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ARTICLE

Fishing for Northern Pike in Minnesota: Comparing Anglers and Dark House Spearers

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Abstract

In order to project fishing effort and demand of individuals targeting Northern Pike *Esox lucius* in Minnesota, it is important to understand the catch orientations, management preferences, and site choice preferences of those individuals. Northern Pike are specifically targeted by about 35% of the approximately 1.5 million licensed anglers in Minnesota and by approximately 14,000–15,000 dark house spearers. Dark house spearing is a traditional method of harvesting fish through the ice in winter. Mail surveys were distributed to three research strata: anglers targeting Northern Pike, dark house spearing license holders spearing Northern Pike, and dark house spearing license holders angling for Northern Pike. Dark house spearers, whether spearing or angling, reported a stronger orientation toward keeping Northern Pike than did anglers. Anglers reported a stronger orientation toward catching large Northern Pike than did dark house spearers when spearing or angling. Northern Pike regulations were the most important attribute affecting site choice for respondents in all three strata. Models for all strata indicated a preference for lakes without protected slot limits. However, protected slot limits had a stronger negative influence on lake preference for dark house spearing licensees (whether spearing or angling) than for anglers.

The Northern Pike *Esox lucius* is the most widely distributed game fish in Minnesota; this species is targeted by about 35% of the approximately 1.5 million licensed anglers in the state and by 14,000–15,000 licensed dark house spearers (Schroeder and Moeckel 2011). During the 1980s, anglers and fisheries managers expressed concern about long-term declines in the size of Northern Pike in Minnesota; in response, the Minnesota Department of Natural Resources (MDNR) implemented a statewide bag limit of three fish, with only one Northern Pike over 30 in (76.2 cm) allowed (Pierce 2010). No other restrictions have been implemented statewide since that time, but in addition to the statewide regulations the MDNR has employed experimental and special regulations (e.g., protected slot limits) that are intended to improve size structure and the opportunity to catch large Northern Pike in at least some Minnesota waters (up to 125 of the 3,351 water bodies with Northern Pike populations; MDNR 2008). Northern Pike protected slot limit regulations have been controversial, particularly for individuals who participate in dark house spearing (Schroeder and Moeckel 2011; Smith 2011). The Northern Pike is the only game fish that is legal for spearing in Minnesota, although rough fish, including suckers and Lake Whitefish *Coregonus clupeaformis*, may also be taken (Anderson 2007). Spearers have argued that lakes with protected slot limits for Northern Pike effectively ban dark house spearing due to the possibility of taking illegal Northern Pike (i.e., accidentally

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spearing an individual that falls within the protected slot limit; Smith 2011).

Effective fisheries management considers a range of constituencies and accommodates fish harvest by a variety of methods (Pierce and Cook 2000; Margenau et al. 2003; Morgan 2006). However, the majority of research has focused on open-water anglers rather than on individuals who pursue fish through the ice or by methods other than hook and line (Morgan 2006). Dark house spearing is a traditional means of harvesting fish through the ice during winter (Pierce and Cook 2000). Spearers cut a large hole in the ice and suspend live bait or artificial decoys in the water to attract fish (Pierce and Cook 2000). Low light levels in the dark house enable the spearer to see into the water and spear the fish (Pierce and Cook 2000). Like hand fishing (Morgan 2006), the origins of dark house spearing can be traced to Native American fishing techniques (Pierce and Cook 2000). Similar to other traditional or "unorthodox" fishing techniques (Quinn 1993; Morgan 2006), dark house spearing has been controversial and is reported to be incompatible with other uses of fisheries resources (Pierce and Cook 2000). In particular, there have been conflicts between spearers and anglers over the harvest of large Northern Pike (Pierce and Cook 2000). Dark house spearing participation in Minnesota has declined from a peak of over 50,000 spearers in the 1950s to 14,000–15,000 spearers today (Pierce and Cook 2000; Anderson 2007; Smith 2011). The decline has been attributed to the fact that the tradition is not being adopted by younger generations (Pierce and Cook 2000).

Limited research has examined human dimensions related to dark house spearing (Schroeder and Moeckel 2011; Longmire 2012a, 2012b) or other niche fishing methods (Reitz and Travnicheck 2005; Baker 2009; Hunt and Hutt 2010). These studies have primarily examined conflicts over niche fishing methods rather than detailing the characteristics and attitudes of participants. Baker (2009), however, provided some insight into the catch orientations of hand "grabbers" who target catfish in Mississippi, finding that these individuals had stronger attitudes toward catching large fish, whereas rod-and-reel anglers had stronger attitudes toward catching greater numbers of fish. Participation in dark house spearing has been documented (Pierce and Cook 2000), but little is known about how spearers differ from anglers in terms of catch orientation, site choice, and management preferences.

Catch orientation includes attitudes about catching fish, the size and number of fish caught, and keeping or releasing fish (Anderson et al. 2007). Studies have demonstrated that catch-related attitudes are important to anglers and relate to satisfaction (Graefe and Fedler 1986; Fedler and Ditton 1994). Catch orientation is a multidimensional concept and has been operationalized to include four factors: (1) catching something, (2) catching many fish, (3) catching large fish, and (4) keeping (or releasing) fish (Fedler and Ditton 1986; Aas and Vittersø 2000; Sutton and Ditton 2001; Arlinghaus 2006; Anderson et al. 2007; Kyle et al. 2007; Hutt et al. 2013; Schroeder and Fulton 2013). A growing body of research supports the reliability and validity of these constructs (Aas and Vittersø 2000; Sutton and Ditton 2001; Anderson et al. 2007; Kyle et al. 2007; Hutt et al. 2013; Schroeder and Fulton 2013). Several studies have noted that situational factors or context (e.g., fishing method, species targeted, and location fished) may influence catch-related attitudes (Fedler and Ditton 1994; Sutton 2003; Beardmore et al. 2011; Schroeder and Fulton 2013). A recent study clarified differences in catch orientation among anglers pursuing different species of freshwater game fish (Schroeder and Fulton 2013). Catch orientation could also depend on the fishing technique employed, particularly for techniques (e.g., spearing or bow fishing) that do not permit catch-and-release fishing. We are unaware of any prior research that has compared catch orientation between groups fishing by different techniques.

