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STATEWIDE EVALUATION OF LENGTH-BASED FISHING REGULATIONS: INTRODUCTION AND SUMMARY OF RESULTS[1]

Andrew J. Carlson and Daniel A. Isermann

Minnesota Department of Natural Resources
Section of Fisheries
1601 Minnesota Drive

Many recreational sportfisheries are regulated by daily bag limits (Cook et al. 2001). However, the effectiveness of these regulations remains questionable, as most daily limits remain too liberal to effectively reduce angler harvest and subsequently restructure fish populations (Munger and Kraai 1997; Cook et al. 2001). While efforts to substantially reduce daily bag limits in some harvest-oriented fisheries may offer effective management strategies (Jacobson 2005), catch-and-release and length-based harvest restrictions have become a popular management option for both fishery managers and anglers. Over the last several decades, catch-and-release and length-based harvest regulations have been increasingly used to manage recreational sportfisheries across North America (Wilde 1997; Paukert et al 2001), including in the state of Minnesota (Radomski et al. 2001). Currently in Minnesota (2009) 12 different species (sunfish, black crappie, bluegill, largemouth bass, muskie, northern pike, smallmouth bass, cisco, trout, walleye, sauger, and yellow perch) on 248 lakes are managed with experimental /special regulations. These regulations fall into three main categories: possession (N = 91), catch-and-release (N = 52), and length-based regulations (protected slots, minimum or maximum length limits, N = 248).

Management objectives associated with the implementation of catch-and-release and length-based harvest regulations vary, but common objectives often include: 1) reducing angler harvest; 2) increasing fish abundance; 3) improving population size structure or the size structure of fish harvested by anglers; 4) protection of spawning adults; 5) providing a trophy fishery; and 6) restructuring one species' population to improve another (Isermann and Paukert *in revision*). Despite the widespread use of catch-and-release and length-based restrictions, their effectiveness in meeting management objectives or angler desires remains uncertain and evaluations designed to access the impacts of the regulations have often been inadequate (Wilde 1997; Allen and Pine 2000).

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In response to angler desires for improved fishing quality and increased lake-specific management efforts, the Minnesota Department Natural Resources initiated a statewide project in 1995 designed to evaluate the impacts of length-based and catch-and - release harvest regulations on populations of black crappies *Pomoxis nigromaculatus*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, northern pike *Esox lucius*, and walleye *Sander vitreus*. This study provided baseline information on Minnesota waters as part of the adaptive approach to fisheries management designed to offer managers guidance regarding which regulations might prove effective in future situations. The objectives of this document are to: 1) summarize the length-based and catch-and-release regulations used in the study; 2) summarize the fate of these regulations after the evaluation period; and 3) provide a short summary of the results of the regulations for each species.

Summary of regulations evaluated in this study

Fifty-one populations were subject to experimental regulations as part of this study (Tables 1 and 2). An additional 81 populations served as reference populations for comparison with the experimental regulation lakes (Tables 1 and 2). Due to inadequate sampling and regulation changes throughout the duration of the study, 13 experimental regulation lakes and 12 control lakes were dropped from the study (Table 1). Experimental regulations fell into four categories (minimum length limits, maximum length limits, protected slots, or mandatory catch-and-release) for each of the five species evaluated as part of this study (Table 1). The reference lakes were all subject to the general statewide regulations (GSWR) throughout the duration of the study (1995 – 2007). The GSWR for black crappie was 15 fish in possession from 1995 to 2002 and changed to 10 fish in possession in 2003, where it remained through the duration of the study. Largemouth and smallmouth bass have the same GSWR, a limit of six bass in possession, which did not change throughout the study. The northern pike GSWR, a possession limit of three fish with only one fish exceeding 30 inches, was also consistent throughout the duration of the study. The walleye GSWR from 1995 – 2005 was six fish in possession with only one fish exceeding 24 inches. In 2006, the walleye GSWR changed to six fish in possession with only one fish exceeding 20 inches, where it remained for the duration of the study.

Table 1. Number of reference and regulation *Reg.* (minimum length limit *min*, maximum length limit *max*, protected slot *PS*, and mandatory catch-and-release *MCR*) lakes for each species (black crappie *BLC*, largemouth bass *LMB*, smallmouth bass *SMB*, northern pike *NOP*, and walleye *WAE*) included in the study. Numbers in parenthesis represent the number of lakes in the category originally proposed but not included in the analysis.

Species	Reference	Reg. - min	Reg. - max	Reg. - PS	Reg. - MCR	Total
BLC	3 (1)	4 (1)				7 (2)
LMB	9 (2)		3 (2)	(1)	6 (4)	18 (9)
SMB	4 (1)		4		(2)	8 (3)
NOP	52 (1)	3	11	4	1	71 (1)
WAE	1 (7)	2 (1)		(2)		3 (10)
Total	69 (12)	9 (2)	18 (2)	4 (3)	7 (6)	107 (25)

Table 2. Experimental regulation and reference *Ref.* lakes for Black crappie *BLC*, largemouth bass *LMB*, smallmouth bass *SMB*, northern pike *NOP*, and Walleye *WAE*. Regulations included minimum *min.* and maximum *max.* length limits, protected slot *PS* limits, mandatory catch and release *MCR* fisheries, possession *Poss.* limits, or general statewide regulations *GSWR*. Current statewide regulations for BLC are 10 fish in possession, LMB and SMB are six bass in possession, NOP are three fish in possession with not more than one over 30 inches, and WAE are six fish in possession with not more than one over 20 inches. The 2009 regulation, and if applicable, year of change(s) is also provided in parenthesis for each lake.

