

Influence of Walleye Stocking on Angler Effort in Wisconsin

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We compared relationships between angler effort and population densities of four species of fish in lakes with stocked and self-sustaining walleye populations in Wisconsin to determine the effect of walleye stocking on angler effort. The origin of walleye populations affected angler effort directed at walleyes in lakes with a daily bag limit of two, but not with daily bag limits of three or five. For lakes with a bag limit of two, angler effort was related to walleye density in lakes with self-sustaining walleye populations but not in stocked lakes. For lakes with a bag limit of three, angler effort did not differ between lakes with stocked and self-sustaining populations. For lakes with a bag limit of five, angler effort was not related to walleye density. Walleye stocking reduced the amount of effort directed at largemouth bass, but had no effect on effort directed at smallmouth bass or muskellunge.

Keywords angler effort, recreational angling, stocking, walleye

Introduction

Angling can directly or indirectly affect community structure in freshwater ecosystems. Direct effects of angling on community structure result from harvesting individual fish, whereas indirect effects of angling can result from altering the magnitude of competitive or predatory interactions between harvested species and other sympatric fish species (Evans, Bax, Marshall, Marshall, Oglesby, & Christie, 1987; Heino & Godo, 2002; Johnson, Stewart, Luecke, Gilbert, & Kitchell, 1992; Kitchell & Carpenter, 1993; Magnuson, 1991; Pimm & Hyman, 1987). The magnitude of the effect of angling on fish populations and community structure is largely determined by the amount of angler effort. The total

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amount of angler effort is unregulated in most recreational fisheries and therefore total harvest is determined at least partly by the amount of angler effort. Given that recreational fisheries can, in some cases, account for harvest equal to that taken by commercial fisheries when both are operating (Coleman, Figueira, Ueland, & Crowder, 2004), the way in which angler effort responds to management actions is important to understand, or management actions may not achieve their desired effect (Lester, Marshall, Armstrong, Dunlop, & Ritchie, 2003; Wilen, Smith, Lockwood, & Botsford, 2002).

Numerous factors determine where and how long anglers will fish. Angler effort is affected by factors related directly to the fish population such as density (Beard, Cox, & Carpenter, 2003; Hansen, Beard, & Hewett, 2000), stocking rates when stocking determines population density (Cox, Beard, & Walters, 2002; Loomis & Fix, 1998; Moring 1993; Ready, Epp, & Delavan, 2005), and catch rates (Johnson & Carpenter, 1994). In addition, many other factors not directly related to the fish population have been shown to affect the amount of angler effort such as water quality (Montgomery & Needelman, 1997), previous fishing success (Finn & Loomis, 2001), and weather (Provencher & Bishop, 1997). Similarly, angler effort may be positively related to anglers' perceptions of fish density (Beard et al., 2003; Radomski & Goeman, 1995). Therefore, fisheries management actions, such as stocking, may change angler effort independent of actual catch rates or population densities depending on whether anglers perceive the management action to be increasing or decreasing population densities (Beard et al., 2003; Cook, Goeman, Radomski, Younk, & Jacobson, 2001; Wilen et al., 2002). For example, the relationship between angler effort and walleye *Sander vitreus* density differed among daily bag limits, with lakes with more restrictive daily bag limits being less attractive to anglers (Beard et al., 2003).

Fish stocking has been shown to increase angler effort in circumstances where stocking increases the catchable fish population (Cox et al., 2002; Loomis & Fix, 1998; Moring 1993; Ready et al., 2005). However, in cases where stocking may not add significantly to the catchable population, such as walleye in some lakes in the upper Midwest (Li, Cohen, Schupp, & Adelman, 1996), fish stocking may still affect angler effort independent from any increases in population density based on the way that anglers expect stocking to alter the population density. Angler expectations can relate to their perception of the fishing quality (Spencer & Spangler, 1992) and stocking may alter angler expectations (Radomski & Goeman, 1995). Anglers may expect higher catch rates in stocked lakes because the purpose of stocking is generally to increase population densities. Anglers may spend more time fishing in a stocked lake than would be predicted by the fish density due to their unrealistic perception of population size. When anglers do not achieve catch rates that coincide with their expectations, they may seek to resolve the conflict by advocating further stocking. Conversely, anglers may see stocking as an indication of small populations with low catch rates, and therefore may reduce effort.