Like catch orientation, site choice may also vary among groups that fish by different techniques. Site choice information is critical to fisheries managers who are trying to understand usage levels within a regional system (Hunt 2005; Hunt et al. 2007). A growing number of studies have applied stated choice methods for fisheries research, and several have specifically modeled site choice (Adamowicz et al. 1994; Aas and Vittersø 2000; Banzhaf et al. 2001; Oh et. al. 2005; Carlin et al. 2012). Results from several stated choice studies emphasize the importance of fishing regulations to angler site choice (Aas and Vittersø 2000; Oh et al. 2005; Carlin et al. 2012). Although management actions do not necessarily produce expected changes in angler effort and harvest (Johnston et al. 2011; Askey and Johnston 2013), different management scenarios may influence site choice (Oh et al. 2005; Carlin et al. 2012), and this might be strikingly different for Northern Pike anglers versus spearers.

Clarification of differences in catch orientation, site choice, and management preferences between Northern Pike anglers and dark house spearers may help managers to provide more-desirable fishing opportunities and to increase angler and spearer satisfaction. Recognizing the need to better quantify catch orientations, management preferences, and site choice between these subpopulations, we established three objectives for this study: (1) compare catch orientation and preferences between Northern Pike anglers and dark house spearers, (2) compare the importance of specific attributes (including travel cost [as measured by driving distance], Northern Pike population characteristics, and fishing regulations) for site choice by anglers and spearers, and (3) compare management preferences between Northern Pike anglers and spearers. Based on previous research, we established several hypotheses: (1) dark house spearers will report a stronger orientation toward keeping Northern Pike; (2) anglers will report a stronger orientation for large Northern Pike; (3) for both spearers and anglers, regulations will have a greater effect on site choice than driving distance or Northern Pike population characteristics; and (4) more-restrictive regulations for Northern Pike will have a greater negative effect on site choice for spearers than for anglers.

METHODS

Survey data.—The populations of interest included anglers and dark house spearers who targeted Northern Pike in Minnesota. We used the MDNR's Electronic Licensing System (ELS) as the sampling frame for the study, and we drew random samples of Minnesota resident anglers and dark house spearers from the ELS. The initial study samples included 4,000 resident anglers and 1,400 resident dark house spearers. The target sample sizes were 300 Northern Pike anglers responding to an angler survey, 300 dark house spearers responding to a spearing survey, and 300 dark house spearers responding to the angler survey (i.e., because a majority of dark house spearers also participate in angling for Northern Pike). Note that the target sample sizes reflect a compromise between reducing study expenses and reducing sampling error; the target sample size of 300 individuals for each stratum reflects a sampling error of ± 5.6–5.7% assuming a confidence level of 95%. Individuals that were drawn for the angler sample were prescreened for Northern Pike fishing prior to receiving a survey. The letter that was mailed to potential angler respondents asked individuals to return a postcard if they had "ever fished specifically for Northern Pike in Minnesota" (i.e., Northern Pike were their primary fishing objective, not incidental to targeting other types of fish) and if they were willing to complete a mail survey about Northern Pike angling and management.

We collected data using a mail-back survey via the process outlined by Dillman (2000) to enhance response rates. We constructed two relatively straightforward questionnaires, created personalized cover letters, and made multiple contacts with the targeted respondents. Potential survey respondents were contacted three times between August and November 2010. Response to a shortened (two-page) mail survey was used to gauge nonresponse bias.

Variables.—We designed 12-page, self-administered surveys with 11 pages of questions to collect data from each study stratum. We measured catch orientation with items that were derived from Graefe (1980) and that were used in subsequent research (e.g., Kyle et al. 2007; Carlin et al. 2012). Items specified catch orientation for Northern Pike, not for fishing in general. Items were adapted for spearing, particularly when addressing catch-and-release fishing (e.g., "I'm just as happy if I release a Northern Pike" became "I'm just as happy if I can watch a Northern Pike and don't spear it") and the catch of large Northern Pike (e.g., "I would rather catch 1 or 2 big Northern Pike than 10 smaller Northern Pike" became "I like to dark house spear where I know I have a chance to get a 'trophy' Northern Pike"). Respondents were asked to rate their agreement with each item on a five-point scale from strongly disagree to strongly agree.

Respondents reported how much they opposed or supported five possible Northern Pike management actions: (1) retaining the current statewide size limit of one Northern Pike over 30 in (76.2 cm); (2) reducing the statewide size limit to one Northern Pike over 24 in (61.0 cm); (3) a statewide 24–36-in (61.0–91.4-cm) protected slot limit on Northern Pike; (4) a special tag for harvesting a single Northern Pike over 36 in (91.4 cm) per year; and (5) a special tag for harvesting a single Northern Pike over 30 in per year. Response options ranged from 1 (strongly oppose) to 5 (strongly support). Respondents were asked how much they would like to see an increase or decrease in the use of three management strategies, which included the number of lakes (1) managed for large Northern Pike (30–36 in [76.2–91.4 cm]), (2) managed for trophy Northern Pike (40 in [101.6 cm] and larger), and (3) managed with a 24–36-in (61.0–91.4-cm) protected slot limit. Response options ranged from 1 (greatly decrease) to 5 (greatly increase). Respondents were also asked if they agreed or disagreed that a regulation limiting the harvest of larger Northern Pike (24–36 in) would increase the number of larger Northern Pike in a lake, with possible responses ranging from 1 (strongly disagree) to 5 (strongly agree).

Stated preference choice models present hypothetical scenarios to respondents so as to derive individuals' preferences for alternatives composed of multiple resource and management attributes (Adamowicz et al. 1994; Oh et al. 2005). The approach depends on the imperfect relationship between behavioral intention and behavior (Ajzen and Fishbein 1980), yet it allows the effects of all parameters of interest to be estimated independently. Individuals are assumed to be utility maximizers, and respondents' choices reflect the perceived utility of the alternatives presented (McFadden 1981). Respondent choices reflect the utilities (or part-worths) of attributes and attribute levels and are aggregated to estimate the utilities of attributes and attribute levels in a population (McFadden 1981). In our study, each respondent was presented with a series of 12 lake choice scenarios and was asked to select his or her preferred choice for each scenario (Figure 1). Respondents chose from among three options: Lake 1, Lake 2, and "If these were my only two choices, I would not go." Each of the two lake choices presented three characteristics of the lake: (1) Northern Pike population, (2) Northern Pike regulations, and (3) distance from the respondent's primary residence. Attributes and levels paralleled a Walleye *Sander vitreus* choice experiment conducted by Carlin et al. (2012). Levels were refined based on discussions with MDNR fisheries managers who were familiar with Northern Pike management in the state, and they reflect realistic site choices that might be encountered by individuals fishing in Minnesota. The nonregulatory attribute of distance from the primary residence was included, as has been done in other site choice experiments for recreational fishing (Oh et al. 2005; Carlin et al. 2012). Levels for choice attributes are summarized in Table 1.

