salmo trutta*) population estimates were calculated for data on station 3 using the Chapman-Petersen method. Relative weights (Wr) were calculated for Brown trout in stations 1-4 based on standard weights (Ws) developed by Miewski and Brown (1994). Relative weights were also calculated for brook trout (*Salvelinus fontinalis*) in station 5 based on Ws values from Hyatt and Hubert (2001). Trout populations were evaluated and re-classification for part this section of the Kickapoo River was recommended. Species composition lists were compiled for each station and data were compared with past sampling efforts to evaluate fish community changes over time that might indicate changes in water quality, temperature conditions, and habitat changes.

Habitat stations were evaluated using the Index of Habitat Integrity (IHI) for stations 1 and 3. Temperature data were collected 1997 through 2003 using a temperature logger above Wilton by the State Bike Trail. Instream and ambient air temperature data were compiled and compared. A Whole Effluent Toxicity (WET) test was conducted in station 1 and results were evaluated.

Introduction

The La Crosse Area WiDNR sampled 15 stations on the Kickapoo River between 1999 and 2003. Sampling information was needed to assess the fisheries community on the Kickapoo River, fisheries populations, biotic potential, establish trout stream classification of the river, evaluate fisheries regulations set by the WiDNR, assess changes in the community over time, and provide water quality information.

In 1999 and 2000, 10 fisheries stations were sampled between Ontario the Gays Mills Dam. In 2003, 5 stations were sampled on the upper reach of the Kickapoo River above Wilton. Data from all 15 stations were quite extensive, so this report is restricted to the analysis of the 5 survey stations from 2003.

The 2003 fisheries sampling effort started at the Highway (HWY) 131 bridge above Wilton, and stations were located throughout the stream to its origination upstream. This section of stream is approximately 12,080 meters long. The 5 stations surveyed covered 949 meters of this stretch. Stations 1-4 were wadeable, warmwater fisheries stations. Mean stream widths per stations range from 8.1 meters in station 1 to 3 meters in station 4. Station 5 was a wadable, coldwater fisheries station and in contrast had a mean stream width of 1.5 meters. Figure 1 shows the 5 stations that were sampled on the Kickapoo River in 2003.

Data from station 5 were evaluated using the Wisconsin IBI for Coldwater Streams and data from stations 1-4 were evaluated using the Wisconsin IBI for Warmwater Streams. The stretch of stream between stations 1-4 is indicative of a coolwater stream that has been degraded to create warmwater conditions. Currently unavailable is an IBI for coolwater, wadable, Wisconsin streams, however several indicators of poor water quality apply to both warm and coolwater streams.

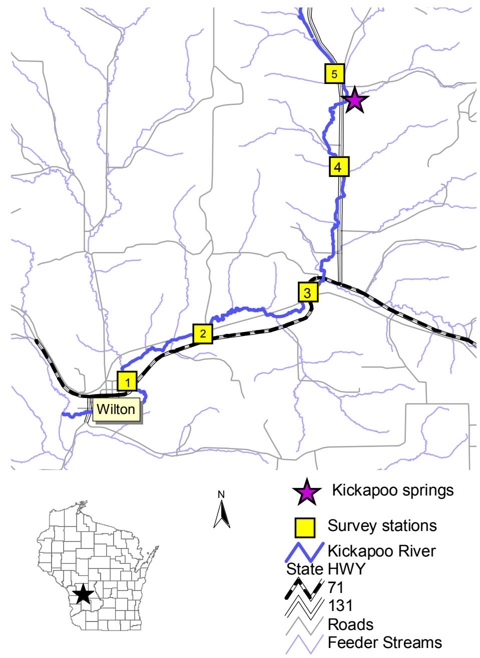

Figure 1. Map of 2003 fisheries survey stations.

Brown trout and brook trout populations were assessed and classification of the stream is in the process of being upgraded accordingly from non-classified trout water to Class 1 above the Kickapoo Springs outlet. Relative weight (Wr) of brook and brown trout populations were evaluated and Proportional Stock Densities (PSDs) were calculated.

Realizing the complexity of managing a stream's fishery, this project looked at several other ecosystem factors that affect the local fishery in addition to fish and habitat information. Other factors evaluated included geology, water temperatures, air temperatures, recent precipitation records, a Whole Effluent Toxicity (WET) test, current land use practices and trout stocking information. While other factors also affect the fishery, this report is based on currently available data.

Background

Watershed Characteristics

The Kickapoo River Watershed is located in the non-glaciated area of Wisconsin. The main stem of the Kickapoo River is approximately 209 kilometers (km) (130 miles) long starting just north of Wilton, and joining the Wisconsin River at Wauzeka. Based on spatial analysis using Arcview 3.2a, sub-watershed data layers in Wisconsin Transverse Mercator (WTM) and datum NAD 1983/91, the Kickapoo River basin consists of 5 sub-watersheds totaling 1,990 square kilometers (491,694 acres). Table 1 shows the size of the 5 sub-watersheds in hectares and acres (WiDNR, 1998). The study area in 2003 was in a portion of the Upper Kickapoo River sub-watershed.

Table 1. Sub-watersheds of the Kickapoo River watershed basin and size structure.

Sub-watershed	Hectares	Acres
Lower Kickapoo	38,920	96,173
Middle Kickapoo	63,876	157,848
Reads & Tainter Cr.	35,159	86,879
Upper Kickapoo	30,401	75,122
West Fork Kickapoo	30,585	75,577

One of the major tributaries to the main stem of the Kickapoo River in this section of river is Sleighton Creek. This creek enters the Kickapoo River in the upper half of station 1 and was last surveyed in 1998. No trout were found at that time and it was not classified as trout water (Raatz et al., 1998).

