6-2015

Comparison of Two Trap Net Designs for Sampling Muskellunge

Brian G. Blackwell

Todd M. Kaufman

Tyrel S. Moos

David O. Lucchesi

The Prairie Naturalist 47:21–25; 2015

Comparison of Two Trap Net Designs for Sampling Muskellunge

BRIAN G. BLACKWELL[1], TODD M. KAUFMAN, TYREL S. MOOS AND DAVID O. LUCCHESI

South Dakota Department of Game, Fish and Parks, 603 E 8th Avenue, Webster, SD 57274, USA (BGB, TMK, TSM)
South Dakota Department of Game, Fish and Parks, 4500 South Oxbow Avenue, Sioux Falls, SD 57106, USA (DOL)

ABSTRACT Sampling adequate numbers of muskellunge (*Esox masquinongy*) is necessary to evaluate stocking success and to collect information on various population metrics (e.g., growth, condition, relative abundance). However, muskellunge are often difficult to sample with standard fish sampling gears. We collected muskellunge in trap nets of two different designs (large trap nets [1.5-m × 1.8-m frames, 1.5-m diameter hoops, double throated, single 1.5-m × 30.5-m lead and 19-mm knotless mesh] and small trap nets [0.9-m × 1.5-m frames, 0.9-m diameter hoops, single throat, single 0.9-m × 15.2-m lead and 19-mm knotted mesh]. We also estimated abundance of muskellunge (>600 mm total length) in three eastern South Dakota waters using marked and recaptured fish collected from the trap net comparisons. Sampling with both large and small trap nets was completed during the spring of 2013 and 2014 soon after ice-out. More muskellunge were collected in large than small trap nets at all three lakes. Mean total lengths of muskellunge did not differ significantly between large and small trap nets; however, length-frequency distributions did differ between net designs. Regardless of trap net design, a small number of muskellunge were collected, likely due to low abundance (population range = 0.10 fish/ha to 0.47 fish/ha) in these populations. Thus, long-term monitoring is necessary to accurately assess populations and associated trends. Sampling with large trap nets during the spring combined with population estimates may improve the ability to monitor and manage muskellunge when compared to sampling with small trap nets.

KEY WORDS *Esox masquinongy*, muskellunge, sampling, South Dakota, trap nets

Muskellunge (*Esox masquinongy*) have been introduced into select waters in eastern South Dakota with the goal of establishing low-density populations that can provide anglers an opportunity to catch trophy-sized fish. None of the muskellunge fisheries currently are self-sustaining and require periodic maintenance stockings. Sampling adequate numbers of muskellunge is necessary to evaluate stocking success and to collect information on various population metrics (e.g., growth, condition, relative abundance). However, muskellunge are difficult to sample with standard fish sampling gears (e.g., trap nets, experimental gill nets and boat electrofishing) used by the South Dakota Department of Game, Fish and Parks (SDGFP) and other resource agencies in North America. Muskellunge management is often difficult because few fish are collected in standard sampling, resulting in limited information on the status of these populations. Improving sampling methodology has been identified as a priority so that management of the species can be based on more quantitative analyses (Hanson et al. 1986, Strand 1986*b*).

Muskellunge are typically sampled during the spring spawning season in shallow water with fyke nets (i.e., trap nets) near areas with suitable spawning habitat (Jennings et al. 2011). Spawning habitat has been described as shallow water (1–2 m; Strand 1986*a*) over organic sediment (Rust et al. 2002) often in the presence of woody debris (<4% of habitat area; Rust et al. 2002) and having submerged vegetation (Farrel 2001), but spawning also occurs in areas without vegetation (Haas 1978). Fyke nets with 1.2-m × 1.8-m or 0.9-m × 1.5-m frames and single 15.2-m leads have been used to collect muskellunge in the spring in several Wisconsin lakes (Hanson 1986, Jennings et al. 2011). In Minnesota, the number of muskellunge caught in standard 0.9-m × 1.8-m trap nets was considered inadequate (MNDNR 2011). As a result, Minnesota began using 1.5-m × 1.8-m trap nets in place of smaller, standard trap nets to sample muskellunge beginning in 1999 (Younk and Pereira 2007).