Angler effort may be linearly or nonlinearly related to catch rate or density (Beard et al., 2003; Carpenter, Munoz-Del-Rio, Newman, Rasmussen, & Johnson, 1994; Cox et al., 2002; Johnson & Carpenter, 1994) and may depend on whether the fish were stocked or wild, among other factors. For example, Johnson and Carpenter (1994) suggested that angler effort was linearly related to walleye catch rate. Carpenter et al. (1994) modeled angler effort as a linear function of walleye harvest, and Cox et al. (2002) found that angler effort was linearly related to stocking rates of rainbow trout in lakes sustained by stocking. Beard et al. (2003) developed a theoretical basis for predicting a nonlinear response between angler effort and walleye population density and showed that daily bag limits, annually implemented in response to tribal harvest of walleyes in Wisconsin, altered the form of the relationship. Similarly, perceived opportunity associated with walleye stocking may alter the form of the relationship between angler effort and fish density.

Just as anglers may direct their effort toward individual waters based on their perceptions of the effect of management actions on their catch rates (Cook et al., 2001; Cox et al., 2002; Johnson & Carpenter, 1994; Lester et al., 2003), anglers may also direct their effort toward some fish species over others, based on similar factors, within specific waters. For example, walleye stocking may attract anglers who target walleyes, but who would not have fished the lake if it were not stocked, thereby increasing angler effort and incidental catch of other species. Alternatively, walleye stocking may buffer effort directed at other species, if total angler effort for a lake is unaffected by stocking but anglers redirect their effort away from other species toward walleyes.

Our objectives were to determine (1) if the relationship between angler effort and walleye population density differed between lakes with stocked and self-sustaining walleye populations, and (2) if walleye stocking was related to angler effort for other popular fish species. We examined both of these questions in northern Wisconsin lakes for which fish populations and angling fisheries were surveyed during 1990–2003. For our first objective, we evaluated the relationship between angler effort and walleye population density in lakes with stocked and self-sustaining walleye populations. For our second objective, we evaluated the relationship between angler effort for muskellunge (*Esox masquinongy*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*Micropterus dolomieu*) and population densities of these species in lakes with stocked and self-sustaining walleye populations.

Methods

Population Estimation

Data were obtained from fish surveys in 257 northern Wisconsin lakes during 1990–2003. Lakes ranged in surface area from 40 to 6,190 hectares and walleye abundance was estimated on 20–25 lakes per year. Fish sampling was conducted shortly after ice out. Walleyes were captured with fyke nets, marked, measured to the nearest 1 cm, and released. All walleyes whose sex could be determined and all walleyes longer than or equal to 38 cm (the length at which most walleyes mature) were marked with a lake-specific fin clip (Beard, Hewett, Yang, King, & Gilbert, 1997). Walleyes of unknown sex and walleyes shorter than 38 cm in length were marked by partial removal of a different fin. One to two days after marking, the entire shoreline was electrofished, and both marked and unmarked walleyes were collected and recorded. Walleye abundance was estimated using the Chapman modification of the Petersen single-census mark-recapture estimator (Ricker, 1975). Abundance of smallmouth bass and largemouth bass was estimated using similar methods on a subset of the same lakes for which walleye abundance was estimated.

