

CHARACTERIZING A HIDDEN FISHERY: SETLINE FISHING IN THE NEW
RIVER, VIRGINIA

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and State
University in partial fulfillment of the requirements for the degree of

Master of Science

In

Fisheries and Wildlife Science

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December 9, 2013

Blacksburg, Virginia

Keywords: catfish, setline, trotline, human dimensions, by-catch

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ABSTRACT

Catfishes *Ictaluridae* are important food fish that are harvested from the New River, Virginia by multiple methods, yet standard creel survey approaches do not accurately sample setline effort, a popular fishing gear for catfish. I characterized the New River setline fishery by estimating setline effort and catch rates of catfish and by-catch in 2011, and by investigating the attitudes and opinions of setline users during 2012. Setline effort was highest during June-August, and declined significantly by mid-September. Several dedicated setline users accounted for a significant portion of total setline effort. Experimental setlines baited with live minnows *Cyprinidae* proved to be an effective method for catching catfish but caught few walleye *Sander vitreus*, smallmouth bass *Micropterus dolomieu*, and muskellunge *Esox masquinongy*. Estimated by-catch of these species by setline fishers is small compared to catch by hook-and-line anglers, though walleye experienced high setline hooking mortality, and catch rates increased in autumn months. Setlines appear to be part of a larger “way of life” for some rural individuals, who may also hunt, trap, and garden as part of activities to supplement their diet or income. New River setline fishers strongly believe that setline fishing has declined significantly in the New River Valley due to improving socioeconomic status of the region, changing recreational values (such as focus on catch-and-release fishing and paddle sports), increasing recreational traffic and law enforcement presence, and decreasing participation in setline fishing by younger generation.

DEDICATION AND ACKNOWLEDGEMENTS

This thesis is dedicated to all those who helped me get to where I am today. A number of special educators inspired, encouraged, prodded, and molded me, from elementary school through college. I would be remiss not to give them substantial credit for my development. Mr. Dorr and Ms. Ringo at Mack Elementary; Mr. Bradley and Mr. Long at Slauson Middle School; Mr. Packard, Mr. Bernardin, and Ms. Chen at Pioneer High School, and Professors Mark Davis and Dan Hornbach at Macalester College come to mind, although I have surely left a few important individuals off the list. Thank you for dedicating your lives to your students.

Although some of them might argue otherwise, I would not have a Master's in fisheries if not for several individuals instrumental in developing and nurturing my love of nature and outdoor recreation.

Dad, thank you for those late-night expeditions searching vernal ponds for amphibians, for endless hours chasing bugs with butterfly nets, for looking at pond water under a microscope, for always pointing out that hawk overhead or that patch of butterfly weed on the side of the highway, and for always knowing (or inventing in rare cases) the scientific names of any plant, tree, or flower imaginable. Thanks for teaching me to fish, and later to flyfish, despite occasional temper tantrums and accidental hooking incidents. Thanks for doing things with your kids instead of doing things for them. Mom, thanks for taking summers off to hang out with your kids. And for involving us in cooking, gardening, and other activities connected to the outdoors from a young age. Thank you for putting up with endless amounts of dirt tracked into the house and all the random critters kept in aquaria and terraria, even though they sometimes escaped. Thanks for taking me fishing almost every day during each summer, and when I got older, for letting me spend nearly every day down at the Huron River, unsupervised.

Thanks Nana and Papa for all the memories up at the cabin. Some of my most treasured memories will always be having 3 generations fishing side by side on the Au Sable or out in the rowboat on Tee Lake. Wish you were here to celebrate with and see all the amazing things your grandchildren are accomplishing.

To my Uncle David Johnston, how can I thank you enough? All the fishing, paddling, and hunting expeditions you led me on taught me an abiding respect for pristine wilderness, how to be responsible in the backcountry, and helped me gain a multitude of skills and learn valuable life lessons. Thanks for letting me learn the hard way just often enough. Thanks for stoking the fire already burning inside of me.

Mark Hove and Bernard Sietman not only employed me in my first scientific jobs, but also taught me the ropes of fieldwork and all about freshwater mussels. They were among the first to encourage me to go to graduate school, so thank you for that. Once at Virginia Tech, Don Orth and Steve McMullin provided excellent guidance both related to academics and navigating graduate research. John Copeland and George Palmer were extremely helpful in many ways and helped me get up to speed on my research from the very start. Thanks to Jason Emmel, Dylan Hann, Bill Bond, and Matt Weberg for both the field help and for the hunting and fishing companionship as a much needed break from school. Finally, thank you to all others who helped in the field or in the office, including but not limited to Nate Adkins, Vic DiCenzo, Matt Vincent, Shannon White, and Sean Lusk.

