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Self-imposed length limits in recreational fisheries

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ABSTRACT

A primary motivating factor on the decision to harvest a fish among consumptive-orientated anglers is the size of the fish. There is likely a cost-benefit trade-off for harvest of individual fish that is size and species dependent, which should produce a logistic-type response of fish fate (release or harvest) as a function of fish size and species. We define the self-imposed length limit as the length at which a captured fish had a 50% probability of being harvested, which was selected because it marks the length of the fish where the probability of harvest becomes greater than the probability of release. We assessed the influences of fish size, catch per unit effort, size distribution of caught fish, and creel limit on the self-imposed length limits for bluegill *Lepomis macrochirus*, channel catfish *Ictalurus punctatus*, black crappie *Pomoxis nigromaculatus* and white crappie *Pomoxis annularis* combined, white bass *Morone chrysops*, and yellow perch *Perca flavescens* at six lakes in Nebraska, USA. As we predicted, the probability of harvest increased with increasing size for all species harvested, which supported the concept of a size-dependent trade-off in costs and benefits of harvesting individual fish. It was also clear that probability of harvest was not simply defined by fish length, but rather was likely influenced to various degrees by interactions between species, catch rate, size distribution, creel-limit regulation and fish size. A greater understanding of harvest decisions within the context of perceived likelihood that a creel limit will be realized by a given angler party, which is a function of fish availability, harvest regulation and angler skill and orientation, is needed to predict the influence that anglers have on fish communities and to allow managers to sustainable manage exploited fish populations in recreational fisheries.

1. Introduction

Recreational harvest is an integral component of most inland fisheries in North America, Europe, and Australia that affects population viability, community interactions, and fishery quality (Isermann and Paukert, 2010; Post, 2013). As such, regulating the harvest of fish by anglers is a common practice within fishery management. A creel or bag limit – the number of fish that can be harvested per fishing day – is the most common type of regulation for recreational angling (Isermann and Paukert, 2010), and most regulating agencies prohibit "culling" or "high grading" (i.e., the act of releasing a fish that has been retained on a stringer, in a bucket, or in a livewell so that a more desirable, often larger, fish may be retained) of fish (Isermann and Paukert, 2010). Thus, an immediate decision must be made at capture on whether to harvest or release a fish that is protected with only a creel limit, and this decision process is repeated with the capture of each subsequent fish. Anglers elect to harvest select species and sizes of captured fish for personal, practical, economic, and regulatory reasons, and the decision of an angler to harvest a captured fish is likely influenced by previous and current angling catch rates, previous and current angling effort, current motivating factors for participating in recreational angling, and current social normative pressures (Hunt et al., 2002; Beardmore et al., 2011). Therefore, the decision to harvest or release a captured fish is likely to depend on the attitudes and characteristics of the angler and is influenced by regulations, species, and size of fish.

There are many factors affecting the decision to harvest fish (Hunt et al., 2002), but the size of a fish is an important motivating factor (Fisher, 1997). The satisfaction gained from harvesting a fish is likely to increase with fish size for most inland freshwater fishes because one potential benefit of harvesting the fish, amount of meat gained, is related to fish size (Willis and Van Zee, 1997; Rutten et al., 2004), whereas one potential cost of harvesting the fish, effort and

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time required to process the harvested fish, is likely only marginally related to fish size. Therefore, the size of fish where the benefit of harvest begins to exceed the cost of harvest likely creates a self-imposed size (length) limit below which an angler releases all or nearly all captured fish even when no formal size limit has been enacted (Stewart and Ferrell, 2003). Although the size of the fish may set a baseline around which decisions are based, other factors may interact with size in the decision to harvest. For example, Näslund et al. (2010) showed that the probability of retaining an individual fish increased with fish size and the enactment of minimum size limits. Further, over time the size at 50% probability of harvest increased with time post regulation change for grayling *Thymallus thymallus* L. in the River Ammerån, Sweden.

