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A Comparison of Modified Fyke Nets for Evaluating Fish Assemblages and Population Structure

Jesse R. Fischer[a,b], Nicholas P. Johnson[a], Randall D. Schultz[c], and Michael C. Quist[a,d]

ABSTRACT

Modified fyke nets have long been used by fisheries managers to assess species composition and evaluate population characteristics of individual species. Despite their widespread use, only recently have recommendations for standard fyke net specifications been made. Therefore, we evaluated species composition and catch rates, size structure, and sample size requirements for bluegill (*Lepomis macrochirus*), black crappie (*Poxomis nigromaculatus*), and white crappie (*P. annularis*) in seven Iowa lakes in the fall of 2009 using two different fyke nets. Fyke net specifications followed a recently recommended standard design and that currently used by Iowa Department of Natural Resources (IDNR). Overall, the standard fyke net sampled more individuals and species than the IDNR net. Additionally, mean catch rates of the focal species were consistently higher with the standard fyke net. Size structure comparisons were limited by fewer than 125 stock-length fishes sampled in several lakes, but when comparison was possible, size structure was similar between the fyke net types. The number of samples needed to obtain at least 125 stock-length individuals with standard fyke nets was consistently lower than that for IDNR fyke nets for all species.

INTRODUCTION

Standardized sampling is necessary to obtain consistent and descriptive information on fish population and assemblage characteristics (e.g., species, abundance). However, fishery assessments are subject to numerous sampling biases (e.g., gear, sex, size, time of day) that affect accurate and precise characterizations of populations and assemblages (Boxrucker and Plosky 1989, Hayes et al. 1996, Hubert 1996, Pope and Willis 1996). For example, relative abundance (e.g., catch-per-unit-effort; CPUE) and size structure (e.g., proportional size distribution; PSD) estimates often vary seasonally (Guy and Willis 1991, Pope and Willis 1996) due to factors such as behavior (e.g., spawning) and growth of individuals throughout the year. Additionally, different sampling gears often capture individuals of different numbers and sizes of the same species (Guy et al. 1996, Tate et al. 2003, Paukert 2004). Similarly, differences in gear specifications (e.g., dimensions and mesh size) and materials (e.g., filament type, color) used to construct sampling gear can bias estimates, such as relative abundance, size structure, and species composition (Willis et al. 1984, Henderson and Nepszy 1992, Gray et al. 2005, Wanner et al. 2010). Therefore, understanding how observed estimates of population structure and function are influenced by biases associated with gear selectivity is critical to developing sampling protocols and making management decisions.

Fisheries assessments often require the use of multiple sampling methods due to selectivity of different gears for certain species, sizes, or sexes. Species selectivity is defined as the overrepresentation of a species observed from a sample compared to the

[a]Department of Natural Resource Ecology and Management, Iowa State University, Ames, Iowa 50011 USA.
[b]Corresponding author; E-mail: fischer@iastate.edu
[c]Iowa Department of Natural Resources, Fisheries Research Section, 24570 Hwy 34, Chariton, Iowa 50049 USA.
[d]Current address: Idaho Cooperative Fish and Wildlife Research Unit, Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho 83843 USA.

true assemblage composition (Hubert 1996). As such, sampling gears with known species selectivity are often used to target groups of similar species to obtain information on populations that most accurately reflect true characteristics with the least amount of effort. A common gear used for sampling the littoral zone of standing water bodies is the modified fyke or fyke net (Hubert 1996, Miranda and Boxrucker 2009, Pope et al. 2009). The fyke net is a passive, entrapment gear that is effective at sampling mobile, cover-seeking fish species, such as sunfishes (*Lepomis* spp.) and crappies (*Poxomis* spp.) (Boxrucker and Plosky 1989, McInerny 1989, Hubert 1996). Other species targeted or commonly encountered with fyke nets include northern pike (*Esox lucius*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), and black bullhead (*Ameiurus melas*) (Miranda and Boxrucker 2009, Pope et al. 2009). Due to a large number of species that can be effectively sampled and known species' selectivity, fyke nets are commonly used for fishery assessments throughout North America (Gabelhouse 1992, Miranda and Boxrucker 2009, Pope et al. 2009).

