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Completion Report

Access Based Creel Survey of the Open Water and Winter Fishery 2015-2016 and Walleye
Population Estimate on the St. Louis River Estuary,
St. Louis County, Minnesota and Douglas County, Wisconsin

by

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Introduction

The St. Louis River Estuary is an 11,500-acre freshwater estuary at the mouth of the St. Louis River which extends from Lake Superior 23 miles upstream to the Fond du Lac Dam. The estuary forms the Minnesota/Wisconsin border and is home to the largest industrial port in the Great Lakes. Navigation channels, hard sided ship slips, and several large scale industries (i.e. logging, paper mills, and steel) have all altered the aquatic habitat creating a less diverse ecosystem. In a 10-year span at the turn of the century 17 miles of 20-foot deep navigation channels were created (Duluth Seaway Port Authority 2004). Along with all these developments for industry came pollution and serious water quality impacts that are still seen today. In the 1950's and 1960's the water was so polluted that locals wouldn't dare enter it let alone fish in it. The Clean Water Act, passed in 1972, instigated the cleanup of the St. Louis River and along with it came improved water quality and an increase in sport-angling pressure, which prompted more active fisheries management by the states of Minnesota and Wisconsin.

Walleye (*Sander vitreum*) is managed for catch-and-release and harvest opportunities, as the majority of anglers on the estuary target Walleye as their primary species (Beard and Spurrier 1990, Lindgren 2004). Walleye regulations have remained at a two fish bag limit and 15-inch minimum length requirement since 1989, and the fishery has been monitored through various population and creel surveys since 1980. Population estimates were computed in 1981, 1987, 1993, 2002 and 2015, with the 2015 population estimate being conducted concurrently with the 2015 creel survey. The 2015 population estimate is described in this report, whereas a comprehensive discussion relative to the previous population estimates is provided by Olson et al. 2017 (in review).

The St. Louis River historically supported a Lake Sturgeon (*Acipenser fulvescens*) population but the species was extirpated from the river in the early 1900's. A Lake Sturgeon rehabilitation program was initiated in 1983 by MN DNR and WI DNR. Efforts to reintroduce Lake Sturgeon and habitat projects have been successful leading to the opening of a catch and release season for Lake Sturgeon in Minnesota waters of the St. Louis Estuary in 2015 and in 2016 for Wisconsin waters. Surveys have been ongoing in the St. Louis River since 2010.

Muskellunge (*Esox masquinongy*) stocking in the estuary has been a cooperative effort between MN DNR and WI DNR, fingerlings were stocked from 1983 through 2005. Initially the minimum length for harvest of Muskellunge on the St. Louis was 36 inches, this increased to 40 inches in the mid 1990's and increased again in 2007 to its current minimum of 50 inches. The fishery has been monitored through various surveys during the past 15 years.

Channel Catfish (*Ictalurus punctatus*) have re-populated the estuary as a result of downstream migration from the St. Louis River above Cloquet. Channel Catfish were first sampled in the estuary in 1983.

Open water (i.e., without ice cover, and sometimes only during the summer) creel surveys were conducted on the St. Louis River Estuary in 1980, 1981, 1982, 1989, and 2003 (Beard and Spurrier 1990, Osborn et al. 1991, Lindgren 2004). Winter creel surveys were conducted on the St. Louis River Estuary in 1979-1980 and 2002-2003 ice fishing seasons (Crosby 1980, Lindgren 2004). The 2015 creel was conducted to: (1) continue the monitoring of angling activity on the St. Louis River Estuary, (2) evaluate interest in the new catch and release Lake Sturgeon regulation, and (3) gather recapture data for estimating the adult spawning Walleye population.

Methods

Creel Survey

Both the open water and winter creels were access based non-uniform probability creels and based on the creel survey design developed for Mille Lacs Lake (Jones 2007). Clerks interviewed both boat and shore anglers as they finished their fishing trips and recorded the number in the party (total anglers on board a boat, or ice and shore anglers fishing together were treated as an angler party), species targeted, start and end time of trip, angler residence (zip code), number and length of each species released and if allowed the clerk measured and recorded the length of each species harvested. Calculations were done in a Microsoft Access database designed for the Mille Lacs Lake creel (see Jones 2007 for calculations). Individual weights were calculated for all measured fish using a length weight relationship determined from fishery data collected on the St. Louis River Estuary from 1983-2004 (Table 1).

A new regulation allowing catch and release of Lake Sturgeon was implemented in 2015, to gauge interest in Lake Sturgeon fishing and knowledge of the new regulation interviews included two questions: “Are you aware of the new Lake Sturgeon regulation?” and “Will you target Lake Sturgeon within the next year?”.

Open Water Creel Design

In 2015, a creel survey was conducted from May 9th to October 31st. The survey was stratified by month, day type, and shift. Sampling sites were assigned into one of two clusters to reduce drive times between accesses and increase the number of interviews. Nine sampling sites (Figure 1) were identified prior to the survey and were sampled at random in proportion to their expected use (Table 2). Two clerks worked eight hour days five days a week. All weekends and six randomly selected weekdays in a two-week period were sampled (Table 3). Each sampling day was divided into two eight hour shifts. Trailer and shore angler counts were conducted at the beginning of each shift to determine usage for future creel surveys (Table 2).

An annual Lake Superior creel is conducted by MN and WI which includes access sites (i.e., boat ramps) near the mouth of the estuary that are used by both Lake Superior and estuary anglers. To avoid double sampling, the access sites were only covered by the Lake Superior creel from May through September. Total pressure, total harvest, and total Walleye harvest and yield estimates from anglers targeting warm water species or those identified as fishing in the estuary only, were calculated and added to the data from the St. Louis Estuary creel. Catches of other species were nominal and all other calculations were produced from the St. Louis Estuary creel only.

Winter

A winter creel survey was conducted from December 30, 2015 to March 1, 2016. The survey was stratified by month and day type. Sampling sites were assigned into one of three clusters to reduce drive times between accesses and increase the number of interviews. Eleven sampling sites (Figure 2) were identified prior to the survey and were sampled at random in proportion to their expected use (Table 4). Two clerks worked ten hour days four days a week. All weekends and four randomly selected weekdays in a two-week period were sampled (Table 3).

Population Estimate

The population was estimated through a mark-recapture method, where MN DNR and WI DNR electrofishing crews marked (tagged) nearly 6,300 Walleye during the spawning run (late-March through early-May) between Chambers Grove and Fond du Lac dam (Figure 1). The electrofishing crews primarily consisted of three people aboard two DC electrofishing boats that delivered approximately 300 volts and two to five amperes to capture Walleye. Each captured Walleye was measured to the nearest 0.1 inch, identified as male, female, or undetermined, and given a uniquely numbered Floy® tag. Walleye were recaptured through the creel survey and during the electrofishing effort. The population estimate consisted only of Walleye ≥ 18.5 in. long based on the largest year class present in the population, specifically to avoid potential tag dilution by immature fish during the recapture sample (Schram et al. 1992).

The population estimate for 2015 was computed using closed and open population estimators: 1) Chapman-Peterson closed estimator, and 2) POPAN open estimator, to document comparability with previous population estimates. Previous estimates were primarily computed through closed estimators, likely because of their popularity, ease, and acceptance prior to the more contemporary open estimators that have become more accepted and applicable over time. Unlike closed population models, which were computed previously for St. Louis River Walleye (Olson et al. in review.), open population models account for mortality, emigration or immigration and do not require a static population (Pine et al. 2003, Hayes et al. 2007).

The Chapman modification of the Petersen estimator, a closed population estimator, was used to estimate N^* since samples were collected without replacement:

$$N^* = \frac{(M + 1)(C + 1)}{(R + 1)} - 1$$

Variance for the Chapman modification was estimated by:

$$V(N^*) = \frac{(M + 1)(C + 1)(M - R)(C - R)}{(R + 1)^2}$$

The open population model POPAN in MARK (Cooch and White 2006) used the uniquely numbered Floy® tags coupled with daily electrofishing throughout the spawning migration, which allowed the construction of encounter histories. The POPAN model is an extension of the

Jolly-Seber model that estimates the total number of individuals present at a spawning site over the spawning period (assuming the entire spawning period is sampled, e.g. Pellet and Schmidt 2011).

Each electrofishing survey day was treated as a separate sampling event, except the first two days and the last two days, which were pooled due to low catches and effort. Goodness-of-fit was tested using program RELEASE in MARK to determine whether the data met the POPAN model assumptions. The variance inflation factor (\hat{c}) value of 1.11 computed for this population estimate indicated the model had a moderately good fit, overall, to the data (Schwarz and Arnason 2015).