Anglers often use regulatory creel limits as a basis to measure their skill or assess the condition of a fishery (Snow, 1982; Noble and Jones, 1993) and the restrictiveness of a regulation can affect angler satisfaction (Cook et al., 2001) and behavior (Beard et al., 2003). Though anglers are more satisfied with more attainable creel limits (Cook et al., 2001), the effect of a creel limit on the size of fish harvested and its interplay with the satisfaction of harvest is unknown. Given an assumption of constant catch rates, we hypothesize that a consumptive-orientated angler would be less selective in the size of the fish harvested from a waterbody with a liberal creel limit, particularly a creel limit that is rarely attained by the angler, because quantity of the fish harvested (i.e., maximization of biomass) likely outweighs the quality of any individual fish harvested. Likewise, we hypothesize that an angler would be more selective in the size of fish harvested from a waterbody with a restrictive creel limit, particularly a creel limit that is frequently attained by the angler, because quality of any individual fish harvested likely outweighs the quantity of the fish harvested. If this hypothesis is correct, then the self-imposed size limits across anglers would encompass a greater size range for waterbodies regulated with a liberal creel limit compared to waterbodies regulated with a restrictive creel limit.

In an effort to simplify regulations, the Nebraska Game and Parks Commission reduced the daily creel limit for channel catfish *Ictalurus punctatus* from 10 to 5 and a reduced the daily creel limit for panfish (includes lepomids, pomoxids, and yellow perch *Perca flavescens*) from 30 to 15, effective 1 January 2011. There was no change in the daily creel limit for temperate bass, which was set at 15; thus, white bass *Morone chrysops* was included as a control for this assessment. These changes in creel limits toward more restrictive creel limits offered us the opportunity to assess the effect of creel limits on the size of the fish harvested. These fishes were not regulated with length limits in the reservoirs assessed. The objective of this study was to determine what influence, if any, these more restrictive creel limits had on the anglers' effective (i.e., self-imposed) length limits for these fishes in reservoirs throughout Nebraska.

2. Materials and methods

Anglers were interviewed during 2010 and 2011 to document angler participation patterns, fishing pressure, catch and harvest at reservoirs across Nebraska. Interviews took place at Enders Reservoir, Harlan County Lake, Medicine Creek Reservoir, Merritt Reservoir, Red Willow Reservoir, Swanson Reservoir, and Sherman Reservoir between 1 April and 31 October. One angler, the representative of the party, completed the survey per interview; thus, all data were collected at the party (i.e., a group of individuals travelling together for the purpose of fishing) level. Though anglers with complete and incomplete trips were interviewed, only completed trips were used in this study. A stratified multi-stage probability sampling regime (Malvestuto, 1996) was used to determine days of interviews. Totals of 10 or 20 days were surveyed per month at each reservoir as determined by logistical constraints. Surveys were stratified by day-type with 6 weekdays and 4 weekend and holiday days per month or 14 weekdays and 6 weekend and holiday days per month. Each creel day was further stratified into two survey periods (sunrise to 1330 [morning] and 1330 to sunset [afternoon]). During the interview process, harvested fish were measured by creel clerks and lengths of released fish were recorded as specified by the angler.