Despite the widespread use of fyke nets to assess fish populations, few studies have evaluated the sampling bias associated with net specifications. Therefore, recent efforts have been made to establish standardized fish sampling methods across freshwater ecosystems in North America (Bonar et al. 2009). Benefits of standardized sampling include minimizing sampling bias, while providing consistently collected information across large temporal and spatial extents. Bonar et al. (2009) recommended standard sampling gear specifications across a diversity of freshwater ecosystems to sample a variety of fish species. The specifications for fyke nets (hereafter referred to as standard) as recommended by Bonar et al. (2009) include 91- x 183-cm frames, 13-mm-bar mesh, and a 15.2- to 30.4-m lead (see Miranda and Boxrucker 2009 and Pope et al. 2009 for further description of fyke specifications).

Currently, the Iowa Department of Natural Resources (IDNR) uses modified fyke nets that differ in specifications from those recommended by Bonar et al. (2009) to assess panfish in standing water bodies throughout Iowa (Iowa Department of Natural Resources 1995). The IDNR fyke net specifications are 71- x 122-cm frames, 19-mm-bar mesh, and a 12.2-m lead. Therefore, the goal of this study was to compare estimates of population and assemblage characteristics observed with fyke nets of the specifications recommended by Bonar et al. (2009) and those used by IDNR to assess lentic fisheries. Specifically, comparisons were made for species composition and catch rates, size structure (i.e., PSD), and the number of samples needed to estimate size structure (i.e., 125 stock-length individuals) for species commonly targeted with fyke nets (i.e., bluegill [*L. macrochirus*], black crappie [*P. nigromaculatus*], and white crappie [*P. annularis*]).

MATERIALS AND METHODS

We sampled seven Iowa lakes from 13 September to 12 October 2009 with standard fyke nets and IDNR fyke nets. All lakes were sampled following the recommendations of Miranda and Boxrucker (2009). Lakes included Easter Lake (72 ha) and Big Creek Lake (357 ha) in Polk County, Hickory Grove Lake (34 ha) in Story County, Diamond Lake (39 ha) in Poweshiek County, Union Grove Lake (39 ha) in Tama County, Lake Ahquabi (44 ha) in Warren County and Lake Manawa (302 ha) in Pottawattamie County. The time between sampling with standard and IDNR nets varied between 1 to 27 days with all but one lake sampled within 15 days or less. The number of nets set on each lake with each net type was determined by lake size. Lakes smaller than 40 ha were sampled with 6 net-nights (NN), lakes larger than 40 ha but smaller than 202 ha were sampled with 10 NN, and lakes larger than 202 ha were sampled with 15 NN. Leads were staked on the shore and nets were set perpendicular to the shoreline. Nets were set in afternoon and retrieved the following morning to encompass two crepuscular periods (Miranda and Boxrucker 2009, Pope et al. 2009). All fishes were

identified to species and measured to the nearest millimeter (total length).

Catch-per-unit-effort was calculated for all species as the mean number of fish per net night. Size structure of bluegill, black crappie, and white crappie was estimated using PSD (Guy et al. 2007). The PSD is the proportion of stock-length fish that are quality-length or greater. Stock-length was 80 mm for bluegill and 130 mm for black crappie and white crappie (Anderson and Neumann 1996). Quality-length was 150 mm for bluegill and 200 mm for black crappie and white crappie (Anderson and Neumann 1996). Approximate 90% confidence intervals were calculated for PSD estimates using methods described by Gustafson (1988). Additionally, the minimum number of samples required to obtain 125 stock-length (minimum recommended sample size to estimate PSD; Quist et al. 2009) bluegill, black crappie, and white crappie was calculated based on stock-length CPUE estimates. Sample size estimates were calculated by dividing 125 by the mean stock-length CPUE. All estimates were made by lake and net type. Two-sample *t*-tests for unequal variances were used to compare estimates of mean CPUE for bluegill, black crappie, and white crappie sampled with different fyke net types (Welch 1947). All statistical analyses were conducted using SAS 9.1.3 (SAS Institute 2006) with type I error rate of 0.10.