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Chapter 1: Introduction and Literature Review

Problem Statement

The Virginia Department of Game and Inland Fisheries (VDGIF) has little information regarding catfishes and the setline fishery on the New River in Virginia. Standard creel surveys used to obtain angler effort and harvest on the New River do not adequately sample catfish anglers, particularly those using setlines. Setlines, a type of passive fishing gear, are baited hook(s) and line(s) that do not require active manipulation by anglers. In order to manage the entire community of fish and anglers using the New River, VDGIF needs information on the currently undescribed setline fishery. This study provides preliminary characterization of setline anglers, estimates potential impact of setlines on catfish *Ictaluridae*, smallmouth bass *Micropterus dolomieu*, walleye *Sander vitreus*, and muskellunge *Esox masquinongy* in the New River, and fisheries management recommendations to VDGIF.

In a broader sense, my research characterizes a relatively hidden, harvest-oriented fishery that coexists with a predominantly recreational and trophy fishery for smallmouth bass, walleye, and muskellunge (Brenden et al. 2004, Copeland et al. 2006, Palmer 2013). Few studies examine the human dimensions of setline fishers or estimate effort, catch, or harvest of catfish by setlines. I estimate effort and harvest of catfish, muskellunge, walleye, and smallmouth bass by setlines, discuss potential impact on the fishery, and describe the motivations and attitudes of setline anglers, revealing what setline fishing means to those using these passive fishing gears. The results of this research will be useful for fisheries managers and policymakers tasked with managing fisheries comprising both popular recreational and subsistence components.

Catfish Management in North America

The North American natural resource management model holds that fish and wildlife are public resources, held in trust for the enjoyment of all citizens (Geist et al. 2001, Ballweber and Schramm 2010). Fisheries professionals, tasked with managing aquatic resources in the public's long-term interest, must manipulate fish populations, habitat, and people to achieve specific human objectives (McMullin and Pert 2010). Consequently, effective fisheries management agencies gather stakeholder input to craft management goals (value choices), and then rely upon fisheries biologists to implement management strategies (technical choices) to achieve those goals (McMullin 1993). Comprehensive fisheries management must involve managers, stakeholders, and policymakers in making decisions that involve both value choices and technical choices (McMullin and Pert 2010). Fisheries managers increasingly recognize that they must identify and include many stakeholders, such as specialized fishing subcultures (Morgan 2006), and often seek to satisfy multiple groups where each holds different expectations (Hahn 1991). Therefore, fisher satisfaction must be central to decision-making processes of fisheries management agencies (Wilde and Ditton 1999), otherwise agencies may fail to provide the variety of fishing opportunities needed to meet stakeholder demands (Fedler and Ditton 1994).

Catfish are important commercial and recreational fish in the United States, particularly throughout their native range (Michaletz and Dillard 1999). Both flathead catfish *Pylodictis olivarius* and channel catfish *Ictalurus punctatus* are highly desired as table fare and in many cases for their strong fighting ability once hooked (Jackson 1999, Hubert 1999). Nationwide, catfish are among the most popular freshwater fish, with 7 million anglers (26% of freshwater anglers) spending 96 million days (22% of freshwater angling effort) pursuing them (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S.

Census Bureau 2011). Catfish also are popular in Virginia, with 36% of licensed anglers targeting catfish, behind only largemouth bass *Micropterus salmoides* (57 %), smallmouth bass (48%), and panfish *Centrarchidae* (41%) (O'Neill 2001). Diverse catfish fisheries exist in Virginia for a variety of species. Both flathead catfish and channel catfish are native to the New, Big Sandy, and Tennessee drainages within Virginia, but now are found within most major drainages of Virginia (Jenkins and Burkhead 1994). Blue catfish *Ictalurus furcatus* are not native in Virginia, but have been introduced into some Atlantic slope rivers such as the Potomac, Rappahannock, York, and James (Jenkins and Burkhead 1994, Schloesser et al. 2011). A notable trophy fishery exists for blue catfish on the James River and in Buggs Island Lake (Kerr Reservoir); both are home to previous and current state record blue catfish. Buggs Island produced the current world record blue catfish in 2011 (143 lbs.) Channel and flathead catfish on the New River are often targeted by setline fishers, some of whom may rely on fish as a major source of protein in their diet.