Data analysis.—We conducted data analyses using SPSS versions 19.0 and 21.0, Lisrel version 8.80, and Sawtooth Software version 8.1.2. Statistical analyses included descriptive statistics, confirmatory factor analysis (CFA), ANOVA, and stated choice modeling.

We conducted CFA of catch orientation constructs in Lisrel version 8.80. For the catch orientation constructs, we used

	Lake 1	Lake 2	
Scenario 1. Which lake would you choose to fish at?	➢ Average northern pike population with most northern pike less than 30" ➢ Catch and release only for northern pike. ➢ 2 hours from your primary home to the lake.	➢ Abundant northern pike population with most northern pike less than 24" ➢ 3 northern pike bag limit with 30-40" slot limit. You must immediately release all fish in this range. You can keep only one northern pike over 40" ➢ Less than 30 minutes from your primary home to the lake.	If these were my only 2 choices I would not go
Check ONE box ▶	❑	❑	❑

FIGURE 1. Sample choice scenario of two Northern Pike lakes presented to survey recipients.

a four-factor structure identified a priori by Kyle et al. (2007) and others. For CFA results, we report factor loadings, composite reliability, and average variance extracted as measures of convergent, content, and discriminant validity, respectively (Diamantopoulos and Siguaw 2000; Tsaur and Liang 2008). A composite reliability value greater than 0.60 suggests acceptable content validity, and an average variance extracted value greater than 0.50 suggests acceptable discriminant validity (Diamantopoulos and Siguaw 2000). For model fit, we report the chi-square statistic, goodness-of-fit index (GFI) and normed fit index (NFI) measures, and root mean square error of approximation (RMSEA). For an acceptable model fit, the chi-square statistic should not be significant, and the GFI and NFI measures should exceed 0.90. For RMSEA, values less than 0.05 suggest a good model fit, values from 0.05 to less than 0.08 suggest a reasonable fit, values between 0.08 and 0.10 indicate a mediocre fit, and values greater than 0.10 indicate a poor fit (Diamantopoulos and Siguaw 2000; Raykov and Marcoulides 2006).

We compared research strata using chi-square analysis and ANOVA; Cramer's V (V) and eta (η) are reported as measured of effect size for chi-square and ANOVA, respectively. Based on the recommendations of Field (2009), for ANOVA we examined results of several post hoc tests, including (1) Hochberg's GT2 pairwise and range tests to identify homogeneous subsets of treatments (considering unequal sample sizes in treatment groups) and (2) the Games–Howell procedure to confirm the results of the Hochberg tests due to uncertainty about equivalent population variances. The Hochberg pairwise multiple comparison test uses a sample size based on the counts for the two groups being examined, whereas the range test uses the sample size based on the harmonic mean of all groups. Therefore, the pairwise multiple comparison uses a larger sample size, providing more statistical power to detect differences.

We conducted stated choice modeling in Sawtooth Software using hierarchical Bayes (HB) methods. Hierarchical Bayes estimation is robust in addressing the "independence from irrelevant

TABLE 1. Possible lake choice characteristics in the stated choice experiment used to assess catch orientation of Minnesota anglers and dark house spearers targeting Northern Pike (NOP).

Lake characteristic	Possible values
NOP population	Abundant NOP populations, with most NOP less than 24 in.
	Average NOP populations, with most NOP less than 30 in.
	Low NOP populations, with some NOP greater than 30 in.
NOP regulations	Catch and release only for NOP.
	Three-fish bag limit for NOP. You must release all NOP over 24 in. You can keep only fish under 24 in.
	Three-fish bag limit for NOP. You must release all NOP between 24 and 36 in. You can keep only one over 36 in.
	Three-fish bag limit for NOP. You must release all NOP between 30 and 40 in. You can keep only one over 40 in.
	Three-fish bag limit for NOP. You can keep only one over 30 in.
Distance from primary residence	Less than 30 min from your primary home to the lake.
	1 h from your primary home to the lake.
	2 h from your primary home to the lake.
	4 h from your primary home to the lake.

alternatives" assumption (Sawtooth Software 2013a). The HB analysis is regarded as a state-of-the-art method for estimating utilities from stated choice studies (Heinzle and Wüstenhagen 2012). Compared with classical methods, the HB approach can improve the reliability and predictive validity of models (Orme 2000) but provides similar results (Huber and Train 2001; Train 2001). We present average utilities of each attribute level of the HB model rescaled by a method called zero-centered diffs. This method rescales utilities so that the total sum of the utility differences between levels of each attribute across attributes is equal to the number of attributes times 100 (Sawtooth Software 2013b). We also present conjoint importances, which describe how much influence each attribute has on the decision. Finally, we used a market simulator to convert individual part-worths from HB estimation into simulated market choices and to compute shares of preference for competing lake choices. Share of preference can be defined as the percentage of respondents who would prefer one of the specified lakes. We applied a randomized first choice simulation method to estimate share of preference. A "maximum utility rule" predicts that respondents would choose the option with the highest composite utility. Randomized first choice simulations then estimate the choices of each participant by adding random error to the utility values at each of 100,000 iterations and averaging those predictions across iterations and respondents (see Huber et al. 2007 and Orme 2006 for more discussion of randomized first choice simulations). With regard to data quality, we used the average root likelihood (RLH) as a measure of fit to assess convergence of HB estimates. The RLH is the geometric mean of the predicted probabilities (Sawtooth Software 2013b). In this study, as each choice task presented three alternatives, each alternative would be selected with a predicted probability of 33.3% (corresponding RLH = 0.33); thus, RLH values larger than 0.33 reflect improvement over the chance level.

RESULTS

Respondent Characteristics

On average, respondents were 45–49 years of age, with individuals who purchased dark house spearing licenses being somewhat younger than anglers (Table 2). Individuals who purchased dark house spearing licenses reported a somewhat lower level of education, on average, than anglers ($F = 11.4$, $P < 0.001$, $\eta = 0.16$). About one-third of respondents from the fishing license stratum reported having completed a 4-year college degree or greater level of education, whereas just under 20% of respondents from the two dark house spearing strata reported having completed this level of education. On average, respondents from all strata had purchased a license during 9 of the previous 10 years, and nearly all had fished in Minnesota during the previous year. Individuals from the dark house spearing sample, however, were more avid fishing participants.