RESULTS

The total number of fish sampled from all lakes was 7,254 with the standard fyke net and 3,797 with the IDNR net. The dominant species sampled with the standard net were bluegill (37.8%), black crappie (22.5%), yellow bass (*Morone mississippiensis*, 16.3%), and white crappie (14.7%). The same four species dominated the samples with the IDNR net, although the relative percentages differed (Table 1). Species richness among all lakes was 27 for the standard net and 20 for the IDNR net. Species sampled exclusively with the standard net included shortnose gar (*Lepisosteus platostomus*), gizzard shad (*Dorosoma cepedianum*), quillback (*Carpiodes cyprinus*), smallmouth buffalo (*Ictiobus bubalus*), bigmouth buffalo (*Ictiobus cyprinellus*), shorthead redhorse (*Moxostoma macrolepidotum*), pumpkinseed (*Lepomis gibbosus*), and orangespotted sunfish (*Lepomis humilis*). Only one species, river carpsucker (*Carpiodes carpio*), was sampled exclusively with the IDNR net.

Bluegill CPUE differed between standard and IDNR nets for Lake Ahquabi ($t_{9.2}$ = -3.56, P = 0.01), Big Creek Lake ($t_{14.2}$= -2.10, P = 0.05), Easter Lake ($t_{13.2}$= -2.04, P = 0.06), and Hickory Grove Lake ($t_{5.0}$= -3.55, P = 0.02; Fig. 1). Similarly, mean white crappie CPUE differed between net types for Lake Ahquabi ($t_{9.5}$ = -2.42, P = 0.04), Big Creek Lake ($t_{17.2}$= -1.97, P = 0.07), Hickory Grove Lake ($t_{5.0}$= -3.97, P = 0.01), and Union Grove Lake ($t_{5.5}$= -2.85, P = 0.03), and mean black crappie CPUE differed between net types for Lake Ahquabi ($t_{9.1}$ = -3.01, P = 0.02), Big Creek Lake ($t_{17.2}$= -2.54, P = 0.02), Hickory Grove Lake ($t_{5.0}$= -3.23, P = 0.02), and Union Grove Lake ($t_{9.7}$= -2.10, P = 0.06). In all but one lake (i.e., Lake Manawa), differences in mean CPUE between net types were observed for at least one of the three focal species.

Proportional size distributions of bluegill, black crappie, and white crappie were similar between net types (Table 2). However, PSD comparisons were limited by fewer than 125 stock-length fish sampled in several lakes. For example, only two lakes (i.e., Big Creek Lake and Lake Manawa) had fewer than 125 stock-length bluegill sampled with the standard net, compared to four lakes (i.e., Lake Ahquabi, Big Creek Lake, Hickory Grove Lake and Lake Manawa) with the IDNR. Similarly, comparisons for black crappie could only be made for two lakes (i.e., Easter Lake and Lake Manawa) and one lake (i.e., Lake Manawa) for white crappie.

The number of net-nights needed to collect 125 stock-length individuals was consistently fewer for the standard net than the IDNR net (Table 3). For the standard net, the estimated number of net-nights needed varied from 2 to 40 for bluegill, 3 to 63 for

black crappie, and 3 to 313 for white crappie. The number of net-nights needed could not be estimated for at least one lake for all three species with the IDNR net, because no individuals of the species were sampled.