Several management tools exist for managing catfish populations for recreational fisheries. Primary catfish management tools include bag limits and gear restrictions, rather than length limits (Michaletz and Dillard 1999). Managers are beginning to recognize the utility of size limits, however. For example, the number of states with catfish size limits increased from two in 1984 to 18 in 1999 (Michaletz and Dillard 1999). Catfish are defined and managed as both sport/game fish and nongame fish in the contiguous United States. The meaning of game fish varies, but generally refers to a fish valued by anglers for its sport and fighting ability, rather than its commercial or food value. Such a definition is inherently subjective, as fish may be valued for more than one purpose. For the purposes of this literature review, the term “game fish” refers to warmwater fish commonly targeted by anglers for sport, such as those in the

Centrarchidae and *Esocidae* families, walleye, and yellow perch *Perca flavescens*. Non-game fish simply means a fish not defined as a game fish. I reviewed the 2012 online fishing regulation booklets for the contiguous United States: 23 states explicitly define at least one of the three major species of catfish (blue, flathead, or channel) as game or sport fish in their regulations guide, whereas eight states specifically define all catfish as nongame or “rough” fish. Seventeen state regulations booklets either did not mention catfish at all, or did not specifically define catfish as game or nongame fish. However, some of the states that did not explicitly define catfish as game or sport fish manage catfish with restrictive bag and/or length limits; similar to fish they define as game fish. Examples of these states are Michigan, which has a possession limit of 10 channel catfish with a 12” minimum length, up to 5 flathead catfish (15” minimum) in combination with northern pike *Esox lucius*, black basses, and walleye, and Minnesota, which has a possession limit of 5 catfish, only one catfish over 24”, and no more than two flatheads. See Appendix A for more information on state regulations. Catfish regulations in Virginia are managed primarily with bag limits. Above the Fall Line, a geomorphologic break between the upland and coastal regions of Virginia, catfish are managed with a 20-fish (combined) daily bag limit. There are no daily bag limits below the Fall Line for blue, channel, flathead, and white catfish *Ameiurus catus*. No possession limit exists for catfish in Virginia. There are no minimum length limits for any catfish species, but only one blue catfish over 32” may be kept per day.

Several factors make effective management of catfish fisheries difficult. For example, Michaletz and Dillard (1999) described the principal constraints of catfish management as a combination of inadequate sampling methods, lack of reasonable data, low participation by fishers in management processes, and low priority placed on managing catfish. Catfish fishers tend to respond to mail surveys at lower rates than other types of anglers (Bray 1997), which can

impede the collection of effort and catch data. Additionally, creel surveys frequently fail to adequately sample catfish fishers because many of them fish in crepuscular periods, at night, from shore, or with passive gears (Michaletz and Dillard 1999). Surveying crepuscular time periods presents physical and logistical hazards of surveying; these fisheries may be better sampled using other methods (Pollock et al. 1994). The historically low importance of catfish management likely is due to the difficulty of sampling catfish, combined with low angler involvement (Michaletz and Dillard 1999). However, as new catfish fisheries develop (particularly trophy fisheries), agencies are beginning to recognize the importance of managing catfish as game fish, and they increasingly are aware that statewide catfish regulations are not always appropriate given the diversity of fisheries (Shepard and Jackson 2005). Managing for trophy catfish fisheries may be difficult, as catfish fishers generally are more harvest-oriented than other angling groups (Schramm et al. 1999, Wilde and Ditton 1999, Reitz and Travnichek 2004). Some evidence suggests setline fishers may be even more harvest-oriented than other catfish fishers (Quinn 1993, Boxrucker and Kuklinski 2008).

Fisheries managers are beginning to realize that there may not be an “average catfish angler” (Gill 1980, Wilde and Riechers 1994, Wilde and Ditton 1999, Morgan 2006). Catfish fishers are somewhat unique among other North American fishers in that they may use multiple different legal methods to fish for their preferred species. Catfish fishers use techniques such as hand fishing, which is also called noodling or “hand grabbling” (Baker 2009), juglines, trotlines, limblines, and other passive fishing techniques not usually legal for catching other fish. Despite often being thought of as low-tech generalists fishing for undesirable fish, catfish anglers may exhibit high degrees of specialization (Gill 1980). Even at high levels of specialization, catfish fishers are generally opposed to regulations and are harvest-oriented (Wilde and Ditton 1999,

Morgan 2006), unlike other specialized anglers, who generally support more restrictive regulations and bag limits (Chipman and Helfrich 1988, Hahn 1991).

Diversity of motivations among catfish fishers is increasing as trophy blue and flathead catfish fisheries emerge, including relatively recent prevalence of trophy catfish tournaments (Arterburn et al. 2002, Holley et al. 2009, Schmitt and Shoup 2013). Despite the growing evidence of diversity among catfish fishers, little documentation of the motivations and attitudes of setline fishers exist in the literature, perhaps because these fishers are not routinely encountered in day-time creel surveys and are hesitant to interact with managers. Participation of stakeholders is a crucial component of the North American model of wildlife management (McMullin and Pert 2010); lack of participation by catfish stakeholders may hinder effective catfish management.