Data were combined across reservoirs for analyses. To maintain species-specific estimates of size at harvest, we excluded any party that harvested multiple species subjected to one regulation, except for black crappie *Pomoxis nigromaculatus* and white crappie *Pomoxis annularis*, which were considered a single group. For example, an angler party that harvested bluegill *Lepomis macrochirus* and yellow perch, species both regulated under the panfish creel limit, was excluded from all analyses. Thus, interpretations provided herein are based on the premise that creel limits were species specific rather than aggregate. Mixed-effects logistic regression (Venables and Dichmont, 2004) was used for each species to predict whether a captured fish was harvested given its length, year in which it was captured (2010 = pre-creel restriction; 2011 = post-creel restriction), catch per unit effort (CPUE), and the length × year interaction using the *lme4* package (Bates et al., 2013) in R (R Development Core Team, 2012). In this analysis, we treated reservoir as a random effect, and length, year, CPUE, and the length × year interaction as fixed effects. The CPUE was calculated as the number of fish caught per angler per hour for each party. The predicted probabilities of harvest and 95% confidence intervals were calculated across species-specific size ranges (i.e., sizes of fish caught by anglers) using the coefficient values and standard errors from fixed effects. A mean CPUE across the two years for each species was used to standardize the predictions across the two years. We define the self-imposed length limit as the length at which a captured fish had a 50% probability of being harvested, which was selected because it marks the length of the fish where the probability of harvest becomes greater than the probability of release. Proportional size distributions (PSDs; Guy et al., 2007) for fishes caught (harvested plus released) by anglers were calculated for each species during each year according to lengths specified by Anderson and Nuemann (1996) and 95% confidence intervals were calculated following Gustafson (1988). Chi-square analysis was used to assess differences in proportions of parties harvesting their creel limit between years as well as differences in PSDs between years. We set our level of significance at $\alpha = 0.05$.

3. Results

Data for this study came from 1584 interviews that comprised 3085 anglers during 2010 and 2011. Length and fate (harvested or released) information was collected on 1007 bluegill (total-length range = 8.0–34.0 cm), 3462 channel catfish (8.0–99.0 cm), 4025 crappie (8.0–41.0 cm), 10387 white bass (4.9–48.0 cm), and 1390 yellow perch (8.0–35.5 cm) (Table 1). The mean ± SE CPUE for bluegill (2010: 0.12 ± 0.02; 2011: 0.05 ± 0.01) and channel catfish (2010: 0.14 ± 0.01; 2011: 0.12 ± 0.01) decreased from 2010 to 2011, whereas mean CPUE for crappie (2010: 0.23 ± 0.08; 2011: 0.55 ± 0.06) and white bass (2010: 0.31 ± 0.06; 2011: 0.54 ± 0.04) increased from 2010 to 2011, and mean CPUE for yellow perch (2010: 0.10 ± 0.02; 2011: 0.09 ± 0.01) remained consistent from 2010 to 2011.

There was no significant change in the percentage of parties that caught their limit of bluegill ($\chi^2 = 0.12$, df = 1, $P = 0.72$), white bass ($\chi^2 = 0.48$, df = 1, $P = 0.49$), channel catfish ($\chi^2 = 2.25$, df = 1, $P = 0.13$), or yellow perch ($\chi^2 = 2.07$, df = 1, $P = 0.15$), whereas the

Table 1
Sample sizes for each species used in the analysis of fish fate during 2010 and 2011 in six reservoirs throughout Nebraska.

Species	Fate	2010	2011
Bluegill	Released	474	274
	Harvested	140	119
Channel catfish	Released	691	929
	Harvested	844	998
Crappie	Released	445	1645
	Harvested	215	1720
White bass	Released	879	3674
	Harvested	1449	4385
Yellow perch	Released	445	788
	Harvested	38	119

Crappie is black crappie and white crappie combined.

percentage of parties that caught their limit of crappie (χ^2 = 9.78, df = 1, P = 0.002) increased from 0.91% in 2010 to 12.55% in 2011. There was no change in the percentage of parties that harvested their limit of bluegill (χ^2 = 0.02, df = 1, P = 0.89), channel catfish (χ^2 = 1.07, df = 1, P = 0.30), yellow perch (χ^2 test could not be calculated because no party harvested their limit in either year) or white bass (χ^2 = 0.00, df = 1, P = 1.00) between 2010 and 2011, whereas the percentage of parties that harvested their limit of crappie (χ^2 = 4.05, df = 1, P = 0.04) increased from 0.0% during 2010 to 9.8% during 2011 (Table 2).