In eastern South Dakota, attempts to sample muskellunge have been completed using spring trap netting with standard SDGFP trap nets (i.e., 0.9-m × 1.5-m frames and 15.2-m leads), short-term (i.e., 1- to 2-hr sets) experimental gill nets with large mesh (i.e., 1.8 m × 46 m; 7.7-m panels of 38, 51, 64, 76, 89 and 102-mm bar mesh) and nighttime electrofishing. All of these efforts have collected very few fish. Because other states have had success at sampling adult muskellunge with large trap nets (Hansen 1986, Younk and Pereira 2007, Jennings et al. 2011), SDGFP has considered using the large trap nets during the spring to sample adult muskellunge. Thus, the objectives of our study were to compare catches and size structure between adult muskellunge captured from the standard SDGFP trap nets (hereafter referred to as small trap net) and large trap nets and to estimate population sizes in three eastern South Dakota water bodies.

STUDY AREA

Muskellunge were sampled at one reservoir (Amsden Dam) and two natural lakes (Lynn Lake and West 81 Lake) in eastern South Dakota, USA. Amsden Dam, located in Day County, is a 95.2-ha impoundment, with a maximum depth of 8.2 m and mean depth of 2.7 m. The reservoir was first stocked with muskellunge in 1975 and more recently has been stocked during six of the last 15 years. Lynn Lake, lo-

[1] Corresponding author email address: brian.blackwell@state.sd.us

cated in Day County, is a natural lake with a surface area of 648 ha, maximum depth is 7.6 m, and mean depth is 3.7 m. Muskellunge were initially stocked in 2001 and seven additional stockings were completed between 2001 and 2013. West 81 Lake, located in Kingsbury County, has a surface area of 554 ha, a maximum depth of 6.7 m and a mean depth of 3.9 m. Muskellunge were first stocked in 2005 and subsequent stockings occurred in 2006, 2010 and 2012. Submersed vegetation is present in all three waters. Coontail (*Ceratophyllum demersum*) and sago pondweed (*Potamogeton pectinatus*) are present in all three waters. Northern milfoil (*Myriophyllum sibiricum*) occurs in Amsden Dam and Lynn Lake and clasping leaf pondweed (*P. richardsonii*) is present only in West 81 Lake. The fish communities in the three waters are similar, and the more abundant fishes present include walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), northern pike (*Esox lucius*) and black bullhead (*Ameiurus melas*).

METHODS

At each lake, we began netting at or soon after ice-out during 2013 and 2014. We used two designs of trap nets to sample muskellunge. The small trap nets had two 0.9-m × 1.5-m frames, three 0.9-m diameter hoops, a single throat, a single 0.9-m × 15.2-m lead and 19-mm knotted mesh. The large trap nets had two 1.5-m × 1.8-m frames, four 1.5-m diameter hoops, a double throat, a single lead of 1.5 m × 30.5 m and 19-mm knotless mesh.

We subjectively selected net sampling sites based on the presence of potential spawning habitat (e.g., shallow water over organic sediment with the presence of woody debris and submersed vegetation [Strand 1986*a*, Farrel 2001, Rust et al. 2002]). In 2013, we sampled 10 sites at each lake with five large nets and five small nets randomly assigned to the 10 identified sites. In 2014, additional nets were available and sampling was expanded to 20 subjective sites at each lake; 10 large nets and 10 small nets were randomly assigned to the selected sites. Nets were set in the morning and lifted the following morning, except when windy conditions prevented access to the nets. Net sites were fixed for the duration of the sampling period (four to six days) each year.

We removed all fish from the nets when lifted. Captured muskellunge were measured for total length (TL, mm), weighed (g) and scanned for the presence of a passive integrated transponder (PIT) tag. If no PIT tag was present, we implanted a PIT tag in the dorsal musculature below the dorsal fin (Younk et al. 2010).

We quantified catch per unit effort (CPUE) as the number of muskellunge collected per net night. Catches from nets that fished more than one night were not included in CPUE analysis. Because CPUE values were heavily skewed towards zero, we made comparisons of CPUE distributions between the two net types with the non-parametric Mann-Whitney *U*-test. Comparisons of CPUE values between the two net sizes were made for each lake and year. We pooled total length data for both years and compared between the two net sizes using analysis of variance (ANOVA) with lake as a blocking factor. A Kolmogorov-Smirnov test was used to compare the length-frequency distributions between the two net types. All statistical tests were completed using SYSTAT (SYSTAT Software Inc., Richmond, CA; Wilkinson, 1990) with a significance level of 0.05.

At each lake, muskellunge collected and marked from both net types were used to estimate population abundance of muskellunge >600 mm TL. We were unable to estimate abundance for each net type because too few muskellunge were captured in the small trap nets. We calculated population estimates with corresponding 95% confidence intervals (CI) using Bailey's modification of the Petersen method (Hanson 1986, Krebs 1999) with 2013 serving as the marking period and 2014 the recapture period.