Muskellunge abundance was estimated for 22 lakes that ranged in surface area from 74 to 1,584 hectares, either as estimated by Margenau and Avelallemant (2000) or estimated using methods outlined by Margenau and Avelallemant (2000). Muskellunge longer than 76 cm were captured in fyke nets and by electrofishing, and marked by fin clip, preopercal tag, or anchor tag. Marking and recapture samples were obtained in two consecutive years and abundance was estimated using Bailey's modification of the Petersen estimator (Ricker, 1975).

Creel Surveys

Creel surveys were conducted on about 20 different lakes in northern Wisconsin each year since 1990. Creel surveys began on the first Saturday in May, the opening of the general

angling season in Wisconsin, and continued through March 1 of the following year, the closure of the general angling season in most Wisconsin waters. The month of November was not surveyed due to extremely low angler effort (caused by unsafe ice conditions). Creel surveys were of a random stratified roving access design (Pollock, Jones, & Brown, 1994; Rasmussen, Staggs, Beard, & Newman, 1998). Surveys were stratified by month and day type (weekend and holidays or weekday) and data included effort, catch, harvest, fish lengths, and marks of harvested fish. Effort was estimated by random instantaneous counts of anglers (Rasmussen et al., 1998). There has been no significant change in total angler effort between 1990 and 2003 (Hennessy, 2002).

Data Analysis

The relationship between angler effort and fish density has previously been treated as both linear (Carpenter et al., 1994; Cox et al., 2002; Johnson & Carpenter, 1994) and nonlinear (Beard et al., 2003). We wanted to avoid making a priori assumptions about the form of the relationship between angler effort and fish density. To allow the relationship to take either a linear or nonlinear form and to test for nonlinearity, we treated the relationship between angler effort and population density as a power function:

$$E = a(N)^b;$$

where E = the mean number of hours of annual directed angler effort per hectare, N = the estimated population density, a = the slope near the origin, and b = the rate of change in E as N increases (Goddard, Loftus, MacLean, Olver, & Shuter, 1987). We defined annual directed effort as the total number of hours/hectare spent by anglers fishing specifically for a given species of fish.

To estimate parameters of the nonlinear model, we \log_e -transformed the equation into its linear form:

$$\log_e(E) = \log_e(a) + b \log_e(N) + \varepsilon,$$

where terms are as defined for the nonlinear version of the model and ε = residual error not explained by the model. Transformation of the model also normalized the residuals. Ordinary least-squares methods require the independent variable to be measured without error, or at least with substantially less error than the dependent variable, to estimate unbiased parameters (Ricker, 1975). Because estimates of angler effort from creel surveys and abundance from mark-recapture surveys were measured with error, we used an errors-in-variables model to estimate unbiased parameters:

$$b_1 = \frac{m_{YY} - \delta m_{XX} + \sqrt{(m_{YY} - \delta m_{XX})^2 + 4\delta m_{XY}^2}}{2m_{XY}},$$

where b_1 is the slope, m_{XX} is the variance among estimates of fish population density N , m_{YY} is the variance among estimates of angler effort E , m_{XY} is the covariance between estimates of mean population density N and mean angler effort E , and δ is the measurement-error ratio (Fuller, 1987). The measurement-error ratio for each datum was estimated by dividing the mean coefficient of variation of individual estimates of angler effort by the mean coefficient of variation of individual estimates of fish population density.

To determine if the relationships between effort/hectare and number/hectare differed between lakes with stocked and self-sustaining walleye populations, we compared slopes and intercepts of relationships between stocked and self-sustaining walleye populations with two-tailed t -tests. Testing slopes and intercepts obtained from an errors-in-variables model using t -tests is equivalent to testing for interaction and stocking effects from a traditional ANCOVA approach where the independent variable is assumed to be measured without error. If intercepts (a) and slopes (b) did not differ between lakes with stocked and self-sustaining walleye populations ($H_0: a_1 = a_2$ and $b_1 = b_2; p > 0.05$), we concluded that angler effort directed at walleyes was unrelated to stocking, whereas if slopes or intercepts differed between lakes with stocked and self-sustaining walleye populations ($H_A: a_1 \neq a_2$ or $b_1 \neq b_2; p \leq 0.05$), we concluded that angler effort directed at walleyes was related to stocking.

