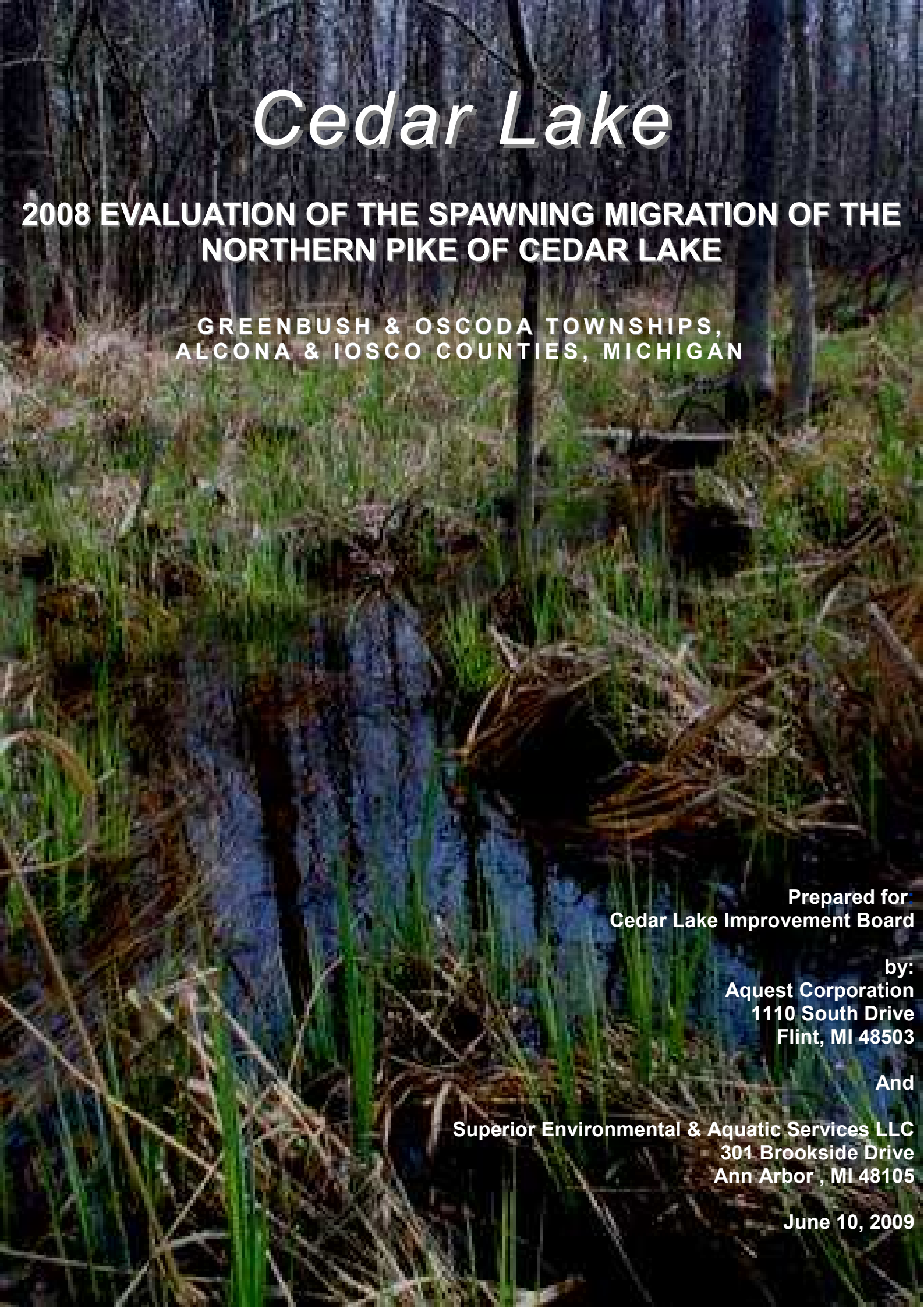

Cedar Lake

2008 EVALUATION OF THE SPAWNING MIGRATION OF THE NORTHERN PIKE OF CEDAR LAKE

GREENBUSH & OSCODA TOWNSHIPS,
ALCONA & IOSCO COUNTIES, MICHIGAN

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INTRODUCTION

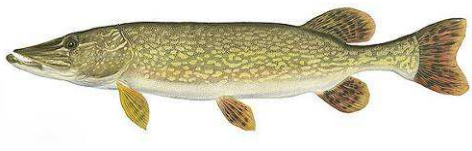
In 2008 the Cedar Lake Board retained the services of Aquest Corporation to evaluate and document the use of Sherman Creek and its associated wetland complex by the resident northern pike (*Esox Lucius*) population of Cedar Lake. Aquest Corporation subcontracted Superior Environmental & Aquatic Services LLC (SEAS) to conduct in field assessment, data analysis and preparation of final report documenting the spawning migration from beginning to end.