There were significant relationships between the length of a fish and the probability of harvest for all species assessed with the probability of harvest increasing with fish length (Fig. 1, Table 3). The length range that encompassed 20% probability of harvest to 80% probability of harvest for bluegill was 18–24 cm during 2010 (50% = 21 cm) and 17–21 cm during 2011 (50% = 19 cm), for channel catfish was 28–61 cm during 2010 (50% = 44 cm) and 34–53 cm during 2011 (50% = 43 cm), for crappie was 21–28 cm during 2010 (50% = 24 cm) and 22–25 cm during 2011 (50% = 23 cm), for white bass was 23–32 cm during 2010 (50% = 27 cm) and 24–30 cm during 2011 (50% = 27 cm), and for yellow perch was 28–37 cm during 2010 (50% = 33 cm) and 21–27 cm during 2011 (50% = 24 cm). There was also a differential response of CPUE on the probability of harvest (Table 3). Probability that a given length bluegill was harvested was greater for angler parties with higher CPUE for bluegill, whereas probability that a given length channel catfish or yellow perch was harvested was lessor for angler parties with higher CPUE for channel catfish or yellow perch, respectively. White bass CPUE was not significantly related to the probability of harvest. There was also evidence that the size distributions of caught fishes shifted between 2010 and 2011. Stock-length bluegill and crappie caught by anglers comprised smaller proportions of quality-length bluegill and crappie during 2010 than during 2011, whereas stock-length channel catfish, white bass, and yellow perch caught by anglers comprised larger proportions of quality-length channel catfish, white bass, and yellow perch during 2010 than during 2011 (Table 4).

Table 3
Results of mixed-effects logistic regression for total length (cm) of fish as a function of fate (released or harvested) that was determined by Nebraska anglers.

Species	Coefficient	Estimate	SE	z value	Prob > |z|
Bluegill	Intercept	−10.27	1.10	−9.32	<0.001
	Length	0.47	0.05	10.20	<0.001
	Year	−6.01	1.76	−3.41	<0.001
	CPUE	0.23	0.06	3.70	<0.001
	Length × Year	0.38	0.10	3.78	<0.001
Channel catfish	Intercept	−3.59	0.54	−6.63	<0.001
	Length	0.08	0.01	15.03	<0.001
	Year	−2.53	0.39	−6.57	<0.001
	CPUE	−0.15	0.07	−2.07	0.038
	Length × Year	0.06	0.01	6.77	<0.001
Crappie	Intercept	−10.31	0.95	−10.81	<0.001
	Length	0.42	0.03	15.24	<0.001
	Year	−8.94	0.91	−9.85	<0.001
	CPUE	0.04	0.02	2.44	0.015
	Length × Year	0.40	0.04	10.71	<0.001
White bass	Intercept	−8.46	0.70	−12.15	<0.001
	Length	0.31	0.01	24.40	<0.001
	Year	−4.71	0.48	−9.81	<0.001
	CPUE	−0.01	0.02	−0.33	0.744
	Length × Year	0.18	0.02	10.03	<0.001
Yellow perch	Intercept	−9.85	1.28	−7.72	<0.001
	Length	0.34	0.04	7.54	<0.001
	Year	−0.17	1.26	−0.14	0.890
	CPUE	−0.87	0.12	−7.50	<0.001
	Length × Year	0.13	0.06	2.13	0.033

Crappie is black crappie and white crappie combined. CPUE is the catch per unit effort (number of fish caught per angler per hour) of the interviewed party. Reservoir was included as a random effect in all models and fixed effects are shown below.

Table 4
The 95% confidence interval of the proportional size distributions (PSD) caught for a given species and the associated chi-square test of the number of quality-length fish to stock-length fish during 2010 and 2011 in six reservoirs throughout Nebraska.

Species	PSD		χ^2	P
	2010	2011		
Bluegill	67–71	78–86	26.01	<0.001
Channel catfish	68–72	48–53	134.90	<0.001
Crappie	64–72	75–78	19.54	<0.001
White bass	83–86	78–79	39.21	<0.001
Yellow perch	31–43	14–20	49.91	<0.001

Crappie is black crappie and white crappie combined. Degrees of freedom for all chi-square tests was 1.