Passive Fishing Gears

Setlines are passive fishing gears that capture fish without being actively moved or managed by fishers (Hubert et al. 2012). Fishers and scientists may use the terms setline, layline, throw line, limb line, drop line, and trotline interchangeably; definitions may vary locally or regionally (Hubert et al. 2012). For the purposes of this thesis, setlines include only trotlines, limblines, and juglines. I define trotlines as horizontal mainlines with multiple hook droppers. They may be anchored to the bottom of a river or lake, or suspended in the water column using floats. A jugline is a line set vertically with a float on the top, and may be either anchored or free-floating. Juglines usually have only one or two hooks, but may have more depending on region and the individual fisherman. One free-floating variation of the jugline is called a “noodle,” so-named because the float is a section of a “pool noodle” toy. Care should be taken not to confuse using such a device to fish with the practice of hand fishing for catfish, sometimes

called “noodling” or “hand-grabbling (Salazar 2002, Morgan 2006, Baker 2009). Finally, I define limblines as simply a length of string or rope tied to a tree limb overhanging the water, most often with a single hook.

Much of the literature focuses on trotlines, as I do here. Trotline catches generally consist of 90% or more catfishes (Sanderson 1961, White 1961, Johnson and Timmons 1989, Timmons et al. 1989). Such selectivity for catfish is not unexpected. Commercial trotline hooks usually are baited with cut fish or dead baits not likely to attract piscivorous game fish and effects on their populations are negligible (Johnson and Timmons 1989). However, setline by-catch and mortality of game fish, turtles, and other animals may be of concern to some managers if live baits are used. Freshwater trotlines are known to catch diving ducks in some areas (Turnbull et al. 1986). Ghost fishing (i.e., abandoned or lost setlines) may account for substantial fish mortality in commercial riverine fisheries (Bettoli et al. 2009) and likely occurs to some extent in recreational fisheries. Angling guides in the New River occasionally report mortality of large walleye and smallmouth bass found on abandoned setlines, and VDGIF officials occasionally observe mortality of snapping turtles *Chelydra serpentina* on abandoned setlines (G. Palmer, VDGIF, personal communication).

Trotlines are effective for catching catfish. Since most trotlines are fished overnight, I refer to catch per unit effort (CPUE) in terms of hook-nights. One hook-night is the effort of one hook deployed on a setline overnight; to express CPUE in integer form I express it as fish per 100 hook-nights. The average CPUE of several studies (N= 8) with available data for trotline catch rate is 9.8 catfish per 100 hook-nights and ranges between 1.2 and 30 catfish per 100 hook-nights (Table 1.1). However, caution must be exercised when comparing trotline data from different systems. Minor changes in sampling methods and environmental conditions greatly

affect catch rates and sampling bias (Brown 2007). Trotline design and deployment differed between studies, as did fish assemblages, catfish abundance, and hydrology.

Table 1.1. Catch per unit effort (CPUE, defined as fish per 100 hook-nights) from available studies which reported trotline catch rates. * = Mean value for multiple sites

Study	Location	CPUE
White 1961	TVA Impoundments, AL	4
Timmons et al. 1989	Kentucky Lake, KY	8.1
Stauffer and Koenen 1999	Minnesota River, MN	13.9
Arterburn and Berry 2002	James and Big Sioux Rivers, SD	8
Stewig 2006a and 2006b	Red River of the North, MN	15.8*
Stewig and Chapman 2009	Mississippi River, MN	17.6
Barada 2009	Platte River, NE	1.2
Average of Studies	n/a	9.8

Setline fishing methods vary between individuals and likely between regions. Setline fishers use various baits, which in turn affects catch rates and catch composition. Recreational fishers targeting flathead catfish in Georgia overwhelmingly used live baits such as *Lepomis spp.*, various cyprinids, and goldfish (*Carassius auratus auratus*) (Quinn 1993). New River valley setline fishers generally prefer to bait their lines with cyprinids (G. Palmer, VDGIF, personal communication). Crayfish, cut fish and worms are other popular baits for setlines targeting catfish, particularly channel catfish. Arterburn and Berry (2002) found that trotlines baited with cut common carp (*Cyprinus carpio*) caught mainly channel catfish, whereas live black bullheads (*Ameiurus melas*) were 28 times more likely to catch flathead catfish. Similarly,

White (1961) found that lines baited with live goldfish overwhelmingly caught flathead catfish (92% by weight); few flathead catfish were caught using all other baits. These results are not unexpected given the highly piscivorous nature of adult flathead catfish (Roell and Orth 1993, Jackson 1999).

Setline fishers also may use several hook styles. Examining difference in catch rates of circle hooks and standard J-style hooks for both catfish and game fish may have important management implications. First used in freshwater by commercial trotline fishers (Ott and Storey 1991), circle hooks are increasingly popular with catfish fishers and show increased catch rates of blue catfish on juglines compared to J-style hooks (Schmitt and Shoup 2013). However, Arterburn and Berry (2002) found no difference in catch rates of channel and flathead catfish caught using trotlines with either circle or J-style hooks. Circle hooks offer other benefits such as reduced by-catch mortality and excellent retention of hooked fish (Cooke and Suski 2004). Other perceived, yet unquantified benefits of circle hooks, are reduced snagging of debris (Cooke and Suski 2004) and the reduced potential for accidental self-hooking when running trotlines.