To determine if the relationship between angler effort and fish density was linear, slopes were tested with two-tailed t -tests. Slopes in the \log_e -transformed equation (b_1) that did not differ significantly from 1.0 indicated a linear relationship between angler effort and fish density ($H_0: b_1 = 1.0; p > 0.05$), whereas slopes that differed significantly from 1.0 indicated a nonlinear relationship between angler effort and fish density ($H_A: b_1 \neq 1.0; p \leq 0.05$).

To determine if walleye stocking significantly affected the amount of angler effort, we compared relationships between walleye density and angler effort between origins (stocked or self-sustaining walleye populations) for different daily bag limits (two, three, or five walleyes per day). Each year, the daily bag limit for walleyes on individual lakes was adjusted to two, three, or five walleyes per day, depending on the intensity of tribal harvest (Staggs, Moody, Hansen, & Hoff, 1990). Although we used a different model than Beard et al. (2003), we separated lakes by daily bag limit category because Beard et al. (2003) showed that the relationship between angler effort and density differed among daily bag limits. Lakes were classified as being supported primarily based on stocking if greater than 50% of recruitment was attributed to stocking efforts (USBIA, 1991). Although it is unlikely that an angler would be aware of whether the walleye population was supported through natural reproduction or stocking efforts when both occur to some degree, the previously mentioned definition of a stocked lake is currently used by the Wisconsin Department of Natural Resources, Chippewa tribal biologists and others, to classify walleye populations in Wisconsin (USBIA, 1991) and the vast majority of lakes in northern Wisconsin are supported entirely by either stocking or natural reproduction (Hennessy, 2002). Therefore, the classification scheme essentially suggests whether the lakes are heavily stocked or not.

There are undoubtedly factors other than walleye stocking that significantly affect angler effort in the lakes we examined. However, our primary objective was to determine whether walleye stocking affected angler effort, not to create a detailed predictive model. Therefore, the only other factor we considered was daily bag limit because Beard et al. (2003) documented that this factor affects angler effort in the same lakes included in our study.

We included only lakes with estimates of both adult population and directed angler effort. The data set we used consisted of 55 lakes with daily bag limits of 2 walleyes

per day (45 lakes with self-sustaining walleye populations and 10 lakes with stocked walleye populations), 160 lakes with daily bag limits of 3 walleyes per day (128 lakes with self-sustaining walleye populations and 32 lakes with stocked walleye populations), and 42 lakes with daily bag limits of 5 walleyes per day (24 lakes with self-sustaining walleye populations and 18 lakes with stocked walleye populations).

To determine if walleye stocking affected the amount of angler effort directed at other species, we compared the amount of angler effort directed at muskellunge, largemouth bass, and smallmouth bass in lakes with stocked and self-sustaining walleye populations. Muskellunge abundance was estimated on 23 lakes (4 lakes with stocked walleye populations and 19 lakes with self-sustaining walleye populations), largemouth bass abundance was estimated on 28 lakes (13 lakes with stocked walleye populations and 15 lakes with self-sustaining walleye populations), and smallmouth bass abundance was estimated on 29 lakes (7 lakes with stocked walleye populations and 22 lakes with self-sustaining walleye populations). Daily bag limits for muskellunge, largemouth bass, and smallmouth bass did not vary among lakes.