Four open population models were generated with combinations of time-varying and constant apparent survival and probability of entry into the population. Probability of capture was allowed to vary between sampling events in all models because sampling effort varied among sampling events. The most supported model was determined based on AICc values (e.g. Schwarz and Arnason 2015). Net superpopulation size N , which represents all fish that enter the population and are available to be detected during the study period (e.g. Williams et al. 2011), was estimated based on the best fitting model.

Results

Open Water Creel

Total estimated fishing pressure in the estuary for the 2015 open water fishery was 118,849 angler hours or 10.33 hours per acre. Pressure in May and June accounted for the majority (74%) of the total pressure (Table 5). Pressure from boats was 83% of total pressure. Harvest for all species was 10,978 fish and catch was 42,045 fish. Walleye was the highest targeted species and Muskellunge was the second most targeted species (Table 6). Average boat trip length was 4.2 hours and shore trip length was 2.3 hours. 3,265 anglers were interviewed and 25 different species were creeled.

The majority of anglers interviewed (73.6%) were from the immediate Duluth/Superior area. Anglers from 18 different states were interviewed and anglers from outside MN and WI represented 1.5% of the anglers.

Walleye harvest and catch were 9,321 and 26,008 respectively (Table 7). Harvest, release and catch rates for Walleye were 0.08, 0.18, and 0.26 fish/angler hour, respectively

(Table 8). Harvest and catch rates during May and June were much greater than the rest of the season with 94% of the Walleye harvest by the end of June. Mean length of harvested Walleye was 18.5 inches, whereas released Walleye were much smaller (Figure 3, Table 9).

Muskellunge harvest during the 2015 open water season was zero. The catch rate overall (i.e., among anglers that fished for all species combined with anglers that fished specifically for Muskellunge) was 0.004 (Table 6). Contrastingly, the targeted catch rate (i.e., consists of anglers that specifically fished for Muskellunge) was 0.030 fish/hr (Table 10). Mean length of all Muskellunge caught, as reported by the anglers, was 36.4 inches (Table 6). Catches were highest in the fall with 28.5% of the catch occurring in October which is also when Muskellunge were heavily targeted. Despite low targeted effort in May, 25.1% of Muskellunge were caught in May, primarily by Walleye anglers. Anglers that targeted Walleye or no species in particular caught 40% of the Muskellunge overall in the open water season.

Northern Pike (*Esox lucius*) harvest and catch were 392 and 2,149 fish, respectively (Table 7). Harvest and catch rates of pike were 0.004 and 0.023 with 81.8% of pike released (Table 11). Percent of parties targeting Northern Pike was 3.4 and mean length of harvested Northern Pike was 24.5 inches (Table 6). Black Crappie (*Pomoxis nigromaculatus*) harvest and catch were 907 and 2,081 fish, respectively (Table 7). Harvest and catch rates of Black Crappie were 0.010 and 0.022 with 56.4% of crappies released. Percent of parties targeting Black Crappie was 3.0 and mean length of harvested Black Crappie was 10.6 inches (Table 6). Yellow Perch (*Perca flavescens*) harvest and catch were 120 and 1,717 fish, respectively (Table 7). Harvest and catch rates of Yellow Perch were 0.001 and 0.018 with 93.0% of perch released. Percent of parties targeting Yellow Perch was 0.4 and mean length of harvested perch was 9.1 inches (Table 6). Channel Catfish harvest and catch were 479 and 3,044 fish, respectively (Table 7). Harvest and catch rates of catfish were 0.006 and 0.042 with 85.8% of catfish released. Mean length of harvested catfish was 16.7 inches with the largest harvested catfish at 26 inches (Table 6). Table 9 shows length distributions among the species.

A new regulation allowing for catch and release of Lake Sturgeon in Minnesota waters of the St. Louis River estuary went into effect in 2015. As part of the creel, anglers were asked if they were aware of the new regulation and if they planned to target Lake Sturgeon within the next year. Only 40% of anglers were aware of the new sturgeon regulation and 33% said they would target sturgeon in the next year. 384 sturgeon were caught during the 2015 open water

season (Table 7). Less than 1% of anglers were targeting sturgeon and most anglers who caught a sturgeon were either targeting Walleye (28.6%) or no specific species at all (48.6%). While boat anglers dominated the overall fishing pressure in the estuary, 71% of Lake Sturgeon were caught by shore anglers. Adult Lake Sturgeon were caught at accesses throughout the estuary during all months of the creel, indicating a possible river resident population that is readily available to sport fishing throughout the year. Average length (as reported by the angler) of sturgeon was 38 inches (Table 6).

Other species of fish that showed up in the creel catch included Bluegill (*Lepomis macrochirus*) (172), Freshwater Drum (*Aplodinotus grunniens*) (816), River Ruffe (*Gymnocephalus cernuus*) (408), Rock Bass (*Ambloplites rupestris*) (2,275), White Bass (*Morone chrysops*) (166), White Perch (*Morone americana*) (112), White Sucker (*Catostomus commersoni*) (52), and others in small numbers. White Bass and White Perch are very similar in appearance, distinguishing between the two species may be difficult for anglers.

Winter Creel

Total estimated fishing pressure in the estuary for the 2015-2016 (herein referred to as 2016) winter fishery was 25,812 angler hours with 64.7% of effort in January. Average trip length for 457 interviewed anglers was 3.58 hours. Most anglers interviewed (79.0%) were from the immediate Duluth/Superior area. All other anglers resided in other areas of either MN or WI. Walleye was the most targeted species with 72.2% percent of anglers targeting Walleye, and Black Crappie was second with 18.6% of anglers.

Walleye harvest and catch for the winter survey were 1,160 and 2,320 fish, respectively (Table 12). Harvest and catch rates for Walleye were 0.023 and 0.156 fish/angler hour, with 85.6% of Walleye released. Mean length of harvested Walleye was 17.4 inches.

Black Crappie harvest and catch were 302 and 371 fish, respectively (Table 12). Harvest and catch rates for Black Crappie were 0.005 and 0.007 fish/angler hour with 18.6% of crappies released. Percent of parties targeting crappie was 18.6 (Table 13) and mean length of harvested Black Crappie was 10.9 inches. Yellow Perch harvest and catch were 507 and 787 fish, respectively (Table 12). Harvest and catch rates for perch were 0.010 and 0.015 with 35.6% of perch released. Only 2% of parties were targeting perch (Table 13) and mean length of

harvested perch was 9.7 inches. Northern Pike harvest and catch were 59 and 267 fish, respectively (Table 12). Northern Pike harvest and catch rates were 0.001 and 0.005 with 77.9% of pike released. Only 2% of parties were targeting pike (Table 13) and mean length of harvested pike was 24.6 inches. Table 14 shows harvest, release, and catch rates by species and month.

Lake Sturgeon total catch was 168 fish, with a mean length of 37 inches (as reported by anglers). During the winter creel 53.0% of anglers were aware of the new catch and release sturgeon regulation and 17.9% of anglers said they would target sturgeon in the next year.

Other species documented in the winter creel catch include: Muskellunge (10), Ruffe (36), Burbot (*Lota lota*) (157), and Rock Bass (83). Table 15 shows length distributions of several species.

Population Estimate

The Chapman modification of the Petersen estimator (i.e., closed population estimator) estimated the adult (≥ 18 inches) Walleye population at 48,616. The best-fit POPAN open population estimate, among the four estimates generated, was 46,862 (Table 16). The best fitting model for 2015 held only apparent mortality constant and allowed probability of entry and capture probability to vary between sampling events.

Discussion

Open Water Creel

Total pressure of 118,849 angler hours is the lowest compared to previous creel surveys (Table 8). As with previous surveys pressure spiked early in the season and dropped significantly later in the summer. 74% of the total pressure was documented in May and June which is similar to 2003. Boats accounted for 83.0% of total effort which is lower than 2003 when 94.5% of effort was from boats. A shift in effort may be due to improvements of piers and docks on both sides of the estuary.