DISCUSSION

The total number of individuals and species sampled was consistently greater with standard fyke nets compared to IDNR nets. In a similar study, Gritters (1997) compared catch between two different fyke nets with identical specifications to those used in the current study except both nets had 19-mm-bar-measure mesh. Gritters (1997) found that the large-frame net (i.e., standard net with 19-mm mesh) sampled 4.2 times as many fish as the small-frame net (i.e., IDNR net), but species composition and the length frequencies of bluegill, black crappie, and white crappie were similar. Our results were similar in that differences in PSD (when comparable) varied from 1 to 5 between both net types in all but one instance where the PSD for bluegill sampled in Diamond Lake was greater with the IDNR net (i.e., PSD = 21) than the standard net (i.e., PSD = 7). Several studies have documented differences in the length distributions of species sampled with fyke nets of differing mesh size. In Kansas reservoirs, catch rates of age-0 (i.e., sub-stock; < 80 mm total length) white crappie were greater with 13-mm than with 25-mm-

Table 1. Total number (*N*) and proportion (%) of species sampled with two different modified fyke nets (IDNR = Iowa Department of Natural Resources) from seven Iowa lakes during September and October, 2009.

		IDNR		Standard	
Common name	Scientific name	*N*	%	*N*	%
Freshwater drum	*Aplodinotus grunniens*	22	0.58	23	0.32
Shortnose gar	*Lepisosteus platostomus*	0	0	3	0.04
Gizzard shad	*Dorosoma cepedianum*	0	0	37	0.51
Golden shiner	*Notemigonus crysoleucas*	2	0.05	23	0.32
Common carp	*Cyprinus carpio*	17	0.45	15	0.21
Black bullhead	*Ameiurus melas*	21	0.55	90	1.24
Yellow bullhead	*Ameiurus natalis*	11	0.29	13	0.18
Channel catfish	*Ictalurus punctatus*	81	2.13	24	0.33
Flathead catfish	*Pylodictis olivaris*	18	0.47	4	0.06
River carpsucker	*Carpiodes carpio*	4	0.11	0	0
Quillback	*Carpiodes cyprinus*	0	0	1	0.01
White sucker	*Catostomus commersoni*	38	1.00	13	0.18
Smallmouth buffalo	*Ictiobus bubalus*	0	0	1	0.01
Bigmouth buffalo	*Ictiobus cyprinellus*	0	0	4	0.06
Shorthead redhorse	*Moxostoma macrolepidotum*	0	0	1	0.01
Green sunfish	*Lepomis cyanellus*	24	0.63	19	0.26
Pumpkinseed	*Lepomis gibbosus*	0	0	2	0.03
Orangespotted sunfish	*Lepomis humilis*	0	0	1	0.01
Bluegill	*Lepomis macrochirus*	482	12.70	2,742	37.8
Redear sunfish	*Lepomis microlophus*	88	2.32	265	3.65
Largemouth bass	*Micropterus salmoides*	12	0.32	25	0.34
White crappie	*Pomoxis annularis*	551	14.5	1,063	14.70
Black crappie	*Pomoxis nigromaculatus*	757	19.9	1,632	22.50
White bass	*Morone chrysops*	24	0.63	11	0.15
Striped bass hybrid	*Morone chrysops x Morone saxatalis*	59	1.55	42	0.58
Yellow bass	*Morone mississippiensis*	1,546	40.70	1,184	16.30
Yellow perch	*Perca flavescens*	3	0.08	1	0.01
Walleye	*Sander vitreus*	37	0.97	15	0.21
Total		3,797		7,254	