The nonresponse check suggested that nonrespondents were somewhat less-avid participants in spearing and angling than were respondents. Among respondents to the spearing survey, a greater proportion of late respondents had not fished (i.e., participated in spearing or angling) in Minnesota during the previous year compared with early respondents (5.2% versus 0.3%; $\chi^2 = 14.5$, $P < 0.001$). Late respondents to the spearing survey had fished fewer days in Minnesota during the previous 12 months than early respondents (49.3 d versus 56.7 d; $t = 2.5$, $P < 0.05$). Likewise, for the dark house spearers responding to the angling survey, a greater proportion of late respondents than early

TABLE 2. Background characteristics of the surveyed Minnesota Northern Pike (NOP) anglers and dark house spearers, Cramer's V (V) and eta (η) are used to report effect size.

	Anglers who received the NOP angling survey	Dark house spearers who received the NOP angling survey	Dark house spearers who received the NOP spearing survey
Average age[a]	49.2	45.3	45.6
Gender (% male)[b]	92.6	95.5	97.6
Average years living in Minnesota[c]	44.8	42.4	44.1
Average number of years among the past 10 years in which the respondent purchased a Minnesota fishing license[d]	9.1	9.3	9.4
Percentage of respondents who had fished in Minnesota during the previous 12 months[e]	97.0	99.1	99.7
Average number of days spent fishing during the previous 12 months[f]	37.5	46.2	56.7

[a] $F = 7.3$, $P = 0.001$, $\eta = 0.13$.
[b] $\chi^2 = 7.7$, $P = 0.021$, $V = 0.09$.
[c] $F = 2.1$ (not significant).
[d] $F = 2.1$ (not significant).
[e] $\chi^2 = 8.6$, $P = 0.013$, $V = 0.10$.
[f] $F = 14.0$, $P = 0.000$, $\eta = 0.17$.

respondents had not fished in Minnesota during the previous year (4.1% versus 0.9%; $\chi^2 = 8.2$, $P < 0.01$). Among angling survey respondents from the dark house spearing sample, late respondents had also fished fewer days in Minnesota during the previous 12 months than early respondents (31.4 d versus 46.3 d; $t = 6.3$, $P < 0.001$). However, for anglers (i.e., fishing license sample) responding to the angling survey, early and late respondents exhibited no significant difference in either the proportion who had fished in Minnesota during the previous year or the number of days fishing in the state during the previous year.

Catch Orientation

The CFA results indicated support for a four-factor structure of catch orientation for Northern Pike anglers, spearers when spearing Northern Pike, and spearers when angling for Northern Pike (Table 3). The model fit in each sample was reasonable. Results indicated evidence of configural invariance. However, because items that were used to measure catch orientation for dark house spearers were tailored to this user group and the item wording did not completely parallel the items that were used to measure angler catch orientation, it was not possible to adequately assess metric, scalar, and residual invariance. Results indicated acceptable content and discriminant validity, although measures of discriminant validity for catching something and catching many fish were low. There were significant differences in all four catch orientation constructs among Northern Pike anglers, spearers when spearing, and spearers when angling for Northern Pike. Differences were greater for orientations to catch many fish and to keep fish than for orientations to catch something or to catch big fish. Results indicated that individuals angling for Northern Pike (i.e., individuals from either the fishing license sample or the spearing license sample) had stronger orientations to catch many fish or to catch something. In support of our first two hypotheses, individuals from the spearing samples had stronger orientations toward keeping Northern Pike and weaker orientations toward catching large Northern Pike (when spearing or angling) relative to the orientations of Northern Pike anglers.

Site Choice

Results for the HB model (Table 4), including average utilities for each attribute level, indicated that all three research strata preferred average-size Northern Pike populations, no additional regulatory restrictions beyond a three-fish bag limit, and the shortest travel time from the primary residence. The relatively large RLH values of 0.68, 0.67, and 0.65 indicated good fit for all models. Attribute importances (Table 5) described the extent to which each attribute influenced lake choice. The importance of attributes in influencing a decision can be measured by comparing the difference between the highest and lowest part-worth utilities of its levels. In support of our third hypothesis, the most important attribute for all research strata was regulations, followed by driving distance and then the characteristics of the Northern Pike population at the lake. In support of our fourth hypothesis, regulations were relatively more important to the two strata that were drawn from dark house spearing licenses, whereas distance from home and characteristics of the Northern Pike population were relatively more important to individuals from the fishing license stratum.

Market simulation models were used to calculate shares of preference for defined sets of lakes with different attributes related to Northern Pike fishing (Table 6). Realistic market situations were demonstrated by calculating the share of preference for two hypothetical lakes or "staying home." In the scenarios shown, the population attribute was set at a constant level to isolate the effects of regulations and distance from home. The results demonstrated the relative strength of respondents' preferences for lakes without protected slot limits among the three research strata. Respondents from the dark house spearing license samples were more likely to choose a lake that lacked a protected slot limit for Northern Pike and was 1 or 2 h from home than to choose a lake that had a protected slot limit and was less than 30 min from home. Northern Pike anglers were more open to fishing the nearby lake with the protected slot limit: 50% of anglers indicated that they would choose a lake with a 24–36-in (61.0–91.4-cm) protected slot limit and situated less than 30 min from home, whereas 42% indicated that they would select a lake without a protected slot limit and located 2 h from home. When presented with (1) a lake having a 24–36-in protected slot limit and that was less than 30 min from home and (2) a lake without a slot limit and that was 4 h from home, over one-fourth of the respondents from the two dark house spearing strata would choose to stay home, while only about 12% of anglers from the fishing license stratum would choose to stay home.

Management Preferences

We found significant differences among research strata for each of the questions addressing management preferences (Table 7); respondents from the fishing license stratum reported more support for management strategies than did respondents from the two dark house spearing strata. Respondents from all three strata were supportive of retaining the current statewide limit of one Northern Pike over 30 in (76.2 cm). On average, none of the strata's respondents were supportive of more-restrictive regulations for Northern Pike, although anglers from the fishing license stratum were close to the neutral point, on average, for support of a statewide 24–36-in (61.0–91.4-cm) protected slot limit. Anglers from the fishing license stratum were also interested in seeing increases in the number of lakes managed for large (30–36-in [76.2–91.4-cm]) Northern Pike and trophy (≥40-in [≥101.6-cm]) Northern Pike, while respondents from the two spearing strata were near the neutral point.