Walleye continue to be the primary species sought in the estuary. Walleye accounted for 84.9% of the total harvest. While harvest of Walleye in 2015 was much lower than in 2003 (Table 8), it's thought that the harvest number was inflated in 2003 due to the methods of that

creel survey. Similar to overall harvest since 1980, harvest rate was at its lowest in 2015 (Table 8), which may be partially explained by the higher, six-Walleye bag limit that existed prior to 1989 when the two-fish limit was imposed. Overall catch rate for 2015 was average compared to past creels. Walleye catches in the estuary historically drop during the warmer months of July and August. Walleye tend to avoid water temperatures above 24°C (McMahon et al. 1984), and water temperature data obtained from a National Estuary Research Reserve (NERR) monitoring station on the Oliver Bridge in the upper estuary were well above 24°C for prolonged periods during this time (Figure 4). Water temperatures in the lower more industrialized area of the estuary, at the NERR monitoring station on the Blatnik Bridge, only reached these high temps for a few days. Lake Superior seiche has a greater effect on water temperature in the lower estuary, and Walleye probably spend more time in the lake and lower estuary during warm water periods.

Muskellunge have surpassed Northern Pike as the second most targeted species since the last census in 2003 (Table 6). Average length of Muskellunge caught in 2015 was 36.4 inches; this is 5 inches larger than the average in 2003 (Table 6). Zero Muskellunge were harvested on the St. Louis River, the largest recorded in the creel was less than the 50 inch minimum; however, Muskellunge anglers generally practice catch and release regardless of the regulation. The minimum length for Muskellunge on the St. Louis River Estuary in Minnesota was increased to 50 inches in 2007 to match the regulation in Wisconsin. Targeted catch rate of Muskellunge was 0.030 fish/hr, which is similar to the 2003 targeted catch rate of 0.028 fish/hr (Table 10). A targeted catch rate of 0.030 fish/hr is higher than any recent creel surveys on large Minnesota lakes such as Leech Lake, Island Reservoir, and Mille Lacs Lakes (Frohnauer 2008; Hallam 2014; Stevens and Ward 2014).

Northern Pike harvest and catch rate were at their lowest in 2015, this may be due to the lowest percent of anglers targeting Northern Pike during the 2015 season (Table 6). Mean length of harvested Northern Pike is the same as it was in 2003 (Table 6) and has not dramatically changed since 1989.

Catch rate and parties targeting Channel Catfish have steadily increased since the 80's (Table 6). Summer gillnet catches have varied but recently catches have increased with several recent year-classes in the catch which will provide an increased fishery in coming years.

Winter Creel

Previous winter creels were conducted on the St. Louis River Estuary in 1980 and 2003. The 1980 winter creel survey was initiated due to an increase in overall fishing activity on the estuary due to water quality improvements. Overall effort in hours was not calculated in 1980, but Walleye was reportedly only occasionally fished for and success was limited, only three catches were noted by the creel clerk; however, Walleye fishing on Lake Superior off Wisconsin Point was said to be substantial but harvest estimates were not produced. A 1982 creel of the Lake Superior winter fishery off Wisconsin point found unfavorable ice conditions with 243 Walleye harvested but observations of this ice fishery in previous years indicated significant harvest (Schram et al 1992). In 2003 only 215 Walleye were harvested on the estuary over a winter fishery that lasted two weeks longer than the 2016 season. A harvest of 1,160 Walleye in 2016 represents a fivefold increase in Walleye harvest despite the 2016 season starting significantly later than most years.

Harvest was dominated by Walleye at 56.4% of total harvest by numbers, with Black Crappie and Yellow Perch making up 39.3% of total harvest. This is very different than the 2003 survey where Walleye only comprised 4% of the harvest and crappie/perch 60%. This can be partially explained by observed changes in species preferences. For example, the percentage of anglers that targeted Walleye in 2016 (72%) was nearly twice that in 2003 (39%). Similarly, nearly three times the number of anglers (60%) targeted Black Crappie and Yellow Perch in 2016 compared to 21% in 2003. Additionally, the percentage of anglers that did not harvest Walleye was 80.2% in 2016 (Table 17), compared to 94.4% in 2003. Part of this shift away from crappie/perch may have resulted from a poor Black Crappie ice fishing season in the bays on the Wisconsin side of the estuary during the 2016 ice fishing season. Black Crappie have provided a popular winter fishery on the estuary in previous years, but in 2016 only 302 were harvested compared to 3,714 in 2003. Anglers expressed concern over the lack of catch in Kimball's Bay on the Wisconsin side of the estuary. Wisconsin DNR noted the potential for low dissolved oxygen, based on findings of low dissolved oxygen in nearby Pokegama Bay documented by the Lake Superior National Estuarine Research Reserve. WI DNR measured dissolved oxygen in Kimball's Bay and found levels to be adequate (WI DNR unpublished files)

Lake Sturgeon catch has almost tripled since the 2003 creel and average length has increased by almost 10 inches, which closely resembles growth rates observed in the St. Louis

River Lake Sturgeon population. Despite expressed interest in targeting sturgeon and frequent encounters of sturgeon by anglers, no anglers identified as targeting sturgeon during the winter creel. A 13% increase in awareness of the new sturgeon regulations was seen in the winter creel compared to the open water creel.

Population Estimate

The closed, Chapman modification of the Petersen estimate of 48,616 Walleye was lower than previous estimates, for example in 2002 when the estimate was 81,472 Walleye (Olson et al. in review). The difference between the two estimates may be partially explained by the limitations of closed population estimate methods when applied to a large, migratory population such as that of Lake Superior. Closed population estimators assume the population is closed to immigration, emigration, mortality, and recruitment (Hayes et al. 2007). The duration of the recapture sampling event (two months in 2002), presence of multiple Walleye populations within the Lake Superior basin (Hoff 2002) and high degree of movement in Lake Superior Basin Walleye (Schram et al. 1992, McKee et al. in prep, Olson et al. in review) may have violated one or all of these assumptions. Although the lower 2015 population estimate corresponded with the lower open water 2015 Walleye harvest, the lower 2015 estimate also corresponded to a much higher 2016 Walleye harvest than in 2003, which suggests Walleye abundance did not necessarily influence harvest.

The open, POPAN estimate in 2015 was 46,862 Walleye, whereas the estimate in 1981 was 76,232 (Table 15; Olson et al. in review). These were the only comparable estimates among all years, as they were based on uniquely tagged fish, a requirement of the open estimator; batch marks such as fin clips were solely used for the 1987, 1993, and 2002 population estimates. In contrast to closed population estimates, open population estimates indicated that abundance was significantly greater in 1981 than 2015, by nearly 15,000 fish. The best fitting model in 1981 held probability of entry into the population constant across sampling periods, while the best fitting model in 2015 allowed probability of entry to vary among sampling periods. This might indicate that spawning movements were different between the two years. Differences in movement to spawning habitat may be related to contrasting temperature conditions (Bozek et al. 2011b). Regardless, abundance estimates appeared to be robust to model selection as only small differences in population estimates existed among models.

Despite potential violations of assumptions, closed population estimates produced 95% confidence intervals that overlapped with open population estimates, when estimated in the same year. Additionally, both methods indicated that abundance was lower in 2015 than previous estimates. However, point estimates for Walleye abundance were substantially different between closed and open estimates in 1981. The large difference in population estimates is likely related to the limited recapture sample used for the 1981 closed population estimate relative to the number of fish marked. Vélez-Espino et al. (2015) similarly found that discrepancies between closed and open population estimates was negatively related to closed population estimate sampling effort. Confidence intervals were considerably smaller when open population estimators were used to estimate adult St. Louis River Walleye abundance, which reflected the limited recapture sample and low recapture rates in closed population estimates relative to open population estimates.

The open and closed population estimates in 2015 enabled an evaluation of whether skipped spawning (e.g. Rideout and Tomkiewicz 2011) was common in the St. Louis Walleye population, as skip spawning can bias the estimates of adult abundance and angler exploitation. The closed population estimate, which used recaptures from the open water creel, would be significantly greater than the open population estimate due to tag dilution from skip spawners. Population estimates were similar between methods and suggested that skipped spawning was not common, which is consistent with annual spawning described in most Walleye populations (Bozek et al. 2011a).