Due to inadequacy of sampling methods and low importance placed upon catfish and setline regulation, many management questions regarding passive fishing gears remain unaddressed or unanswered. For example, unanswered questions include the extent to which these gears are used, their efficiency of capturing catfish and other species, and their potential capability to negatively affect catfish or game fish populations. Attitudes and motivations of setline fishers remain unquantified. Subsequently, many agencies manage passive fishing gears either using a mostly *laissez faire* approach, or prohibiting these gears altogether. Without adequate data regarding these issues, managers cannot effectively make informed decisions to appropriately manage these somewhat hidden fisheries

Estimating Setline Effort

On-site creel and angler surveys provide fisheries managers with valuable information such as the amount of fishing effort, catch rates, and harvest rates (Pollock et al. 1994, Gould et al. 1997). Obtaining a complete census of catch and effort usually is not practical due to time and budget constraints, so managers frequently utilize smaller samples to evaluate some aspects of the fishery (Best and Boles 1956, Gould et al. 1997). Ideally, investigators should have prior knowledge of the spatial and temporal distribution of angling effort in order to design a valid survey (Pollock et al. 1994). However, because catfish fishers often fish at night, from private shore locations, and because those utilizing passive fishing gears often represent a small percentage of the entire fisher population, precise estimates of creel statistics are difficult to obtain (Michaletz and Dillard 1999). Consequently, traditional methods of effort and harvest estimation may not be prudent for riverine catfish fisheries, particularly those with diffuse access points, navigational hazards, and substantial fishing effort at night or with setlines. In such difficult conditions, sometimes it is necessary and even appropriate to accept high variation and low precision in initial exploratory surveys of a fishery (Pollock et al. 1994).

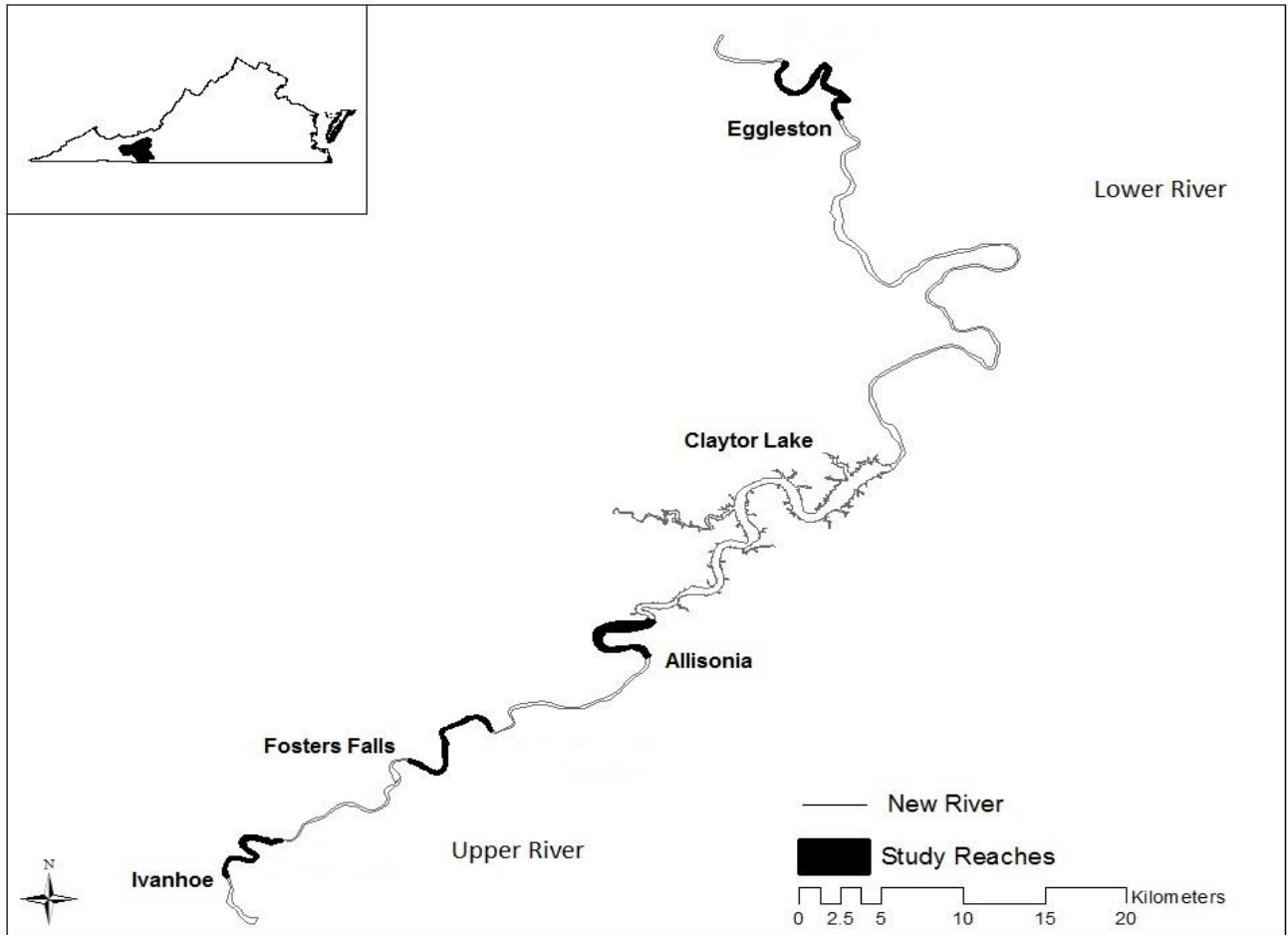
In a fishery with diffuse access, such as the New River, a roving survey is more appropriate than an access-based survey (Pollock et al. 1994) due to the fragmentation of access points and widespread private access to the river. Roving surveys typically utilize either an instantaneous count or a progressive count to estimate angling effort. Instantaneous counts must quickly estimate angler numbers over the entire body of water, whereas progressive counts take place over an extended time period, usually because the fishery spans a large area (Pollock et al. 1994). The probability of intercepting an angler is proportional to the duration of the fishing trip (Pollock et al. 1997), meaning those who fish longer have a higher probability of being surveyed.

