FISH BEHAVIOR WHEN ENCOUNTERING A MODIFIED FYKE NET AT TWO BLACK HILLS RESERVOIRS

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ABSTRACT

This study used video photography to document the behavioral reaction of fish exposed to a modified fyke net. We conducted two-hour video sessions with five underwater video cameras over six net nights at two Black Hills reservoirs from May 24 to July 20, 2016. Six behaviors were observed. When first encountering the lead line most fish followed the net, loitered, wandered, or escaped. A small percentage of fish avoided the net or crossed-over the lead line. Overall, yellow perch *Perca flavescens* showed the highest net retention, whereas bluegill *Lepomis macrochirus* had the highest escapement. This study demonstrates fish behavior around sampling gear, with inferences on how species-specific behavior may potentially lead to gear-selectivity bias.

Keywords

fish behavior, modified fyke net, lead line, escapement

INTRODUCTION

Sampling fish populations is typically conducted using various gear types, such as gill nets, fyke nets, and traps. However, each gear type, in conjunction with the species and size of fish targeted, introduces bias (Boxrucker and Plosky 1989; Hubert 1996; Pope and Willis 1996; Fischer et al. 2010), and can influence the amount and size of fish sampled (Willis et al. 1984; Henderson and Nepszy 1992; Guy et al. 1996; Tate et al. 2003; Paukert 2004; Gray et al. 2005; Wanner et al. 2010). Fish behavior also influences the effectiveness of each gear type (Guy and Willis 1991; Pope and Willis 1996).

Modified fyke nets are commonly used to sample littoral areas of lentic freshwater (Hubert 1996; Pope et al. 2009). This net captures fish as they swim along the shoreline, subsequently encounter the lead line, and are eventually trapped as they try to swim around the net. It is a passive gear effective in catching actively moving species, such as centrarchids or others of similar behavior and body shape (Boxrucker and Plosky 1989; Hubert 1996; Smith et al. 2016). It has also been

used to target other sport fish, such as northern pike (*Esox lucius*) and walleye (*Sander vitreus*). Yet modified frame nets are poor sampling devices to evaluate largemouth bass (*Micropterus salmoides*) populations (Patriarche 1968).

Despite the sampling bias associated with fyke nets (Shoup et al. 2003; Fischer et al. 2010), few studies have determined the extent of fish escapement. In other gear types, Grant et al. (2004) studied the retention of walleye when interacting with gill nets and Bacheler et al. (2013) investigated escapement of black sea bass in marine trap nets through video. No studies that we are aware of have looked specifically at the extent of escapement from modified fyke nets used in freshwater fisheries management. Additionally, no work has been attempted to study fish behavior when encountering fyke nets. Thus the objective of this study was to describe fish behavior and quantify escapement from modified fyke nets.

METHODS

We recorded fish behavior for six evenings from 1820 to 2020 hours between May 24 and July 20, 2016 at Deerfield (lat 44.028624, long -103.785981) and Pactola (lat 44.070247, long -103.486463) Reservoirs in the Black Hills, South Dakota (Figures 1 and 2). Figure 3 illustrates the fyke net and video camera loca-

Figure 1. Net locations at Deerfield Reservoir with approximate locations noted with a white star.