Rationale


Speared Northern Pike

The wetland complex located west of the lake is directly connected by two small streams called Sherman Creek and Jones Creek. Historically, wetland complex was identified by fisheries biologists of the Michigan Department of Natural Resources (MDNR) as a viable pike spawning area. Historically, spear fisherman would park along Cedar Lake Road and hike into the marsh to spear pike during the spawning run. The robust spawning migration and equally robust seasonal harvest necessitated a ban on spearing of pike within the marsh by the MDNR out of concern that the fishery might be severely overharvested at its most vulnerable stage. Anthropogenic alterations to the hydrology of the wetland complex have resulted in impairment of catchment and water retention within the wetland resulting in increased discharge and sub optimal time frame for completion of the spawning run and survival of fry.

A proper assessment of critical components of the Cedar Lake watershed and development of a watershed management plan to protect and conserve such components required an assessment of the wetland complex as a pike spawning marsh. The degree to which the wetland complex contributes new recruits to the fish community of Cedar Lake and specifics of the spawning migration have not been quantified . Consequently, this study was conducted to evaluate and document spawning activity, nursery activity and potential for recruitment within the wetland complex and develop management recommendations for its conservation or enhancement.



NORTHERN PIKE LIFE HISTORY AND HABITAT REQUIREMENTS

Distribution and Abundance: Northern pike distribution is holartic, ranging from northwestern Europe, across northern Asia, to northern North America. In North America they range from Alaska to Labrador, south through New England and much of New York, the northern part of the Ohio Valley, the Great Lakes region, and southward to Missouri and Nebraska. In it's native range, northern pike abundance varies and in northern Wisconsin lakes northern pike >35 cm (14 in.) was reported to averaged 16.1 fish/ha (40 fish/acre) and ranged from 2.8-38.0 fish/ha (7-94 fish/acre) (Margenau et al 1998).

Temperature: Upper lethal temperature for northern pike was reported to be 29° C (84° F), optimal growth occurs from 19-25° C (66-77° F) (Casselman 1978, Bevelhimer et al. 1985, Jacobson 1992), and upper lethal temperature based from measurements in different parts of U.S. was reported to be 30° C (86° F) (R. Pierce, Minnesota Department of Natural Resources, transcripts of Lake Davis Steering Committee meeting, August 25, 1999). Northern pike were reported to be susceptible to winter kill in small shallow lakes (Margenau et al. 1998).

Salinity: The species is salinity tolerant and occurs regularly in the Baltic Sea (Crossman 1979). In Alaska, northern pike were reported to have migrated downstream from the Sustina River, survived the brackish waters along the Sustina Flats, and moved into the Little Susitna River (Medred 1998).

Dissolved Oxygen: Dissolved oxygen lower threshold for growth was reported to be 3 mg DO/l (3 ppm DO/l) (Headrick and Carline 1993).

Ph: Ph typically ranges from 6.1 to 8.6 in northern pike lakes (Margenau et al. 1998)

Fecundity (Egg Production): The number of eggs produced by individual northern pike were expressed as Y = 4401.4X - 66,245 (Y = number of eggs and X = total length in inches) (Franklin and Smith 1963). Female pike weighing 0.75 lb (0.3 kg) may produce 9-10,000 eggs, while a 10 lb (4.5 female may produce 100,000 eggs (Lagler 1956).

Average Life Span in Michigan: 7 years

MDNR State Average Growth Rate (Length at Age): In Michigan the rate of growth for northern pike is greatest within the first three years of life at an average of four inches per year and reaches approximately one foot (11.7 in, 29.7 cm) during the first growing season. Growth decreases to an average rate of three inches per year for the remaining four years of life.