Results

For lakes with a bag limit of two walleyes per day, the relationship between angler effort directed at walleyes and walleye population density differed significantly between lakes with stocked and self-sustaining walleye populations. Slopes of the relationships differed significantly ($t = 2.58$; $df = 51$; $p = 0.01$). Angler effort was related to walleye density in lakes with self-sustaining walleye populations and a daily bag limit of two because the exponent of the relationship was significantly different from zero ($t = 3.75$; $df = 43$; $p < 0.01$), and was nonlinear because the exponent was also significantly greater than one ($t = 2.62$; $df = 43$; $p = 0.01$) (Figure 1). Conversely, there was no evidence that angler effort was related to walleye density in lakes with stocked walleye populations and a daily bag limit of two because the exponent of the relationship in these lakes did not differ from zero ($t = 2.00$, $df = 8$, $p = 0.08$). The mean amount of angler effort directed at walleyes in stocked lakes with a daily bag limit of two was 23.15 hours/hectare (Figure 1).

For lakes with daily bag limits of three or five walleyes, there was no evidence that the relationship between angler effort directed at walleyes and adult walleye population density differed between lakes with stocked and self-sustaining walleye populations. For lakes with a daily bag limit of three walleyes, slopes ($t = 0.62$; $df = 156$; $p = 0.53$) and intercepts ($t = 1.15$; $df = 156$; $p = 0.25$) did not differ significantly between lakes with stocked and self-sustaining walleye populations. Similarly, for lakes with a daily bag limit of five walleyes, slopes ($t = 0.25$; $df = 38$; $p = 0.80$) and intercepts ($t = 0.16$; $df = 38$; $p = 0.88$) did not differ significantly between lakes with stocked and self-sustaining walleye populations. For lakes with a daily bag limit of three walleyes, the slope of the relationship increased nonlinearly with density ($t = 4.17$; $df = 158$; $p < 0.01$; Figure 2). For lakes with a daily bag of five walleyes there was no evidence that angler effort was related to walleye population density because the common slope of the relationship for both stocked and self-sustaining walleye populations did not differ significantly from zero ($t = 1.89$; $df = 40$; $p = 0.07$). The mean amount of angler effort directed at walleyes in lakes with a daily bag limit of 5 was 27.43 hours/hectare.

Anglers spent more time fishing for largemouth bass at a given density in lakes with self-sustaining walleye populations than in lakes with stocked walleye populations. Slopes of the relationships between angler effort directed at largemouth bass differed significantly between lakes with stocked and self-sustaining walleye populations ($t = 2.49$;

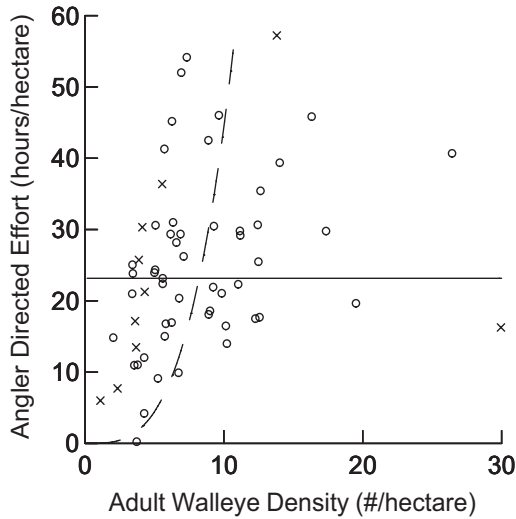


Figure 1. Angler effort (angler-hours/hectare) directed toward walleyes versus adult walleye population density (fish/hectare) in 55 northern Wisconsin lakes for lakes with self-sustaining ($E = 0.021(N)^{3.31}$; $n = 45$; symbol = \circ ; line = dashed) and stocked ($E = 23.15$; $n = 10$; symbol = \times ; line = solid) walleye populations sampled during 1990–2003.