Lake name	DOW	County	Species	Regulation	2009 Regulation
Maple	21007900	Douglas	BLC	10" min.	10" min.
Spider	29011700	Hubbard	BLC	10" min.	10" min.
North Lida[1]	56074701	Otter Tail	BLC	11" min.	11" min.
South Lida	56074702	Otter Tail	BLC	11" min.	11" min.
Green	13004100	Chisago	BLC	9" min.	9" min.
Little Mantrap[1]	29031300	Hubbard	BLC	Ref. (GSWR)	GSWR
Moose	04001100	Beltrami	BLC	Ref. (GSWR)	GSWR
Mound	77000700	Todd	BLC	Ref. (GSWR)	GSWR
West Silent	56051900	Otter Tail	BLC	Ref. (GSWR)	GSWR
Chisago[1]	13001200	Chisago	LMB	12" max.	MCR
Long	34006600	Kandiyohi	LMB	12" max.	12" max., Poss. 1 >20" (2006)
Moose Lake	77002600	Todd	LMB	12" max.	12" max.
Pierz (Fish)	49002400	Morrison	LMB	12" max.	12" max., Poss. 1 >20" (2006)
South Lindstrom[1]	13002800	Chisago	LMB	12" max.	12" max.
Little Mantrap[1]	29031300	Hubbard	LMB	12-18" PS	12-18" PS
Ann[1]	10001200	Carver	LMB	MCR	MCR
Bavaria[1]	10001900	Carver	LMB	MCR	GSWR (2005)
Clear	81001401	Waseca	LMB	MCR	GSWR (2002)
Green[1]	34007900	Kandiyohi	LMB	MCR	GSWR (2005)
Jane	82010400	Washington	LMB	MCR	MCR
Minnewashta	10000900	Carver	LMB	MCR	MCR
Moccasin Lake	11029600	Cass	LMB	MCR	MCR
Portage Lake	11047600	Cass	LMB	MCR	MCR
Stieger[1]	10004500	Carver	LMB	MCR	MCR
Turtle	62006100	Ramsey	LMB	MCR	MCR
Black Bear	18014000	Crow Wing	LMB	Ref. (GSWR)	GSWR
Camp	86022100	Wright	LMB	Ref. (GSWR)	GSWR
Erie	47006400	Meeker	LMB	Ref. (GSWR)	GSWR
Maple	21007900	Douglas	LMB	Ref. (GSWR)	GSWR
Mary	86019300	Wright	LMB	Ref. (GSWR)	GSWR
Moose	4001100	Beltrami	LMB	Ref. (GSWR)	GSWR
Mound	77000700	Todd	LMB	Ref. (GSWR)	GSWR
Pierson[1]	10005300	Carver	LMB	Ref. (GSWR)	GSWR
Spider	29011700	Hubbard	LMB	Ref. (GSWR)	GSWR

Lake name	DOW	County	Species	Regulation	2009 Regulation
West Silent	56051900	Otter Tail	LMB	Ref. (GSWR)	GSWR
Zumbra[1]	10004100	Carver	LMB	Ref. (GSWR)	GSWR
Flour	16014700	Cook	SMB	11" max.	12" max., Poss. 1 >20" (2004)
Hungry Jack	16022700	Cook	SMB	11" max.	12" max., Poss. 1 >20" (2004)
Pike	16025200	Cook	SMB	11" max.	GSWR (2005)
Two Island	16015600	Cook	SMB	11" max.	12" max., Poss. 1 >20" (2004)
Green[1]	34007900	Kandiyohi	SMB	MCR	14" min. (2001), GSW (2006)
Portage Lake[1]	11047600	Cass	SMB	MCR	MCR
Aspen	16020400	Cook	SMB	Ref. (GSWR)	GSWR
Caribou	16036000	Cook	SMB	Ref. (GSWR)	GSWR
Devil Track	16014300	Cook	SMB	Ref. (GSWR)	GSWR
East Bearskin	16014600	Cook	SMB	Ref. (GSWR)	GSWR
Three Island[1]	31054200	Itasca	SMB	Ref. (GSWR)	GSWR
Sturgeon	58006700	Pine	NOP	20" max.	24-36" PS, Poss. 1>36" (2008)
Ten Mile	11041300	Cass	NOP	20" max.	24-36" PS, Poss. 1>36" (2008)
Coon-Sandwick[2]	31052400	Itasca	NOP	20-30" PS	24-36" PS, Poss. 1>36" (2007)
Sissabagamah[2]	01012900	Aitkin	NOP	20-30" PS, Poss. 1>30"	20-30" PS, Poss. 1>30"
East Battle	56013800	Otter Tail	NOP	22" max.	GSWR (2008)
Andrews	21008500	Douglas	NOP	24" max.	GSWR (2008)
Big Birch	77008400	Todd	NOP	24" max.	24-36" PS, Poss. 1>36" (2006)
Big Swan	77002300	Todd	NOP	24" max.	24-36" PS, Poss. 1>36" (2008)
Burgen	21004900	Douglas	NOP	24" max.	GSWR (2008)
Green	34007900	Kandiyohi	NOP	24" max.	GSWR (2006)
Melissa	03047500	Becker	NOP	24" max.	24" max.
Rachel	21016000	Douglas	NOP	24" max.	24-36" PS, Poss. 1>36" (2008)
Sallie	03035900	Becker	NOP	24" max.	24" max.
Pelican[2]	69084100	St. Louis	NOP	24-38" PS, Poss. 1>38"	24-36" PS, Poss. 1>36" (2008)
Kelly-Dudley[2]	66001400	Rice	NOP	30" min.	GSWR (2008)
Reeds[2]	81005500	Waseca	NOP	30" min.	GSWR (2008)
St. Olaf[2]	81000300	Waseca	NOP	30" min.	30" min. & Poss 1 (2008)
Lake of the Woods[2]	39000200	Lake of the Woods	NOP	30-40" PS, Poss. 3, Poss. 1>40"	30-40" PS, Poss 3, 1>40"
Steiger	10004500	Carver	NOP	MCR	MCR
Auburn[2]	10004400	Carver	NOP	Ref. (GSWR)	GSWR