Just above station 4 is a man-made impoundment that flows into the Kickapoo River named Kickapoo Springs. This impoundment, owned by the WiDNR, is approximately 1.25 surface hectares (3 acres) in size, contains a bottom draw dam, has been stocked with trout yearly in the past, and has been in existence since at least 1967. The WiDNR did work on this impoundment in 1993, the dike was repaired and beaver dams were removed from the adjoining Kickapoo River area. No recent creel surveys are available for this impoundment, however in 1970, car counts were preformed and 75 cars were counted in the parking lot at one time. Today it remains a heavily used recreational fishing area.

Approximately 1,824 kilometers (1,135 miles) of stream enters the Kickapoo River. The WiDNR has classified 87.4 kilometers (54.3 miles) of these as Class 1 trout water, 123.6 kilometers (76.8 miles) as Class 2 trout water, and 108.6 kilometers (67.5 miles) as Class 3 trout water. Classifications are defined as follows. Class 1 is high quality trout water that has enough natural reproduction to sustain populations of wild trout near carrying capacity. Class 2 has some natural reproduction but not enough to take full advantage of available food and space. Class 3 trout water has marginal habitat with no natural reproduction occurring, and indicates little to no survival of trout from year to year (WiDNR, 2002).

Geology and Land cover

The geology in the study area consists of layers of dolomite on the ridge tops with underlying layers of sandstone and shale. Covered with shallow soils, a recent study done on baseflows in the Upper Kickapoo Sub-watershed indicates that the pronounced topography of the area creates strong local groundwater flow systems. This implies "that most groundwater flowing into a stream originates from within its surface watershed" (Gaffield et al., 1998). Groundwater that affects baseflow in this area originates from the St. Lawrence Formation and Upper Tunnel City Group. Gaffield's (1998) study suggested that wooded hillslopes are probably the most critical recharge areas to the watershed and that "spring forms are an important hydraulic connection between aquifer and streams".

High gradient coldwater streams in this area rely heavily on ground water to control summer stream temperatures. The impact is greatest in headwater streams were the groundwater discharge rate is large relative to stream discharge (Gaffield, 2000). Other conditions effecting instream temperatures include shading by riparian vegetation and channel width with these factors being as important as groundwater inputs in some locations. Gaffield's research indicated springs produced the greatest cooling in concentrated areas at a spring but diffuse groundwater discharge "probably provides valuable summer habitat in less than extreme weather conditions".

Land cover for the Kickapoo River watershed in 1993, consisted of 28% forage crops, 23% northern oak, 18% mixed/other broad-leaved deciduous forest, 12% grassland, 12% corn, 2% other row crops, 1% coniferous forest, 1% wet meadow, and 1% barren. Pre-settlement land cover by comparison consisted of 86% deciduous forest with sugar maple, basswood, red oak, white oak, black oak, burr oak and oak openings, 9% grassland and brush, 3% mixed conifer/deciduous forest made up of white and red pine, and 2% wetland vegetation, including lowland hardwoods, marsh, sedge meadow, wet prairie, and lowland shrubs (WiDNR, 1998).

The study area is still a traditional agricultural area with three major feeding operations using the river for watering and grazing of livestock. However, the region just south and downstream of the survey area is becoming increasingly a recreational destination. The Kickapoo River watershed has several large state-owned recreational areas that include: Wildcat State Park at 1,457 hectares (3,600 acres) with only 65 of these hectares (160 acres) in crop production, the La Farge Recreation Area at 3,468 hectares (8,569 acres) with 362 hectares (894 acres) in crop production, and the Kickapoo River Wildlife Area which includes over 2,833 hectares (7,000 acres) of DNR owned land and easements. In 1999, it is estimated that anglers and canoeist spent approximately 2 million dollars in the Kickapoo River Valley (Ripp et al., 2002).

Seven documented dams have existed on the Kickapoo main stem over the last 100 yrs. All dams have been abandoned, except the Gays Mills Dam. In 1971, the U.S. Army Corps of Engineers (Corps) started construction of a new dam at La Farge but the project was abandoned after local concerns were raised and funding was canceled.

Removal of the dams, improved agricultural practices such as contour strips, the Trout Unlimited Home Rivers Initiative, and conversion of land from agricultural to recreational use has helped improve river conditions in several areas. However, water quality and fisheries community health still needs improvement especially in the 2003 sampling area. Several water quality issues still need to be addressed in the area above Wilton to improve water quality including poor land use practices, bank erosion, lack of overhead cover in the stream corridor, grazing of woodlots, and illegal irrigation practice. More demographic and detailed background information can be found in the State of the Basin Report - Lower Wisconsin (Ripp et al., 2002) and "Integrated Demographic Information and LandSat ™ Data at a Watershed Scale" (Kuczenski et al., 2000).

Fisheries

As early as 1947, there was already public interest in classifying the Kickapoo River as trout water. A letter from WiDNR personnel, Thayre Mc Cutchin to Charles Lloyd explains how panfish and bullheads were being stocked between Ontario and La Farge at the time. Local sportsmen claimed to be catching trout in this area but Mr. McCutchin stated "the nearly impossible conditions for shocking" at that time and believed the Kickapoo River should remain non-trout water (Mc Cutchin, 1947).

Past fisheries sampling efforts occurred on the Kickapoo River between 1940 and 1993. Previous fisheries surveys on the study area occurred in 1962, 1970, and 1993 using electrofishing sampling techniques. During the time of these surveys, pH, conductivity, water temperature, and habitat data were also collected.