Diet: Northern pike demonstrate opportunistic feeding strategies and reflect species availability (Margenau et al 1998). Fusiform shaped prey are preferred, juvenile northern pike 4 to 5 in (10 - 12.5 mm) reported to feed on microcrustacea and aquatic insects; juvenile pike feed on aquatic insects with increasing piscivorous as size increases; adults are very piscivorous but will include a variety of items in their diet including frogs, crayfish, ducklings (Lawler 1965, Frost 1954, Allen 1939, Hunt and Carbine 1950, Lux and Smith 1960, Lagler 1956).

Sexual Maturity: Northern pike in the southern parts of its range spawn occasionally at one year of age, while the majority spawn initially at two years (McClane 1998). In Minnesota 1% were one year old, 84% were 2-5 years, and 15% were over 5 years of age at spawning. Distances traveled during spawning migrations are variable but pike have been reported to migrate up to 25 miles in streams.

Spawning Migration: Mature pike migrate to shallow, calm, weedy bays, flooded wetlands, and slow flowing tributary streams to spawn just prior to, or immediately following ice-out in late March or early April. Water temperatures during this period may range from the mid 30's to the mid 40's. Northern pike migrating from Green Bay in Wisconsin have been recorded traveling as far as fifteen to 45 miles (74 kilometers) inland to find suitable spawning areas (Rost and Gaumnitz, 2004). Male northern pike begin the spawning migration from several days to a week before female pike. As they travel, adult pike form spawning groups that usually consist of one or two relatively small males and a larger female who is full of eggs. Females may be tended by more than one male during the act of spawning, as adhesive eggs are randomly broadcast over vegetation in shallow water often less than 18 inches (45 centimeters) deep. Suitable vegetation provides the necessary stimuli to prompt the simultaneous discharge of eggs and milt. The vegetation may be true wetland plants or even submerged terrestrial vegetation, but it must be clean and have plenty of places for the adhesive eggs to attach. The vegetation also must be sturdy and dense enough to keep the fertilized eggs off the bottom in well-oxygenated water for two weeks until the fry hatch. Sedges and other true wetland species were used historically, but submerged grasses including the persistent exotic reed canary grass are used. Eggs and milt may be simultaneously released periodically throughout the daytime hours over a period of 2 to 5 days. A number of environmental factors may delay or inhibit spawning, including the absence of vegetation, the presence of cold weather, water level drawdown, strong wind, or rain.

Egg to Fry: Developing eggs are extended no parental care and depending on water temperature hatch in about 12 to 14 days. Upon hatching pike may attach to vegetation by means of an adhesive pad located on the head and continue to feed on the yolk for about a week. Mean egg density varied between 469–1829 eggs per m^2 (561 to 2188 eggs per yard) with the lowest

density observed in Kalmar Sound of the Baltic Sea (Nilsson, 2006).The habitat of the embryos becomes the in initial habitat of the fry (Franklin and Smith 1963). Dense vegetative cover provides several advantages to larval northern pike (Frost and Kipling 1967). Yolk sac fry have small papillae on the front of their heads with which they can attach to vegetation and remain suspended above the sediments. This keeps the fry removed from dangerously low levels of oxygen, and high levels of hydrogen sulfide at the sediment water interface at the wetlands. Hydrogen sulfide concentrations greater than 0.004 to 0.006 ppm (96-hour exposure) decrease growth and survival of sac fry (Adelman and Smith 1970). Once the yolk sac is absorbed and the fry are ready to feed, approximately 10 days after hatching in Minnesota (Franklin and Smith 1963), the invertebrate fauna associated with the vegetation provides a suitable food base. Thick vegetation also provides refuge from potential predators. Young northern pike are vulnerable to predation from a variety of fishes, including other northern pike (Hunt and Carbine 1951). Immediately after hatching, fry are very active (Frost and Kipling 1967; Howard and Thomas 1970). Within the first day, however, most attach to vegetation, where they remain for several days while the yolk sac is being absorbed (Frost and Kipling 1967). In hatchery jars, with no vegetation, fry became quiescent after the initial burst of activity and sank to the bottom (Howard and Thomas 1970). Fry average 7 to 9 mm (0.3 in to 0.4 in) in length at hatching (Frost and Kipling1967; Forney 1968).