Lake name	DOW	County	Species	Regulation	2009 Regulation
Bagley[2]	15004000	Clearwater	NOP	Ref. (GSWR)	GSWR
Bavaria[2]	10001900	Carver	NOP	Ref. (GSWR)	GSWR
Beauty[2]	31002800	Itasca	NOP	Ref. (GSWR)	GSWR
Big Bass[2]	04013202	Beltrami	NOP	Ref. (GSWR)	GSWR
Big Island[2]	31067100	Itasca	NOP	Ref. (GSWR)	GSWR
Big Pine[2]	56013000	Otter Tail	NOP	Ref. (GSWR)	GSWR
Big Sand[2]	11007700	Cass	NOP	Ref. (GSWR)	GSWR
Black Hoof	18011700	Crow Wing	NOP	Ref. (GSWR)	GSWR
Brophy[2]	21010200	Douglas	NOP	Ref. (GSWR)	GSWR
Cotton[2]	03028600	Becker	NOP	Ref. (GSWR)	GSWR
Detroit	03038100	Becker	NOP	Ref. (GSWR)	GSWR
Fish[2]	70006900	Scott	NOP	Ref. (GSWR)	GSWR
Floyd[2]	03038700	Becker	NOP	Ref. (GSWR)	GSWR
French	01010400	Aitkin	NOP	Ref. (GSWR)	GSWR
Grant[2]	04021700	Beltrami	NOP	Ref. (GSWR)	GSWR
Green[1]	13004100	Chisago	NOP	Ref. (GSWR)	GSWR
Hanging Kettle[2]	01017000	Aitkin	NOP	Ref. (GSWR)	GSWR
Hay[2]	01005900	Aitkin	NOP	Ref. (GSWR)	GSWR
Julia	04016600	Beltrami	NOP	Ref. (GSWR)	GSWR
Lake-of-Isles[2]	31050600	Itasca	NOP	Ref. (GSWR)	GSWR
Le Homme Dieu[2]	21005600	Douglas	NOP	Ref. (GSWR)	GSWR
Leech[2]	11020300	Cass	NOP	Ref. (GSWR)	GSWR
Long[2]	27016000	Hennepin	NOP	Ref. (GSWR)	GSWR
Marion[2]	56024300	Otter Tail	NOP	Ref. (GSWR)	GSWR
Medicine[2]	27010400	Hennepin	NOP	Ref. (GSWR)	GSWR
Minnewashta	10000900	Carver	NOP	Ref. (GSWR)	GSWR
Minnewaska	61013000	Pope	NOP	Ref. (GSWR)	GSWR
North Lida	56074701	Otter Tail	NOP	Ref. (GSWR)	GSWR
Osakis	77021500	Douglas/Todd	NOP	Ref. (GSWR)	GSWR
Pine Mountain[2]	11041100	Cass	NOP	Ref. (GSWR)	GSWR
Riley[2]	10000200	Carver	NOP	Ref. (GSWR)	GSWR
Roemhildts[2]	40003900	Le Sueur	NOP	Ref. (GSWR)	GSWR
Sandy[2]	04012400	Beltrami	NOP	Ref. (GSWR)	GSWR
Sarah[2]	27019100	Hennepin	NOP	Ref. (GSWR)	GSWR
South Twin[2]	04005300	Beltrami	NOP	Ref. (GSWR)	GSWR
Star	56038500	Otter Tail	NOP	Ref. (GSWR)	GSWR
Steamboat[2]	11050400	Cass	NOP	Ref. (GSWR)	GSWR
Sugar[2]	01008700	Aitkin	NOP	Ref. (GSWR)	GSWR
Toad	03010700	Becker	NOP	Ref. (GSWR)	GSWR
Washburn	11005900	Cass	NOP	Ref. (GSWR)	GSWR
Winnibigoshish[2]	11014700	Cass	NOP	Ref. (GSWR)	GSWR

Lake name	DOW	County	Species	Regulation	2009 Regulation
Big Stone	06015200	Big Stone	WAE	14" min.	Poss 4, Poss. 1>20" (2004)
Lac Qui Parle	37004600	Lac Qui Parle/Chippewa	WAE	15" min.	Poss 4, Poss. 1>20" (2005)
Osakis[1]	77021500	Douglas/Todd	WAE	15" min.	15" min.
Farm Island[1]	01015900	Aitkin	WAE	16-19" PS	16-19" PS
Big Sand[1]	29018500	Hubbard	WAE	18-26" PS, Poss. 1>26"	20-28" PS, Poss. 1>28" (2005)
Andrews[1]	21008500	Douglas	WAE	Ref. (GSWR)	GSWR
Big Kandiyohi[1]	34008600	Kandiyohi	WAE	Ref. (GSWR)	GSWR
Big Swan[1]	77002300	Todd	WAE	Ref. (GSWR)	GSWR
Detroit[1]	03038100	Becker	WAE	Ref. (GSWR)	GSWR
North Lida[1]	56074701	Otter Tail	WAE	Ref. (GSWR)	GSWR
Ten Mile[1]	11041300	Cass	WAE	Ref. (GSWR)	GSWR
Toad[1]	03010700	Becker	WAE	Ref. (GSWR)	GSWR
Traverse	78002500	Traverse	WAE	Ref. (GSWR)	GSWR

[1] Lake excluded from final analysis due to regulation change or inadequate data.
[2] Lake not included in initial study design.

