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MINNESOTA DEPARTMENT OF NATURAL RESROUCES
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SECTION OF FISHERIES

Completion Report

An evaluation of muskellunge stocking in a southern Minnesota impoundment, Lake Zumbro.

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Abstract- Fingerling muskellunge (*Esox masquinongy*) were stocked from 1994 to 2008 into Lake Zumbro, a southeast Minnesota reservoir. Muskellunge were known to have escaped from the reservoir and established a population downstream in the Zumbro River, but the population status in the reservoir was unknown. Six spring sampling efforts from 1996 to 2007 with large frame and standard frame trap nets yielded an average catch of only one muskellunge per year. Low catch rates of muskellunge indicated that either the population was very small or sampling methods were not effective in capturing fish that may be present. We used radio telemetry to determine if muskellunge congregated in areas of the reservoir where sampling could be targeted. Ten adult muskellunge were collected by electrofishing in the plunge pool below the Lake Zumbro dam in early November 2007. Radio transmitters were surgically implanted and the fish were released above the dam in the reservoir. After spring ice-out, fish began to move as water temperature approached 10 °C and flows increased. Large frame trap nets were set in locations muskellunge frequented. A total of five muskellunge were captured, four of which had radio tags and one was a juvenile stocked the previous fall. By late April, one fish was located in the plunge pool below the dam and by late May eight of the ten tagged fish were found below the dam from the plunge pool to 21 km downstream. One other fish had moved about 13 km upstream to the riverine portion of the reservoir. Of the 10 tagged fish, nine had moved back to riverine environments by late May. We have discontinued muskellunge stocking in Lake Zumbro as a result of this study.

Introduction

Fingerling muskellunge *Esox masquinongy* were first stocked in Lake Zumbro in 1994 (Appendix 1). As early as 1996 it was known that some of the stocked muskellunge had escaped from the reservoir and established a population downstream in the Zumbro River. The dam is a complete barrier to upstream fish migration; therefore muskellunge that moved over the dam were permanently lost from the reservoir. Initially, it was assumed the number of muskellunge leaving the reservoir was not a significant percentage of fish that had been stocked. However, from 1996 to 2007 there was a steady increase in the number of muskellunge sighted during annual electrofishing in a long-term smallmouth bass monitoring station located 3.2 kilometers downstream of the dam.

From 1996 to 2007 we attempted to sample the muskellunge population using large frame (1.5 m x 1.8 m) trap nets with 1.5 m hoops and a 30 m lead. We also used standard lake survey trap nets (0.9 m x 1.8 m) to sample additional locations and augment overall netting effort. Six spring trap netting efforts during these years resulted in a total catch of only seven muskellunge. Four of the muskellunge sampled (two each in 2002 and 2003) were yearlings that had been stocked the previous fall. We were uncertain if the low catch rate was an indication of low survival of stocked muskellunge or simply poor trap netting efficiency due to the steep drop-offs of Lake Zumbro.

We used radio telemetry to determine if fish congregated in certain areas of the reservoir in spring where sampling was feasible. From electrofishing in the Zumbro River below the Lake Zumbro dam, we knew that we could capture an adequate number of fish for implanting radio transmitters. These fish would then be released back into Lake Zumbro and located in the spring to determine if the fish were congregating in specific areas of the lake where trap nets could be set. The objectives of this study were to determine if muskellunge congregate in specific areas of Lake Zumbro in the spring and evaluate the success of fingerling muskellunge stocking in Lake Zumbro.

Study Area

Lake Zumbro is a 313ha impoundment of the Zumbro River in Olmsted and Wabasha counties in southeast Minnesota (Figure 1). The reservoir is fed by the Middle and South forks of the Zumbro River and has a drainage area of 206,400 ha. Land use in the watershed is primarily agricultural, however the South Fork Zumbro River flows through the City of Rochester (population of 97,000) and is impacted by urban run-off. The hydroelectric dam is owned and operated by Rochester Public Utilities. The crest of the dam is at an elevation of 280.4 meters. The dam is 135 m wide and 17 m high (Figure 2). Water levels can vary considerably and rise quickly during periods of significant run-off. The reservoir is narrow and riverine in nature with several arms and multiple small bays. Habitat is predominantly steep dropping shorelines with sand and gravel substrates. Aquatic vegetation is limited to emergent cattail stands near tributary streams and in the upper, riverine portion of the reservoir. Submergent vegetation is scarce. The reservoir is hyper-eutrophic with high levels of nitrogen and phosphorous and high turbidity particularly during spring run-off events (Minnesota Pollution Control Agency 2008)

The reservoir has high recreational boating use during the summer months (Binder 2008). The shoreline is highly developed with lakeshore homes, campgrounds, and several restaurants. Lake Zumbro is a popular fishery for black crappie *Pomoxis nigromaculatus*, bluegill *Lepomis macrochirus*, largemouth *Micropterus salmoides* and smallmouth *Micropterus dolomieu* bass, northern pike *Esox lucius* and channel catfish *Ictaluris punctatus*.

Methods

Ten adult muskellunge with a mean length of 1,000 mm (range 950 to 1,140 mm) were captured by DC electrofishing in the plunge pool below the Lake Zumbro dam on 6-November 2007 (Table 1). Radio transmitters (Model F1850; ATS - Advanced Telemetry Systems, Isanti, Minnesota) were fitted with a mortality switch and a 305 mm trailing whip antenna. Transmitter dimensions were 17 mm in diameter, 70 mm long and they weighed 25 g. Frequencies ranged from 48.011 MHz to 48.191 MHz and were separated by 0.020 MHz. The pulse rate was 40 ppm with a pulse width of 20 ms. Because each transmitter had a unique frequency, we used the frequency number to identify and report locations of individual fish (i.e. Fish-11 had a transmitter frequency of 48.011MHz). Battery life estimated by the manufacturer was 1,416 d.