Continuous forage species removal from the Kickapoo River by bait dealers, increase trout fishing in the area, water quality improvement in surrounding streams, removal of several Kickapoo River dams, and the stocking of trout in this area have increased the need for new data to affirm or reject possible trout water status for this section of the Kickapoo River. The WiDNR has been stocking this portion of the Kickapoo River above Wilton since 1990 with brown trout. Over these last 13 years, 12,335 domestic-strain yearlings, 500 domestic-strain adults, and 3,060 wild-strain yearlings have been stocked. The 3,060 wild-strain, brown trout were stocked in 2003 on April 30th. These trout had an average length of 165 millimeters (mm) (6.5") with an average weight of 53 grams (g). Also 1,000 domestic-strain, brown trout were stocked on April 14, 2003. The domestic-strain trout averaged 249 mm (9.8") in length and 172 g in weight. Both domestic and wild-strain fish were stocked between stations 2 and 4.

In 1997, 2 Hilsenhoff Biotic Index scores were calculated for this reach of stream between station 3 and 4 off Lincoln Avenue. This index indicates the amount of organic pollution based on invertebrates sampled. Scores and rating for this test are defined in Table 2. The Kickapoo River Hilsenhoff Biotic Index scores ranged from 5.825 (fair) in April to 4.435 (very good) in October. This is important because it verifies organic pollution is occurring in this section of the Kickapoo River during the spring.

Table 2. Hilsenhoff Biotic Index scores and rating model information.

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

This organic loading coincides with when farmers would be doing spring planting and fertilizing on local farms.

Methods

The 5 stations surveyed on the headwaters of the Kickapoo River in 2003, were sampled by single run electrofishing surveys with a stream shocker on stations 1 through 4 with a second mark and recapture run on station 3. The stream shocker consisted of a 1.8 meter (m) (6') long by .9 m (3') wide fiberglass boat that was .4 m (15") deep with a 2,500 watt generator. Three electrode probes were used on the front of the boat with oblong anode rings that were approximately 229 mm (9") wide by 305 mm (12") long. A metal plate on the bottom of the boat worked as the cathode. Straight direct current (DC) power was used during sampling. All stream shocker electrofishing stations had 3 people netting using 6.35 mm (.25") mesh.

Station 5 was sampled using a backpack shocker consisting of a 12 volt DC battery with an adjustable pulse rate that was set at 80 pulses per second with a duty of 20% of available current. The anodes were consistent with the probes used on the stream shocker. The cathode consisted of an attached tail that was 1.8 m (6') in length. One netter used a dip net consisting of 6.35 mm (.25") stretch mesh to sample the station.

All game fish were measured by .5 inch groups and weighed in grams. The length of each fish was measured as total length. Non-game species were counted and aggregate weight was recorded. Past sampling efforts only established non-game species as abundant (A), common (C), or scarce (S), so non-game species from these 2003 data were then put into the appropriate categories.

Stations were established based on past locations of surveys, ability to get landowner permission to conduct surveys on their property, and IBI protocols. Station length was established by taking the estimated mean stream length X 35 as specified in IBI protocol. Some stations were lengthened to end at an instream habitat change. Station 1 was the most downstream station gradually moving up stream to station 5. Station lengths are indicated in Table 3.

Table 3. Length of stations surveyed on the Kickapoo River in 2003.

Station	Length Meters
1	240
2	250
3	202
4	120
5	137

The IBI to Measure Environmental Quality in Warmwater Streams of Wisconsin was used to evaluate fish data from stations 1-4. The warmwater IBI model was used because the section of stream between Wilton and the Kickapoo Springs outflow, which had traditionally been a coolwater stream, has been degraded to warmwater status. Instream temperature monitoring between 1997 and 2003 indicate water temperatures exceeding coolwater stream temperatures. Coolwater streams are considered streams with average maximum daily mean temperatures between 22^{o}C and 24^{o}C (Lyons et al., 1996). No coolwater IBI exists for Wisconsin at this time. The Coldwater Index of Biotic Integrity (IBI) to Measure Environmental Quality was used to calculate a water quality score for station 5.

The warmwater IBI scores are based on 12 different metrics. The last 2 metrics only affect the score when extreme. These include low numbers of individual fish or high percent of deformities, eroded fins, lesions, or tumors (Lyons, 1992). The 10 constant metrics are:

Species Richness and Composition
Total number of native species
Number of darter species
Number of sucker species
Number of sunfish species
Number of intolerant species
Percent that are tolerant species

Trophic and Reproductive function
Percent that are omnivores
Percent that are an insectivore
Percent that are a top carnivore
Percent that are simple lithophilous spawners (Lyons, 1992)

Warmwater IBI scores range from 0 to 100. Scores and ranges are generalized into 6 categories. Table 4 shows overall Warmwater IBI scores with the corresponding IBI rating.

Table 4. IBI scores and corresponding IBI rating.

Overall IBI score	Biotic Integrity rating
100-65	Excellent
64-50	Good
49-30	Fair
29-20	Poor
19-0	Very poor
No score	Very poor

An excellent rating represents minimal human disturbance, expected species for habitat and stream size with a balanced trophic structure. Good represents a species richness that is below expectations with a loss of the most intolerant species and a trophic structure that shows signs of an imbalance. A fair rating shows a greater decrease in species richness, increased abundance of tolerant species, loss of intolerant species, a highly skewed trophic structure, and an older age class of top carnivores that are rare or absent. A poor rating indicates relatively few species that are tolerant to low water quality, dominated by omnivores, habitat generalists, with few top carnivores or simple lithophilous spawners, and growth rates and condition factors that are sometimes depressed. A very poor rating shows very few species present that are mostly tolerant forms, exotics, or hybrids with few large or old fish. A very poor rating may also indicate not enough species were present to calculate an IBI (Lyons, 1992).

The coldwater IBI looks at 5 different metrics including:

Number of intolerant species
Percent of all individuals that are tolerant species
Percent of all individuals that are top carnivore species
Percent of all individuals that are native or exotic stenothermal cold water or cool water species
Percent of salmonid individuals that are brook trout (Lyons et al., 1996).