RESULTS

Ice-out was late in 2013; this resulted in 2014 sampling being approximately 3 weeks earlier than that of 2013 (Table 1). In 2013, a total of 78 large trap net nights and 76 small trap net nights were included in the analysis and effort totaled 112 large trap net nights and 114 small trap net nights in 2014. We collected a total of 35 muskellunge in large trap nets in 2013 and three in small trap nets. In 2014, 109 muskellunge were collected in large trap nets and five in small trap nets.

At all three lakes and during both years, more muskellunge were collected in large trap nets than small trap nets (Table 2). Catches for both net designs were highly skewed towards zero resulting in median CPUE values of zero for all waters during both years with the exception of Lynn Lake in 2014 when the median CPUE was 1. The highest individual net catch occurred at Lynn Lake when 26 muskellunge were collected in a large net during an overnight set in 2014. Significant differences in median CPUE between the two net designs were found at Amsden Dam in 2013 (U = 715; P = 0.006) and at Lynn Lake in both 2013 (U = 352, P = 0.003) and 2014 (U = 1,460, P < 0.001; Table 2). Collected muskellunge ranged in TL from 610 mm to 1,219 mm (Fig. 1A, n = 150) in the large trap nets and 711 mm to 991 mm TL (Fig. 1B, n = 8) in the small trap nets. The mean TL of collected muskellunge did not differ ($F_{1, 152}$ = 1.85, P = 0.18) between large trap nets (mean = 913 mm, SE = 9.58) and small trap nets (mean = 827 mm, SE = 32.56). A significant difference in length-frequency distributions between the two net designs was identified (P= 0.03)

The number of muskellunge >600 mm TL was estimated at 13 individuals (95% CI = 8–17; density = 0.15/ha), in Amsden Dam, 306 individuals (95% CI = 114–498; density = 0.47/ha) in Lynn Lake, and 56 individuals (95% CI = 4–108; density = 0.10/ha) in West 81 Lake. The large trap nets sam-

Table 1. Dates muskellunge were sampled from Amsden Dam, Lynn Lake, and West 81 Lake, South Dakota, 2013–2014, the number of nights fished and the total number of nets nights for large and small trap nets.

			Number of net nights		
Year	Lake	Dates	Nights	Large nets	Small nets
2013	Amsden	May 2–7	5	29	29
	Lynn	May 8–13	5	24	22
	West 81	May 3–8	5	25	25
2014	Amsden	Apr 10–18	5	38	40
	Lynn	Apr 19–25	6	41	44
	West 81	Apr 21–25	4	33	30

Table 2. Median catch per unit effort (CPUE), CPUE range, number of net nights, number (n) of muskellunge collected by trap net size and results of Mann-Whitney U-test comparing CPUE distributions between trap net sizes by year for Amsden Dam, Lynn Lake and West 81 Lake, South Dakota, 2013–2014.

		Large net				Small net				Mann-Whitney	
Lake	Year	Net nights	*n*	CPUE median	CPUE range	Net nights	*n*	CPUE median	CPUE range	U-stat	*P*-value
Amsden	2013	29	12	0	0–3	29	1	0	0–1	715	0.006
	2014	38	5	0	0–2	40	1	0	0–1	822	0.147
Lynn	2013	24	19	0	0–4	22	0	0	0–0	352	0.003
	2014	41	84	1	0–26	44	1	0	0–1	1,460	<0.001
West 81	2013	25	4	0	0–1	25	2	0	0–1	326	0.615
	2014	33	20	0	0–12	30	3	0	0–1	569	0.125

pled 42% of the population estimate at Amsden Dam in 2014, 27% of the estimated population at Lynn Lake and 35% at West 81, whereas, the small trap nets sampled 8%, <1%, and 5% of the respective population estimates.

DISCUSSION

Sampling muskellunge has proven difficult in South Dakota waters and elsewhere. Strand (1986*b*) indicated that the inability to obtain sufficient samples of muskellunge precluded detailed statistical analysis across their range and that this limitation needed to be overcome to improve management through quantitative analysis. The first step in overcoming these issues is to identify the best gears for sampling. Our results and those of Younk and Pereira (2007) indicate that large trap nets are more effective at capturing muskellunge than small trap nets. The higher catches in the large trap nets are likely the result of the longer and deeper leads increasing the area for muskellunge to encounter. Also, the double throats in the large trap nets may have better retention of captured fish than single throats in the small trap nets; however, removal of fish daily should have minimized escapement.