Transmitters were implanted following the procedures of Hart and Summerfelt (1975). The fish were anesthetized with tricane methanesulfonate to the point where the fish could not maintain equilibrium and rolled laterally. The fish were then transferred to a wooden operating trough that was covered with a wet towel. The gills were initially irrigated with anesthesia-laden water from the trough then fresh water was used when implantation was nearing completion. An incision was made in the abdomen midway between the pelvic and pectoral girdles and offset from the ventral midline. Prior to insertion, each transmitter was tested for operation and then placed in a 10% topical solution of povidone iodine for disinfection. The transmitter was inserted with the antenna protruding from the posterior end of the incision. Non-absorbable 3-0 nylon suture with a reverse cutting 24 mm curved needle was used to close the incision. Four sutures were used over the transmitter body and an additional suture was placed over the base of the antenna to limit movement. After suturing was completed, the entire vicinity of the incision was treated with the iodine solution. The fish were then placed in an aerated stocking tank for recovery and transport. All fish were released at Fisherman's Inn on Lake Zumbro, approximately 5.5 km upstream of the dam.

Fish locations were determined using an ATS receiver set to scroll through the 10 frequencies at a scan rate of 4 s. A boat mounted yagi directional antenna was used for open water tracking on the reservoir while a hand-held loop antenna was used during winter and for tracking in the rivers. Open water tracking was conducted by following the lake shoreline at a distance of 50 to 100 m from the shore and moving at speeds of 4-8 kph When a signal was attained the boat was turned from side to side to pinpoint the signal to within an approximate 10 m distance. The location was marked with a boat mounted or handheld global positioning satellite unit (GPS). During winter 2007-08, ice conditions allowed safe tracking of the fish beginning in early February. Winter tracking

was conducted on five occasions to determine general fish locations, to be certain that transmitters were functioning properly, and to monitor post implantation mortality. The reservoir was traversed in a grid pattern and when a signal was attained the fish was located by pointing the handheld antenna straight down at the ice. When a strong signal was attained, the location was marked with a (GPS). When tracking in the river, the handheld antenna was mounted to the cross bar of a canoe. The point of strongest signal strength was marked with a GPS unit, as it was difficult to maintain position in the river current to obtain a more exact fish location. Water temperature was recorded at each fish location in the reservoir. Reservoir water level data was obtained from Rochester Public Utilities (www.rpu.org).

Trap nets were set perpendicular to shore by anchoring the lead to the shore using a 1-m-long section of metal rebar. The net was extended and stretched using a boat. The cod end of the net was anchored and a float line attached for marking the net location. Nets were fished for approximately 24 hrs and then emptied.

Results

During winter, most fish were located in the main reservoir basin where the maximum depth was 10 m (Figure 3). In general, the fish were located further offshore as compared to spring and summer locations. Movement was less frequent and distances shorter under ice cover than in open water.

In mid March flows increased in the Zumbro River causing Lake Zumbro to rise (Figure 4). The lake was above the spillway crest for the entire month of April (Rochester Public Utilities). Ice began to recede and boat access to the upper reservoir was made on 2-April. Six of the ten fish were located but approximately 50% of the reservoir remained ice-covered and was inaccessible. By 9-April the entire lake was ice-free and nine fish were located. Surface water temperature ranged from 4.6 to 6.3 °C. On 15-April all fish were located and water surface temperatures ranged from 3.7 to 7.6 °C with cooler temperatures in the lower section of the reservoir. Fish movement increased as water temperature approached 10°C. Trap nets were first set on 21-April in five locations used in past spring sampling efforts. The area most frequented by tagged fish was Nass Bay adjacent to the dam (Figure 5). On 24-April three radio-tagged muskellunge and a juvenile stocked the previous fall were captured in a trap net in Nass Bay. On 30-April one tagged muskellunge was captured in the same net location. These were the only adult muskellunge captured in a total of 30 tap-net-days on various dates from 21-April to 7-May.

Three tagged muskellunge moved upstream from the reservoir into the South Fork Zumbro River. Fish-11 used an area with a side channel that drained a cattail marsh. The fish was located five times in this vicinity during the period 9-April to 5-May. Water temperatures ranged from 5.8 to 11.9 °C. On 7-May the fish was located 10 km down lake in Nass Bay near the dam where the water temperature was 12.8 °C. Fish-31 was located on three dates from 29-April to 7-May in an oxbow channel with flooded terrestrial vegetation. Water temperatures ranged from 8.3 to 11.8 °C. The fish was then

located on a point in the lower reservoir on 16-May where the water temperature was 15.5 °C. Fish-71 was located on 15-April in an open, shallow area bordered by cattails where water depth was <1 m. We were then unable to locate this fish for a period of two weeks. On 29-April we canoed the South Fork Zumbro River from the Silver Lake dam in Rochester down to Lake Zumbro. Fish-71 was located in a long pool just downstream from the Silver Lake dam, approximately 13 km upstream from Lake Zumbro. The water temperature was 6.7 °C. This fish remained in the South Fork Zumbro River throughout the summer.