Emigration: Fry begin to emigrate from spawning grounds when 15 to 20 mm long (0.6 to 0.8 in) (Carbine 1942; Franklin and Smith 1963; Forney 1968). The time required to grow to this size is variable. Emigration began 10 to 13 days after hatching in New York (Forney 1968) and 16 to 24 days after hatching in Minnesota (Franklin and Smith 1963). Emigration may be concentrated or prolonged. Forney (1968) reported that 82, 99, and 37% of the fry left a controlled marsh within 20 days after emigration started, in three successive years. Data of Franklin and Smith (1963) indicate similar variability in the length of time for emigration. Most young-of-the-year pike emigrated from a Saskatchewan marsh within a one week period, six weeks after the completion of spawning (Koshinsky 1979). The reasons for this variability are unclear. Emigration is inhibited by low light intensity; pro longed periods of overcast weather might extend the emigration period (Forney 1968). Other factors, such as water level and food supply, may also determine when the fry depart (Royer 1971). Growth and survival rates of northern pike fry depend on temperature. Survival is poor at temperatures less than 5.8°C (42°F) (Lillelund 1966). Growth rate is positively related to temperature for pike fry held at constant temperatures between 7.5°C and 25.6°C (46°F and 81°F), but mortality of one day old yolk sac fry increases significantly at temperatures greater than 20.8°C (69°F); thus, the rate of net biomass gain is highest at 20.8°C (69°F) (Hokanson et al. 1973). The rate is high for temperatures from 18.0 to 25.6°C. (64°F to 81°F). Northern pike are spring spawners, and early developmental stages experience a progressively warmer average temperature. Tolerance of high temperatures increases within the embryo and fry stages (Lillelund 1966; Hokanson et al., 1973). The optimal temperature for growth and survival of fry increases from about 21°C (70°F) shortly after hatching to 26° C (79°F) after 1 or 2 weeks (Hokanson et al. 1973).

Mortality: A three year study found mortality of eggs and young pike was between 99.56 and 99.93% Franklin and Smith,1963. Predation by insects and other fish including the northern pike itself are primary sources of mortality in the that follow spawning. MDNR fish population models typically assume an average natural mortality of adult fish to be 50%.

METHODS AND MATERIALS

Site

Cedar Lake lies within two counties in the Michigan's Lower Peninsula and is roughly 1100 acres in size. The lake is situated in southeast corner of Alcona County and the northeast corner of Iosco County (Figure 1). Cedar Lake is a long (approximately six miles in length), narrow, shallow (five feet deep on average) reservoir. MDNR lake maps indicate that the lake was formed by impounding Cedar Creek (MDNR Lake Map, 1954). The primary surface water input is Sherman Creek which drains Cedar Lake

Swamp referred to in this report as the Cedar Lake/Sherman Creek wetland complex: a large wetland complex located west of the lake (Figure 2).

SEAS was responsible for providing video and photographic documentation of the entire northern pike spawning migration and methods and materials used varied with conditions specific to three stages of reproductive activity including 1) spawning migration from Cedar Lake into Sherman Creek; 2) eggs and fry production; and 3) emigration from the marsh into Sherman Creek. The study commenced on 24 March 2008.

Figure 1

Spawning Migration
Video recordings of pike migrating from Cedar Lake to Sherman Creek were conducted using a fully submersible UV Infrared Sony ® CCD camera with LED night vision enhancement. Video recording typically began at 9:00 PM and ended at 3:00 AM the following morning. The video recording system was employed to record pre-spawning behavior in the Cedar Lake/Sherman Creek wetland complex. Counts of individual fish migrating into Sherman Creek from Cedar Lake were conducted on 24, 25, 26 and 31 March and 1 April 2008. Each night an initial or clearing count was conducted by walking along the stream counting all fish from the confluence at Cedar Lake to two connecting channels that drain the wetland complex. After the clearing count, SEAS personnel were positioned at the confluence of Sherman Creek and Cedar Lake to conduct counts of new fish entering the stream. The count was ended after a five hour interval of observation. SEAS fisheries personnel chose to be as unobtrusive as possible to minimize stress to adult fish and allow for unencumbered progression of spawning activity. Qualitative determination of sex of fish was estimated based on prior experience of the investigator and size of fish.