4. Discussion

The behavior of anglers is affected by their motivations (i.e., desired outcomes) and satisfactions (i.e., fulfillment of those outcomes) (Holland and Ditton, 1992; Arlinghaus, 2006a). Self-imposed length limits were evident for bluegill, channel catfish,

Table 2
Number of angler parties that caught and harvested the maximum number of individuals allowed (i.e., creel limit) for a given species (represented as number of parties catching limit/total parties that caught the species).

Species	2010			2011		
	Angler parties catching limit	Angler parties harvesting limit	HPUE	Angler parties catching limit	Angler parties harvesting limit	HPUE
Bluegill	1/132	0/29	0.05 ± 0.02	2/87	1/21	0.03 ± 0.01
Channel catfish	4/188	0/103	0.16 ± 0.02	18/332	4/169	0.10 ± 0.01
Crappie	1/110	0/56	0.12 ± 0.04	33/263	16/163	0.49 ± 0.06
White bass	7/191	1/81	0.26 ± 0.07	29/542	2/261	0.38 ± 0.03
Yellow perch	0/139	0/26	0.01 ± 0.00	5/191	0/47	0.03 ± 0.01

Total number of parties that harvested at least one individual for a given species, and the mean ± SE number of fish harvested per angler per hour of fishing (HPUE) for a given species during 2010 and 2011 in six reservoirs throughout Nebraska. Crappie is black crappie and white crappie combined.