Fish-171 was found emitting a mortality signal on 15-April. The fish was located very close to shore in the main lake. The mortality signal continued through at least 19-April. The fish was located on 21-April in Nass Bay adjacent to the dam and was captured in a trap net on 24-April. This fish had a broken right lower jaw at the time of transmitter implantation: however it was in good condition when recaptured. The surgical wound did not show signs of infection but was still healing (Figures 6 and 7).

On 22-April Fish-91 was located in the plunge pool below the Lake Zumbro dam (Figure 8). Seven of the other tagged fish went over the dam by late May before water levels receded below the dam crest. The furthest downstream movement documented in the Zumbro River was 40.2 km downstream from the dam. By late fall, six of the eight fish in the river had moved back upstream to the plunge pool where they were originally captured. Two fish remained above the dam as of February 9, 2009. None of the tagged fish were reported as being captured by anglers.

Discussion

Muskellunge are native to the large river systems of the upper Midwest and the southeastern and northeastern United States (Crossman 1986). The perception that the muskellunge is a riverine species is supported by the propensity for stocked muskellunge to move from reservoirs and establish populations in connected riverine environments (Wahl 1999; MDOC 2007). Muskellunge will also move into rivers that flow into natural lakes (Dombeck 1979). We assumed that the muskellunge escaping from Lake Zumbro were juvenile fish that went over the dam during high flows or possibly through the power generating turbines. Eight of the ten tagged muskellunge in Lake Zumbro went over the dam in our study. This is not uncommon as barriers to prevent musky escapement have been constructed on the dams of several reservoirs in Illinois (ILDNR 2008) and Missouri (MDOC 2007). We do not view this as a viable option for Lake Zumbro as the amount of debris that can move through the reservoir during runoff events would damage a barrier and require frequent maintenance.

Muskellunge moved the most in spring and fall. This corroborates the findings of other muskellunge movement studies in Minnesota (Younk et al. 1996), Wisconsin (Dombeck 1979; Weeks 2006), and elsewhere (Minor and Crossman 1978). Spring movements were likely related to spawning while fall movement in the Zumbro River was towards over wintering habitat.

Tagging fish from a river environment and transferring them back to the reservoir may have influenced our results. The 10 individuals tagged may have a higher propensity for the river and were more likely to move back to that environment. It is also possible that the adult muskellunge we moved into the reservoir would have behavior different from an adult fish that had spent years within the reservoir. However, the only adult muskellunge captured by trap nets in spring 2009 were radio-tagged and this represented 30% of the tagged fish known to be in the reservoir. Historical spring trap net catches of adult muskellunge in Lake Zumbro have been extremely low indicating poor survival of stocked fish in the reservoir, escapement out of the reservoir, or poor sampling efficiency.

The presence of largemouth bass and northern pike in Lake Zumbro could influence the survival of stocked fingerling muskellunge. Largemouth bass are abundant in the reservoir (MNDNR 2007) and will prey on fingerling muskellunge after stocking (Stein et al. 1981; Wahl and Stein 1989). However, the size of fingerling muskellunge at the time of stocking greatly influences largemouth bass predation. Wahl and Stein (1989) found that largemouth bass predation on muskellunge >205 mm TL at stocking was low. Muskellunge stocked in Lake Zumbro averaged well over 205 mm and predation by largemouth bass was likely low. Northern pike may also prey on stocked fingerling muskellunge. However, the population density of northern pike is low in Lake Zumbro and fingerling muskellunge have survived when stocked into waters with low-density northern pike populations (Serns and Andrews 1986). Therefore our low muskellunge catch rates over time in Lake Zumbro are most likely due to escapement into the Zumbro River.

The muskellunge tagged during this study that subsequently went over the dam have now done so on two occasions. A tagging study on Kincaid Lake in Illinois also documented the repeated movement of translocated muskellunge over a dam (ILDNR 2008). One fish had gone over the dam on three occasions and survived. The fish tagged from the Zumbro River did have numerous healed wounds that were possibly the result of plunging over the dam and onto rocks below. One of the tagged fish had a broken right lower jaw from which approximately one inch of the jawbone was exposed. Of the ten fish tagged, this fish exhibited the most extensive movement and seemed unaffected by this injury. This fish had moved 40.2 km downstream from the dam by 18-July but returned to the plunge pool to over winter.

The radio transmitters performed very well overall. The apparently erroneous mortality signal from Fish-171 was the only questionable aspect of performance. Signals could be attained on open water from a distance of >1 km using the yagi antenna. Maximum distance for the loop antenna was limited to approximately 0.40 km. The fish recaptured in the trap nets were healing by mid-April five months post surgery. However complete healing was not expected due to low water temperatures from the time of surgery until recapture in April. Irritation around the antenna protrusion was noted on one fish, but the wound did not appear to be infected.

Muskellunge stocking has been discontinued on Lake Zumbro as a result of this study. We will evaluate stocking strategies for muskellunge directly into the Zumbro River in 2009. We will continue tracking the radio tagged fish in the Zumbro River since the transmitter batteries may remain viable until fall 2010. We have now been presented with the opportunity to evaluate musky movement in a riverine environment. We plan to conduct an assessment of the muskellunge population in the Zumbro River in 2009-10 and will examine population abundance, size structure and age structure. This information will be used to develop management strategies to maintain the popular muskellunge fishery that has developed in the Zumbro River.

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Table 1. Length and transmitter frequencies of tagged muskellunge collected from the Zumbro Dam plunge pool on November 6, 2007.