Table 5 shows the coldwater IBI scoring system with the appropriate ratings.

Table 5. Coldwater IBI scores and ratings.

Overall IBI score	Biotic Integrity rating
100-90	Excellent
80-60	Good
50-30	Fair
20-10	Poor
0 or no score	Very poor

An excellent rating indicates the least human disturbance, mottled sculpins (*Cottus bairdi*) or slimy sculpins (*Cottus cognatus*) are usually common, and brook trout are the top carnivores. Good represents a stream that has some environmental degradation and reduction in biotic integrity, exotic salmonids often dominate, and brook trout or sculpins are either absent or uncommon. Fair coldwater streams have moderate environmental degradation, intolerant and native stenothermal coldwater species are uncommon or absent. Poor streams have major environmental degradation and total species richness may be relatively high but intolerant species and top carnivores are absent. Very poor coldwater IBI scores represent a stream that has had so much degradation that either only warmwater or tolerant species remain (Lyon et al., 1996).

Data from stations 1 through 5 were used to calculate biomass of trout in kilograms (kg) per hectare (pounds per acre), kg per kilometer (km) (pounds per mile), number of trout per hectare (acre), and number per km (mile). These numbers were calculated based on actual fish caught with an estimated gear efficiency of 49%. This is consistent with the gear efficiency calculated in the population estimate preformed in Station 3. An overall population estimate of brown trout was calculated using information from stations 1-4 for 10.5 km (6.5 miles) of stream. There was such a change in habitat and stream conditions above the outflow of Kickapoo Springs that separate population estimates were calculated for brook trout in the upper reach and brown trout in the lower reach. A list of species for all stations was also generated showing total number caught.

The condition factor of brown trout on the Kickapoo was calculated using weight-length regressions, grouping data from stations 1-4, and comparing them to the proposed standard weight (Ws) equations and length-categorization stands established by Milewski and Brown (1994). The Ws equation for brown trout used was $\log_{10}$ Ws (g) = -4.867 + 2.960 $\log_{10}$ TL (mm). The data set only included fish 140 mm (5.5 in) in length up to 554 mm (23 in). Brook trout Wr was calculated using Ws equation of log10 Ws (g) = -5.186 + 3.103 log10 TL (mm) for station 5 (Hyatt and Huberts, 2001).

Proportional Stock Densities (PSDs) for brown trout on stations 1-4 were measured using number of fish $\geq$ quality length/number of fish $\geq$ stock length X 100. A brook trout PSD was calculated for station 5 using the same equation. Quality and stock lengths were based on lotic trout species research only. The brown trout stock length used was 15 centimeters (cm) (6”) with a quality length of 23 cm (9”) (Milewski and Brown, 1994). The brook trout stock length was 13 cm (5”) with a quality length of 20 cm (8”) (Hyatt and Huberts, 2001). A PSD of 40-70 is considered balanced, <40 dominated by small fish, and >70 comprised primarily of large fish.

Limited habitat data were collected on station 5. Habitat information was collected on stations 1 and 3 following the protocol established in the “Guideline For Evaluating Habitat of Wadeable Streams” (Simonson et al., 1994). In stations 1 and 3, data were collected at transect locations that ran perpendicular to the stream bank. Each station had 12 transects that were equally spaced throughout stations 1 and 3. Data collection included substrate evaluation, stream width/depth measurements, instream fish cover measurements, riffle/pool/run distances, stream bank elevations, stream buffer information and erosion. Measurements were then entered into the Index of Habitat Integrity (IHI) for Wisconsin. This model calculated individual scores for riparin buffer width, bank erosion, pool area, width:depth ratio, riffle:riffle or bend:bend ratio, fine sediment, and cover for fish. An overall score was then assigned representing a range from poor to excellent. Qualitative ratings are excellent ≥ 75; good 50 to 74; fair 25 to 49; poor < 25.

Instream temperature data were collected at the lower end of station 3 from 1997 through 2003. For this report the temperature data from 2001-2003 will be used because those are the only years that data for all months were collected. A StowAway Tidbit temperature data logger was used to record hourly temperatures each day. Mean, median, minimum, maximum, and range of temperature per month was calculated.

Precipitation data were acquired from the National Climate Data Center. This information was based on readings from the Sparta, Wisconsin weather station. Precipitation records from 2002 and half of 2003 were then compared to 30-year precipitation averages.

On November 11, 2003 water samples were collected from the Kickapoo River in station 1. A Whole Effluent Toxicity (WET) test was performed. For this toxicity test fathead minnows (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*) were exposed to the undiluted water sample. Survival/reproduction of *Ceriodaphnia dubia* and survival/growth rates for the fathead minnows in the sample water were then compared to rates of survival/growth/reproduction of laboratory controls (Koperski, 2004; WiSLH, 2004). Water chemistry was evaluated for dissolved oxygen, pH, conductivity, hardness, and alkalinity.

Results

Warmwater IBI scores for stations 1-4 are shown in Table 6. Station 5 scored 90 or excellent rating using the Coldwater IBI for Wisconsin streams.

Table 6. Warmwater IBI scores for stations 1-4.

Station	**Warmwater**
1	24 poor
2	17 very poor
3	12 very poor
4	39 fair

The poor to very poor ratings of stations 1-3 indicate a lack of species that are intolerant to poor water quality. Low scores for stations 1-4 also verify a skewed trophic structure for the area with an older age class of top carnivores that is rare or absent. Species are dominated by omnivores, habitat generalists, with few simple lithophilous spawners. All of these indicators suggest poor water quality in this area.