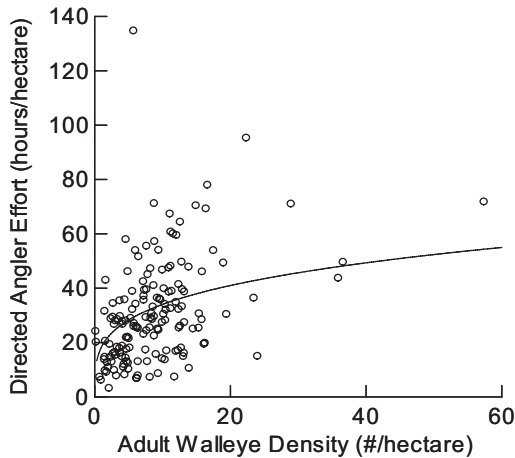


Figure 2. Angler effort (angler-hours/hectare) directed toward walleyes versus adult walleye population density (fish/hectare) in 160 northern Wisconsin lakes with a daily bag limit of three walleyes per day ($E = 2.91(N)^{0.27}$) sampled during 1990–2003.

$df = 24$, $p = 0.02$). Angler effort directed at largemouth bass was related to largemouth bass density in lakes with self-sustaining walleye populations because the exponent of the relationship was significantly different from zero ($t = 2.83$; $df = 13$; $p = 0.01$), and was linear because the exponent was not different from one ($t = 0.10$; $df = 13$; $p = 0.92$; Figure 3). Angler effort was related to largemouth bass density in lakes that were stocked with walleyes because the exponent of the relationship in these lakes differed significantly

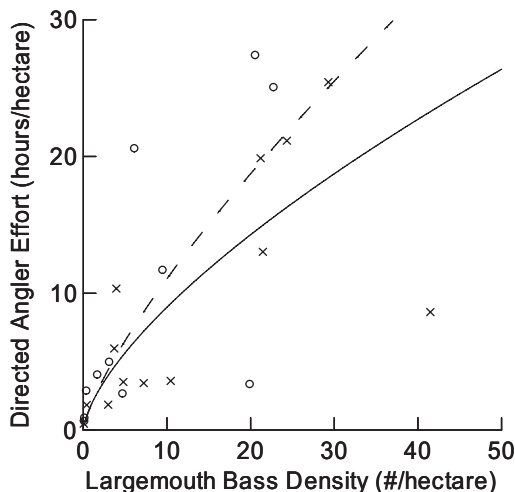


Figure 3. Angler effort (angler-hours/hectare) directed toward largemouth bass versus largemouth bass population density (fish/hectare) in 28 northern Wisconsin lakes for lakes with stocked ($E = 0.56(N)^{0.67}$; $n = 13$; symbol = \times ; line = solid) and self-sustaining ($E = 1.01(N)^{1.04}$; $n = 15$; symbol = \circ ; line = dashed) walleye populations sampled during 1990–2003.

from zero ($t = 5.81$; $df = 11$, $p < 0.01$), and was nonlinear because the exponent differed significantly from one ($t = 2.87$; $df = 11$; $p = 0.02$; Figure 3).

We found no evidence to suggest that walleye stocking affected the amount of angler effort directed at either muskellunge or smallmouth bass. The amount of angler effort directed at muskellunge did not differ between lakes with stocked and self-sustaining walleye populations (slopes: $t = 0.36$; $df = 19$; $p = 0.72$; intercepts: $t = 0.31$; $df = 19$; $p = 0.76$). There was no evidence to suggest that angler effort directed at muskellunge was related to muskellunge population density because the exponent of the relationship did not differ significantly from zero ($t = 1.19$; $df = 21$, $p = 0.25$). The mean amount of angler effort directed at muskellunge was 29.64 hours/hectare. The amount of angler effort directed at smallmouth bass also did not differ between lakes with stocked and self-sustaining walleye populations (slopes: $t = 0.12$; $df = 25$; $p = 0.91$; intercepts: $t = 0.08$; $df = 25$; $p = 0.94$). Angler effort directed at smallmouth bass was linearly related to population density of smallmouth bass because the slope of the relationship differed significantly from zero ($t = 3.20$; $df = 27$; $p < 0.01$) but did not differ significantly from one ($t = 0.11$; $df = 27$; $p = 0.91$; Figure 4).