Setlines are actively fishing even when the user is not actively tending the line, unlike rod-and-reel users, who are always present when fishing. Setline fishers spend minimal time on the water setting and running lines, therefore any sort of roving survey designed to intercept and interview setline fishers directly (while they fish) is impractical, due to extremely low probability of encountering these fishers. Surveying crepuscular time periods presents additional logistical problems, in addition to physical hazards of surveying; these fisheries may be better sampled using other methods, such as mail or telephone interviews (Pollock et al. 1994).

Study Area: New River, Virginia

The New River originates in Watauga County, North Carolina, and flows northeast into Virginia. Claytor Lake Dam, a hydroelectric facility operated by Appalachian Power Company, impounds the river near Dublin, Virginia, forming 1,874-ha, 34-km-long Claytor Lake. Below Claytor Lake, the river flows north into West Virginia, where it is impounded by Bluestone Dam, operated by the U.S. Army Corps of Engineers. The headwaters of Bluestone Lake reach the Virginia-WestVirginia border near the town of Glen Lyn, Virginia. Popular uses of the New River in Virginia include fishing and other recreation such as kayaking, canoeing, swimming, and tubing. The study area for this project encompasses the New River from Ivanhoe, VA downstream to the area near Eggleston, VA (Figure 1.1).

Figure 1.1. Map of the general study area with specific study reaches. The term “upper river” refers to the reach of the New River (within Virginia) upstream of Claytor Lake, and “lower river” refers to the reach of river downstream of Claytor Lake Dam.



Although the literature contains scant reference to the participation rate, effort, and catches of setline users, several estimates of setline fisher proportions exist, at various spatial scales. The 2009 VDGIF statewide mail survey obtained responses from 2,280 fishers, 144 of whom primarily fish the New River or Claytor Lake. Only 15 of these 144 fishers (10.4%) indicated that they had ever used setlines, almost double the setline usage rate (5.6%) of all

respondents statewide (VDGIF, unpublished data). The percentage of fishers utilizing passive fishing gears on the New River is comparable to fishers in eastern Oklahoma streams (9.7%, Fisher et al. 2002), statewide in Missouri (13%, Reitz and Travnichek 2004), and among fishers living in the Mississippi River drainage who subscribed to a popular catfishing magazine (9%, Arterburn et al. 2002).