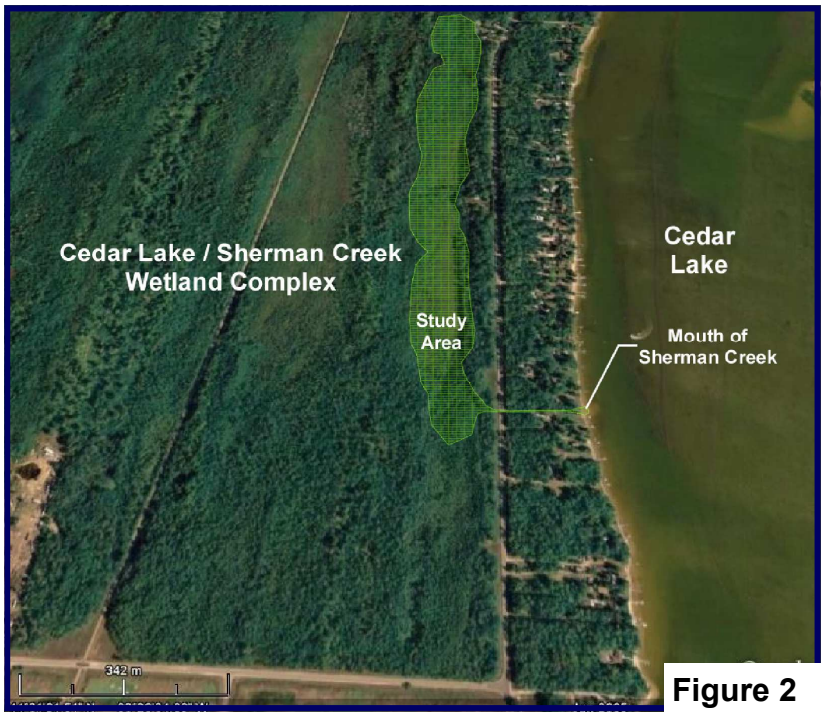


Figure 2

Eggs and Fry
Eggs and fry were counted within one square meter plots at ten locations non random within the marsh. At each site a wooden box frame 1.0 m^2 by 0.6 m^2 was placed over submerged vegetation. Vegetation and a portion of bottom sediment within the frame was removed and placed into a large plastic bag containing a ninety five percent ethanol solution. The entire sample was processed or "picked" in the lab to separate eggs from the vegetation and assorted debris. A total count of eggs per site were recorded. This method was repeated for the assessment of fry production within the marsh.

Emigration
Fry were observed in access channels within the marsh and Sherman Creek as early as 26 April 2009. SEAS employed the use of a kick net was three feet high by six feet wide with 500 micron mesh screening. SEAS placed the kick net within the stream for a 15 minute sampling period. After the sampling period the kick net was carefully lifted from the screen and fry were enumerated and returned to the stream. After each sample interval the screen was rinsed with clean water from Sherman Creek and inspected to prevent contamination with additional larvae prior to the sample period. A total of sixteen sampling periods totaling four hours were conducted.

RESULTS

Photographs taken during the study are found in Appendix 1.

Spawning Migration
Cedar Lake Association member Ron Henning observed northern pike entering Sherman Creek on 20 March 2008. SEAS biologist began video documentation and counts of the spawning migration on 24 March 2008 (Table 1). Water temperature was 33 F (0 C). A total of one hundred and twenty one pike were counted in twenty five hours of surveillance. The beginning of the spawning migration was comprised of males and a few females. The number of females increased as the migration progressed and by 1 April 2009 mostly large females were observed in and entering the stream. Movement of pike upstream began at night fall and lasted until dawn. During the daylight a small number of pike were observed burrowed head first under streamside vegetation and leaf litter or hidden under woody debris.

Table 1. Number of northern pike counted in Sherman Creek during the 2008 spawning migration.

Date	Count
24-Mar-08	13
25-Mar-08	15
26-Mar-08	18
31-Mar-08	32
1-Apr-08	43

Photo and video documentation of northern pike in the Cedar Lake / Sherman Creek wetland complex began on 5 April 2008. Water temperature was 34 F (1 C) degrees. Much of the wetland was covered in ice.
The wetland was bounded on the east by in second growth trees and woody vegetation. Alternating and intermixed areas of shrub/scrub, forested and herbaceous wetland habitat comprised the wetland complex to the north and west. Water was clear and flowing strongly southwest towards Sherman Creek. Bottom substrate within the wetland consisted of particulate organic matter including leaves, twigs and decaying vegetation over firm sandy soils. Two distinct channels from the wetland to the stream provided a clear hydrologic connection. Northern pike were observed using these channels to enter the wetland. These two channels appeared to be the preferred points of entry into the spawning areas within the wetland as pike were not found in Sherman Creek upstream of the primary channels to the wetland. Additional sheet flow from the wetland to the stream was also evident.