Fish ID Number	Total Length (mm)	Transmitter Frequency (MHz)
11	995	48.011
31	882	48.031
51	1,140	48.051
71	915	48.071
91	1,020	48.091
111	1,000	48.111
131	1,060	48.131
151	950	48.151
171	1,015	48.171
191	1,015	48.191

Figure 1. Lake Zumbro, Olmsted County, Minnesota.

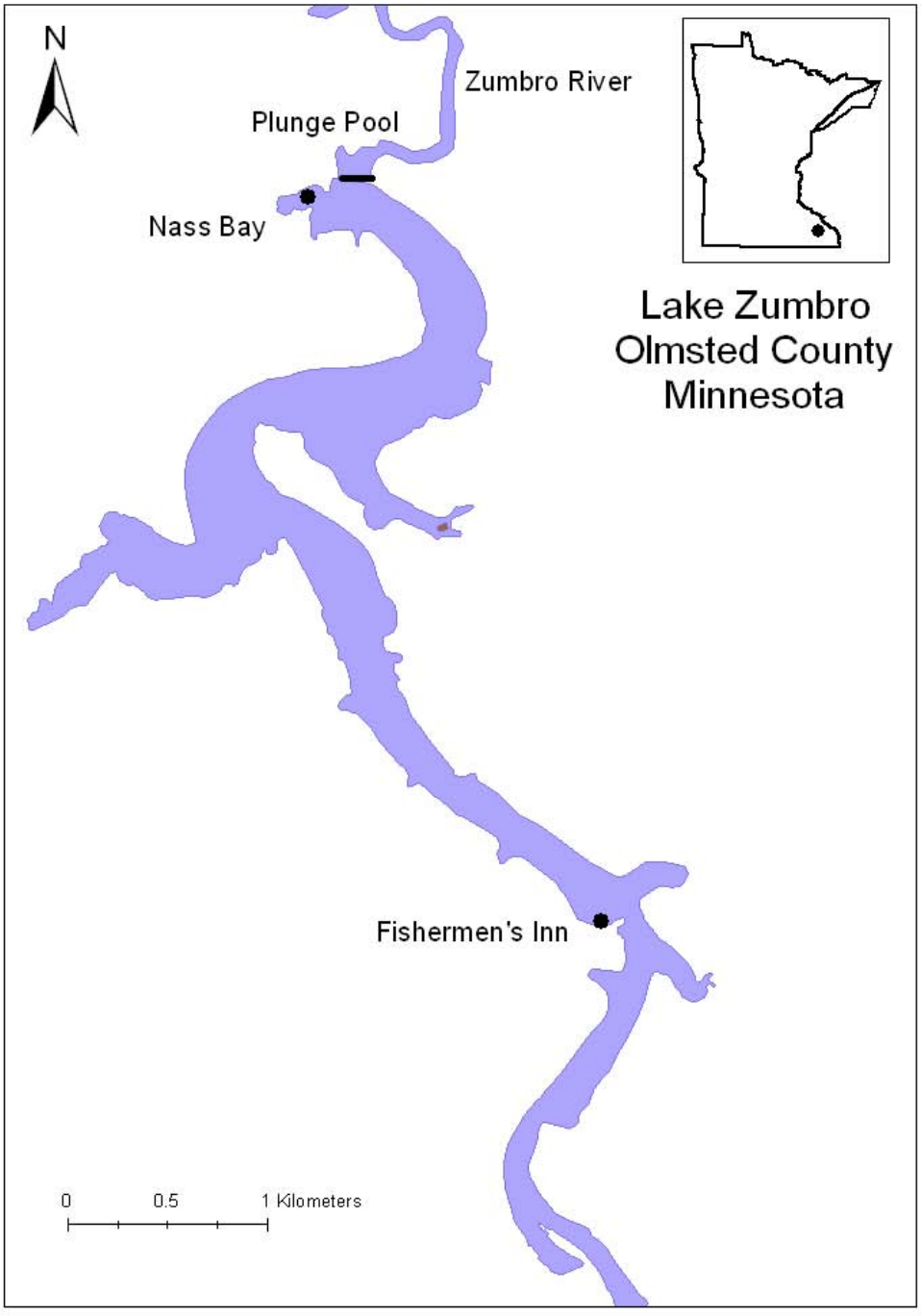


Figure 2. Zumbro Dam March 2009.

Figure 3. Muskellunge locations in Lake Zumbro on February 1, 8, 15, 29, and March 7, 2008.