Most of the fishing effort on the New River focuses on smallmouth bass, muskellunge, and walleye. New River anglers in Virginia targeting smallmouth bass have become much more catch-and-release oriented in the past 30 years, with the implementation of slot limits and the emergence of a trophy bass fishery (Austen and Orth 1984, Copeland et al. 2006). The New River is one of the top rivers nationwide for smallmouth bass fishing, and the best place to catch trophy muskellunge and walleye in Virginia: the river lays claim to the state record for all three species, and produces more “citation” smallmouth (> 508 mm in length) and muskellunge (>1,016 mm) than any other water body in Virginia (Copeland et al. 2006). The New River supports a thriving guided fishing industry for three game fish species: smallmouth bass, muskellunge, and to a lesser degree, walleye. Some of these outfitters and anglers have concerns about the prevalence of setlines in the New River. Some feel that setline users disproportionately (and illegally) harvest these three game fish species, illegally use game fish for bait, are a safety hazard for fishermen, swimmers, and boaters, and are not an acceptable recreational fishing technique (G. Palmer and J. Copeland, VDGIF, personal communication). Consequently, setline fishers may use setlines clandestinely in order to avoid conflict with other river users (G. Palmer, VDGIF, personal communication, B. Dickinson, personal observation).

Setline regulations vary depending on waterbody in Virginia. Setlines are legal statewide in Virginia, except in VDGIF-owned lakes. Although use of live bait on setlines is prohibited in

most of Virginia, regulations permit live bait use on setlines in the New River (Carroll, Giles, Grayson, Montgomery, Pulaski and Wythe counties), and in the Clinch River (Russell, Scott, and Wise counties). These regulations stem from local legislation during the 1960s (VDGIF 2009).

Few quantitative data exist to assess New River catfish populations or setline fishing effort. While VDGIF conducts standardized sampling for popular walleye, smallmouth bass, and muskellunge in the New River, they do not have standardized procedures for sampling catfish. Although most New River fishing effort is for smallmouth bass, limitations in creel sampling likely underestimate targeted catfish effort. Recent creel surveys conducted by VDGIF show the majority of New River daytime angling effort (>80%) directed toward smallmouth bass (J. Copeland, VDGIF, personal communication). However, standard VDGIF creel surveys do not adequately sample catfish fishers, missing those that fish at night or use setlines. Consequently, VDGIF has few data on setline fisher effort and harvest. Without even basic information on setline effort, VDGIF cannot consider the need for or the applicability of harvest regulations or other management strategies for the New River.

Preliminary Investigation of New River Setline Fishing

Prior to finalizing my study objectives, I conducted an informal investigation into the New River setline fishery during summer of 2010. I conducted this investigation to obtain basic knowledge of New River setline fishing methods, identify emerging themes and concepts worthy of further investigation, clarify study objectives, and identify areas of the New River with high setline use. I spoke with biologists, sporting goods store owners, campground owners, setline fishers, and fishing guides. I asked questions regarding setline fishing methods, history, high-use areas, and opinions of how setline fishing coexisted with other New River recreation. I also floated several sections of the New River to look for setlines and become familiar with the area.

I discovered that most New River setline fishers use trotlines and spend little time in the field when deploying their lines. Setline fishers usually bait their lines in the evening and return to check the line very early the next morning. Many users leave their lines unbaited but deployed between fishing trips to save time in retrieving and deploying their lines when they return to fish. Setline fishers prefer live bait but indicated that various other baits such as cut fish, or chicken liver are used by some individuals. Both biologists and New River users believe the bulk of setline fishing occurs above Claytor Lake. Most New River users indicated the majority of setline effort occurs during spring and summer. Several New River users indicated they did not like setlines, and believed them to be a safety threat. Others believed setlines harmed fish populations and were not a sporting method of fishing. I discovered setlines while paddling the river by kayak, although many were difficult to check for ownership, number or type of hooks, and bait, due to heavy anchoring weights.

Study Goal and Objectives

The goal of this study was to characterize the hidden and undescribed setline fishery of the New River. The specific objectives of the study were to 1) characterize the demographics, motivations, and attitudes of setline anglers in the New River, 2) determine the efficiency and selectivity of setlines for catching catfish, walleye, smallmouth bass, and muskellunge in the New River, and 3) describe characteristics of the setline fishery in the New River; particularly the temporal and spatial distribution of effort, amount of effort, bait use, and harvest.

CHAPTER 2: Human Dimensions of Setline Use

Abstract

Setline fishers are not well understood compared to other groups of anglers. Describing setline fisher motivations, attitudes, and opinions is essential if they are to be adequately represented in fisheries management of the New River, managed primarily for smallmouth bass *Micropterus dolomieu*, muskellunge *Esox masquinongy*, and walleye *Sander vitreus*. I used a grounded theory approach to interview setline fishers about their fishing habits and techniques, mechanisms for acquiring and transferring setline fishing knowledge, and their recreational motivations. I also explored their opinions of the fishery, regulations, and conflicts with other river users. Setline fishers on the New River are generally poorly-educated, and some may be socioeconomically disadvantaged. Setline fishers place high importance on catch- and harvest-related factors, even though they exhibit several characteristics of highly-specialized anglers. They may rely on harvesting catfish *Ictaluridae* for varying degrees of sustenance to their diet or income, and feel that setline fishing is part of their heritage activity and way of life. Although setline fishing appears to have been a family-oriented activity in past years, it is now primarily a solitary activity with little supporting social network. Setline fishing appears to be declining on the New River. Major reasons for this perceived decline include improving socioeconomic well-being of the region compared to the mid-1900s, increased non-consumptive use of the New River, greater law enforcement presence, and failure of older generations to pass down the setline tradition to their offspring, who may be more interested in screen media than the outdoors.