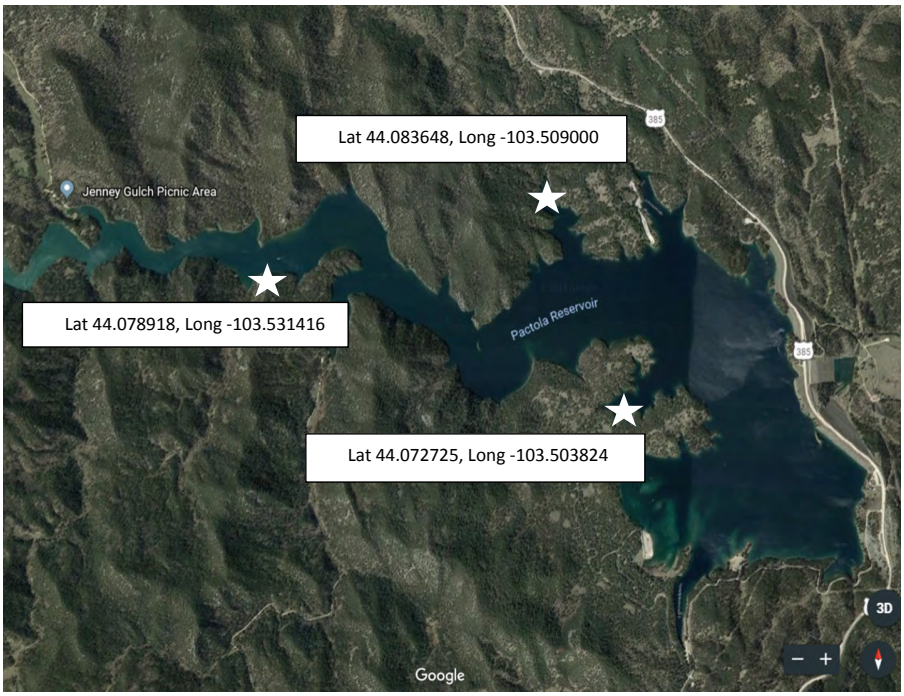

Figure 2. Net locations at Pactola Reservoir with approximate locations noted with a white star.

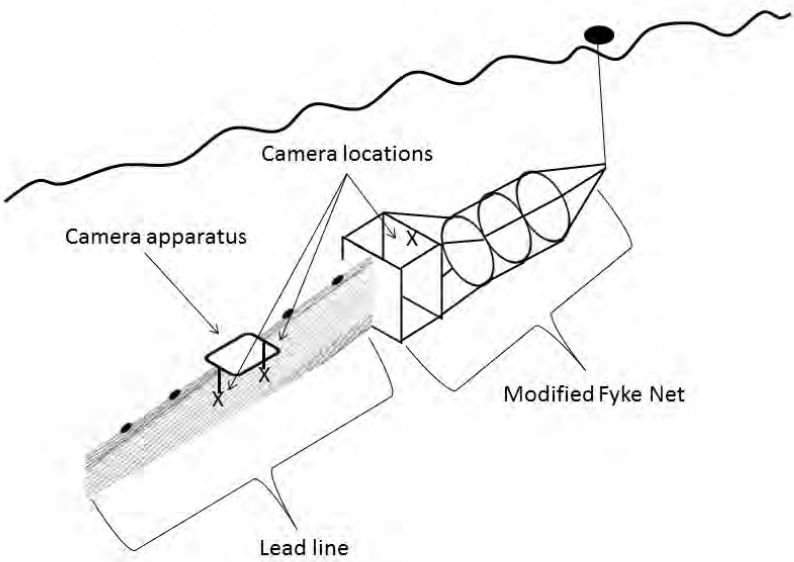

Figure 3. Modified trap net showing position of camera apparatus and camera locations used to document fish escapement and reaction to the lead line. Camera positions are noted with "X".

tions. Each net and video camera recordings lasted two hours (approximate life of camera battery). Camera recordings were verified when attached to the net or floating camera mount. The floating camera mount was a 0.6 x 0.9 m rectangular structure constructed of two-inch polyvinyl chloride (PVC) sealed at each joint. One-inch diameter PVC extended 0.3m below the water surface, to which four GoPro ® (GoPro, Inc. San Mateo, California, GoPro Hero2 and GoPro Hero3) cameras were affixed by common handlebar connectors. A fifth camera was attached within the modified fyke net at the second frame. In total, thirty videos (60 hours) recording fish activity with six nets were used in this study. Water temperatures during the study ranged from 9.4 °C to 26 °C. The cameras on the floating mount recorded fish behavior upon encountering the fyke net lead line, while the camera within the net recorded fish escapement.

All of the recorded video was watched by the same individual to avoid observer bias. Fish responses to the net were categorized into one of six different behaviors described in Table 1 (following, loitering, wandering, leaving, staying away, crossing). Because of the difficulty in identifying fish species using the video from the relatively distant floating platform, behaviors were pooled for all fish. However, the video obtained from the camera located within the net was close enough to the fish to allow for species identification so that escapement could be determined for each fish species.