DISCUSSION

Results indicated differences in catch orientation, lake choice, and management preferences between anglers and spearers targeting Northern Pike in Minnesota. In general, we found

TABLE 3. Confirmatory factor analyses (CFAs; based on Kyle et al. 2007) of items used to measure catch orientation of Minnesota anglers and dark house spearers targeting Northern Pike (NOP; CR = composite reliability; AVE = average variance extracted; Coef = standardized factor loading). Means with different letters are significantly different (Hochberg range test: $P < 0.05$).

	Angler CFA[a]				Spearer CFA[b]				Spearer when angling CFA[c]			
Factor (in bold) and item	Mean	CR	AVE	Coef	Mean	CR	AVE	Coef	Mean	CR	AVE	Coef
Catch many fish[d]	**3.14 z**	**0.58**	**0.42**		**2.60 y**	**0.68**	**0.52**		**3.12 z**	**0.64**	**0.49**	
The more NOP I catch/spear the happier I am.				0.55				0.64				0.59
A successful NOP fishing trip is one in which many NOP are caught./A successful dark house spearing trip is one in which more than one NOP is speared.				0.73				0.79				0.78
Catch something[e]	**2.71 z**	**0.61**	**0.35**		**2.54 y**	**0.57**	**0.40**		**2.83 z**	**0.69**	**0.44**	
A NOP fishing/spearing trip can be enjoyable even if no NOP are caught/speared.[f]				0.59				0.64				0.67
When I go NOP fishing/dark house spearing, I'm just as happy if I don't catch/spear NOP[f]				0.51				0.63				0.49
I must catch NOP for the NOP fishing trip to be enjoyable.				0.66								0.79
Catch big fish[g]	**3.57 z**	**0.89**	**0.80**		**3.22 y**	**0.74**	**0.62**		**3.30 y**	**0.90**	**0.82**	
I would rather catch 1 or 2 big NOP than 5 smaller NOP./I would rather spear 1 big NOP than 3 smaller NOP.				0.89				0.48				0.96
I would rather catch 1 or 2 big NOP than 10 smaller NOP./I like to dark house spear where I know I have a chance to get a "trophy" NOP.				0.90				1.00				0.85
Keep catch[h]	**1.79 y**	**0.72**	**0.56**		**2.32 z**	**0.62**	**0.45**		**2.23 z**	**0.71**	**0.55**	
I'm just as happy if I release the NOP I catch.[f]/I'm just as happy if I can watch a NOP and don't spear it.				0.82				0.60				0.63
I must keep/spear the NOP I catch for the trip to be successful.				0.67				0.73				0.84

[a]NOP anglers include Minnesota resident anglers that were prescreened for NOP angling ($\chi^2 = 40.73$, $P < 0.01$, df = 21; goodness-of-fit index [GFI] = 0.96; normed fit index [NFI] = 0.93; root mean square error of approximation [RMSEA] = 0.06).

[b]Spearers include Minnesota residents who purchased a dark house spearing license and received a NOP spearing survey ($\chi^2 = 35.07$, $P < 0.05$, df = 21; GFI = 0.97; NFI = 0.97; RMSEA = 0.04).

[c]Spearers when angling include Minnesota residents who purchased a dark house spearing license and received a NOP angling survey ($\chi^2 = 31.04$, $P < 0.01$, df = 15; GFI = 0.97; NFI = 0.97; RMSEA = 0.06).

[d]$F_{2, 817} = 30.59$, $P = 0.000$.

[e]$F_{2, 818} = 8.810$, $P = 0.000$.

[f]Item scores reversed in factor calculations.

[g]$F_{2, 817} = 7.622$, $P = 0.001$.

[h]$F_{2, 817} = 29.713$, $P = 0.000$.

TABLE 4. Results of the hierarchical Bayes model for survey respondents' lake choice for Northern Pike (NOP) fishing, showing the utilities of different lake attribute levels for Minnesota NOP anglers, dark house spearers when spearing, and dark house spearers when angling.

	Anglers[a]		Spearers[b]		Spearers when angling[c]	
Attribute (in bold) and level	Average utility	SD	Average utility	SD	Average utility	SD
NOP population						
Abundant NOP populations, with most NOP less than 24 in.	0.53	29.98	0.13	16.1	−1.51	21.17
Average NOP populations, with most NOP less than 30 in.	13.99	14.91	13.59	12.3	13.6	18.98
Low NOP populations, with some NOP greater than 30 in.	−14.52	33.71	−13.72	18.69	−12.1	27.11
NOP regulations						
Catch and release only for NOP.	−57.47	49.55	−76.35	28.84	−76.47	28.74
Three-fish bag limit for NOP. You must release all NOP over 24 in. You can keep only fish under 24 in.	−14.34	28.4	−36.42	23.69	−23.91	26.78
Three-fish bag limit for NOP. You must release all NOP between 24 and 36 in. You can keep only one over 36 in.	7.61	18.52	−3.47	25.18	1.37	23.48
Three-fish bag limit for NOP. You must release all NOP between 30 and 40 in. You can keep only one over 40 in.	26.18	28.31	34.11	16.94	31.23	24.23
Three-fish bag limit for NOP. You can keep only one over 30 in.	38.02	47.09	82.12	41.47	67.79	50.24
Distance from primary residence						
Less than 30 min from your primary home to the lake.	37.88	37.26	33.18	24.68	32.53	28.67
1 h from your primary home to the lake.	21.21	21.92	20.52	18.01	17.27	15.27
2 h from your primary home to the lake.	1.60	25.17	−1.99	18.41	2.84	19.01
4 h from your primary home to the lake.	−60.69	36.66	−51.71	30.55	−52.63	29.27

[a]NOP anglers include Minnesota resident anglers that were prescreened for NOP angling ($n = 250$).
[b]Spearers include Minnesota residents who purchased a dark house spearing license and received a NOP spearing survey ($n = 290$).
[c]Spearers when angling include Minnesota residents who purchased a dark house spearing license and received a NOP angling survey ($n = 291$).

support for our study hypotheses. In terms of catch orientation, we found that dark house spearers reported a stronger orientation to keep Northern Pike than did anglers. This finding held true for dark house spearers whether spearing or angling. We also found that anglers had a stronger orientation toward catching large Northern Pike relative to dark house spearers when spearing or spearers when angling. Regulations strongly affected site choice preferences, particularly for spearers.