Brown trout populations greatly increased over the past 10 years, going from 2 in 1,432 m of sampling in 1993 to 88 in 572 m of sampling in 2003. The PSD calculated for brown trout using data from stations 1-4 equaled 22. The PSD for brook trout in station 5 equaled 16. Any score under 40 indicates a fishery dominated by small fish. Relative weights (Wr) calculated for wild-strain and domestic-strain brown trout at the time of stocking were 135 and 95 receptively. Wr's of 105-95 were considered in the normal condition range. Scores calculated for fish surveyed indicated that 6% of sampled brown trout over 5.5 inches long were above the 105 range, indicating better than average condition with 79% in the normal condition range, and 15% below the normal range of 95. None of the 6% that had condition factors greater than 105 were higher than 135, the original condition of stocked wild strain trout. These condition factors verify that growth rates are poorer than expected if this was a high quality stream.

Habitat ratings were also calculated in 2003 for stations 1 and 3. Station 1 was considered fair with a rating of 43 and station 3 was considered good with a rating of 60. However fish cover for both stations was considered poor with a rating of 0.

Monthly median, maximum, and range of instream water temperatures collected in station 3 for July-December in 2001-2003 showed maximum temperatures reaching at least 27.2^{o}C (81^{o}F) each year with minimum temperatures reaching -.07^{o}C (31.88^{o}F). Temperature highs and lows ranged up to 19^{o}C (34.28^{o}F) within a one month period. Median water temperatures were highest in July and August for all three years. Median temperatures ranged from 19.9^{o}C (66.08^{o}F) to 20.9^{o}C (69.58^{o}F). Instream water temperatures were also taken downstream by Ontario, Wisconsin. These data consistently showed the same temperature variation with similar maximums, medians, and ranges. Monthly mean ambient air temperatures for January to July of 2003 showed no significant variation from 30 year averages.

Yearly precipitation in this area was 43.2 mm (1.7") above average in 2002 and 168.9 mm (6.65") below average in 2003. Water levels were low when sampling occurred due to low accumulative precipitation starting in November 2002 to June 2003. During the time of our sampling, it was also discovered that water was being removed from the stream in station 5 for irrigation purposes.

The Whole Effluent Toxicity test showed no toxicity to fathead minnows (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*) that were exposed to the undiluted water sample.
Water chemistry showed dissolved oxygen levels around 11 mg/l, pH of 8, conductivity ranging between 391-455 umhos/cm, hardness ranging from 228-236 mg/l, and an alkalinity of 211 mg/l. All of these chemistry readings were within a range conducive to trout survival.

Station 1

A 240-meter section of stream on the Kickapoo River was sampled starting at the Hwy 131 bridge in Wilton and going upstream. This area is just below were Sleighton Creek enters the Kickapoo River. This section of stream was also surveyed in 1962 and 1970. The 1962 survey station was 732 meters long and started downstream from the bridge. The 1970 station started at the bridge but was 274 meters long. A complete listing of species found per year is shown in Table 7. The table also shows each species, tolerance to poor water quality and temperature type based on Lyons (1992) classifications.

The greenside darter (*Etheostoma blennioides*) and the red shiner (*Notropis lutrensis*) were also found on previous occasions but were most likely misidentified based on distribution ranges in Wisconsin established in "Fishes of Wisconsin" (Becker, 1983). Important species changes in this station were the disappearance between 1962 and 2003 from this stretch of the Kickapoo River of the American brook lamprey (*Lampetra appendix*), central stoneroller (*Campostoma oligolepis*), and suckermouth minnow (*Phenacobius mirabilis*). However the previously absent longnose dace (*Rhinichthys cataractae*) became abundant.

Table 7. Fish species list by year for station 1 including 1962, 1970, and 2003. Temperature types and tolerances to poor water quality per species are presented. Abbreviations for number of species are as follows: S, scarce; C, common; A, abundant. Tolerance abbreviations are as follows: I, intolerant; T, tolerant; O, other. Appreviations for temperature types based on Lyons (1992) are as follows: ECD, exotic stenothermal coldwater; NCL, native stenothermal coolwater; NCD, native stenothermal coldwater; NWW native stenothermal warmwater; NEU, native eurythermal.

Common name	Scientific name	Tolerance	Temp.	1962	1970	2003
	Lampreys Petromyzontidae					
American brook lamprey	*Lampetra appendix*	I	NCL	S	S	-
	Minnows - Cyprinidae					
Central stoneroller	*Campostoma oligolepis*	O	NEU	A	A	-
Common shiner	*Luxilus cornutus*	O	NEU	A	A	C
Bigmouth Shiner	*Notopis dorsalis*	O	NWW	C	-	C
Suckermouth minnow	*Phenacobius mirabilis*	O	NWW	A	-	-
Southern redbelly dace	*Phoxinus erythrogaste*r	O	NEU	C	S	C
Bluntnose minnow	*Pimephales notatus*	T	NEU	A	S	C
Fathead minnow	*Pimephales promelas*	T	NEU	S	-	-
Bullhead minnow	*Pimephales vigilax*	O	NEU	-	-	S
Blacknose dace	*Rhinichthys atratulus*	T	NEU	A	-	A
Longnose dace	*Rhinichthys cataractae*	O	NEU	-	-	C
Creek chub	*Semotilus atromaculatus*	T	NEU	A	A	C
	Suckers-Catostomidae					
White sucker	*Catostomus commersoni*	T	NEU	A	A	A
	Bullhead catfishes-Ictaluridae					
Stonecat	*Noturus flavus*	O	NEU	S	S	S
	Trouts-Saimonidae					
Rainbow trout	*Oncorhynchus mykiss*	O	ECD	S	-	-
Brown trout	*Salmo trutta*	O	ECD	S	-	C
Brook trout	*Salvelinus fontinalis*	I	NCD	-	-	S (Only 1)
	Sunfishes-Centrarchidae					
Green sunfish	*Lepomis cyanellus*	T	NEU	-	-	S
	Perches-Percidae					
Fantail darter	*Etheostoma flabellare*	O	NEU	-	C	C
Johnny darter	*Etheostoma nigrum*	O	NEU	S	-	C

Seventy-nine percent of all species caught were tolerant to lower dissolved oxygen levels and disturbed habitat.