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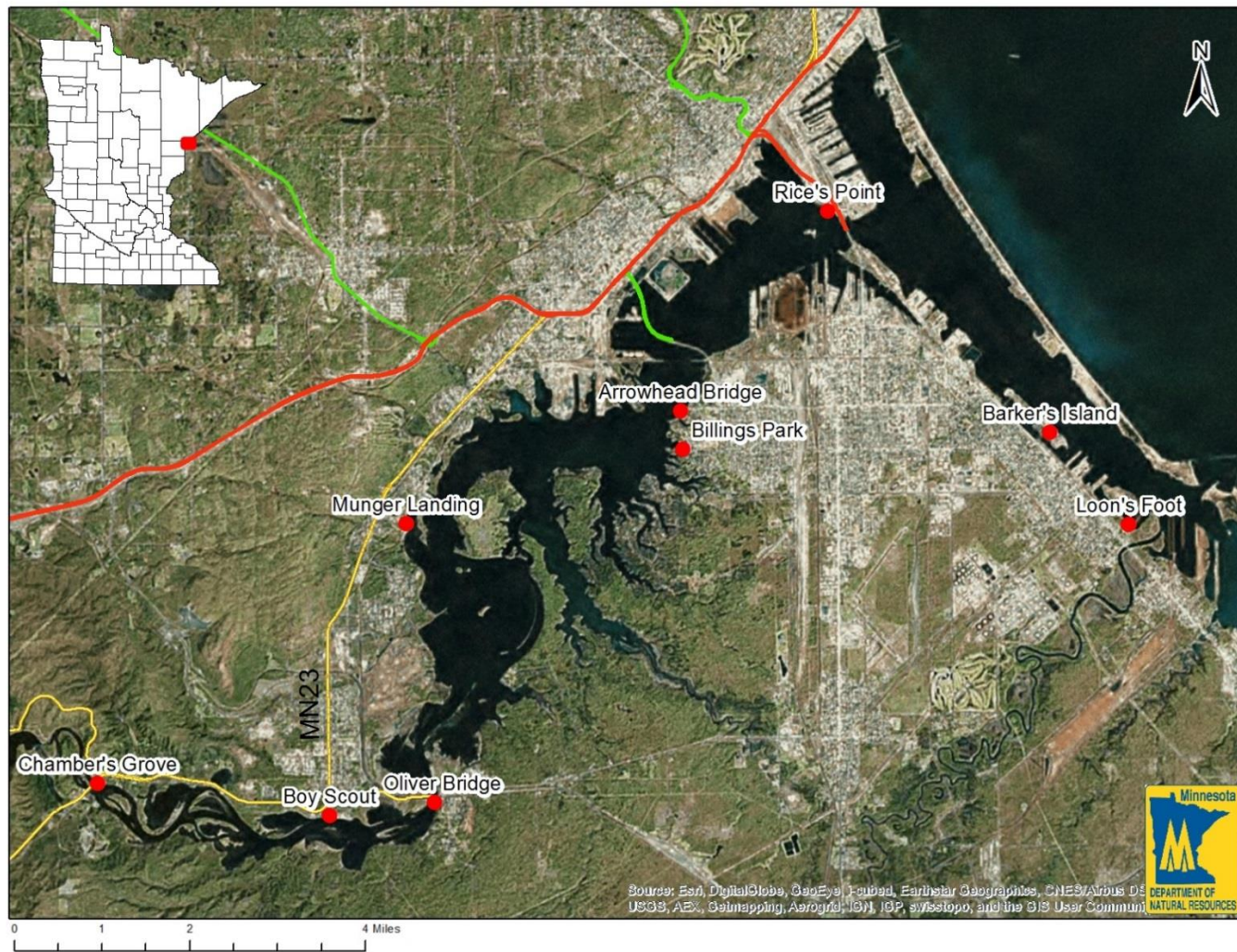


Figure 1. St. Louis Estuary access locations used during the 2015 open water creel season.

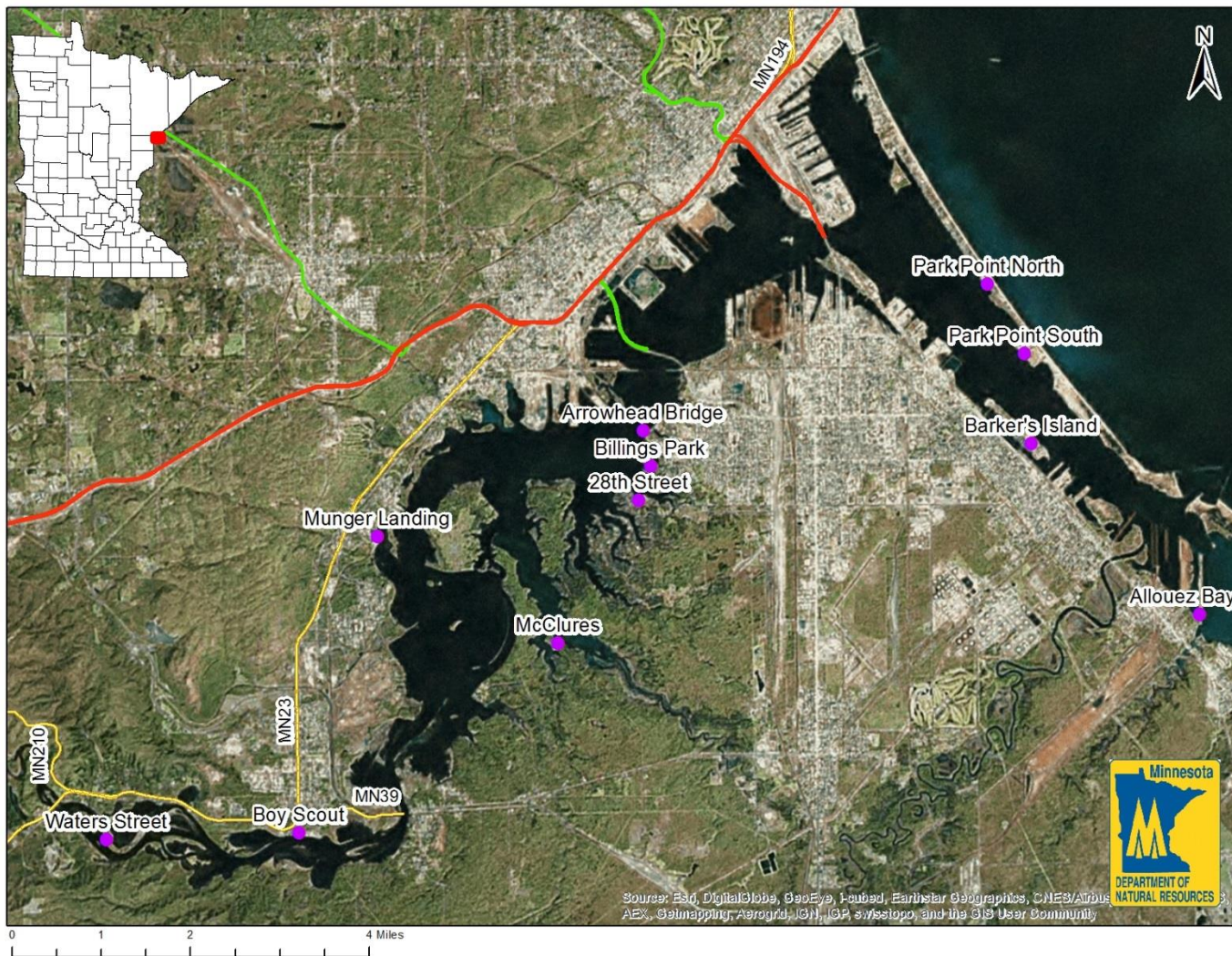


Figure 2. St. Louis Estuary access locations used during the 2016 winter creel season.