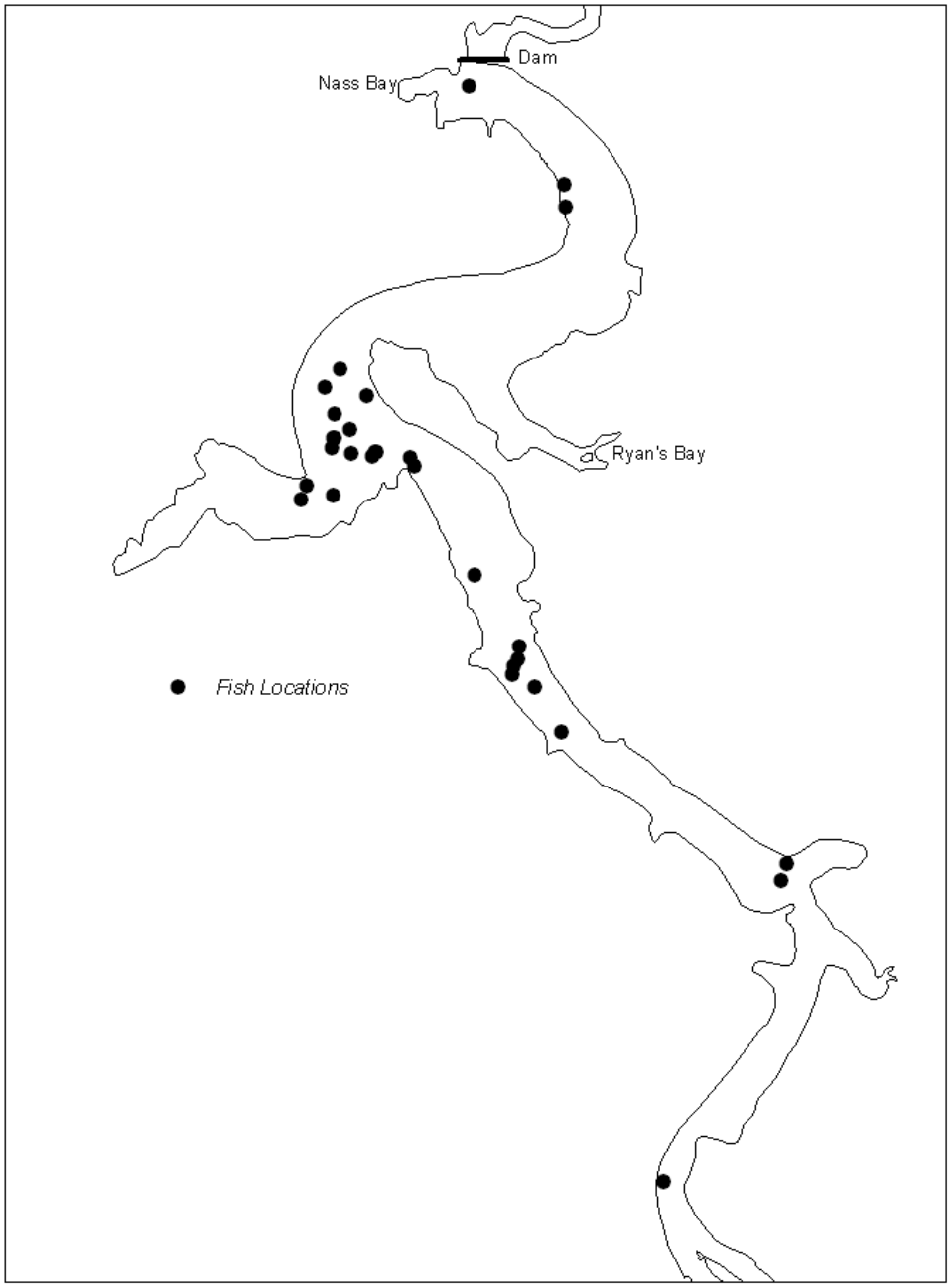


Figure 4. Hourly stage of the Zumbro River at Zumbro Falls from the U.S. Army Corps of Engineers www.mvp-usace.army.mil/dcp/.

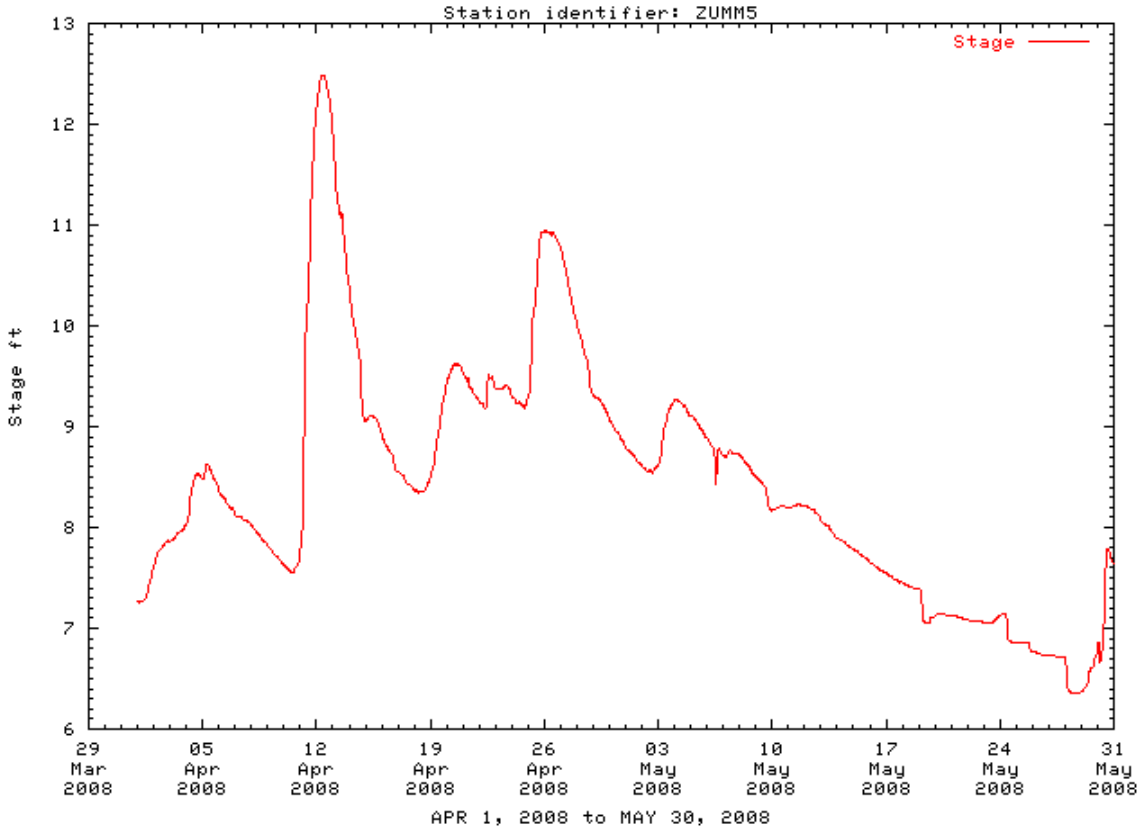


Figure 5. Trap net and muskellunge locations in Lake Zumbro on April 21, 22, 30 and May 2, 5, and 7, 2008.