Three minimum length limits (9, 10 and 11 inch minimums) were evaluated on four black crappie populations across Minnesota (Figure 1). These regulations were implemented with the intention of improving the size structure of the populations. Creel data collected before the implementation of the minimum length limits suggested the regulation would reduce harvest by 40% and potentially restructure the population by protecting fish over the minimum length.

Maximum length limits (12 inch, N = 3) and mandatory catch-and-release (N = 6) regulations were evaluated on largemouth bass populations across Minnesota (Figure 2). Maximum length limits (11 inch) were also evaluated on four smallmouth bass populations in northeast Minnesota (Figure 3). These regulations were implemented with the intention of maintaining or improving the quality of bass populations while protecting brood stock that were thought to be limited due to harvest.

Four different regulation types were evaluated for northern pike populations across 19 Minnesota lakes (Figure 4). Regulations included minimum length limits (30 inch, N = 3), maximum length limits (20 inch, N = 2; 22 inch, N = 1; and 24 inch, N = 8), protected slots (20–30 inch, N = 2; 24–38 inch, N = 1; and 30–40 inch, N = 1), and mandatory catch-and-release (N = 1). These regulations were implemented with the intention of promoting fisheries with large (30–40 inch) and trophy (40+ inches) northern pike.

Minimum length limits (14 and 15 inch) were evaluated on two walleye populations in western Minnesota (Figure 5). These regulations were implemented to increase catch rates of quality and larger sized fish.

Figure 1. Black crappie study lakes. Filled circles represent the reference lakes with general statewide regulations and filled triangles represent the experimental regulation lakes (minimum length limits).

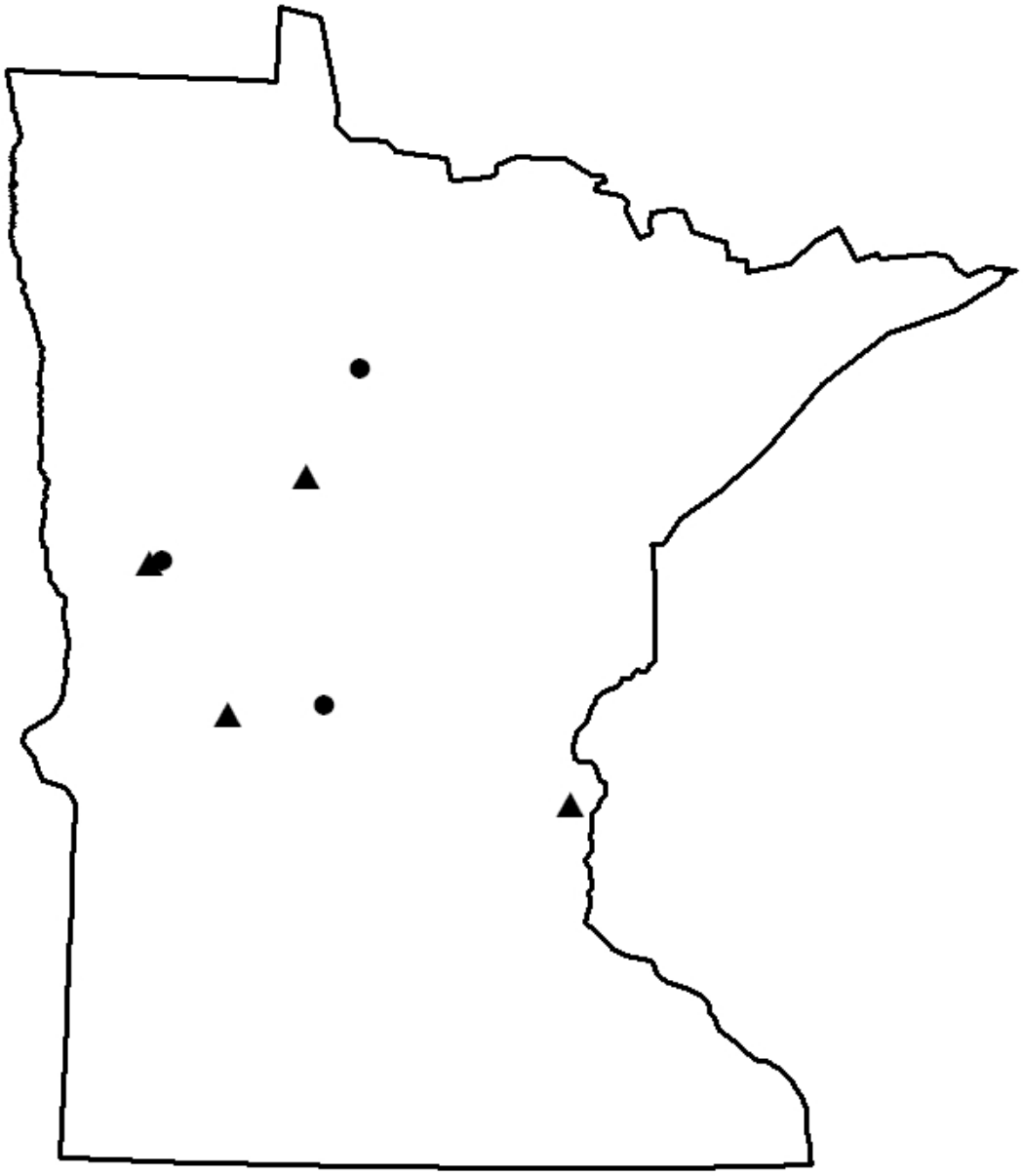


Figure 2. Largemouth bass study lakes. Filled circles represent the reference lakes with general statewide regulations and filled triangles represent the experimental regulation lakes (maximum length limits or mandatory catch-and-release).