Low population abundance limits interpretation of the CPUE values in the waters we studied. High numbers of zero catches were found for both lakes resulting in low median CPUE values. Similarly, trap net CPUE data collected from 1985 to 2002 in 47 Minnesota lakes contained a large number of zero values (Younk and Pereira 2007). These results may be due to the low overall population size in study lakes.

Although we did find a difference in length frequencies of collected muskellunge between net designs, the limited number of fish collected in the small nets makes this differ-

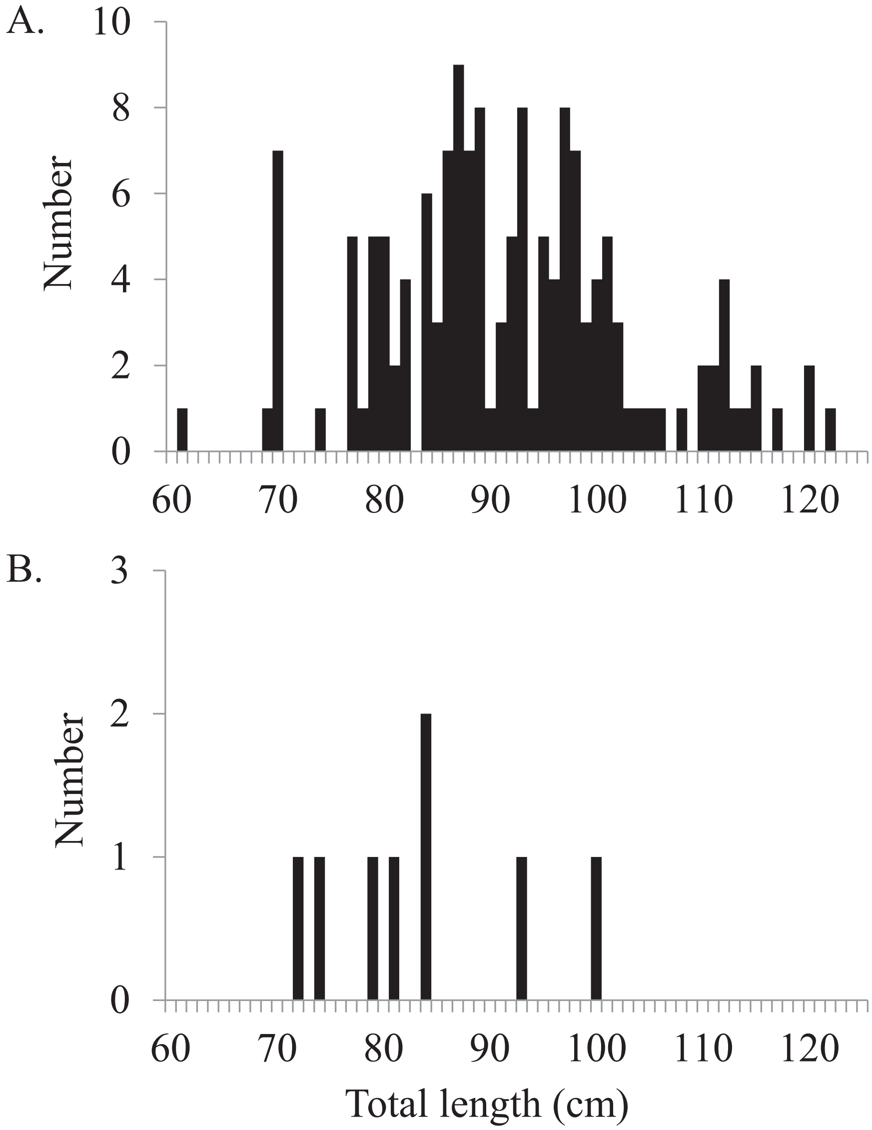

Figure 1. Length-frequency histograms of muskellunge collected in large trap nets (A) and small trap nets (B) from Amsden Dam, Lynn Lake, and West 81 Lake, South Dakota, 2013–2014.

ence suspect. There was no statistical difference in mean TL of muskellunge collected between the two net designs. This was not a surprise as during the spring when fish are using spawning habitat, both net types should have been sampling the at-large adult population. Likewise, no difference in mean length of muskellunge caught in small and large trap nets fished during the spring in Minnesota waters was observed (Younk and Pereira 2007).