Actual number of brown trout caught in this section of stream was calculated to be 84 trout per km (134 trout per mile). If the gear efficiency of this sample were consistent with rates found in station 3, it could be estimated that the total population of brown trout in this stretch of the Kickapoo River was 171 trout per km (273 trout per mile) with a biomass estimates of 20.6 kg per km (74 lbs per mile).

The habitat rating index for station 1 was fair with a score of 43. Under the rating system the following individual ratings were also calculated:
riparian buffer/good, bank erosion (lack of)/good, pool areas/fair, width to depth ratio/fair, riffle to bend ratio/excellent, fine sediment/fair, and fish cover/poor.

Stations 2-4

Fish species composition was evaluated with comparable stations from previous fisheries surveys paying particular attention to 1970 and 1993 data on stations 2-4. When looking at station 2-4, species diversity increased from 10 fish species in 1970, 17 in 1993 (Hanson et al., 1993), to 18 in 2003. A detailed species comparison per station from the 1993 to 2003 data can be found in Table 8.

Though there was not a large change in the number of species between 1993 and 2003, the shift in species composition between these years indicates a decrease in water quality conditions. Species intolerant to poor water quality decreased between stations 2-4 including redside dace (*Clinostomus elongates*), American brook lamprey, and sculpins. The most important of these decreases was the complete loss of sculpins from station 3, where they were once common, and the loss of redside dace from stations 2/3. Species tolerant to poor water quality that became more

Table 8 – Fish species list by year for stations 2-4 including 1993 and 2003. Temperature types and tolerances to poor water quality per species are presented. Abbreviations for number of species are as follows: S, scarce; C, common; A, abundant. Numbers following species found indicate what stations they were found throughout. Tolerance abbreviations are as follows: I, intolerant; T, tolerant; O, other. Appreviations for temperature types based on Lyons (1992a) are as follows: ECD, exotic stenothermal coldwater; NCL, native stenothermal coolwater; NCD, native stenothermal coldwater; NWW native stenothermal warmwater; NEU, native eurythermal.

Common name	Scientific name	Tolerance	Temp.	1993	2003
	Lampreys Petromyzontidae				
American brook lamprey	*Lampetra appendix*	I	NCL	S 3	-
	Sculpins Cottidae				
Mottled Sculpin	*Cottus bairdi*	I	NCL	-	C 4
Slimy Sculpin	*Cottus cognatus*	I	NCL	C 3/4	-
	Minnows – Cyprinidae				
Central stoneroller	*Campostoma oligolepis*	O	NEU	C	C
Common shiner	*Luxilus cornutus*	O	NEU	C	S
Bigmouth Shiner	*Notopis dorsalis*	O	NWW	-	S 2/3
Southern redbelly dace	*Phoxinus erythrogaste*r	O	NEU	S	S
Bluntnose minnow	*Pimephales notatus*	T	NEU	C	A
Fathead minnow	*Pimephales promelas*	T	NEU	S 2	S 3/4
Bullhead minnow	*Pimephales vigilax*	O	NEU	S 4	C 4
Blacknose dace	*Rhinichthys atratulus*	T	NEU	S 2	A 2/3
Longnose dace	*Rhinichthys cataractae*	O	NEU	C	C
Redside dace	*Clinostomus elongatus*	I	NCL	C 2/3	S 4
Creek chub	*Semotilus atromaculatus*	T	NEU	C	C
	Stickleback Gasterosteidae				
Brook stickleback	*Culaea inconstans*	O	NCL	C 4	S 3/4
	Suckers-Catostomidae				
White sucker	*Catostomus commersoni*	T	NEU	A	A
	Bullhead catfishes-Ictaluridae				
Stonecat	*Noturus flavus*	O	NEU	-	S 2
	Trouts-Saimonidae				
Rainbow trout	*Oncorhynchus mykiss*	O	ECD	-	S 3 (Only 1)
Brown trout	*Salmo trutta*	O	ECD	S 3	C 2/3/4
	Perches-Percidae				
Fantail darter	*Etheostoma flabellare*	O	NEU	A	A
Johnny darter	*Etheostoma nigrum*	O	NEU	S	C

common included the bluntnose minnow (*Pimephales notatus*), creek chub (*Semotilus atromaculatus*), fathead minnow, and the blacknose dace (*Rhinichthys atratulus*). The percent of species tolerant to poor water quality was 67% in station 2, 65% in station 3, and 42% in station 4. Percent of omnivorous species was 49% in station 2, 43% in station 3, and 11% in station 4. These changes represent a change from poor water quality in station 2 to fair water quality in station 4.

It should be noted that based on Beckers "Fisheries of Wisconsin" (1983) fisheries distribution maps, it is probable that sculpins identified in previous surveys should have been identified as mottled sculpins not slimy sculpins. Only mottled sculpins were found in stations 4 and 5 in 2003, which would also indicated the slimy sculpins were misidentified. This is important to note because mottled sculpins are more tolerant to higher temperatures than slimy.

The population estimate of brown trout in station 3 using the Chapman-Peterson model shows an estimated 430 brown trout per km (696 per mile) with a 95% confidence interval of +/- 134 trout per km (+/- 215 fish per mile). Biomass of brown trout in this section of stream was 48 kg per km (168 lbs per mile) of brown trout was based on average weights X population estimates per inch group. Gear efficiency was 49%. No young of the year were found and only 2 age groups of brown trout were apparent.