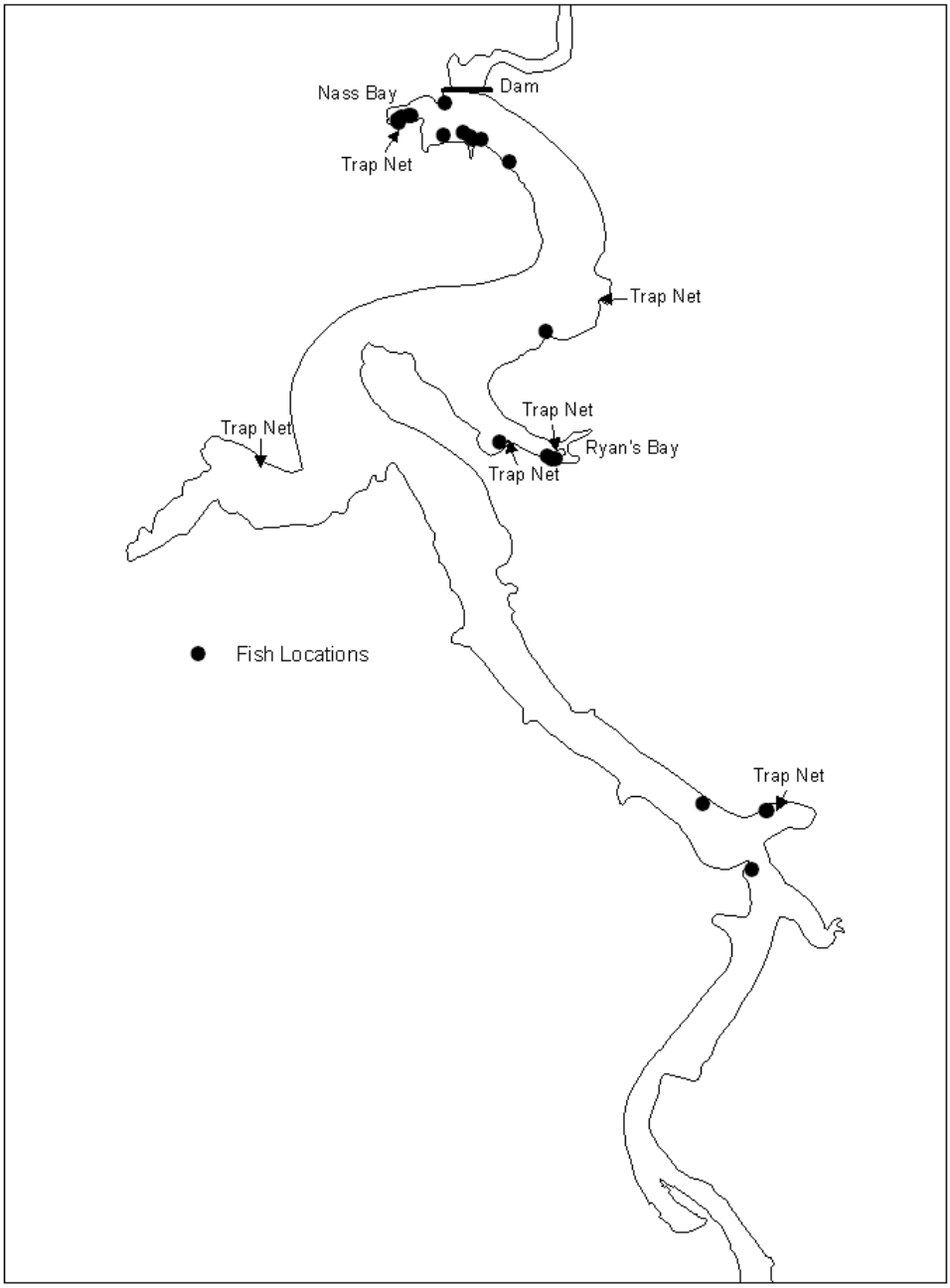
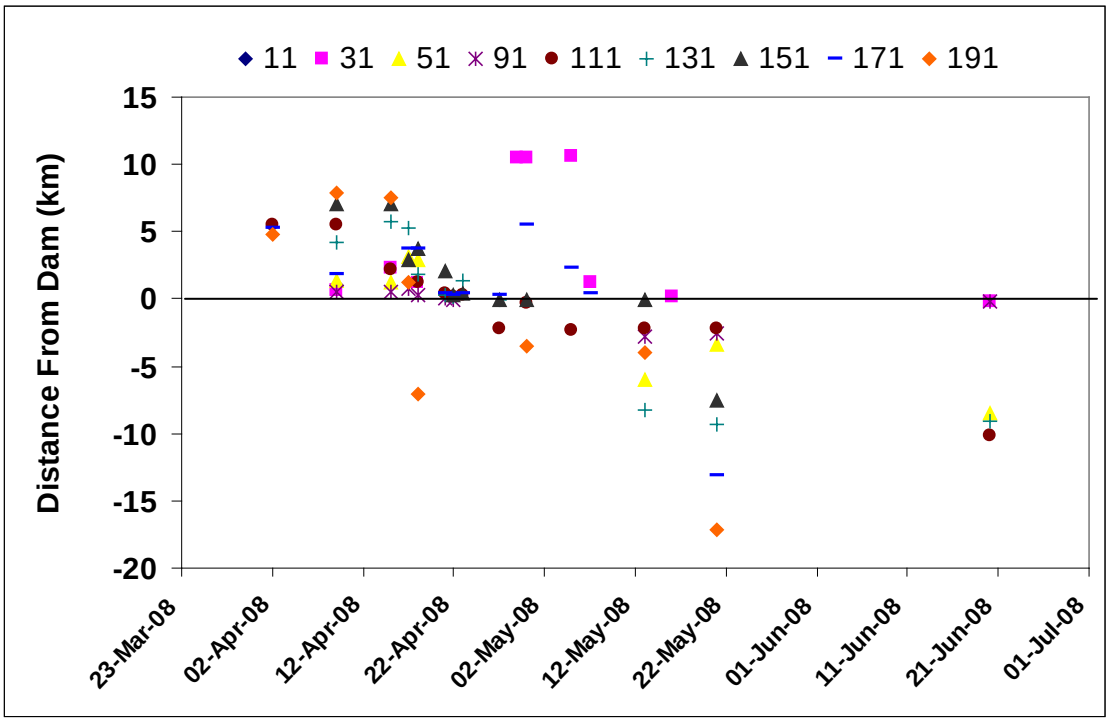