Because of the low population abundance and subsequent low CPUE, the likelihood of collecting sufficient numbers of muskellunge for robust analysis of length-structure indices is low for most waters. Koch et al. (2014) believed that objective-based sampling should be considered when determining the minimum sampling effort needed. The minimum effort for sampling muskellunge will likely be driven by available resources (e.g., available nets and time) and not the number of fish collected. The use of long-term data sets will be necessary to monitor changes in length structure and relative abundance. In Minnesota, it is believed that population estimates provided a more useful perspective on density than CPUE because CPUE can be strongly influenced by weather conditions and timing (MNDNR 2011). We recommend that population estimates should be combined with annual spring sampling with large trap nets to monitor muskellunge populations.

MANAGEMENT IMPLICATIONS

Because of our inability to sample muskellunge using standard gears in South Dakota, we sought a means of improving our ability to collect muskellunge to allow for increased biological data to assist with the management of this species. The use of large trap nets near spawning habitat during spring will improve the ability to sample muskellunge in South Dakota and elsewhere. Establishment of long-term data sets collected with large trap nets combined with population estimates will allow for monitoring changes in length structure and relative abundance and ultimately improve management and quality of muskellunge fisheries.

ACKNOWLEDGMENTS

The Hugh Becker Foundation provided funding to purchase the materials to construct the large trap nets. We thank Blue Dog State Fish Hatchery staff for constructing the large trap nets. We are grateful to all of the SDGFP personnel, especially Region 3 and Region 4, who assisted with running the trap nets and collecting data. Reviews by M. Fincel, J. Davis, and two anonymous reviewers improved an earlier version of the manuscript. Funding for this project was provided in part by a Federal Aid in Sport Fish Restoration grant, F-21-R, activity 2102.

LITERATURE CITED

Farrel, J. M. 2001. Reproductive success of sympatric northern pike and muskellunge in an upper St. Lawrence River bay. Transactions of the American Fisheries Society 130:796–808.

Haas, R. C. 1978. The muskellunge in Lake St. Clair. Pages 334–339 *in* R. L. Kendall, editor. A symposium on selected coolwater fishes of North America. American Fisheries Society, Special Publication 11, Bethesda, Maryland, USA.

Hanson, D. A. 1986. Population characteristics and angler use of muskellunge in eight northern Wisconsin lakes. Pages 238–248 *in* G. E. Hall, editor. Managing muskies. American Fisheries Society Special Publication 15, Bethesda, Maryland, USA.

Hanson, D. A., J. R. Axon, J. M. Casselman, R. C. Haas, A. Schiavone, and M. R. Smith. 1986. Improving musky management: a review of management and research needs. Pages 335–341 *in* G. E. Hall, editor. Managing muskies. American Fisheries Society Special Publication 15, Bethesda, Maryland, USA.

Jennings, M. J., G. R. Hatzenbeler, and J. M. Kampa. 2011. Spring capture site fidelity of adult muskellunge in inland lakes. North American Journal of Fisheries Management 31:461–467.

Koch, J. D., B. C. Neely, and M. E. Colvin. 2014. Evaluation of precision and sample sizes using standardized sampling in Kansas reservoirs. North American Journal of Fisheries Management 34:1211–1220.

Krebs, C. J. 1999. Ecological methodology, Second edition. Benjamin Cummings, Menlo Park, California, USA.

MNDNR (Minnesota Department of Natural Resources). 2011. Long range plan for muskellunge and large northern pike management through 2020. Minnesota Department of Natural Resources, Section of Fisheries Management, St. Paul, USA.

Rust, A. J., J. S. Diana, T. L. Margenau, and C. J. Edwards. 2002. Lake characteristics influencing spawning success of muskellunge in northern Wisconsin lakes. North American Journal of Fisheries Management 22:834–841.

Strand, R. F. 1986*a*. Identification of principal spawning areas and seasonal distribution and movements of muskellunge in Leech Lake, Minnesota. Pages 62–73 *in* G. E. Hall, editor. Managing muskies. American Fisheries Society Special Publication 15, Bethesda, Maryland, USA.

Strand, R. F. 1986*b*. Summary review of technical contributions. Pages 360–369 *in* G. E. Hall, editor. Managing muskies. American Fisheries Society Special Publication 15, Bethesda, Maryland, USA.

Wilkinson, L. 1990. SYSTAT: the system for statistics. SYSTAT, Inc., Evanston, Illinois, USA.

Younk, J. A., B. R. Herwig, and B. J. Pittman. 2010. Short- and long-term evaluation of passive integrated transponder and visible implant elastomer tag performance in muskellunge. North American Journal of Fisheries Management 30:281–288.

Younk, J. A., and D. L. Pereira. 2007. An examination of Minnesota's muskellunge waters. Environmental Biology of Fishes 79:125–136.

Submitted 1 December 2014. Accepted 17 March 2015. Associate Editor was M. Wuellner.