RESULTS

Behavior responses when encountering the lead line were similar between both of the reservoirs, with the majority of fish following the net, loitering, or wandering (Table 2). Very few fish avoided the net or crossed over the lead line.

Table 1. Ethogram used to describe behavioral reactions of fish as they came in contact with modified fyke nets.

Behavior	Definition
Following	Following the lead line in one direction
Loitering	Motionless near the net
Wandering	Traveling back and forth along the lead line
Leaving	Departing after contacting the net
Crossing over	Crossing over or under the lead line

Table 2. Mean (SE) Fish (%) performing one of six behaviors upon encountering a modified fyke net in Deerfield and Pactola Reservoirs.

Location	Following	Loitering	Wandering	Leaving	Avoidance	Crossing over
Deerfield	58.7 (28.1)	10.1 (1.9)	19.6 (6.7)	6.4 (2.5)	2.8 (3.5)	0.2 (3.3)
Pactola	42.6 (290.0)	28.9 (218.4)	14.0 (49.7)	13.4 (85.7)	0.9 (3.0)	0.2 (0.6)

Table 3. The number of fish by species, entering and exiting modified fyke nets, and escapement rates at Deerfield and Pactola reservoirs, as observed through video recordings.

Location	Common Name	Entries	Exits	Escapement rate
Deerfield	Creek chub	2	1	50
	Golden shiner	85	68	20
	White sucker	16	7	56
	Rock bass	763	457	40
	Yellow perch	81	26	68
Pactola	Bluegill	43	17	60
	Rock bass	278	211	24

Rock bass (*Ambloplites rupestris*) were the most numerous fish species observed in the nets at both Pactola and Deerfield Reservoirs (Table 3). Escapement rates were relatively low in both reservoirs, at 40% in Deerfield and 24% in Pactola. In contrast, 68% of the yellow perch (*Perca flavescens*) escaped from the nets in Deerfield, as did 60% of the bluegill (*Lepomis macrochirus*) in Pactola. Creek chubs (*Semotilus atromaculatus*), golden shiners (*Notemigonus crysoleucas*), and white suckers (*Catostomus commersonii*) were also observed in the nets in Deerfield, with only golden shiners observed in any numbers and a relatively low escapement rate.

DISCUSSION

This is the first known study using video cameras to document fish behavior around modified fyke nets. Grant et al. (2004) used underwater video to determine gear selectivity and retention of walleye in gill nets. The Grant et al. (2004) study was unusual because it occurred before the widespread development of video cameras and their subsequent prevalence throughout society (Struthers et al. 2015).

The results from this study indicate that not all freshwater fish are caught by modified fyke nets with the same frequency. The escapement observed in this study is similar to that found by Grant et al. (2004), Bacheler et. al (2013), and Smith et al. (2016). As was first elucidated by Grant et al. (2004), the results from this study clearly show that direct approaches, such as video evidence, can be used to validate gear-selectivity models. If escapement can be estimated and gear validated, fisheries managers can be confident that the sample obtained from nets is indeed representative of the actual fish population (Bacheler et al. 2013).

We found no other studies using video equipment to record fish behavior in response to modified fyke nets. Smith et al. (2016) did study escapement of trap nets using slightly different configurations, but used known numbers of marked

fish to determine catch after a 24 hour period. Further improvements in video equipment, including High Definition (Mallet and Pelletier 2014), will better allow for observing fish behavior free of human influences (Kumpf 1964) in relation to sampling gear. Indeed, relatively inexpensive video cameras have recently been used in fisheries management and research (Struthers et al. 2015). From saltwater (Domenici et al 2014; Wilson et al. 2014) to freshwater (Binder et al. 2015; Vivancos and Closs 2015), a variety of studies have shown the usefulness of action cameras in aquatic research. Our equipment was limited by the relatively short battery life and reliance on visible light (daylight conditions). Future work may be improved as advances in technology result in greater clarity, longer battery life, and larger memory.

ACKNOWLEDGEMENTS

We offer special thanks to Editor Robert Tatina and the SDAS for the invitation to include this paper in the 2019 SDAS Proceedings. We also thank Joellyn Moine for field assistance, anonymous reviewers and Michael Barnes for their helpful comments and editorial suggestions relative to this manuscript.

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