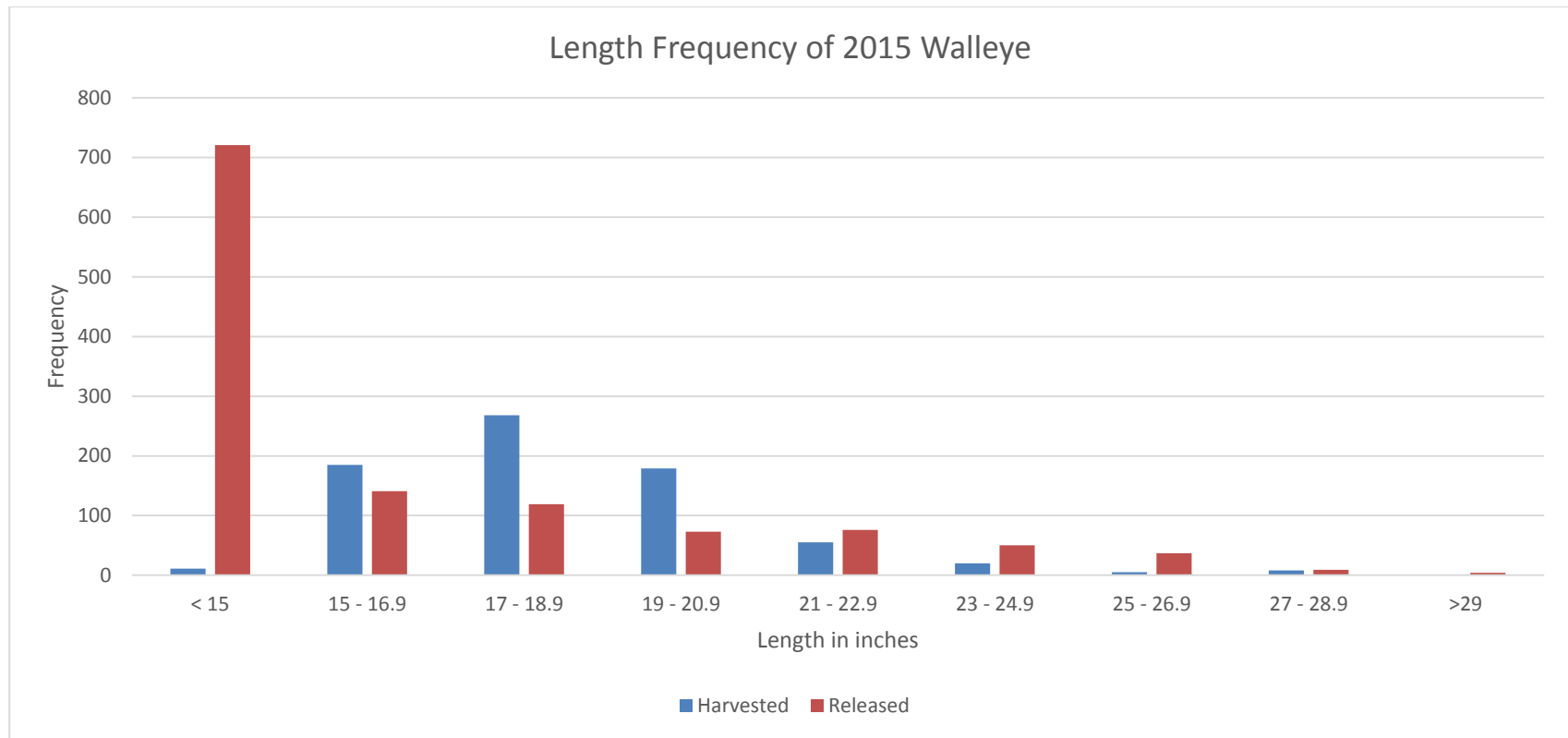


Figure 3. Length frequency of Walleye harvested and released (lengths reported by anglers) during the 2015 open water season on the St. Louis Estuary.

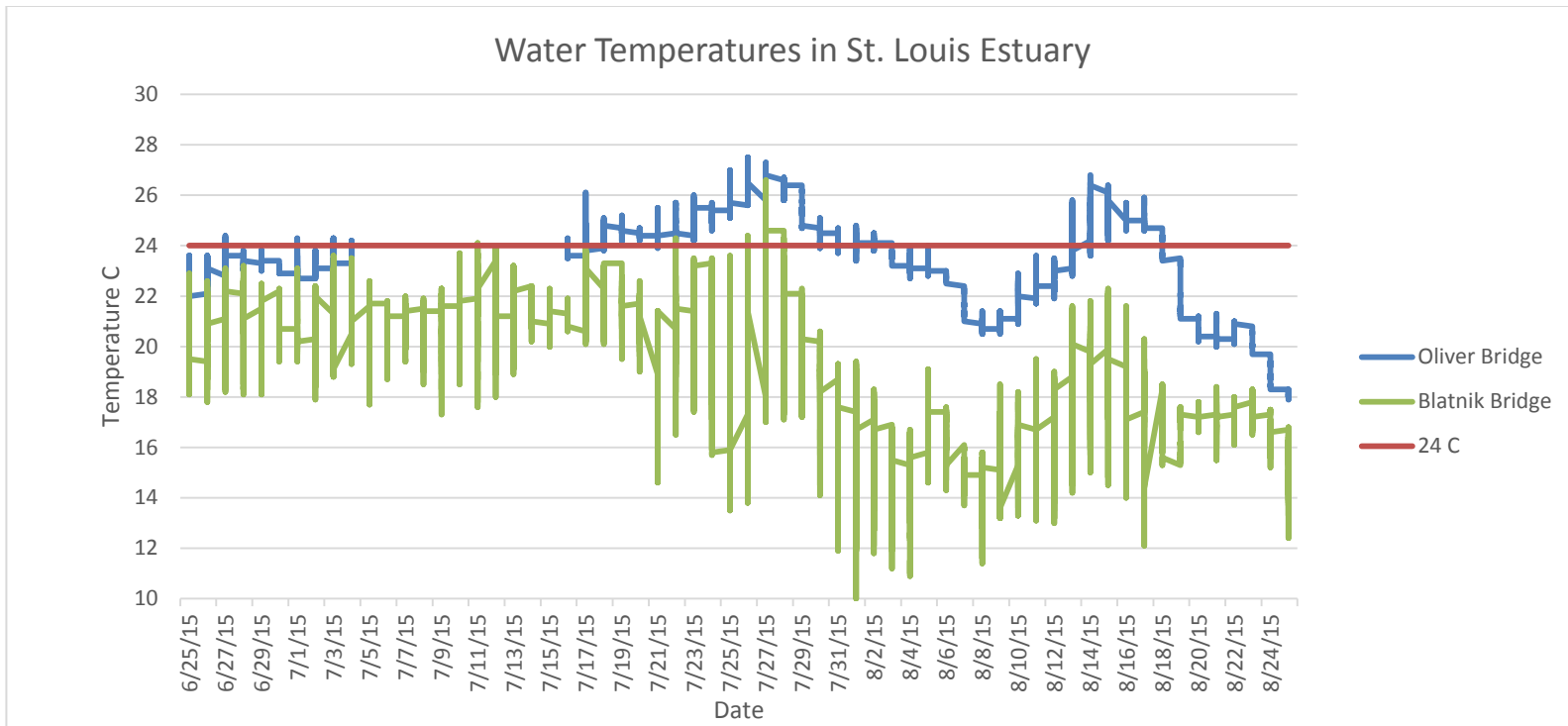


Figure 4. Water temperatures from two National Estuary Research Reserve monitoring locations on the St. Louis Estuary.

Table 1. Length (a) and weight (b) factors for the relationship $W=10^aL^b$ (W=weight in grams, L=length in millimeters), used to estimate weights of fish harvested from the St. Louis River Estuary during the 2015 open water and 2016 winter creel survey. The factors were empirically derived from data collected 1983 through 2004.

Species	Factor a	Factor b
Black Crappie	-3.35514	3.11339
Bluegill	-3.29274	3.22044
Burbot	-3.45400	2.89800
Channel Catfish	-3.70724	3.16129
Lake Sturgeon	-4.29929	3.35678
Muskellunge	-4.66524	3.72687
Northern Pike	-3.87016	3.13971
Rock Bass	-3.17507	3.07067
Smallmouth Bass	-3.18090	2.91607
Walleye	-3.65273	3.13170
White Perch	-3.17507	3.07067
Yellow Perch	-3.33995	3.22044

Table 2. Probabilities for sampling access based locations during the 2015 open water fishery on the St. Louis Estuary.

Location	May		June		July		August		September		October	
	Predicted	Observed ^a	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed	Predicted	Observed
Rice's Point	0.30	0.38	*		*		*		*		0.225	0.19
Munger	0.10	0.14	0.30	0.43	0.30	0.40	0.25	0.27	0.25	0.18	0.200	0.18
Boy Scout	0.20	0.29	0.30	0.32	0.30	0.47	0.30	0.46	0.30	0.48	0.200	0.40
Chambers Grove	0.15	0.05	0.10	0.03	0.05	0.02	0.05	0.03	0.05	0.02	0.050	0.03
Oliver Bridge	0.05	0.02	0.10	0.03	0.15	0.04	0.15	0.06	0.15	0.07	0.050	0.02
Billing's Park	0.10	0.06	0.10	0.08	0.10	0.03	0.10	0.05	0.10	0.07	0.025	0.04
Arrowhead Bridge	0.10	0.10	0.10	0.12	0.10	0.08	0.15	0.15	0.15	0.17	0.150	0.09
Barkers Island	*		*		*		*		*		0.025	0.01
Loons Foot	*		*		*		*		*		0.075	0.05

* Covered by Lake Superior creel

^a Observed estimates were calculated by multiplying average party size per period by trailer counts, adding shore angler counts and dividing by the total for the period.