The habitat rating index for station 3 was fair with a score of 60. Individual matrix ratings for station 3 were riparian buffer/good, bank erosion (lack of)/ good, pool areas/excellent, width to depth ratio/good, riffle to bend ratio/ excellent, fine sediment/fair, and fish cover/poor.

Station 5

Station 5 had a completely different species composition that included 115 mottled sculpins, 59 brook trout, 5 American brook lampreys (ammoceate), 1 brook stickleback (*Culaea inconstans*), and 1 white sucker (*Catostomus commersoni*). With a mean stream width of 1.5 meters, this section of stream was considered excellent brook trout water. No direct survey comparison could be made based on past survey locations however a downstream station surveyed in 1993 showed similar results. That station was above the Kickapoo Springs outflow and contained a more diverse species composition. It also contained more adult brook trout and year classes, which would be expected because the streams width and depth are greater in that area. Relative weights (Wr) calculated for the brook trout in station 5 showed ¼ of the fish sampled had less than average condition factors. There were only 17 fish in the sample size, so no distinct trend could be assumed.

Discussion

Fisheries

Wisconsin Warmwater IBI scores indicate the water quality between stations 1-4 is very poor to fair. Not only is the water quality marginal, trends indicate the water quality and biotic fitness of the Kickapoo River between station 1 and 4 has decreased over the last 10 years. This trend is apparent due to the fact that previously sculpins were found throughout station 3 and 4 not just in station 4. American brook lampreys were not found in the 2003 surveys, however it should be noted that they were very scarce in past sampling efforts. Redside dace, another species intolerant to poor water quality were also found in stations 2 or 3 before and now are only in station 4. Generally there has been an increase in fish species tolerant to poor water quality and a decrease in intolerant species.

For the last 3 years, temperature data collected in station 3 showed instream water temperatures that reached 27°C (81°F). Temperatures ranged up to 19°C (34.28°F) in a month period. Unstable temperature conditions have lead to an increase in eurythermal fish species and a decrease in stenothermal species. These temperature variations and extreme highs will not only affect species composition but also limit brown trout survival.

While this section of stream should be considered Class 3 brown trout water, conditions are less than ideal. Brown trout prefer temperatures below 20°C (68°F) for satisfactory growth, 12.2°C (54°F) for spawning, and the upper lethal limit is considered 25.6°C (78°F) (Becker, 1983). Even though brown trout can survive temperatures up to 27.2°C (81°F) for short periods of time, there are only a few small feeder streams in this area that fish could seek refuge in during extreme temperatures.

Habitat sampling in station 1 and 3 scored adult fish cover as 0 or very poor. Width to depth ratio ranged from fair to good, and fine sediment ratings were fair indicating instream sedimentation was occurring. The extreme temperature conditions and lack of adult fish habitat is reflected with a low PSD and average to below average condition factors.

Stocked with brown trout in mid and late April at a rate of 390 fish per km (625 fish per mile), survey work in early June showed an estimated rate of 273 fish per km (436 fish per mile). This difference in an $1^{1}/_{2}$ month period would indicate that survival rates are low. Low survival rates are also evident when looking at year to year survival. The stream has been stocked since 1990, however brown trout over 25.4 cm (10") only comprised an estimated 31 fish per km (49 fish per mile) or 9% of the survey sample. No brown trout were captured over 35.6 cm (14") long. Young of the year (YOY's) were also absent in this section of the Kickapoo River. This can be attributed to the extremely cold instream water temperatures during the peak spawning period.

Condition factors of the trout stocked in April compared to the trout caught in June, showed poor condition maintenance. It is expected that stocked fish would loss some conditioning, however it is hoped that the length/ weight ratio would not fall below average expected condition. Of the fish stocked in April, ¾ of the fish stocked were at 135% of average condition factors. Approximately 45 days later, 79% of fish displayed average conditioning and 6% had below average conditioning.

Even though water quality is not the best in this stream, it must be noted that 2003 was the first year that wild-strain brown trout were stocked in the study area. In 2004, this area is scheduled for stocking with only wild-strain brown trout and no domestic-strain trout. A study done in the West Fork of the Kickapoo River proved that yearly survival rates were much higher for wild brown trout strains vs. domestic-strain trout. Survival rates of wild-strain brown trout were 1.3-4.5 times higher than domestic-strain brown trout after 1 year and 4-42 times higher after 2 years (Avery et al., 2001). Several other streams around the state have seen this same trend, were previously poor trout streams had better survival rates and natural reproduction when wild-strains of brown trout were introduced (Vetrano, 2004). Not only are survival rates of wild trout higher, growth rates improved in released wild-strain fish and reduced noticeably the initial size advantage of domestic fish in the West Fork study (Avery et al., 2001)

Due to budget restraints, it should be noted that the WiDNR stocking program is changing in 2004. All impoundments, including Kickapoo Springs, will not be stocked. This is important to this section of the Kickapoo Watershed because Kickapoo Springs is a major public impoundment and provides accessibility to several different user groups. In comparison, access on the main stem of the Kickapoo River above Wilton is limited. From a recreational perspective and due to poor survival rates of stocked fish, it maybe a better use of stocking resources to stock some of the brown trout scheduled for the Kickapoo River main stem into Kickapoo Springs instead.

Seining by commercial bait harvesters heavily impacts this section of stream, especially in station 1. This is most likely the reason that central stoneroller and suckermouth minnows are no longer in station 1. The central stoneroller species is particular susceptible to depletion in a specific location because the species does not tend to move back into areas of over harvest (Becker, 1983). Another species that the WiDNR needs to be concerned with in this section of stream is the redside dace . This species is on the states special concern list and due to its rarity may not be identified properly by harvester. This is also a species that has been declining in this section of stream due to poorer water quality conditions over the last 10 years.