As temperatures increased to 40 F (4 C) male and female pike began to form spawning pairs or a spawning group of two to three males per female. Pike were primarily found in large, open expanses of sedge hummocks and flats containing various herbaceous grasses and were occasionally found in shrub/scrub and forested wetland areas but always over herbaceous vegetation.

Table 2. Number of northern pike eggs collected from one square meter plots from the study area within the study area on 9 April 2008.

Plot No.	No. of Eggs per m^2
1	223
2	227
3	184
4	56
5	132
6	174
7	31
8	161
9	146
10	23
Total No. Eggs Counted	1357
Average No. of Eggs per m^2	135.7

Eggs and Fry
Eggs were collected from the study area on 9 April 2008. All plots contained eggs. A total of 1357 eggs were collected from all plots combined (Table 2) . Average density was 135.7 (1SD± 74.93) eggs per m^2 with a range of 23 to 227 eggs per m^2.

Sac-fry were collected from the study site on 26 April 2009 Fry were on 9 mm (0.4 in) in size on average. A total of 399 fry were collected from all plots combined (Table 3). Average density was 39.9 (1SD± 22.55) fry/m^2 with a range of 6 to 71 fry fry/m^2.

Larval aquatic beetles (dytiscid and hydrophilids), mosquito, midge and caddisflies (phriganeidae) were very abundant in samples and were observed throughout the study area.

Emigration
Northern pike fry were collected from Sherman Creek 1 May 2008. A total of 150 fry were collected (Table 3) Average rate of emigration was 0.63 (1SD± 0.49) fry/min or 37.8 per hour. Fry averaged approximately 13.0 mm in length (0.5 in).

Estimation of Productivity
Our attempts to estimate the number of adult pike produced from Sherman Creek are based on the following assumptions:

- Cedar Lake/Sherman Creek Wetland Complex of approximately1600 acres in size and approximately 8 acres (or 0.5%) utilization by spawning pike by way of Sherman Creek.
- Average egg production of 135.7 eggs / m^2 (549,151 eggs per acre)
- Estimated survival from egg to fry 25%.
- Estimated survival of egg to spawning adult of 1%.

Table 3. Rate per minute of northern pike fry counted in Sherman Creek on 1 May 2008.

Sample Interval No.	No. of fry/min
1	0.9
2	0.6
3	1.1
4	0.2
5	0.4
6	0.8
7	0.1
8	0.3
9	0.7
10	1.5
11	0.5
12	0.2
13	0.1
14	0.6
15	0.3
16	1.8
Total No. fry Counted	150
Average No. of fry/min	0.63

Based on these assumptions we estimate 137,288 young-of-the-year pike (17,161 per acre) would be produced and of this year class we would approximately 5,492 spawning adults would return to spawn in the Cedar Lake /Sherman Creek wetland complex within a two to five year period. This estimate may be somewhat elevated, due to the sampling bias in egg collection. Documentation of eggs produced was a high priority and therefore our plots were located where the chance of finding eggs would be greatest. Consequently, the non random location of plots introduces sampling bias towards higher densities of eggs per plot in than what would be found in a random plot sampling design. Mean egg density varied between 469–1829 m^2 with a the calculated egg loss occurring from approximately one day after spawning to one day before hatching ranged from 41±7% in to 67±6% during the study (Nilson, 2006). In 1993, a five-acre spawning marsh of intermittent streams and wetlands in Minnesota produced approximately 67,000 young of the year northern pike or 13,400 per acre (Rost and Gaumnitz, 2004). Production of 1,930 fingerlings per acre in ten managed marshes were recorded in Michigan during a three year period 1959-1961 (DiAngelo and Williams, 1962). Additional estimates of production of fingerlings per acre were found to be 4,834 in 1962 and 1,788 in 1963; (Jarvenpa, 1967). A restored pike spawning area in Wisconsin estimated pike production at 20,000 fry per acre (Wisconsin DNR, 2009). It should be noted that strong pike year classes are produced on the average only once in every four to five years. Based on other literature we believe our estimate of production is high but not outside the realm of possibility as Cedar Lake / Sherman Creek wetland complex exhibits very high quality and nearly ideal habitat for spawning northern pike.