Table 3. Strata used during the 2015-2016 open water and winter creel of the St. Louis Estuary.

	Open Water Season						Winter Season	
	May	June	July	Aug	Sept	Oct	Dec-Jan	Feb
Start date	5/9/15	6/1/15	7/1/15	8/1/15	9/1/15	10/1/15	12/30/15	1/31/16
End date	5/31/15	6/30/15	7/31/15	8/31/15	9/30/15	11/2/15	1/30/16	3/1/16
Weekdays								
Number	14	22	22	21	21	23	18	21
Number sampled*	8	13	13	13	11	14	8.5	8.5
Weekend days/Holidays								
Number	9	8	9	10	9	9	11	9
Number sampled*	9	8	9	10	9	9	11	8.5

*Number sampled is per creel clerk, two creel clerks worked throughout the creel.

Table 4. Probabilities for sampling access based locations during the 2015-2016 winter fishery on the St. Louis Estuary.

Location	Dec-January	February
Water St.	0.0165	0.03
Boy Scout	0.0495	0.09
Munger	0.0495	0.06
McClure	0.2145	0.12
28 th St.	0.1320	0.08
Billings	0.1320	0.30
Arrowhead	0.0165	0.08
Barkers	0.0330	0.16
Allouez	0.0495	0.04
Park Point North	0.1485	0.15
Park Point South	0.1485	0.15

Table 5. Angling effort by month for St. Louis Estuary 2015 open water season.

Month	Angler hours	Standard Error
May	42,391	4,271
June	44,149	3,276
July	11,055	832
August	8,952	810
September	6,951	578
October	5,348	934
Total	118,849	5,615

Table 6. Catch statistics for Black Crappie (BLC), Channel Catfish (CCF), Lake Sturgeon (LKS), Muskellunge (MUE), Northern Pike (NOP), Smallmouth Bass (SMB), Walleye (WAE), and Yellow Perch (YEP) from St. Louis Estuary creel surveys conducted during the open-water seasons of 1989, 2003, and 2015.

Estimate	BLC	CCF	LKS	MUE	NOP	SMB	WAE	YEP
Catch rate (fish/angler hr)								
1989	0.011	0.006	N/A	0.002	0.023	0.024	0.378	0.099
2003	0.018	0.013	0.004	0.004	0.038	0.035	0.410	0.043
2015	0.022	0.042	0.003	0.004	0.023	0.015	0.260	0.018
Mean Length (inches)								
1989	11.7	14.5	N/A	N/A	23.3	13.1	17.6	6.5
2003	11.2	17.6	24.9	32.6	24.5	15.7	17.5	8.8
2015	10.6	16.7	38.0	36.4	24.5	15.6	18.5	9.1
Percent of parties targeting								
1989	1.2	0.4	N/A	0.0	9.7	0.3	55.60	0.4
2003	1.6	0.6	N/A	3.6	7.2	2.8	68.30	N/A
2015	3.0	2.5	0.0	6.7	3.4	1.5	60.70	0.4

Table 7. Estimated harvest, catch and yield for fish harvested (standard error in parentheses) from the St. Louis River Estuary during the 2015 open water creel survey.

	Harvest		Catch		Yield	
	Total Number	Number Per Acre	Total Number	Number Per Acre	Total Pounds	Pounds Per Acre
Black Crappie	907 (168.6)	0.079	2,081 (264.0)	0.181	496 (120.9)	0.043
Channel Catfish	479 (91.1)	0.042	3,044 (176.3)	0.265	436 (167.7)	0.038
Lake Sturgeon	0	0.000	384 (33.4)	0.033	0	0.000
Muskellunge	0	0.000	414 (84.0)	0.036	0	0.000
Northern Pike	392 (97.1)	0.034	2,149 (208.5)	0.187	916 (380.5)	0.080
Rock Bass	127 (28.9)	0.011	2,275 (269.0)	0.198	21 (17.3)	0.002
Smallmouth Bass	44 (10.4)	0.004	1,443 (312.4)	0.125	32 (24.0)	0.003
Walleye	9,321 (662.4)	0.811	26,008 (1,563.3)	2.262	18,762 (1,372.1)	1.631
Yellow Perch	120 (26.2)	0.010	1,717 (177.9)	0.149	22 (18.2)	0.002

Table 8. Total creel and selected Walleye catch statistics from St. Louis Estuary creel surveys conducted during the open water seasons in 1980, 1981, 1982, 1989, 2003 and 2015.

Estimate	1980 ^{1,4}	1981 ¹	1982 ¹	1989 ²	2003 ³	2015 ³
Angler hours	179,745	149,900	134,829	142,166	295,621	118,849
Angler hours/acre	15.63	13.03	11.72	12.36	25.71	10.33
Walleye harvest (fish)	45,718	24,141	23,816	18,735	42,876	9,321
Walleye yield (pounds/acre)	11.0	4.5	3.8	N/A	6.8	1.6
Walleye mean length at harvest (inches)	N/A	N/A	N/A	17.6	17.5	18.5
Walleye harvest rate (fish/angler hr)	0.250	0.160	0.180	0.130	0.145	0.080
Walleye catch rate (fish/angler hr)	0.221	0.171	0.170	0.378	0.410	0.260
Percent of parties targeting	N/A	N/A	N/A	55.60	68.30	60.70

¹ Creel season May – July, ² Creel season May-September, ³ Creel season May – Oct, ⁴ Estimates from 1980 were considered too high because of a potential bias caused by sample site clustering.

Table 9. Length-frequency distributions of harvested (H) and released (R) fish from the 2015 open water creel survey. BLC=Black Crappie, CCF= Channel Catfish, LKS= Lake Sturgeon, MUE= Muskie, NOP= Northern Pike, SMB=Smallmouth Bass, WAE= Walleye, YEP= Yellow Perch.

Length (in)	BLC H	BLC R	CCF H	CCF R	LKS R	MUE R	NOP H	NOP R	SMB H	SMB R	WAE H	WAE R	YEP H	YEP R
3.0-3.9														1
4.0-4.9														2
5.0-5.9		3												2
6.0-6.9		14		3					1		8			18
7.0-7.9		4							1		2			5
8.0-8.9	2	17	1	19					6		18		1	15
9.0-9.9	19	36									3		1	6
10.0-10.9	23	29	7	41				2		16	1	52	2	6
11.0-11.9	16	8	3	3					1			20		
12.0-12.9	14	9	1	22				9		30		4		1
13.0-13.9	5	1	2	2					9		1	121		
14.0-14.9	1		1	12				11		29	1	210		
15.0-15.9			1	2				7		10	4	238		
16.0-16.9			1	2			1	5		5	62	94		
17.0-17.9			1	1				4		13	116	36		
18.0-18.9			3	9			1	20		10	113	41		
19.0-19.9			2				1	3		7	141	60		
20.0-20.9			2	5			3	11		1	90	25		
21.0-21.9			3	1			5	3		1	73	41		
22.0-22.9				3				5			32	17		
23.0-23.9			1	2			3	3			19	51		
24.0-24.9			1	5	1	1	2	12			12	23		
25.0-25.9			1	1		2		7			6	22		
26.0-26.9			1	7			5	2			3	19		
27.0-27.9							3	4			2	13		
28.0-28.9				1		1	1	2			3	4		
29.0-29.9						1	1	1			2	4		
30.0-30.9				1	1	5	1	8				3		
31.0-31.9								1						
32.0-32.9						1		3				1		

Table 9. Length-frequency distributions of harvested (H) and released (R) fish from the 2015 open water creel survey. BLC=Black Crappie, CCF= Channel Catfish, LKS= Lake Sturgeon, MUE= Muskie, NOP= Northern Pike, SMB=Smallmouth Bass, WAE= Walleye, YEP= Yellow Perch.

Length (in)	BLC H	BLC R	CCF H	CCF R	LKS R	MUE R	NOP H	NOP R	SMB H	SMB R	WAE H	WAE R	YEP H	YEP R
33.0-33.9						1								
34.0-34.9						3								
35.0-35.9						1		2						
36.0-36.9					1	2		2						
37.0-37.9						2								
38.0-38.9						2								
39.0-39.9						1								
40.0-40.9						5								
41.0-41.9					1	3								
42.0-42.9						3								
43.0-43.9						1								
44.0-44.9					1	3								
45.0-45.9						3								
46.0-46.9														
47.0-49.9					1									

Table 10. Interviewed angling parties targeting various fish species, with their harvest, release, and catch rates (fish/angler –hour) for the 2003^{ab} and 2015 St. Louis River Estuary open water creel survey.