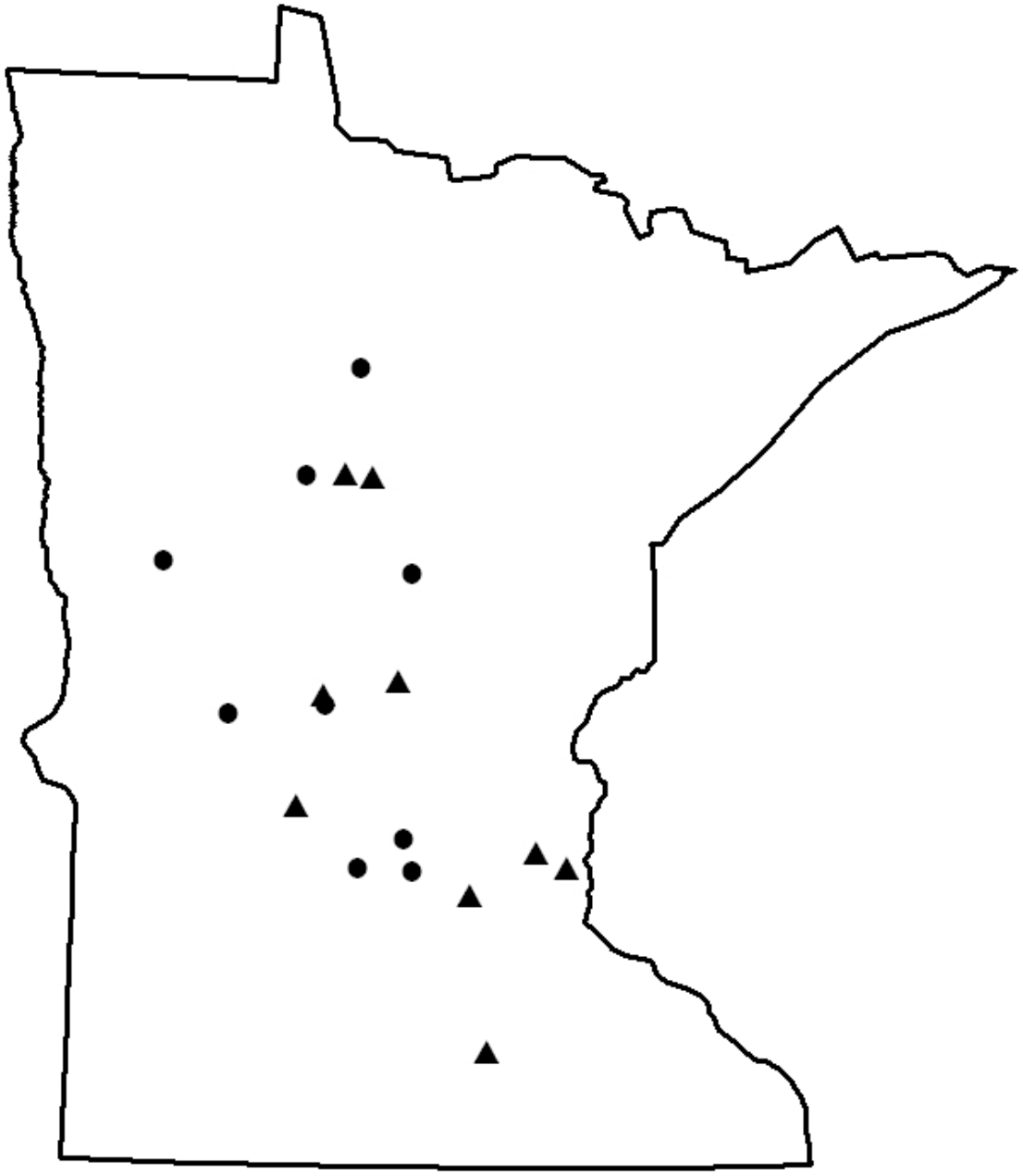


Figure 3. Smallmouth bass study lakes. Filled circles represent the reference lakes with general statewide regulations and filled triangles represent the experimental regulation lakes (maximum length limits).