Emigration
In 2008 the average size of pike emigrating from the spawning area was 12.7 mm. Prior studies indicate a size at emigration of 15 to 20 mm long (Carbine 1942; Franklin and Smith 1963; Forney 1968). Morro et al., reported emigration from the wetlands into Conesus Inlet began at sizes as small as 14 mm and was usually complete at a length of 30 mm. Northern pike were collected in Conesus Inlet as early as 6 April at sizes of 14 mm and as late as 2 June at sizes of 80 mm. MDNR Fisheries biologist along with SEAS personnel observed emigrating pike and concluded that the fry appeared to be undersized and would

likely experience higher mortality than if emigration took place at a larger size. At the estimated rate of emigration, it would take nearly five months for all fry estimated to have been produced to exit the wetland. Emigration is not expected to remain constant and it is probable that additional sampling would capture additional variability. However, a rate of 1.05 fry per minute would be necessary for all fry produced to exit the marsh before mid July when Sherman Creek no longer discharges to Cedar Lake.

Monetary Value
Considering the money spent on fishing equipment, motel rooms, food, gas, bait and other supplies for a fishing trip, each harvestable pike would be worth $143.00 (Rost and Gaumnitz, 2004). We estimate that ten percent of the mature adult fish would survive to a catchable size, which would result in a value of approximately $89,400.00 dollars (adjusted for inflation of 13.9% since 2004) worth of northern pike produced from the Cedar Lake / Sherman Creek wetland complex in 2008.

Genetic Value
The Cedar Lake northern pike population consists of several different spawning populations that utilize spawning habitat within the Cedar Lake / Sherman Creek wetland complex, the Cedar Lake / Jones Creek wetland complex and areas within Cedar Lake proper. These populations are a source of genetic variability that ensures a vigorous and resilient population will continue to inhabit the lake.

Habitat Value
The wetland contains the ideal northern pike spawning habitat including exceptional water clarity and flow, excellent herbaceous vegetation and grasses and clean, firm bottom substrate. The close proximity of the wetland to the lake (0.2 miles) and the low gradient channel of Sherman Creek are two factors which greatly lessen the stress associated with the spawning migration. Presently, the wetland is also well buffered from development throughout much of its area, however, developmental pressure along Cedar Lake Road to the east and Kings Corner Road to the south are encroaching upon the riparian buffer.

The Cedar Lake / Sherman Creek wetland complex continues to serve as an important spawning habitat for the Cedar Lake pike population. It is the opinion of the investigator that the spawning migration of northern pike from Cedar Lake provides an abundant and sustainable source of recruits to bolster the resident pike population. Size of fry at emigration is a concern however minor changes to the wetland habitat may be implemented to increase retention of fry until a larger size reached. The spawning migration and associated habitat should be protected and enhanced.

RECOMMENDATIONS

As a result of the assessment of the Cedar Lake northern pike spawning migration we offer the following recommendations:

Preservation
Preservation of the Sherman Creek / Cedar Lake wetland complex through establishment of local wetland protection ordinances including the establishment of riparian buffer zones of a minimum size of 100 meters (330 feet) between wetland habitat and developing interests.

The Cedar Lake Board should continue to work with MDNR fisheries personnel to investigate and put forward the option of potential land swaps that would result in the conveyance of additional acreage within the wetland complex into the public trust under the stewardship of the Michigan Department of Natural Resources.

Presently, the majority of the Cedar Lake / Sherman Creek wetland complex is privately owned. In some instances this can be a impediment to establishing long term protection, however, it has now been established that this land supports a valuable natural resource. It is possible that conversations with property owners could be developed concerning deeding a designated portion to a trust or conservancy that would allow preservation of the critical wetland habitat in perpetuity.

Establishment of a wetland mitigation bank would require a considerable investment of time, effort and expertise, however, as an alternative for wetland habitat preservation this option should not be omitted. In this instance, proper valuation (price per acre) for a number of acres designated as critical and high quality within the wetland complex would be established and accepted by the MDEQ and MDNR . Consequently, an bank could be created whereby acres could be purchased and held under conservation to pay for impacts to wetland habitat in other areas within the watershed. The end result would be the 1) preservation of high quality wetland habitat and its associated resource value; 2) payment to the land owner for land with virtually no development potential and 3) reduction in the creation of mitigation wetland habitats that commonly fail to equal the habitat value of impacted natural wetlands.

Enhancement
Retention of flow from the wetland into Sherman Creek can be established by installation of a low head berm to impede sheet flow from the wetland. In addition a structure is needed to restrict direct discharge to Sherman Creek. The structure should be designed to 1) have minimal maintenance requirements; 2) provide for normal movement into and out of the wetland complex by adult pike during the spawning migration; and 3) maintain water levels within the wetland that suppress the trigger for premature emigration by fry.