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IDNR		Standard	
N	%	*N*	%
22	0.58	23	0.32
0	0	3	0.04
0	0	37	0.51
2	0.05	23	0.32
17	0.45	15	0.21
21	0.55	90	1.24
11	0.29	13	0.18
81	2.13	24	0.33
18	0.47	4	0.06
4	0.11	0	0
0	0	1	0.01
38	1.00	13	0.18
0	0	1	0.01
0	0	4	0.06
0	0	1	0.01
24	0.63	19	0.26
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,797		7,254	

mesh fyke nets (Willis et al. 1984), and catch rates of stock-length bluegill (≥80 mm total length) were greater with 13- than 25-mm mesh fyke nets (Schultz and Haines 2005). Jackson and Bauer (2000) found that 16-mm mesh fyke nets sampled fewer bluegill less than 80 mm and white crappie less than 130 mm than 13-mm mesh fyke nets in Nebraska reservoirs. Therefore, increased PSDs with larger mesh would be expected because fewer small (i.e., stock-length) individuals relative to large (i.e., quality-length) individuals would be sampled. Consequently, the INDR net likely overestimated size structure in Diamond Lake.

Estimating the size structure of fish populations is one of the primary goals of fisheries assessments (Anderson and Neumann 1996). As such, several studies have

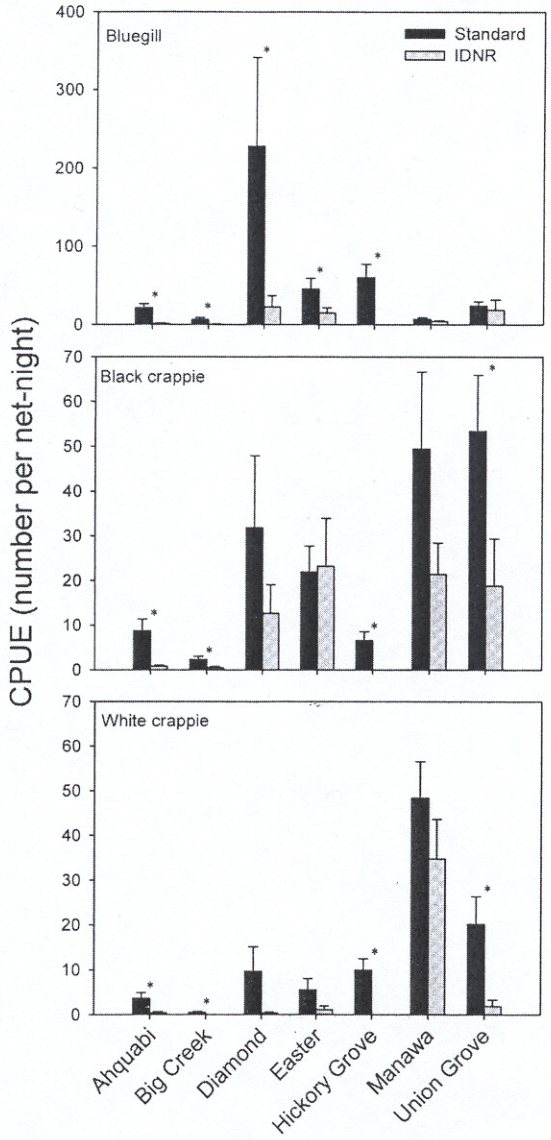

Figure 1. Catch-per-unit-effort (CPUE) of bluegill, black crappie, and white crappie sampled with two different modified fyke nets from seven Iowa lakes during September and October, 2009. Bars represent standard error. An asterisk indicates mean CPUE differed significantly ($P < 0.10$).

evaluated the number stock-length fish that should be measured to describe the length frequency distribution of a population and the number of samples needed to detect differences in size structure indices (Vokoun et al. 2001, Miranda 1993, Miranda 2007). Based on the results of these studies, Quist et al. (2009) recommended that a minimum of 125 fish be measured to calculated basic size structure indices (i.e., PSD). With the IDNR fyke nets, the number fish captured rarely exceeded 125 stock-length individuals for bluegill, black crappie, and white crappie. Thus, PSD was not estimated or interpreted with the majority of the IDNR fyke net samples. Sampling with the standard fyke nets however, yielded 125 individuals consistently more often with similar effort for the three focal species. Therefore, effort (i.e., number of net-nights) could be reduced with the standard net depending on the goals and objectives of sampling.