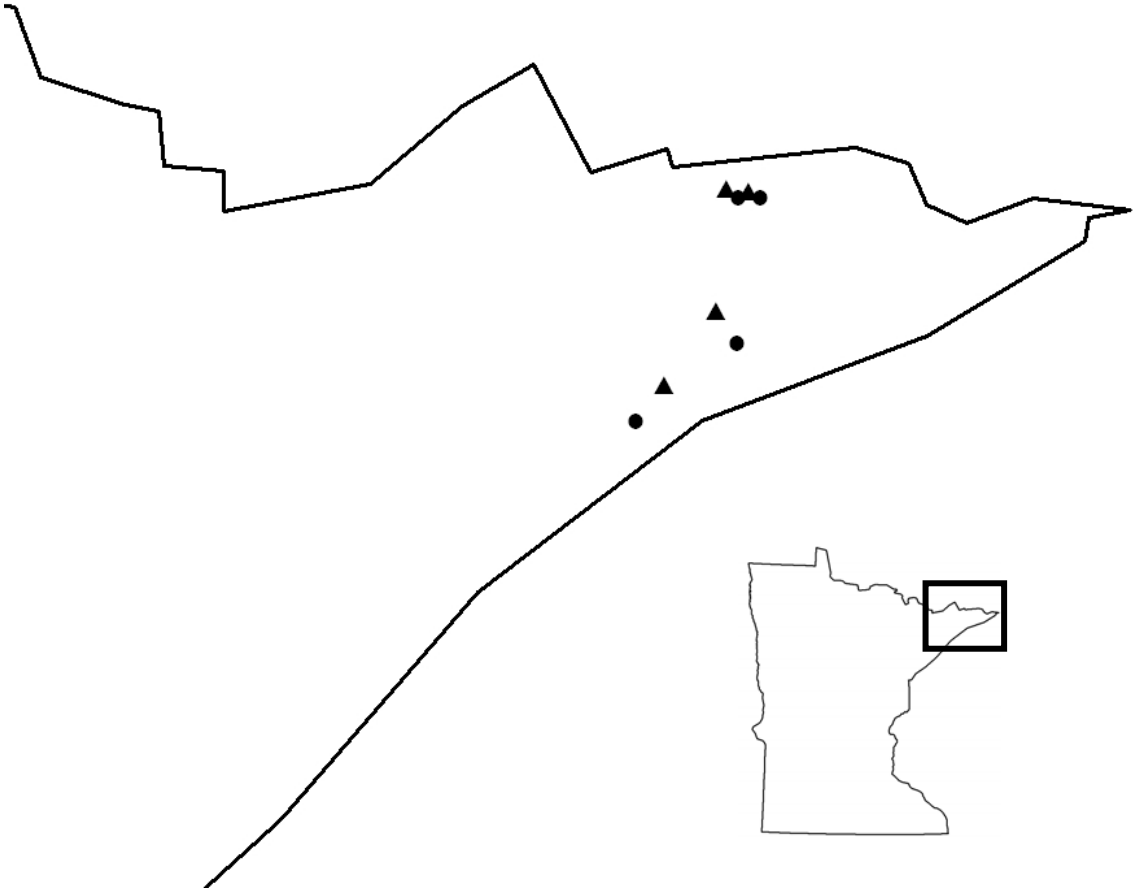


Figure 4. Northern pike study lakes. Circles represent the reference lakes with general statewide regulations (filled circles are lakes in the original proposal and open circles are supplemental lakes) and triangles represent the experimental regulation lakes (solid triangles are lakes in the original proposal and open triangles are supplemental lakes; regulations were: minimum or maximum length limits, protected slots, or mandatory catch-and-release).