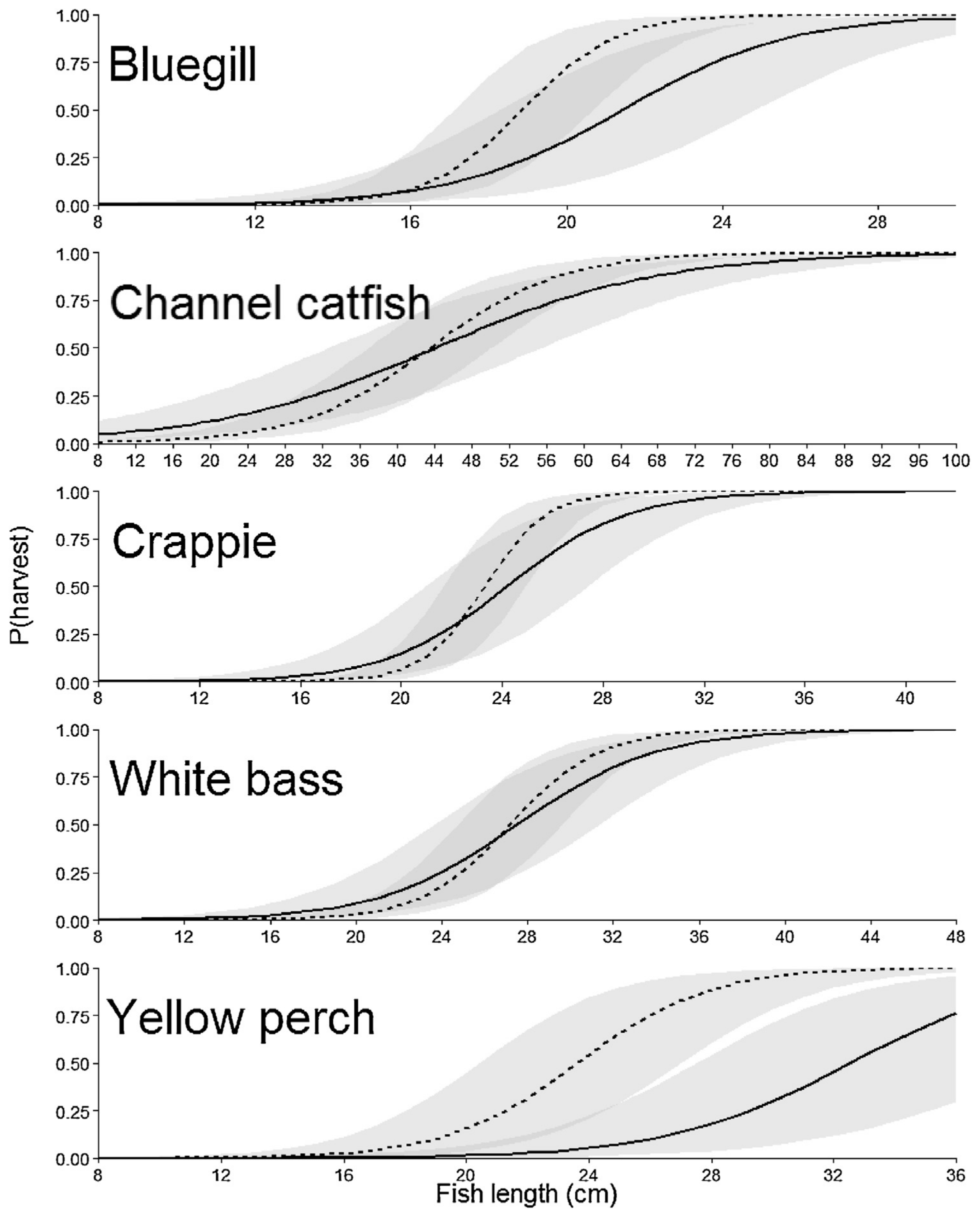

Fig. 1. Predicted probabilities (lines) with 95% confidence intervals (gray ribbons) that bluegill, channel catfish, crappie (black crappie and white crappie combined), white bass, and yellow perch captured by anglers were harvested during 2010 (solid lines) and 2011 (dashed lines) in six reservoirs throughout Nebraska.

crappie, white bass, and yellow perch. The self-imposed length limits corresponded to sizes observed in other studies that assessed sizes of harvested fish (e.g., Colvin, 2002; Paukert et al., 2002; Isermann et al., 2005; Holley et al., 2009). For example, Isermann et al. (2005) found that the mean minimum length of yellow perch harvested by anglers ranged from 21 to 26 cm, depending on the South Dakota lake assessed. In our assessment, the self-imposed length limit ranged from 24 to 33 cm, depending on the year assessed. Anderson (1980) defined quality length as the size of fish that most anglers like to catch. Perhaps not surprising, the self-imposed length limits fell within the quality- to preferred-length category (Anderson, 1980; Gabelhouse, 1984) for the fishes assessed in both years, except the self-imposed length limit for yellow perch during 2010 fell within the memorable- to trophy-length category (Gabelhouse, 1984). Weithman and Anderson (1978) developed the minimum length for the quality-length category from the relationship between world-record length and fish quality, and related the minimum to a length that is 36–41% of the species-specific world-record length. Even though fish harvest is an important part of the fishing experience for most anglers (Matlock et al., 1988; Peyton and Gigliotti, 1989; Spencer, 1989), the actualized minimum length of a quality-length fish likely differs between catch-and-release-orientated anglers and harvest-orientated anglers (Wilde and Ditton, 1994; Arlinghaus, 2006b; Anderson et al., 2007)

The decision to harvest any given fish depends on the dynamic relationship of an anglers' expectation, or perceptions, of what can be potentially caught in the waterbody within the confines of the harvest regulation (Cook et al., 2001; Hunt et al., 2002; Anderson et al., 2007). In our study, we were unable to conclude that the restriction of the harvest regulation altered the self-imposed length limits across the species assessed. As expected there was no change in the self-imposed length limit of white bass, which was included as a control species (i.e., creel limit did not change). However, the same was true for channel catfish for which the daily limit was reduced from 10 to 5 and crappie for which the daily limit was reduced from 30 to 15 fish. For bluegill, we observed a 2-cm decrease in the self-imposed length limits and for yellow perch a 10-cm decrease in the self-imposed length limits, but there were corresponding shifts in CPUE and size structure that may have influenced these reductions. This is not to say that restrictions to creel limits cannot alter self-imposed length limits, rather the creel limits assessed in this study may not have been restrictive enough to alter the behavior of the angler party, particularly the perceived ability of a party to harvest their limit. For example, if a harvest-orientated angler party has low expectations of catching large fish and catches fish infrequently (i.e., low CPUE), they may be less likely to release a small fish in hopes of catching a larger fish, particularly if generous creel limits exceed the biological capacity of the waterbody to produce those individuals. During 2010 and 2011, it appeared that the creel limits exceeded the perceived biological capabilities of the Nebraska reservoirs assessed because few parties captured and harvested the number of fish legally allowed on any given day. Though the frequencies of angler parties harvesting their creel limits were low, they increased from 0.0–1.2% during 2010 to 0.0–9.8% during 2011.