Discussion

Several studies suggest that stocking of fish may increase angler effort in cases where the population size of catchable fish is increased as a result of stocking (Cox et al., 2002; Loomis & Fix, 1998; Moring 1993; Ready et al., 2005). Our findings suggest that in some cases, such as in lakes with average to low densities of walleyes and a daily bag limit of two, angler effort may be increased simply due to the act of stocking independent of any increases in population size. Stocking fish may therefore increase angler effort both due to the physical addition of fish, which presumably will increase catch rates, and also due to the act of stocking, which the anglers assume will increase population densities. Anglers

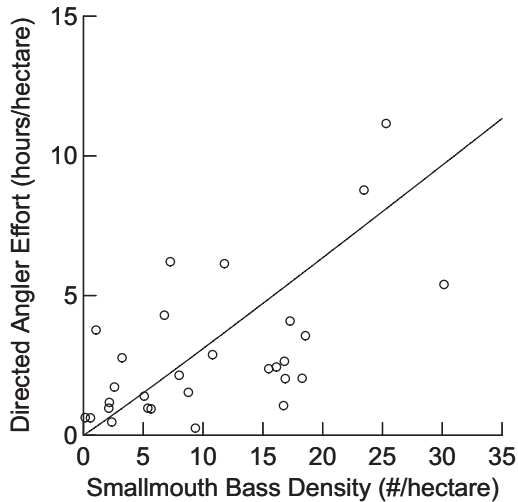


Figure 4. Angler effort (angler-hours/hectare) directed toward smallmouth bass versus smallmouth bass population density (fish/hectare) in 22 northern Wisconsin lakes ($E = 0.29(N)^{1.04}$) sampled during 1990–2003.

respond to both perceived and actual opportunities (Beard et al., 2003; Spencer & Spangler, 1992), so stocking walleye into Wisconsin lakes may, in some situations, lead anglers to believe that walleye population density is greater than it actually is. As such, anglers may also expect higher catch rates in stocked lakes because catch rate and density are related in walleye fisheries in Wisconsin (Beard et al., 1997; Hansen et al., 2000; Newby, Hansen, Newman, & Edwards, 2000).

We found that the relationship between walleye density and angler effort differed based on the origin of the walleye population in lakes with a daily bag limit of two, but not in lakes with daily bag limits of three or five. Wisconsin lakes with a daily bag limit of two walleyes have a lower *index of attractiveness* (defined as the slope of a nonlinear relationship between walleye density and directed angler effort near the origin) than lakes with bag limits of three or five walleyes per day (Beard et al., 2003). Thus, the origin of the walleyes may have played a larger role in determining angler effort in lakes with a daily bag limit of two than three or five. Wisconsin lakes with high daily bag limits have a high *index of attractiveness* to anglers (Beard et al., 2003), so the relationship between angler effort and walleye population density may be masked when anglers are presented with the opportunity to harvest a large number of fish.

Our findings also suggest that other fish species may experience reduced fishing pressure when walleyes are stocked. Anglers may direct their effort in response to management actions (Beard et al., 2003) or fish density (Cox et al., 2002; Loomis & Fix, 1998; Moring 1993; Ready et al., 2005), and the catch rate of a fish species may affect the likelihood of harvest for other species (Hunt, Haider, & Armstrong 2002), so anglers may direct their effort based on their perceptions of species present. For example, anglers who target one species, such as largemouth bass, may devote some time fishing for another species, such as walleye, if they are unsuccessful fishing for their primary species of interest (largemouth bass). In addition, walleye feed primarily during low light conditions (Becker, 1983), whereas largemouth bass are primarily active during the day (Demers, McKinley, Weatherly, & McQueen, 1996). The difference in temporal susceptibility to

angling may facilitate anglers switching from targeting walleyes in the early morning to largemouth bass during the day and back to walleyes in the evening. The apparent reduction of angler effort directed at largemouth bass in the presence of walleye stocking suggests that walleye stocking may buffer largemouth bass populations from the effects of fishing exploitation.