Figure 6. Recaptured muskellunge on April 24, 2008 illustrating the sutures and healing of the surgical wound.

Figure 7. Fish number 171 showing a broken lower left jaw and protruding bone.

Figure 8. Muskellunge distance from the Lake Zumbro dam, March 13 to June 20 2008. Symbols represent individual fish and numbers indicate radio frequency of for each fish.



Appendix 1. Lake Zumbro Fingerling muskellunge stocking history.

Year	Number
1994	300
1997	300
1998	300
1999	300
2000	400
2001	564
2002	300
2004	300
2005	299
2006	300
2007	300

Appendix 2. Muskellunge location points in Lake Zumbro and the Zumbro River, November 2007 to February 2009. Coordinate system is North America Datum 1983 Zone 15.

Date	Fish_ID	UTM_Y	UTM_X	Temperature °C
11/8/2007	31	4892169	542735	
11/8/2007	71	4891488	543029	
11/8/2007	91	4892317	542650	
11/8/2007	111	4892152	542966	
11/8/2007	131	4892840	541940	
11/8/2007	151	4892871	541824	
11/8/2007	171	4893858	541258	
11/8/2007	191	4892694	542069	
11/9/2007	91	4892563	542175	
11/9/2007	111	4894720	542192	
11/9/2007	131	4892401	542260	
11/13/2007	31	4894186	541109	
11/13/2007	71	4894486	540927	
11/13/2007	91	4894447	541122	
11/13/2007	111	4889376	542389	
11/13/2007	131	4889547	542947	
11/13/2007	151	4894419	541096	
11/13/2007	171	4890551	542505	
11/13/2007	191	4891858	543054	
2/1/2008	31	4894024	541008	
2/1/2008	51	4893382	541556	
2/1/2008	71	4893778	540821	
2/1/2008	91	4893943	540930	
2/1/2008	111	4892120	542928	
2/1/2008	131	4894170	541084	
2/1/2008	171	4890719	542389	
2/15/2008	31	4894286	540965	
2/15/2008	51	4894089	540946	
2/15/2008	71	4893733	540938	
2/15/2008	91	4894208	540898	
2/15/2008	131	4892948	541727	
2/15/2008	151	4892983	541730	
2/15/2008	171	4892892	541825	
2/29/2008	51	4893908	541105	
2/29/2008	91	4893989	540939	
2/29/2008	131	4893902	541276	
2/29/2008	151	4893015	541749	
2/29/2008	171	4893071	541755	
2/29/2008	191	4895537	541535	

Appendix 1 (*continued*)

Date	Fish_ID	UTM_Y	UTM_X	Temperature °C
3/7/2008	11	4895003	541957	
3/7/2008	51	4893925	541124	
3/7/2008	71	4893918	541018	
3/7/2008	91	4893718	540794	
3/7/2008	111	4892045	542903	
3/7/2008	131	4893866	541292	
3/7/2008	151	4892698	541940	
3/7/2008	171	4893924	541121	
3/7/2008	191	4895105	541953	
4/2/2008	71	4891130	542415	3.3
4/2/2008	111	4892066	542975	3.3
4/2/2008	171	4892064	542854	3.3
4/2/2008	191	4892263	542409	3.3
4/9/2008	11	4888766	542266	5.8
4/9/2008	31	4895268	542092	5.4
4/9/2008	51	4894477	541986	6.3
4/9/2008	91	4895258	541863	5.4
4/9/2008	111	4892052	543040	4.7
4/9/2008	131	4892722	541912	4.7
4/9/2008	151	4890757	542396	4.6
4/9/2008	171	4894200	541505	6.3
4/9/2008	191	4890064	542992	4.6
4/15/2008	11	4888265	542419	7.4
4/15/2008	31	4893866	542034	4.4
4/15/2008	51	4894685	542260	3.7
4/15/2008	71	4888640	542509	6.3
4/15/2008	91	4895297	542051	4
4/15/2008	111	4894398	541081	5.4
4/15/2008	131	4891819	543129	5.4
4/15/2008	151	4890762	542405	5.8
4/15/2008	191	4890294	542745	6.3
4/17/2008	31	4894635	542212	7.5
4/17/2008	51	4893575	540725	7.9
4/17/2008	91	4894976	542006	7.5
4/17/2008	111	4895507	541263	6.3
4/17/2008	131	4892217	542777	8.9
4/17/2008	151	4893731	541126	7.7
4/17/2008	171	4893093	541817	9.3
4/17/2008	191	4890574	542490	9.1