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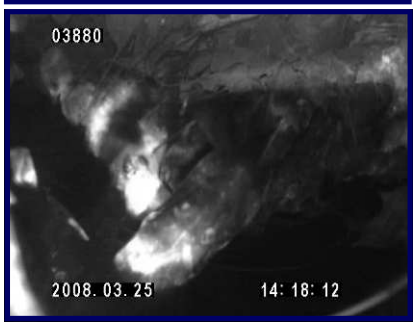
APPENDIX 1

PHOTODOCUMENTATION

Northern pike migrating up Sherman Creek

Northern pike migrating up Sherman Creek

Northern pike migrating up Sherman Creek



Northern pike migrating up Sherman Creek

Northern Pike in Cedar Lake / Sherman Creek Wetland Complex

Cedar Lake / Sherman Creek wetland complex

One of the primary channels providing pike access to the Cedar Lake /Sherman Creek Wetland Complex.

Male northern pike in the Cedar Lake / Sherman Creek Wetland Complex prior to spawning

Female northern pike in the Cedar Lake / Sherman Creek Wetland Complex prior to spawning

Male northern pike in the Cedar Lake / Sherman Creek Wetland Complex prior to spawning

Spawning pair of northern pike in the Cedar Lake /Sherman Creek Wetland Complex.

Spawning group of northern pike (two males and one female) in the Cedar Lake /Sherman Creek Wetland Complex. Note the abundant, clean vegetation and high water clarity.

Main accessory channel linking the Cedar Lake /Sherman Creek Wetland Complex to Sherman Creek.

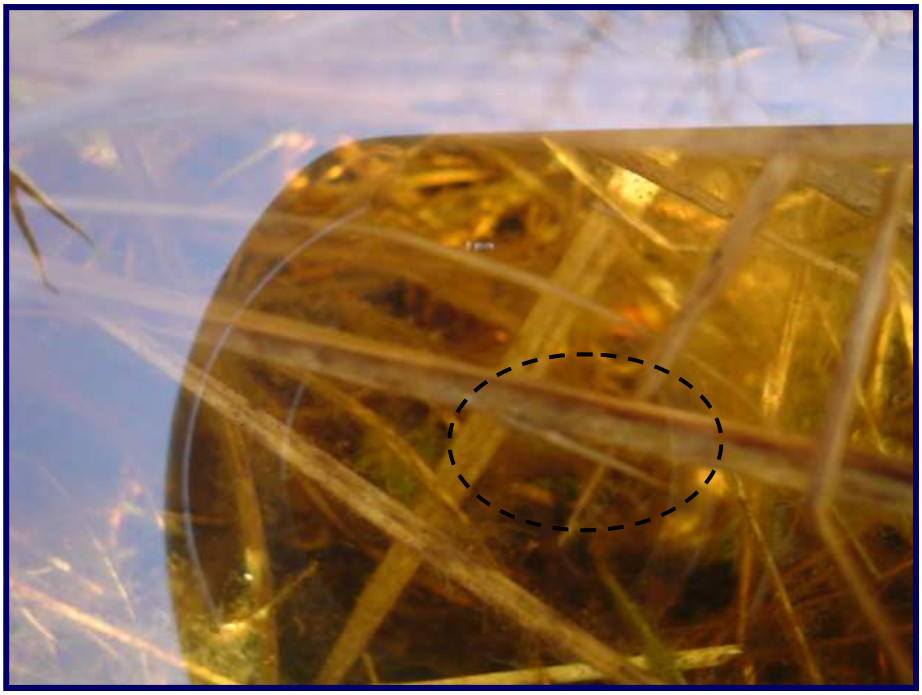
Spawning swales and micro channels were eggs and fry are highly concentrated within the Cedar Lake /Sherman Creek Wetland Complex.

High quality northern pike spawning habitat within the Cedar Lake / Sherman Creek Wetland Complex.

Sac fry captured from the Cedar Lake /Sherman Creek Wetland Complex.

Sac fry captured from the Cedar Lake /Sherman Creek Wetland Complex.

Sac fry attached to vegetation in the Cedar Lake / Sherman Creek Wetland Complex. (Fry approximately 9 mm).



Sherman Creek exceeding bank full stage during the northern pike spawning migration.