The size distribution and catch rate of fish are important factors in an anglers' perception of the quality of a fishery (Teirney and Richardson, 1992), which could in turn influence perception of anglers' abilities to harvest their creel limits and in turn, affect the decision to harvest a given fish. There was no obvious relationship between the distributions of lengths of captured fishes or CPUE and the self-imposed length limits, except for yellow perch. For example, an increase in size structure and decrease in catch rate for bluegill between 2010 and 2011 corresponded with a decrease of 2 cm in the self-imposed length limit, whereas decreases in size structure and catch rate for channel catfish corresponded with no change in the self-imposed length limit. Further, there was also no obvious relationship between the distributions of lengths of captured fishes and the mean number of fish harvested per angler per trip (Table 2). For example, a decrease in larger-sized channel catfish caught by anglers corresponded with no decrease in the mean number harvested, whereas a decrease in larger-sized yellow perch caught by anglers corresponded with an increase of 1 in the mean number harvested.

The size distributions of yellow perch caught by anglers changed significantly between 2010 and 2011 (i.e., fewer large fish during 2011) but still fell within ranges observed in other studies (e.g., Isermann et al., 2005). We observed the strongest change in the self-imposed length limit for yellow perch, but it is unknown whether this was from the change in the creel limit or change in the available size structure. Further, the increase in the number of smaller fish also corresponded with an increase in the catch rates during 2011. What still remains unknown, and warrants further study, is how the change in the creel limit interacting with the size distribution and CPUE altered anglers' perceptions of their abilities to attain their creel limit. During 2011, there was an increase in the number of parties harvesting yellow perch, and anglers within those parties harvested 2.5 times more yellow perch per angler per day. Further, the proportions of yellow perch released did not substantially differ between 2010 (84%) and 2011 (79%). It is possible that anglers during 2011, given the increased availability of yellow perch and the reduction in creel limits, perceived an increased ability to attain their limits of yellow perch and subsequently kept smaller fish. Although there may have been an increased perception in anglers' abilities to attain their limit, no interviewed party harvested the creel limit for yellow perch.

As we predicted the probability of harvest increased with increasing size for all species assessed, which supports the concept of a cost-benefit trade-off for harvesting individual fish. It is also clear that probability of harvest is not simply defined by fish length. Not surprising, in most recreational fisheries, exploitation of larger-sized fish is common (Lewin et al., 2006), which is a result of angler preference for larger-sized fish (Arlinghaus and Mehner, 2003; Beardmore et al., 2011). We hypothesized that the self-imposed size limits across anglers would encompass a greater size range for waterbodies regulated with a liberal creel limit compared to waterbodies regulated with a restrictive creel limit. Among all species, there was a significant interaction among year and length as indicated by a steeper slope of the relationships and a narrowing of the size ranges in the 20 to 80% probability of harvested. It is tempting to conclude that the restricted creel limits reduced among-party variability in the self-imposed length limits, be we also observed this trend for the control species, white bass. Perhaps these reductions in among-party variability in self-imposed length limits were responses to increased catches and associated harvests of fish that occurred from 2010 to 2011. For example, crappie had only a shift of 1 cm in the self-imposed length limit but had a narrowing of the range in the 20 to 80% probability of harvest from 21–28 cm during 2010 to 22–25 cm during 2011; there was an associated increase in the percentage of 22–25-cm crappie caught by anglers from 13% of total catch during 2010 to 28% of the total catch during 2011. In contrast, white bass had no shift in the self-imposed length limit but had a narrowing of the range in the 20 to 80% probability of harvest from 23–32 cm during 2010 to 24–30 cm in 2011; there was an associated decrease in the percentage of 24–30-cm white bass caught by anglers from 55% of the total catch during 2010 to 39% of the total catch during 2011. It is possible that there are interactions between the CPUE of fish in these size ranges and the probabilities of harvest. Preliminary evidence indicates an interaction between the length of the fish and CPUE on the probability of harvest, but we were unable to separate these effects with year (i.e., regulation change). Future research should consider the influence the CPUE on the size and intensity of harvest, particularly assessing this influence across a larger range of CPUE than what was considered in this study and without the confounding influence of changes of creel limits.