Reliable estimates of population and assemblage characteristics are dependent on consistent sampling methods. Consequently, standardization of fisheries sampling and data collected led to the recommendations of sampling gear specifications (see Bonar et al. 2009). The results of this study indicated that fisheries assessments conducted with fyke nets following the specifications currently used by the IDNR sampled substantially fewer species and individuals than the standard fyke net recommend by Miranda and Boxrucker (2009) and Pope et al. (2009). The IDNR fyke net was less effective at

Table 2. Proportional size distribution (± 90% confidence interval) and number (*N*) of stock length-bluegill, black crappie, and white crappie sampled with two different modified fyke nets from seven Iowa lakes during September and October, 2009. -- indicates that less than 125 stock-length or greater fish were sampled and PSD was not estimated.

	IDNR		Standard	
Lake	PSD	*N*	PSD	*N*
Bluegill (Stock = 80 mm Quality = 150)				
Ahquabi	--	16	34(±7)	126
Big Creek	--	0	--	47
Diamond	21(±6)	136	7(±2)	417
Easter	13(±5)	147	14(±3)	420
Hickory Grove	--	0	30(±4)	317
Manawa	--	60	--	99
Union Grove	--	110	32(±7)	131
Black crappie (Stock = 130 mm, Quality = 200)				
Ahquabi	--	8	--	51
Big Creek	--	7	--	30
Diamond	--	76	4(±3)	191
Easter	4(±2)	217	7(±3)	206
Hickory Grove	--	0	--	35
Manawa	3(±2)	319	2(±1)	733
Union Grove	--	113	32(±4)	320
White crappie (Stock = 130 mm , Quality = 200)				
Ahquabi	--	3	--	9
Big Creek	--	0	--	6
Diamond	--	2	--	47
Easter	--	11	--	50
Hickory Grove	--	0	--	57
Manawa	48(±4)	517	43(±3)	679
Union Grove	--	11	--	121

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—	Standard	
	PSD	*N*
0)		
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)	--	47
)	7(±2)	417
)	14(±3)	420
)	30(±4)	317
)	--	99
)	32(±7)	131
= 200)		
)	--	51
)	--	30
)	4(±3)	191
)	7(±3)	206
)	--	35
)	2(±1)	733
)	32(±4)	320
= 200)		
)	--	9
)	--	6
)	--	47
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)	--	57
)	43(±3)	679
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sampling panfish species than the standard net, and the sample sizes required to estimate population characteristics (i.e., size structure) were not attained for the focal species. Although differences in size structure were not observed in the majority of study lakes, small sample sizes and the use of a size structure index (i.e., PSD) may have limited our ability to detect differences. Regardless, the adoption of standard fyke net specifications will allow fishery managers to avoid possible size structure biases associated with larger mesh sizes, use less sampling effort (i.e., fewer net-nights) to sufficiently estimate size structure indices, and more accurately reflect assemblage composition.

Table 3. Number of net-nights needed to collect 125 individuals of stock length bluegill, black crappie, and white crappie sampled with two different modified fyke nets from seven Iowa lakes during September and October, 2009. -- indicates that no fish were collected (i.e., mean catch-per-unit-effort equaled zero).

Lake	IDNR	Standard
Bluegill		
Ahquabi	79	10
Big Creek	188	40
Diamond	6	2
Easter	9	3
Hickory Grove	--	4
Manawa	32	19
Union Grove	7	6
Black crappie		
Ahquabi	267	25
Big Creek	268	63
Diamond	10	4
Easter	7	6
Hickory Grove	--	36
Manawa	6	3
Union Grove	7	3
White crappie		
Ahquabi	417	139
Big Creek	--	313
Diamond	375	16
Easter	114	25
Hickory Grove	--	22
Manawa	4	3
Union Grove	69	7

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