Station 5 is comprised of a totally different type of fisheries. This section of stream is Class 1 brook trout water. The brook trout population consists of smaller fish and YOY's. This area is relatively small and lacks a lot of adult fish cover. In 1993, more adults were found directly down stream between station 5 and the Kickapoo Springs outflow.

Land use

One of the major reasons for doing long term monitoring of this stretch of the Kickapoo River was not only to assess the fisheries but also to discover why biotic potential and water quality were substandard. Trends in the Wisconsin driftless area have indicated that changes in agricultural practices have decreased erosion rates, increased infiltration, decreased flood peaks, and increased low flow in area streams (Gebert and Krug, 1996). However, it is apparent that this stretch of stream is not following the same trend.

Several factors contribute to instream temperature conditions, so finding one particular cause-effect relationship may be impossible. What can be ascertained is that a change in water temperature occurred in the time period between 1993 and 2003 based on changes in fish species compositions. Temperature data between 2001-2003 showed consistent warmwater temperatures from year to year even though precipitation changed yearly.

Ambient air temperatures did not vary significantly from 30-year average in the 6-month period prior to our sampling effort. Beaver activity in 1993 could have affected instream temperatures, however they were removed in 1993 and removal should have actually improved water temperatures.

It is reasonable to assume that warmer water would be entering the Kickapoo River from Kickapoo Springs and elevating stream temperatures. However, this impoundment has not had any depth or discharge increase since the 1960's. Kickapoo Springs is also a bottom draw dam, which is suppose to reduce or eliminate the thermal effects of the impoundment. Stream widths will also affect instream water temperatures. When comparing habitat surveys from 1993 to 2003, no appreciable difference in stream widths or depths could be found.

Looking at as many factors as possible, it appears water quality has decreased due to poor land use practices and illegal irrigation in the area. What we know for sure is that water was being illegally drawn from the coldest part of the Kickapoo River for irrigation purposes in 2003. The area this water was drawn from has been under new ownership since 2000 and the water is being used for a commercial greenhouse operation. This could have a significant impact on water temperatures in the stream during the summer when water needs for irrigation would also be highest. This is especially critical due to the geology of the area, where relatively shallow aquifers contribute the most to the stream's baseflow. A reduction in baseflow could increase stream temperatures to a level that would reduce habitat for cold-water species. A reduction in quantity of water might ultimately change the possible use of the surface water, and stream classification (WiDNR, 1997)

Agricultural land use practices in the area are not following the same trends as in lower areas of the Kickapoo Watershed. This area is still intensely farmed and ideal management practices are not in place. Stream banks remain relatively unstable, buffer strips are minimal, and erosion problems are prevalent. Organic loading is occurring during spring planting and livestock watering areas on the stream are common. The change from 86% deciduous forest in presettlement times to approximately 42% forest in 1993, verifies the trend of deforestation in the area. This is again especially critical due to the shallowness of the aquifer providing baseflow to the Upper Kickapoo Watershed. Loss of vegetation and organic topsoil drastically decrease the ability of the soil to absorb precipitation, creating flooding, and erosion problems (Garfield et al., 1998).

Recommendations

The Kickapoo River from the Hwy 131 Wilton, bridge to below the Kickapoo Springs outflow should be monitored the next few years to evaluate if stocking wild-strain brown trout has improved trout survival rates. All waters upstream of the Kickapoo Springs outflow should be classified as Class 1 trout water. This would provide protection of this section of stream from further seining for forage species, development of ponds, and use of water for irrigation.

The temperature of the Kickapoo River should continue to be monitored in Station 3. In conjunction, temperature monitors should be installed below the outflow of Kickapoo Springs impoundment to ascertain if the impoundment is having an effect on instream water temperatures. Even though Kickapoo Springs may not be causing the higher than usual water temperatures, the WiDNR can possible use control measures on the impoundment to improve water temperatures. A temperature monitor should also be put in the feeder stream that enters the Kickapoo River above the impoundment. Fisheries surveys should be conducted next year also to assess the area between the outflow of the impoundment and upstream.

From a recreational and biological perspective, WiDNR resources might be better allocated by only stocking half of the wild brown trout scheduled for this section of the Kickapoo River into the river proper next year. With limited access to this stretch of stream, low survival rates, and the use of Kickapoo Springs in this area, it seems pragmatic to provide more angling opportunities to a diverse clientele at the Kickapoo Springs impoundment. Enough wild brown trout would still be stocked into the Kickapoo River to try and establish a better trout fishery. Follow up survey work should be completed to determine if survival rates are better in this section of stream using wild-strain brown trout.

Most importantly and probably the hardest to do, poor land use practices should be addressed in this section of stream. The best case scenario would be to provide financial incentives and educational information to the agricultural community to help improve land use practices. The community needs to understand that establishing better erosion control methods, eliminate animal grazing and massive watering areas from the stream corridor, and provide better stream canopy will improve water quality conditions. They also need the means to implement these practices. As a part of this, illegal irrigation from the stream in this area should be stopped.

The lack of fish cover in this area also makes this an ideal section of stream for the WiDNR's easement program. Through this program not only could poor land use practices be address but also the stream could be narrowed and deepened, instream habitat could be established, and overhead cover could be restored. This stream has the potential of having trophy size brown trout due to the large amount of forage species but only if temperature issues are addressed and adult fish cover is provided.

Lastly, there is a proposed project on this stretch of stream to evaluate stream flow and geology of the area (Whistler, 2000). This project would help define stream flows in the area and evaluate future land use changes. If funding becomes available, this could be used to ascertain correlations between land use, baseflow, and water quality effects on fisheries compositions.

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