There may be other physical and biological characteristics of stocked lakes and their fisheries that result in the differences in angler effort that we observed. For example, physical features of lakes stocked with walleyes (e.g., amount of vegetation, maximum depth) may lead anglers to believe that the population density is higher or lower than it actually is. However, Nate, Bozek, Hansen, Ramm, Bremigan, and Hewett (2003) showed that habitat parameters could be used to predict the presence or absence of walleye in general, but could not be used to differentiate between lakes with self-sustaining and stocked walleye populations in northern Wisconsin. This suggests that lakes with walleye, regardless of their origin, are roughly similar in their habitats and therefore are unlikely to affect angler's perception of fish density. Although our results do not definitively prove that observed differences in angler effort associated with the origin of the walleye populations were caused by stocking, they are consistent with this hypothesis.

Our inability to detect significant relationships between fish density and angler effort and between stocked lakes and lakes supported through natural walleye reproduction may, in some cases, be a function of relatively small sample sizes. Data were available for only a relatively few lakes with smallmouth bass, muskellunge, a daily bag limit of five walleyes, and a daily bag limit of two whose walleye population was supported by stocking. The lack of significant results in these cases does not exclude the possibility that a relationship exists. However, at least in lakes with a daily bag limit of five, Beard et al. (2003) found that anglers fished at a higher rate than in lakes with lower bag limits because of the potential to harvest five walleyes even though walleye densities are generally relatively low in these lakes. The fact that anglers continued to fish at relatively high rates in spite of low walleye densities in lakes with a daily bag limit of five supports our finding of no relationship between walleye density and angler effort in these lakes.

Our findings suggest that angler effort may be linearly related to population density, as suggested by Carpenter et al. (1994), Johnson and Carpenter (1994), and Cox et al. (2002), or nonlinearly related to population density, as suggested by Beard et al. (2003). Given that the relationship between angler effort and population density can be linear or nonlinear for the same species, the form of the relationship should not be assumed a priori when attempting to predict changes in angler effort for management purposes, but rather should be explicitly tested using an appropriate model, such as a power function. Although none of the authors mentioned earlier explicitly tested to determine if the relationships between angler effort and fish density were linear, they were not attempting to quantify a particular response in angler effort to a change in fish population density. Instead, they were primarily interested in describing the dynamics of angler effort, and therefore their conclusions would likely be unaffected if their assumptions about linearity of the relationships were incorrect.

Because the amount of angler effort can determine the efficacy of harvest regulations on harvest (Radomski, Grant, Jacobson, & Cook, 2001), changes in angler effort in response to stocking should be considered prior to stocking. Policies for stocking fish into public waters often qualitatively consider system carrying capacity and potential interactions between the species stocked and other species present (MDNR, 1996; NDGFD, 2002; OMNR, 2002), but indirect effects of stocking, such as effects of stocking on angler effort, are usually not considered (Wilens et al., 2002). For example, we found that stocking

walleyes in lakes with a daily bag limit of two walleyes may de-couple the relationship between angler effort and walleye population density. The amount of time anglers spent fishing for walleyes in lakes with a daily bag limit of two that were stocked with walleyes appeared to be independent of the number of walleyes present. Consequently, anglers are expected to spend the same amount of time fishing for walleyes regardless of the population size. Constant fishing pressure could further reduce small populations because angler effort may be higher than expected for a given walleye population density. Conversely, larger walleye populations would likely benefit from constant angler effort because angler effort would be lower than expected. Stocking walleyes may also cause a decrease in angler effort directed at largemouth bass, which could favorably affect largemouth bass populations, notwithstanding any possible fish community effects that walleye stocking may have on largemouth bass. Given that stocking can affect angler effort directed toward the species being stocked, and also angler effort directed toward other species, changes in angler effort should be considered and evaluated as a potential consequence of any stocking event.

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