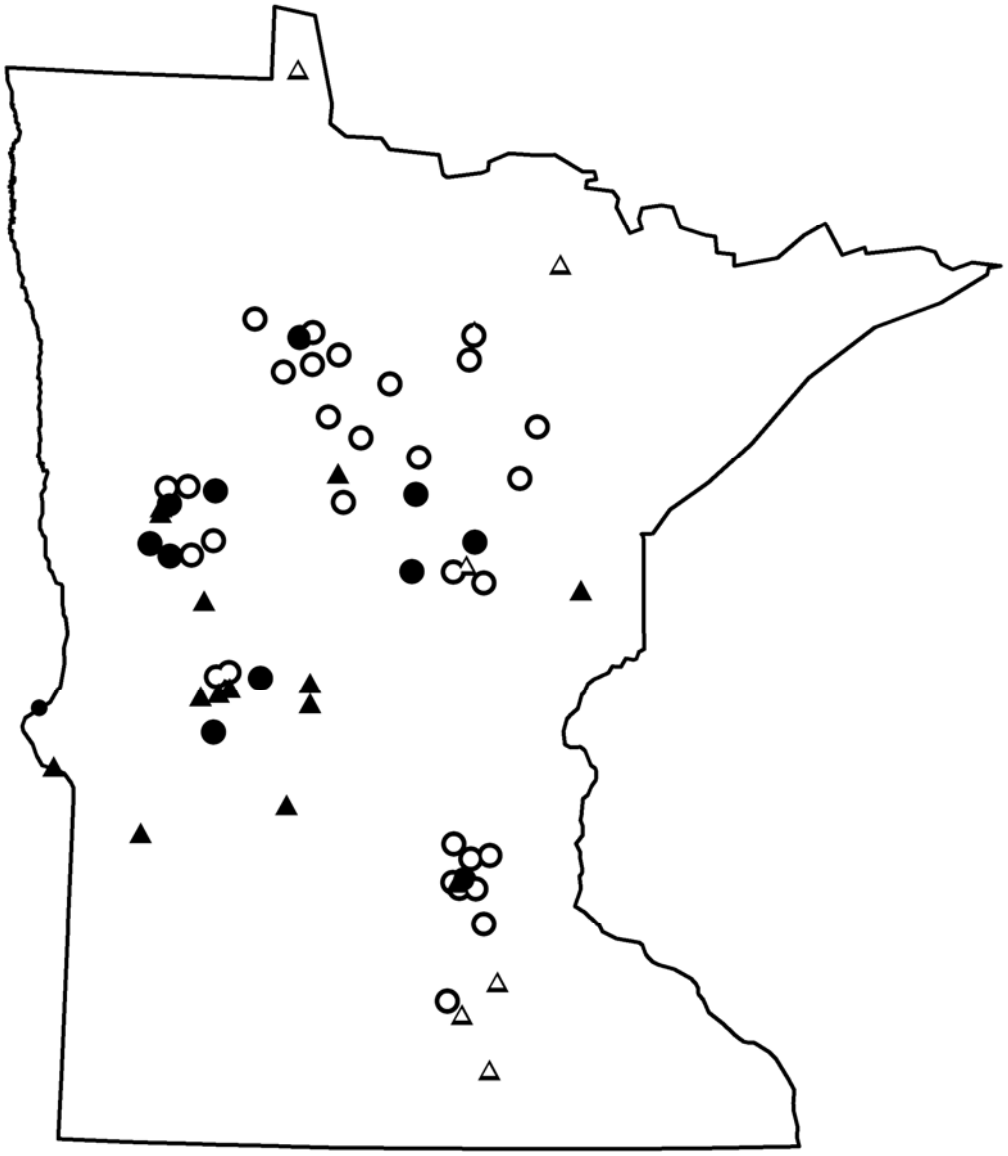
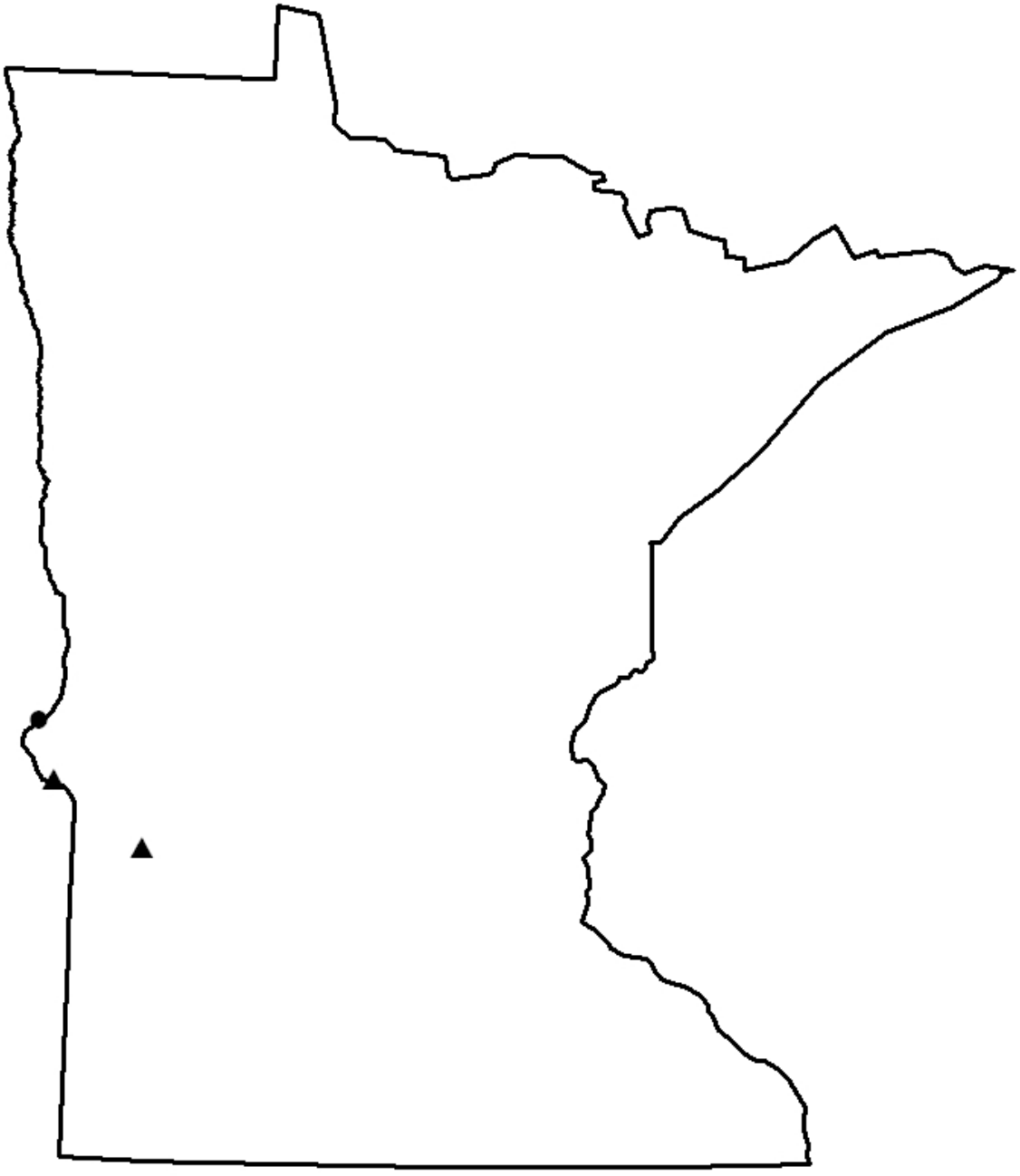


Figure 5. Walleye study lakes. Filled circle represents the reference lake with general statewide regulations and the filled triangles represent the experimental regulation lakes (minimum length limits).



Summary of the fate of the experimental regulations after the evaluation period

The fate of the experimental regulations initially posed in 1995 varied across species and regulation type (Table 3). Of the 38 experimental regulation lakes, 42% had the same regulations in effect in 2009. Thirty-four percent of the lakes retained regulations that were modified in some manner after the study, but still afforded some protection through length-based regulations. The remaining 24% of the lakes reverted to the general statewide regulations upon completion of the study.

Species summaries (abstracts from individual reports)

Black Crappie (Isermann and Carlson 2009)

During 1993 to 2008 we monitored black crappie populations in four Minnesota lakes before and after implementation of minimum total length limits (MLLs; 9-, 10- and 11-in minimums, Figure 1) to determine whether these harvest regulations were effective in improving crappie size structure. Length frequencies of harvested black crappies observed in creel surveys conducted before MLLs were implemented suggested that in most instances MLLs would have reduced harvest by 40% or more had they been in place prior to 1997. However, no size structure improvements were apparent in three of the four lakes where MLLs were implemented. In Green Lake it appeared that the 9-in MLL had a positive impact on black crappie size structure in trap nets but size structure remained relatively poor when compared with other study lakes, and size structure of harvested crappies did not improve. Illegal harvest varied widely among fisheries, but in three of six creel surveys conducted after MLLs were implemented more than 20% of the crappies measured by creel clerks were smaller than the specified MLL.