Species Sought	Percent Targeting	Harvest Rate	Release Rate	Catch Rate
Black Crappie				
2015 (N=35) ^c	2.3	0.134	0.142	0.276
2003 (N=11)	1.6	1.075	1.689	2.764
Channel Catfish				
2015 (N=6)	0.4	0.068	0.196	0.264
2003 (N=4)	0.6	0.000	0.586	0.586
Muskellunge				
2015 (N=111)	7.4	0.000	0.030	0.030
2003 (N=25)	3.6	0.000	0.028	0.028
Northern Pike				
2015 (N=57)	3.8	0.033	0.013	0.046
2003 (N=50)	7.2	0.046	0.069	0.115
Smallmouth Bass				
2015 (N=24)	1.6	0.000	0.386	0.386
2003 (N=19)	2.8	0.007	0.394	0.402
Walleye				
2015 (N=1,005)	67.4	0.098	0.227	0.325
2003 (N=471)	68.3	0.107	0.206	0.314

^a Based on GENCREEL estimates for the entire season.

^b Percentages do not add to 100 due to parties targeting more than one species or no particular species.

^c N = number of parties interviewed.

Table 11. Harvest, release, and total catch rates (fish/angler-hour) by species and month for the St. Louis River Estuary 2015 open water creel survey.

Species and month	Harvest Rate			Release Rate			Catch Rate		
	Boat	Shore	Total	Boat	Shore	Total	Boat	Shore	Total
Black Crappie									
May	0.0026	0.0041	0.0027	0.0044	0.0081	0.0046	0.0070	0.0122	0.0073
June	0.0065	0.0000	0.0052	0.0082	0.0051	0.0076	0.0147	0.0051	0.0128
July	0.0238	0.0087	0.0188	0.0312	0.0043	0.0222	0.0550	0.0130	0.0410
August	0.0454	0.0707	0.0544	0.1029	0.0000	0.0666	0.1483	0.0707	0.1209
September	0.0383	0.0175	0.0286	0.0620	0.0044	0.0352	0.1003	0.0219	0.0639
October	0.0055	0.0000	0.0046	0.0021	0.0000	0.0018	0.0076	0.0000	0.0064
Total		0.0097			0.0126			0.0223	
Channel Catfish									
May	0.0026	0.0000	0.0025	0.0060	0.0368	0.0079	0.0086	0.0368	0.0104
June	0.0053	0.0149	0.0071	0.0201	0.0572	0.0271	0.0254	0.0721	0.0342
July	0.0000	0.0043	0.0015	0.0189	0.0211	0.0197	0.0189	0.0254	0.0211
August	0.0068	0.0385	0.0180	0.0695	0.1669	0.1039	0.0763	0.2054	0.1220
September	0.0030	0.0179	0.0099	0.0122	0.2433	0.1196	0.0152	0.2612	0.1295
October	0.0000	0.0000	0.0000	0.0027	0.0000	0.0023	0.0027	0.0000	0.0023
Total		0.0051			0.0275			0.0326	
Lake Sturgeon									
May	0.0000	0.0000	0.0000	0.0009	0.0163	0.0018	0.0009	0.0163	0.0018
June	0.0000	0.0000	0.0000	0.0014	0.0103	0.0031	0.0014	0.0103	0.0031
July	0.0000	0.0000	0.0000	0.0042	0.0124	0.0070	0.0042	0.0124	0.0070
August	0.0000	0.0000	0.0000	0.0000	0.0185	0.0065	0.0000	0.0185	0.0065
September	0.0000	0.0000	0.0000	0.0000	0.0401	0.0186	0.0000	0.0401	0.0186
October	0.0000	0.0000	0.0000	0.0000	0.0310	0.0049	0.0000	0.0310	0.0049
Total		0.0000			0.0041			0.0041	
Muskellunge									
May	0.0000	0.0000	0.0000	0.0027	0.0000	0.0026	0.0027	0.0000	0.0026
June	0.0000	0.0000	0.0000	0.0040	0.0000	0.0032	0.0040	0.0000	0.0032
July	0.0000	0.0000	0.0000	0.0056	0.0037	0.0050	0.0056	0.0037	0.0050
August	0.0000	0.0000	0.0000	0.0063	0.0000	0.0041	0.0063	0.0000	0.0041
September	0.0000	0.0000	0.0000	0.0094	0.0044	0.0071	0.0094	0.0044	0.0071
October	0.0000	0.0000	0.0000	0.0262	0.0000	0.0220	0.0262	0.0000	0.0220
Total		0.0000			0.0044			0.0044	
Northern Pike									
May	0.0051	0.0081	0.0053	0.0193	0.0041	0.0184	0.0244	0.0122	0.0237
June	0.0021	0.0114	0.0039	0.0225	0.0119	0.0205	0.0246	0.0233	0.0244
July	0.0011	0.0124	0.0049	0.0254	0.0043	0.0183	0.0265	0.0167	0.0232
August	0.0049	0.0000	0.0032	0.0169	0.0158	0.0165	0.0218	0.0158	0.0197
September	0.0000	0.0000	0.0000	0.0164	0.0091	0.0130	0.0164	0.0091	0.0130
October	0.0027	0.0000	0.0023	0.0248	0.0103	0.0225	0.0275	0.0103	0.0248
Total		0.0042			0.0188			0.0230	

Table 11. continued									
Species and month	Harvest Rate			Release Rate			Catch Rate		
	Boat	Shore	Total	Boat	Shore	Total	Boat	Shore	Total
Rock Bass									
May	0.0010	0.0041	0.0011	0.0132	0.0814	0.0174	0.0142	0.0855	0.0185
June	0.0000	0.0026	0.0005	0.0163	0.0608	0.0247	0.0163	0.0634	0.0252
July	0.0000	0.0043	0.0015	0.0155	0.0255	0.0189	0.0155	0.0298	0.0203
August	0.0000	0.0127	0.0045	0.0158	0.0490	0.0276	0.0158	0.0617	0.0320
September	0.0000	0.0048	0.0022	0.0124	0.0306	0.0208	0.0124	0.0354	0.0230
October	0.0000	0.0195	0.0031	0.0666	0.0195	0.0591	0.0666	0.0390	0.0622
Total		0.0014			0.0230			0.0244	
Smallmouth Bass									
May	0.0000	0.0000	0.0000	0.0044	0.0081	0.0046	0.0044	0.0081	0.0046
June	0.0000	0.0000	0.0000	0.0260	0.0188	0.0247	0.0260	0.0188	0.0247
July	0.0000	0.0037	0.0012	0.0186	0.0081	0.0151	0.0186	0.0118	0.0163
August	0.0022	0.0000	0.0014	0.0376	0.0143	0.0293	0.0398	0.0143	0.0308
September	0.0017	0.0048	0.0031	0.0686	0.0000	0.0367	0.0703	0.0048	0.0399
October	0.0000	0.0097	0.0016	0.0021	0.0000	0.0018	0.0021	0.0097	0.0033
Total		0.0005			0.0150			0.0155	
Walleye									
May	0.1131	0.0611	0.1099	0.2263	0.1057	0.2189	0.3394	0.1668	0.3289
June	0.0918	0.0423	0.0824	0.1981	0.0259	0.1656	0.2899	0.0682	0.2480
July	0.0174	0.0248	0.0199	0.1439	0.0323	0.1066	0.1613	0.0571	0.1265
August	0.0131	0.0259	0.0176	0.1891	0.0201	0.1294	0.2022	0.0460	0.1470
September	0.0183	0.0175	0.0179	0.1033	0.0274	0.0680	0.1216	0.0449	0.0859
October	0.0248	0.0097	0.0224	0.2358	0.1094	0.2156	0.2606	0.1191	0.2380
Total		0.0781			0.1788			0.2569	
Yellow Perch									
May	0.0002	0.0000	0.0002	0.0135	0.0489	0.0157	0.0137	0.0489	0.0159
June	0.0013	0.0042	0.0019	0.0135	0.0310	0.0168	0.0148	0.0352	0.0187
July	0.0000	0.0000	0.0000	0.0021	0.0366	0.0136	0.0021	0.0366	0.0136
August	0.0000	0.0174	0.0061	0.0041	0.0755	0.0293	0.0041	0.0929	0.0355
September	0.0000	0.0048	0.0022	0.0030	0.0555	0.0274	0.0030	0.0603	0.0296
October	0.0000	0.0097	0.0016	0.0000	0.0584	0.0093	0.0000	0.0681	0.0109
Total		0.0013			0.0171			0.0184	

Table 12. Estimated harvest, catch, and yield for fish harvested (standard error in parentheses) from the St. Louis River Estuary during the 2015-2016 winter creel survey.