There are a couple of factors that need to be considered when interpreting the results of this study. First, information was collected at the party level and the response of the decision to harvest was collective of the party. There is the possibility that there may have been subtle decisions at the individual level that may have been masked at the party level, though we primarily generalized across two individuals (mean $\pm$ SE party size was 2.25 ± 0.02 anglers). Second, there is the possibility that repeated measures of parties could have biased the results if some parties consistently caught larger or smaller fish. We did not collect personally identifiable information and were unable to account for this possible source of variability. Third, the sizes and numbers of released fish were based on angler recollection of the size and number of released fish by species, and thus subject to recall bias (Pollock et al., 1994). It is unlikely that recall bias was an important factor given that the recollection period was relatively short (<3 h) as anglers were interviewed while preparing to depart from the reservoir (completed trips). Fourth, the premise of this study is grounded on the requirement that an angler must make a decision to harvest a fish at the time of catch. Current regulation in Nebraska dictates that "any fish that is not to be counted in the daily creel limit must be returned immediately to the water with as little injury as possible." Although it is possible that some anglers may do this illegally, culling and high-grading is not allowed and thus, we did not believe it to be strongly influential on estimates of self-imposed length limits.

5. Conclusions

In our assessment, we used revealed preferences across multiple waterbodies and angler types to assess generalized self-imposed length limits. We considered the size structure and catch rates of catchable fish for five species, but there are many other factors that could help elucidate patterns in the self-imposed length limits. Perhaps most importantly, the harvest orientation of the different angler groups (Fisher, 1997; Aas and Vittersø, 2000; Hunt et al., 2002; Dorow et al., 2010) was not considered in this study. Anglers seeking a specific species or trophy-sized fish could have an influence on the sizes that are harvested. For example, an angler seeking channel catfish that catches a channel catfish may have a different self-imposed length limit for channel catfish than an angler seeking bluegill that catches a channel catfish. Further, the degree of specialization within each species seeking group could also have an influence on the self-imposed length limits. Further, differences in angler specialization (Fisher, 1997) and choice of gear used (Wilde et al., 2003) may alter the anglers' perception of sizes available in a water body and their ability to catch their limit, hence affecting the size of the fish harvested.

We observed a significant relationship in all the species assessed that the probability of harvest increased with increasing length and CPUE, but there was no clear evidence that more restrictive creel limits had an effect on the self-imposed length limits. We believe that further examinations into more restrictive creel limits than those assessed in this study, which broadly increase an anglers' ability to achieve that limit, are needed to determine the interplay of creel limits, anglers' perceptions on achievability of those limits, and the size of fish that are harvested. We suspect that there is a point between a very restrictive creel limit and a very liberal creel limit at which anglers may become motivated to attain their creel limit (Snow, 1982; Noble and Jones, 1993) and perhaps begin harvesting smaller fish in order to achieve that limit. Further, as the creel limit is further restricted and anglers perceive that they will easily attain their creel limit (e.g., 1 or 2 fish), anglers may become motivated to harvest large fish because they can only keep a few and thus increase their self-imposed length limit in order to achieve a limit of the largest fish possible. This understanding of anglers' harvest decisions within the context of perceived likelihood that a creel limit will be realized, which is a function of fish availability, harvest regulations and angler skill and orientation, is needed to predict the influence that anglers have on fish communities.

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