Appendix 1 (*continued*)

Date	Fish_ID	UTM_Y	UTM_X	Temperature °C
4/18/2008	31	4894595	542215	7.7
4/18/2008	51	4893968	541417	8.9
4/18/2008	91	4895415	541667	7.7
4/18/2008	111	4894704	542262	7.7
4/18/2008	131	4894215	541692	8.4
4/18/2008	151	4893242	541827	8.4
4/18/2008	171	4893093	541817	
4/18/2008	191	4890652	542416	7.2
4/21/2008	91	4895581	541500	9
4/21/2008	111	4895300	541809	8.6
4/21/2008	131	4895525	541339	10.2
4/21/2008	151	4893951	541759	9.8
4/21/2008	171	4895499	541269	10.2
4/22/2008	11	4888772	542278	11.9
4/22/2008	91	4895728	541587	
4/22/2008	111	4895441	541588	10.2
4/22/2008	131	4895423	541624	10.2
4/22/2008	151	4895425	541491	10.6
4/22/2008	171	4895406	541672	10.2
4/23/2008	11	4888758	542302	11
4/23/2008	111	4895406	541637	10.7
4/23/2008	131	4894487	541995	12.2
4/23/2008	151	4895517	541247	10.7
4/23/2008	171	4895522	541278	10.6
4/27/2008	51	4895728	541587	
4/27/2008	111	4899355	541055	8.9
4/27/2008	131	4895728	541587	
4/27/2008	151	4895728	541587	
4/27/2008	171	4895407	541633	7.7
4/29/2008	11	4888772	542278	8.3
4/29/2008	31	4888131	542924	8.3
4/29/2008	71	4877018	542902	6.7
4/30/2008	11	4888772	542278	8.3
4/30/2008	31	488121	542912	8.7
4/30/2008	51	4895728	541587	
4/30/2008	111	4895523	541327	7.9
4/30/2008	151	4895728	541587	
4/30/2008	171	4892220	542738	7.1
4/30/2008	171	4892184	543039	8.2
4/30/2008	191	4898007	541439	

Appendix 1 (*continued*)

Date	Fish_ID	UTM_Y	UTM_X	Temperature °C
5/5/2008	11	4888738	542280	11.4
5/5/2008	31	4888123	542920	11.8
5/5/2008	111	4893876	542029	11.4
5/5/2008	171	4893872	542011	11.4
5/7/2008	11	4895515	541289	12.8
5/7/2008	31	4888104	542974	12.8
5/7/2008	171	4895488	541281	12.8
5/13/2008	51	4899914	541584	
5/13/2008	91	4897363	541670	
5/13/2008	111	4897060	541678	
5/13/2008	131	4900896	541893	
5/13/2008	151	4895677	541655	
5/13/2008	191	4898424	541528	
5/16/2008	11	4892346	542337	15.1
5/16/2008	31	4894627	542206	15.5
5/21/2008	51	4897871	541365	15
5/21/2008	71	4877018	542902	
5/21/2008	91	4897213	541800	15
5/21/2008	111	4897047	541666	15
5/21/2008	131	4900451	542457	15
5/21/2008	151	4901089	541411	15
5/21/2008	171	4902704	543058	15
5/21/2008	191	4903500	544662	15
6/20/2008	31	4895765	541617	19.7
6/20/2008	51	4900911	542097	21.2
6/20/2008	91	4895768	541639	19.7
6/20/2008	111	4900966	543019	21.2
6/20/2008	131	4900593	542313	21.2
6/25/2008	11	4895468	541515	22.4
7/18/2008	151	4901000	547885	
7/18/2008	171	4899745	556697	
7/24/2008	31	4895793	541697	
7/24/2008	51	4901128	541407	
7/24/2008	91	4895727	541597	
7/24/2008	111	4900450	542433	
7/24/2008	131	4900923	541864	
9/31/2008	31	4895697	541532	16.7
9/31/2008	51	4895695	541569	16.7
9/31/2008	91	4895692	541539	16.7
9/31/2008	111	4895681	541584	16.7
9/31/2008	131	4895765	541646	16.7
9/31/2008	191	4895707	541640	16.7

Appendix 1 (*continued*)

Date	Fish_ID	UTM_Y	UTM_X	Temperature °C
2/6/2009	31	4895701	541582	
2/6/2009	51	4895701	541582	
2/6/2009	91	4895701	541582	
2/6/2009	111	4895701	541582	
2/6/2009	131	4895701	541582	
2/6/2009	171	4895701	541582	
2/6/2009	191	4895701	541582	

Minnesota
F-29-R(p)-28
Study IV
Job 797

MINNESOTA DEPARTMENT OF NATURAL RESROUCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES

Completion Report

An evaluation of muskellunge stocking in a southern Minnesota impoundment, Lake Zumbro.

By

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