	Harvest		Catch		Yield	
	Total Number	Number Per Acre	Total Number	Number Per Acre	Total Pounds	Pounds Per Acre
Black Crappie	302 (86.7)	0.026	371 (50.2)	0.032	224 (69.9)	0.019
Burbot	30 (22.3)	0.003	157 (69.2)	0.014	89 (64.1)	0.000
Lake Sturgeon	0	0.000	167 (47.0)	0.015	0	0.000
Muskellunge	0	0.000	10 (9.8)	0.000	0	0.000
Northern Pike	59 (25.0)	0.005	267 (76.6)	0.023	219 (106.1)	0.019
Rock Bass	0	0.000	83 (57.2)	0.007	0	0.000
Walleye	1,160 (196.9)	0.101	2,320 (1,066.0)	0.202	2,155 (411.1)	0.187
Yellow Perch	507 (196.1)	0.044	787 (78.8)	0.068	362 (143.0)	0.031

Table 13. Interviewed angling parties targeting various fish species, with their harvest, release, and catch rates (fish/angler-hour) for the 2003^{ab} and 2015-2016 St. Louis River Estuary winter creel survey.

Species Sought	Percent Targeting	Harvest Rate	Release Rate	Catch Rate
Black Crappie				
2016 (N=95)	18.6	0.033	0.007	0.040
2003 (N=245)	42.1	0.673	0.272	0.945
Northern Pike				
2016 (N=10)	2.0	0.012	0.000	0.012
2003 (N=76)	13.1	0.044	0.044	0.088
Walleye				
2016 (N=368)	72.2	0.029	0.178	0.207
2003 (N=227)	39.2	0.051	0.325	0.376
Yellow Perch				
2016 (N=10)	2.0	0.580	0.145	0.725
2003 (N=103)	17.8	0.899	1.133	2.032

^a Based on GENCREEL estimates for the entire season.

^b Percentages do not add to 100 due to parties targeting more than one species or no particular species.

^c N = number of parties interviewed.

Table 14. Harvest, release and total catch rates (fish/angler-hour) by species and month for the St. Louis River Estuary 2015-2016 winter creel survey.

	Harvest Rate	Release Rate	Catch Rate
Black Crappie			
Dec-Jan	0.0033	0.0000	0.0033
February	0.0104	0.0038	0.0142
Total	0.0058	0.0013	0.0072
Burbot			
Dec-Jan	0.0000	0.0038	0.0038
February	0.0016	0.0000	0.0016
Total	0.0006	0.0025	0.0030
Lake Sturgeon			
Dec-Jan	0.0000	0.0023	0.0023
February	0.0000	0.0049	0.0049
Total	0.0000	0.0032	0.0032
Muskellunge			
January	0.0000	0.0003	0.0003
February	0.0000	0.0000	0.0000
Total	0.0000	0.0002	0.0002
Northern Pike			
Dec-Jan	0.0006	0.0047	0.0053
February	0.0022	0.0027	0.0049
Total	0.0012	0.0040	0.0052
Walleye			
Dec-Jan	0.0217	0.1639	0.1856
February	0.0238	0.0787	0.1025
Total	0.0225	0.1338	0.1563
Yellow Perch			
Dec-Jan	0.0055	0.0036	0.0091
February	0.0177	0.0087	0.0264
Total	0.0098	0.0054	0.0152

Table 15. Length-frequency distributions of harvested (H) and released (R) fish from the 2015-2016 winter creel survey. BLC= Black Crappie, BUB=Burbot, LKS=Lake Sturgeon, MUE=Muskellunge, NOP=Northern Pike, WAE= Walleye, YEP=Yellow Perch.

Length (in)	BLC H.	BLC R.	BUB H.	BUB R	LKS R	MUE R	NOP H	NOP R	WAE H	WAE R	YEP H	YEP R
3.0-3.9	1									1		1
4.0-4.9												1
5.0-5.9										3		
6.0-6.9										18		3
7.0-7.9										12	1	
8.0-8.9	1									29	4	4
9.0-9.9	3									7	10	2
10.0-10.9	6	3								61	5	5
11.0-11.9	7	1								17	4	1
12.0-12.9	4	1					1		1	60		
13.0-13.9								1	1	48		
14.0-14.9										37		
15.0-15.9									14	8		
16.0-16.9									18	2		
17.0-17.9								1	14	4		
18.0-18.9								1	12	5		
19.0-19.9								1	3	3		
20.0-20.9			1	1				3	2	3		
21.0-21.9									3	1		
22.0-22.9								1	1	3		
23.0-23.9									2			
24.0-24.9				1			1	3		2		
25.0-25.9							1					
26.0-26.9			1	2	1		1			3		
27.0-27.9										2		
28.0-28.9					1		1	1				
29.0-29.9										1		
30.0-30.9					1		1			1		
32.0-32.9					1							
33.0-33.9					1							
35.0-35.9					3			1				
36.0-36.9					1	1						
40.0-40.9					1							
42.0-42.9					1							
45.0-45.9					1							
48.0-48.9					1							
52.0-52.9					1							

Table 16. Adult Walleye population estimates, upper and lower 95% confidence intervals and AICc values of models for 1981 and 2015. Phi = apparent survival, p = capture probability, pent = probability of entry. Asterisks indicate that the parameter was held constant between each sampling occasion and “t” indicates that the parameter was allowed to vary between sampling occasions. Models in bold had the most support and were used for population estimates.

MARK - POPAN Models						
Year	Model	PE	95% Upper CI	95% Lower CI	C-hat	AICc
1981	phi(*)p(t)pent(*)	76232	84863	68542	1.41	2669
1981	phi(*)p(t)pent(t)	71389	83139	61422	1.41	2685
1981	phi(*)p(*)pent(*)	77831	86669	69958	1.41	3376
1981 ^y	phi(1)p(*)pent(0)	50802	56388	45770	1.41	4323
1981*	phi(t)p(t)pent(*)					*
2015	phi(*)p(t)pent(t)	46862	52845	41647	1.11	7601
2015	phi(t)p(t)pent(*)	52440	77574	36162	1.11	7634
2015	phi(*)p(t)pent(*)	51840	55436	48506	1.11	7638
2015	phi(*)p(*)pent(*)	42553	45589	39752	1.11	10188
2015 ^y	ph(1)p(*)pent(0)	27661	29497	25970	1.11	10829

*Model did not converge on a solution

^y Closed model

Table 17. Percent of anglers who harvested a given number of fish from the St. Louis River Estuary during the open water creel 2015 season.

		Number of Fish per Angler											
Bag Limit		0	0.1-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	>10
Black Crappie		25											
Open Water													
	Harvest	97.4	1.3	0.5	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	Release	96.2	2.2	0.9	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Winter													
	Harvest	95.4	2.4	1.8	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	99.5	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern Pike		2											
Open Water													
	Harvest	98.2	1.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	89.9	7.7	1.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Winter													
	Harvest	98.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	96.4	3.1	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smallmouth Bass		5											
Open Water													
	Harvest	99.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	95.2	3.2	0.7	0.2	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.1
Walleye		2											
Open Water													
	Harvest	76.0	10.6	8.7	4.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	71.0	11.4	8.0	3.4	2.1	1.0	0.8	0.5	0.4	0.2	0.1	1.1
Winter													
	Harvest	80.2	14.6	4.4	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	52.7	20.5	15.6	4.6	2.0	1.3	0.3	1.8	0.2	0.7	0.2	0.3
Yellow Perch		25											
Open Water													
	Harvest	99.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Release	94.1	4.1	1.3	0.3	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Winter													
	Harvest	95.9	3.3	0.7	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
	Release	95.3	3.6	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

^a The fish per angler was determined by dividing the number of a species caught by the number of anglers in the party for each interview.

Minnesota
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Study 4
Job 998

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISHERIES AND WILDLIFE
SECTION OF FISHERIES

Completion Report

Access Based Creel Survey of the Open Water and Winter Fishery 2015-2016 and Walleye
Population Estimate on the St. Louis River Estuary,
St. Louis County, Minnesota and Douglas County, Wisconsin

by

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