Catch-related attitudes have been found to be related to the fish species targeted (Sutton 2003; Schroeder and Fulton 2013), and our results indicated that these attitudes may also be related to fishing method. Individuals participating in dark house

TABLE 5. Relative attribute importance (%) derived from hierarchical Bayes estimation of utilities for Northern Pike (NOP) anglers, dark house spearers when spearing, and dark house spearers when angling.

	Anglers[a]		Spearers[b]		Spearers when angling[c]	
Attribute	Importance	SD	Importance	SD	Importance	SD
NOP population[d]	19.8	12.4	12.5	8.3	15.3	12.2
NOP regulations[e]	42.4	19.6	55.7	15.7	52.8	18.4
Distance from primary residence[f]	37.8	18.8	31.8	13.3	31.9	14.4

[a] NOP anglers include Minnesota resident anglers that were prescreened for NOP angling.
[b] Spearers include Minnesota residents who purchased a dark house spearing license and received a NOP spearing survey.
[c] Spearers when angling include Minnesota residents who purchased a dark house spearing license and received a NOP angling survey.
[d] $F_{2, 828} = 29.4$, $P = 0.000$.
[e] $F_{2, 828} = 40.5$, $P = 0.000$.
[f] $F_{2, 828} = 13.1$, $P = 0.000$.

spearing reported weaker attitudes toward catching some or many Northern Pike than did anglers. The inability to release a speared fish may limit the orientation to catch many fish. However, differences in catch-related attitudes might not just be dictated by method-related constraints. Individuals who participated in dark house spearing held stronger orientations to keep fish and weaker orientations to catch large Northern Pike regardless of whether they were using rod and reel or spear, indicating that spearers are targeting Northern Pike as a food fish to a greater extent than other anglers do. About one-fourth of the Minnesota resident anglers who targeted Northern Pike reported releasing all of the legal Northern Pike they caught while angling, whereas only about 10% of dark house spearing participants reported releasing all legal Northern Pike when angling (Schroeder and Moeckel 2011). Previous studies have reported that anglers may be less oriented toward keeping fish of less-preferred species (Hunt et al. 2002; Sutton 2003; Schroeder and Fulton 2013). Northern Pike may be a less-preferred species for many Minnesota anglers but a more-preferred species among individuals who participate in dark house spearing.

In support of our hypothesis asserting that regulations would have a greater effect on site choice relative to driving distance and Northern Pike population characteristics, we found that regulations were the most important attribute affecting lake choice for both spearers and anglers. Similar to results from Carlin et al. (2012), who examined the effect of bag limits and protected slot limits on lake choice for Walleye angling in Minnesota, we found that fishing regulations had a strong effect on lake choice. Furthermore, like Carlin et al. (2012), we also found less resistance to a protected slot limit for larger fish, perhaps because larger fish are less likely to be encountered. Choice experiments depend on the fishery being studied and the attributes and attribute levels employed. Our study and the Carlin et al. (2012) study examined Minnesota anglers targeting specific species and included fish population, regulatory, and travel time attributes while excluding stocking and specific catch expectations. For other fisheries, studies employing variables such as specific catch expectations, stocking status, and permit price have found a limited influence of regulations on site choice (Askey et al. 2013; Beardmore et al. 2013). In a study of general anglers in a regional fishery in Germany, Beardmore et al. (2013) found fishing preferences to be driven mainly by permit cost and travel time. Askey et al. (2013) found that changes in the stocking status of Rainbow Trout *Oncorhynchus mykiss* exerted a primary influence on angler effort. If we had included specific costs of licenses and travel or the stocking status of the lake for the species targeted, we might have found regulations to have less of an influence on site choice.

Respondents from all three research strata reported reduced preferences for lakes with protected slot limits, but these regulations were an even more important factor in lake choice for dark house spearing participants. Previous research on anglers documented higher-than-expected noncompliance with protected slot limits for Northern Pike in Minnesota, which may reflect a lack of either knowledge or support for the limits (Pierce and Tomcko 1998). Although we found that both anglers and spearers disliked protected slot limits, individuals who participated in dark house spearing were particularly resistant to the limits. A substantial proportion of dark house spearers would opt to stay home if their only nearby lake choices had protected slot limits on Northern Pike.

Interestingly, preferences for Northern Pike management were similar among dark house spearing license buyers whether they were angling or spearing. Although a majority of dark house spearers also target Northern Pike with hook and line, their management preferences may be directed more by their interest in dark house spearing. Specifically, Northern Pike may be a more-preferred species among dark house spearers because Northern Pike stand out as the only game fish that is legal for spearing. Individuals who participate in dark house spearing have relatively less interest in management for large or trophy-sized Northern Pike in Minnesota and have relatively more interest in keeping the Northern Pike they catch. However, it is important to note that the decreased orientation toward catching large fish and the increased orientation toward keeping fish may not be present among other groups that fish by traditional methods. Baker (2009) found that hand "grabbers" in Mississippi were oriented more toward large catfish. Research on niche fisheries

TABLE 6. Shares of preference (95% confidence interval in parentheses) for hypothetical lake choices for Northern Pike (NOP) fishing as indicated by survey respondents (Minnesota NOP anglers, dark house spearers when spearing, and dark house spearers when angling).