Largemouth bass (Carlson and Isermann *in revision*)

We evaluated the response of Minnesota largemouth bass populations to implementation of 305-mm maximum total length (TL) limits (N = 3 lakes) and mandatory catch-and-release regulations (N = 6 lakes, Figure 2). Responses were compared to population trends observed in 9 reference populations where bass harvest was regulated by prevailing statewide regulations (Figure 2). Increased harvest regulation generally improved largemouth bass size structure, but statistically significant improvements in size structure indices were detected in only a few individual lakes. Increased regulation of harvest did not appear to influence electrofishing catch-per-unit effort (CPUE; fish / h) of largemouth bass less than 381 mm TL. Electrofishing CPUE of bass greater than or equal to 381 mm TL (CPUE-381) generally improved after more stringent harvest regulations were in place, but improvements were only significant for 2 of the 3 lakes where a 305-mm maximum length limit was implemented. With the exception of one lake, increased harvest regulation did not appear to reduce largemouth bass growth rates. Improvements in size structure and CPUE-381 were rarely observed in reference lakes. Our results suggest that despite increases in voluntary catch-and-release of largemouth bass, angler exploitation is still an important factor regulating size structure in some Minnesota lakes and more intensive harvest regulations can improve size structure in some populations.

Smallmouth bass (Isermann et al. 2009)

We evaluated the effects of an 11-in maximum length limit (total length; TL) on the size structure of smallmouth bass caught by anglers in four northern Minnesota lakes (Figure 3). Using angler catch data collected during creel surveys, we compared size structure and catch rate of smallmouth bass prior to and after the implementation of the maximum length limit on four lakes. For comparative purposes, we examined angler catch data from four lakes regulated with only the prevailing statewide restriction on black bass harvest (i.e., 6 bass daily). The total assessment period was 10 years or more for all lakes. Based on available data it appeared that the size structure of smallmouth bass captured by anglers improved following implementation of the maximum length

limit; however, angler catch rates of bass greater than or equal to 11 in TL did not increase significantly.

Northern pike (Pierce *in review*)

The effects of maximum, minimum, and slot length limits (along with one catch-and-release regulation) on sizes and relative abundance of northern pike were evaluated in 23 Minnesota lakes (Figure 4). The regulations began in 1989-1998 and lasted 9-15 years. Pre-regulation information was available back to the 1970s so that evaluation periods covered 21-37 years in each lake. For experimental control, comparisons were made during the same extended period with reference populations from 47 ecologically similar lakes. Although regulations did not work in every lake, the broader-scale statewide finding was that regulations improved size structure of northern pike populations but produced no consistent trends in relative abundance. Maximum length limits protecting fish over 20, 22, or 24 inches improved fish sizes in 8 of 11 lakes, producing significant long-term increases in percentages of northern pike $\geq$ 24 inches and $\geq$ 30 inches compared to reference populations. The catch-and-release regulation on all three lakes with 30 inch minimum length limits increased percentages of fish $\geq$ 20 inches, but improvements did not carry over to fish $\geq$ 30 inches. A mix of slot length limits produced results more difficult to interpret, but generally improved fish sizes. A meta-analysis incorporating all the length regulations indicated that changes in northern pike size structure in regulated lakes relative to unregulated lakes were very large for ecological experiments. However, these levels of alterations in size structure did not seem to affect yellow perch *Perca flavescens* and walleye populations. Length limits protected large northern pike with the expectation that reduced yields were an acceptable trade-off for producing larger fish for recreational fisheries. This study revealed the range and magnitude of responses we can reasonably expect from length limits, as well as the substantial value of conserving large fish when the goal is improved population size structure.

Walleye (Isermann 2007)

Walleye population and fishery responses to the implementation of minimum length limits (356 and 381 mm total length) were evaluated for two Minnesota walleye populations (Big Stone Lake and Lac Qui Parle) and were compared to population trends observed in a single reference lake (Lake Traverse) between 1991 and 2004 (Figure 5). High variation in walleye recruitment (CV in mean gill-net CPUE of age-2 walleyes > 98%) was observed in all study populations and also in recruitment indices from 20 walleye populations across North America (mean CV = 112%), indicating that high variability in recruitment is common. Walleye growth rates were also variable, with mean lengths at age 3 varying by more than 120 mm among year classes in all three study populations. Observed trends in population age and size structure indices estimated from gill nets appeared to be largely related to growth and recruitment patterns both before and after the regulations were in place. There was no direct evidence that adult walleye abundance, size or age structure were improved following implementation of length limits and there was no evidence that the regulations reduced annual variation in size structure. In light of recruitment variation, meaningful evaluation of walleye length limits will require long-term annual sampling efforts designed to monitor the fate of multiple year classes of similar magnitudes during both pre- and post regulation periods. Lastly, managers must select meaningful metrics to measure the effects of length limits, as observed improvements in fishery-related metrics such as size structure of harvested fish may merely reflect changes in angler behavior, rather than actual improvements in the population and fishery-based metrics may be difficult to measure given the budgetary and logistical constraints associated with creel surveys.

Table 3. Summary of regulation changes for experimental lakes following the completion of the study (2009) for all study species (black crappie *BLC*, largemouth bass *LMB*, smallmouth bass *SMB*, northern pike *NOP*, and walleye *WAE*). Constant regulations indicated no changes were made throughout the study or since the completion of the study. A minor change represents a regulation that changed after the completion of the study, but the new regulation still afforded some protection though a length-based regulation (minimum, maximum, or protected slot). GSWR represent experimental lakes that reverted to the general statewide regulation *GSWR* after the completion of the study.

Species	Regulation type	Constant regulation	Minor change	GSWR	Total
BLC	Min.	4			4
LMB	Max.	1	2		3
	MCR	5		1	6
SMB	Max.	1	3		4
NOP	Max.	2	5	4	11
	PS	2	1		3
	Min.		2	2	4
	MCR	1			1
WAE	Min.			2[1]	2
Total		16	13	9	38

[1]GSWR bag reduced to 4 in both lakes

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