Attribute (in bold) and stratum	Option 1	Option 2	Option 3
	Scenario 1		
NOP population	Average NOP population; most NOP < 30 in.	Average NOP population; most NOP < 30 in.	Neither (stay home)
NOP regulations	Three-NOP bag limit with 24–36-in slot limit. Immediately release all fish in this range. Keep only one NOP > 36 in.	Three-NOP bag limit with no slot limit. Keep only one NOP > 30 in.	
Distance from primary residence	<30 min	1 h	
Share of preference (%)			
Anglers[a]	42.1 (37.9–46.4)	51.0 (46.9–55.1)	6.9 (5.1–8.7)
Spearers[b]	15.3 (12.4–18.1)	73.5 (70.3–46.7)	11.2 (9.0–13.5)
Spearers when angling[c]	26.2 (22.4–30.1)	62.8 (58.9–66.7)	11.0 (8.6–13.3)
	Scenario 2		
NOP population	Average NOP population; most NOP < 30 in.	Average NOP population; most NOP < 30 in.	Neither (stay home)
NOP regulations	Three-NOP bag limit with 24–36-in slot limit. Immediately release all fish in this range. Keep only one NOP > 36 in.	Three-NOP bag limit with no slot limit. Keep only one NOP > 30 in.	
Distance from primary residence	<30 min	2 h	
Share of preference (%)			
Anglers	50.4 (45.6–55.1)	41.2 (36.6–45.8)	8.4 (6.3–10.6)
Spearers	24.1 (20.2–27.9)	56.4 (52.2–60.5)	19.6 (16.3–22.8)
Spearers when angling	31.6 (27.5–35.8)	54.1	14.7
	Scenario 3		
NOP population	Average NOP population; most NOP < 30 in.	Average NOP population; most NOP < 30 in.	Neither (stay home)
NOP regulations	Three-NOP bag limit with 24–36-in slot limit. Immediately release all fish in this range. Keep only one NOP > 36 in.	Three-NOP bag limit with no slot limit. Keep only one NOP > 30 in.	
Distance from primary residence	<30 min	4 h	
Share of preference (%)			
Anglers	64.7 (60.1–69.4)	23.6 (19.5–27.7)	11.7 (9.2–14.1)
Spearers	38.2 (33.6–42.7)	32.5 (28.4–36.6)	29.3 (25.5–33.1)
Spearers when angling	44.1	30.6	25.3

[a]NOP anglers include Minnesota resident anglers that were prescreened for NOP angling.
[b]Spearers include Minnesota residents who purchased a dark house spearing license and received a NOP spearing survey.
[c]Spearers when angling include Minnesota residents who purchased a dark house spearing license and received a NOP angling survey.

is very limited, and our results suggest the need to better understand unique user groups.

This study faced limitations that are common to survey research in general and to mail surveys in particular. Due to the nature of dark house spearing, there was some incompatibility between the questions used to address catch orientation for anglers and those used to examine catch orientation for spearers. In addition, the respondents in our study may not perfectly represent Minnesota resident anglers or dark house spearers who target Northern Pike. In particular, the use of a postcard to prescreen anglers likely narrowed the response, to some degree, to anglers who were interested in Northern Pike fishing and who were willing to respond to multiple mailings. Future research could clarify dark house spearers' experience

TABLE 7. Comparison of Northern Pike (NOP) management preferences among NOP anglers, dark house spearers when spearing, and dark house spearers when angling. Means with different letters are significantly different (Hochberg range test: $P < 0.05$). An asterisk indicates $P = 0.000$; eta (η) is used to report effect size.

Regulation	Mean			F	η
	Anglers[a]	Spearers[b]	Spearers when angling[c]		
Management should retain the current statewide limit of one NOP over 30 in.[d]	3.9 y	3.6 z	3.6 z	7.8*	0.14
Management should reduce the statewide limit to one NOP over 24 in.[d]	2.5 y	1.8 z	1.9 z	25.3*	0.25
Management should enact a statewide 24–36-in protected slot limit for NOP.[d]	2.9 y	1.8 z	1.8 z	77.2*	0.40
Management should introduce a special tag or endorsement allowing harvest of a single NOP over 36 in per year.[d]	2.6 y	1.9 z	1.9 z	31.9*	0.27
Management should introduce a special tag or endorsement allowing harvest of a single NOP over 30 in per year.[d]	2.2 y	1.6 z	1.7 z	29.1*	0.26
The number of Minnesota lakes managed for large (30–36-in) NOP.[e]	3.6 y	3.1 z	3.1 z	26.4*	0.25
The number of Minnesota lakes managed with a 24–36-in slot limit for NOP.[e]	3.2 y	2.5 z	2.5 z	44.2*	0.31
The number of Minnesota lakes managed for trophy (40-in and larger) NOP.[e]	3.7 y	3.0 z	3.0 z	35.4*	0.28
A regulation that limits harvest of larger NOP (24–36 in) will increase the number of larger NOP in a lake.[f]	3.7 y	3.1 z	3.1 z	26.8*	0.25

[a]NOP anglers include Minnesota resident anglers that were prescreened for NOP angling.

[b]Spearers include Minnesota residents who purchased a dark house spearing license and received a NOP spearing survey.

[c]Spearers when angling include Minnesota residents who purchased a dark house spearing license and received a NOP angling survey.

[d]Means are based on the following scale: 1 = strongly oppose, 2 = oppose, 3 = neutral, 4 = support, 5 = strongly support.

[e]Questions asked, "How much would you like to see the use of the following management strategies increase or decrease?" Means are based on the following scale: 1 = greatly decrease, 2 = decrease, 3 = neutral, 4 = increase, 5 = greatly increase.

[f]Means are based on the following scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

preferences and motivations for targeting other fish species. Future research could also examine and compare catch orientation for individuals using other unique methods to catch fish (e.g., ice fishing, hand fishing, or netting). This study underscores the need to clarify differences among subpopulations of individuals that use different methods to catch fish.

Conclusions, Management Implications, and Future Research

Our results provide additional insight into previous observations of anglers' catch-related attitudes and clarify distinctions among subpopulations of individuals targeting Northern Pike. The four-factor structure of catch orientation that has been established in previous studies (i.e., catching many fish, catching some fish, catching big fish, and catching and keeping fish) was supported for individuals targeting Northern Pike by dark house spearing. We also clarified differences in catch orientation between dark house spearers and anglers. Specifically, we found that dark house spearers, who had a stronger orientation to keep Northern Pike, had reduced support for protected slot limits relative to anglers, who had a weaker orientation to keep Northern Pike. A growing body of research indicates that a stronger

orientation to keep fish is negatively related to support for more-restrictive management actions for fishing in Minnesota (Carlin et al. 2012; Schroeder and Fulton 2013). Similarly, European Eel *Anguilla anguilla* anglers in Germany with strong catch orientations tended to be less supportive of conservation-oriented regulations (Dorow et al. 2010), and catch-oriented catfish anglers in Texas were less supportive of restrictive regulations (Wilde and Ditton 1999). Anglers' catch orientations might present a management challenge when restrictions are necessary to protect a fishery, especially if the anglers do not perceive themselves as having an impact on fish populations (Dorow et al. 2010).

Results from this study underscore the challenge of managing fisheries to meet conservation and fisheries objectives and to optimize satisfaction for different users. Fish life history type, fishing behavior, and regulatory options interact to affect sustainable management of fish populations (Johnston et al. 2013). Optimal management of Northern Pike in North America is particularly challenging given the range of ecological conditions and the diversity of angling preferences (Paukert et al. 2001). In Minnesota, special regulations have been enacted to increase the size structure of Northern Pike in some waters. In 2008, of the total 2.17 million acres of Minnesota water bodies with Northern Pike populations, 106 water bodies comprising 675,111 acres (29.5% of the total surface area) were managed by use of experimental or special regulations intended to improve the opportunity to catch large Northern Pike (MDNR 2008).

Across Minnesota lakes, Pierce's (2010) long-term evaluation of experimental Northern Pike regulations indicated that both maximum length and protected slot regulations (but not a minimum length of 30 in [76.2 cm]) produced significant increases in the size structure of Northern Pike. These results were obtained in comparison with reference lakes subject to the statewide regulation that allowed the harvest of three Northern Pike, with one Northern Pike over 30 in. Maximum length regulations provided the clearest improvement in Minnesota's moderate-sized lakes, but a protected slot of 24–36 in (61.0–91.4 cm) also generally increased the size structure of Northern Pike populations. A protected slot of 30–40 in (76.2–101.6 cm) was effective at preventing a decline of fish in that size range but could cause a shift in harvest onto fish larger than 40 in (101.6 cm). Pierce (2010) noted, however, that the wide range of ecological settings in the state and the variance in natural recruitment necessitated the application of varied regulations statewide. Based largely on the results of long-term experiments, the MDNR developed a suite of special "toolbox" regulations that could be used on a limited number of lakes (up to 125) that match specific ecological criteria (MDNR 2008). The number of lakes was later reduced to 100 (MDNR 2011).

These special regulations include a 40-in (101.6-cm) minimum regulation and 24–36-in (61.0–91.4-cm) protected slot limit, primarily for lakes in the central and northern tiers of Minnesota (MDNR 2008). The 40-in minimum regulation is analogous to the 30–40-in (76.2–101.6-cm) protected slot regulation evaluated in our study and in the study by Pierce (2010). Within Minnesota, this regulation is directed at lakes with good-quality Northern Pike populations that could benefit from protection. In general, such lakes have low densities of Northern Pike with fast growth rates and have the potential to produce very large Northern Pike. This regulation would protect Northern Pike from harvest until they are over 40 in or trophy size. These lakes are often large, deep lakes that have limited spawning and nursery habitat but contain coolwater refugia. The 24–36-in protected slot limit targets lakes with moderate to high rates of reproductive success, with the objective of providing opportunity to harvest small Northern Pike while improving the densities of medium- to large-sized fish. Targeted lakes tend to have large areas of Northern Pike spawning and nursery habitat and slower Northern Pike growth rates than lakes that contain low Northern Pike densities.

At the statewide level, the results of our study support continued application of the current statewide Northern Pike regulation of three fish with one fish over 30 in (76.2 cm) for both anglers and spearers. Lake choice results indicated that the current statewide regulations provided the highest utility to both anglers and spearers, and most anglers and spearers supported maintaining the regulation at a statewide level. These regulations will not increase the size structure of Northern Pike populations statewide, but most anglers and spearers preferred choices involving an average Northern Pike population containing mostly individuals less than 30 in over choices involving a smaller Northern Pike population containing some individuals greater than 30 in.

Some anglers and spearers do want an opportunity to fish for larger Northern Pike. Unfortunately, the regulation considered in our study that is most likely to increase the size structure of the Northern Pike population—a maximum length of 24 in (61.0 cm)—had the lowest utility, especially for spearers. A protected slot of 24–36 in (61.0–91.4 cm) would also likely increase Northern Pike size structures in many lakes, but this regulation had lower utility than a protected slot of 30–40 in (76.2–101.6 cm). Although the protected slot of 30–40 in could maintain the number of Northern Pike in that size range if they already existed in a population, this regulation is not biologically appropriate in many Minnesota waters that do not already have relatively high numbers of large Northern Pike. Results of our study provide support for the current strategies in place for special regulations that are intended to increase the size structure of Northern Pike populations (MDNR 2008). Application of such special regulations is limited to about 30% of the surface area with Northern Pike populations (up to 100 lakes). In the relatively few lakes where it is biologically suitable, the 40-in (101.6-cm) minimum size limit would be preferable for both anglers and spearers. Application of the 24–36-in protected slot limit in select other lakes with appropriate ecological conditions will likely meet the angler demand for enhanced opportunities to fish for quality Northern Pike in Minnesota. As was noted by Pierce (2010), communication about expectations

concerning enhanced Northern Pike quality is essential because improvement in size structure of Northern Pike populations takes a relatively long time, likely measured in decades rather than in a fishing season or two. Implementation of either strategy may also be challenged by users' lack of knowledge of the connection between regulations and fish population characteristics and by the need for effective education and communication to ensure awareness of and compliance with complex regulations (Pierce and Tomcko 1998).

Future research could focus on obtaining a better understanding of the effect of catch orientation on angler support for restrictive regulations. We found some support for protected slot limits among Northern Pike anglers in our study, and prior research has suggested that Northern Pike anglers who place greater importance on catching large fish are more supportive of restrictive regulations (Schroeder and Fulton 2013); however, our results indicate that people generally still prefer to fish at lakes without protective slot limits. Further research is needed to clarify anglers' knowledge of how protected slot limits can influence fish population characteristics in a lake. We also evaluated a limited set of Northern Pike regulations within the choice experiment; the experiment only included regulations that had been previously evaluated in long-term field experiments or that were statewide Minnesota regulations. For example, we did not assess the utility of harvest slot limits, which have demonstrated value for achieving conservation objectives (e.g., maintaining natural age structure or spawning stock) and recreational fisheries objectives (e.g., maximizing yield or harvest numbers or increasing the production of trophy fish; Arlinghaus et al. 2010; Matsumura et al. 2011). Future human dimensions research could directly examine harvest slot limits versus protected slot limits for Minnesota Northern Pike fishing in terms of management effectiveness and user support, while ecological research could use modeling approaches or long-term field experiments to assess the effectiveness of harvest slot versus protected slot regulations for increasing the size structure of Northern Pike in Minnesota lakes. Of course, the preferences and behaviors of anglers and spearers and the population sizes of Northern Pike are dynamic rather than static, and management effectiveness will likely be increased by assessing each over the long term as a linked social–ecological system (Hunt et al. 2013).

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