Introduction

Catfish fishers have historically been poorly represented in fisheries management processes compared to other fishing groups. Communicating effectively with catfish fishers can be difficult (Schramm et al. 1999), especially because catfish fishers tend to respond to mail surveys at lower rates than other types of anglers (Bray 1997, Schramm et al. 1999). Additionally, standard daytime creel surveys often fail to capture catfish fishers, because many of them fish at night, from shore, or with passive gears, or even by hand (Michaletz and Dillard 1999). Lastly, there are few organized catfish fishing clubs, and none of the size or notoriety of widely-known groups representing other fish species, such as B.A.S.S or Trout Unlimited. These factors lead to underrepresentation of catfish fishers in the management process (Michaletz and Dillard 1999).

Numerous studies shed light on the human dimensions of catfish fishers (e.g., Wilde and Reichers 1994, Wilde and Ditton 1999, Burlingame and Guy 1999, Schramm et al. 1999, Salazar 2002, Morgan 2006, Steffen and Hunt 2011). Catfish fishers generally could be described as rural, middle-aged, male, low-tech fishers who fish from shore at night, and are more harvest-oriented than other angler groups (Michaletz and Dillard, 1999, Schramm et al. 1999, Wilde and Ditton 1999, Reitz and Travnichek 2004). Catfish anglers have lower education and income levels than other species-specific anglers (Schramm et al. 1999, Burlingame and Guy 1999). However, despite often being thought of as low-tech, harvest-oriented generalists fishing for bottom-feeding fish, catfish fishers may exhibit high degrees of specialization (Gill 1980). Therefore, some fisheries managers are beginning to realize no “average catfish angler” exists (Schramm et al. 1999). Distinct catfish subcultures may exist (Gill 1980, Wilde and Reichers 1994, Wilde and Ditton 1999, Morgan 2006), possibly because catfish are somewhat unique

among popular North American freshwater sport fish and catfish fishers may pursue catfish with several different fishing gears and methods. In addition to those angling with rod and reel, other fishers use techniques such as hand-fishing (“noodling” or “hand grabbling”), jug lines, trotlines, limb lines, and other passive fishing techniques not usually legal for catching game fish such as black basses *Micropterus*, walleye, pikes *Esocidae*, and trout and salmon *Salmonidae*.

Catfish fishers have wide variation in preferred fishing gear and technique, species of catfish sought, consumptive attitudes, and support for management activities (Gill 1980, Schramm et al. 1999, Arterburn et al. 2002, Reitz and Travnicek 2004). Even at high levels of specialization, catfish fishers generally oppose restrictive regulations and are harvest-oriented (Schramm et al. 1999, Wilde and Ditton 1999, Morgan 2006), which contrasts catfish specialists with other species-specific angling groups (Bryan 1977, Chipman and Helfrich 1988, Hahn 1991). However, Arterburn et al. (2002) found that 65% of subscribers of the specialized magazine *Catfish In-Sider* supported stricter harvest limits and supported creating trophy fisheries for blue catfish *Ictalurus furcatus* and flathead catfish *Pylodictis olivaris*.

Although a growing body of human dimensions literature exists for rod-and-reel catfish fishers, and to a lesser degree, hand fishers, little information exists on setline fishers. Available studies suggest setline fishers generally are more harvest-oriented than other catfish fishers (Quinn 1993, Boxrucker and Kuklinski 2008). Some New River fishermen and fishing guides disparage setline fishers, who they feel are “meat hunters,” bordering on commercial or subsistence fishermen, rather than recreational fishers (J. Copeland, VDIGF, personal communication). Some New River users feel that setlines are not acceptable recreational fishing gears, though setline fishers may view them as important and traditional fishing methods (Dickinson 2013, Chapter 1 of this thesis, G. Palmer, VDGIF, personal communication). In this

regard, setline fishers also share similarities with another small, sometimes controversial catfish fisher group: hand fishers, also called “noodlers” and “hand grabblers” (Baker 2009). Sixty-seven percent of hand fishers in Missouri also fished with setlines (Morgan 2008), although hand fishers appear to be less harvest-oriented than catfish fishers in general (Morgan 2006, Baker 2009). Both groups are predominantly male, rural fishers that rely on social networks to pass on their preferred fishing technique (Salazar 2002, Reitz and Travnichek 2004, Morgan 2008). Setline fishers and hand fishers may practice their activity clandestinely due to conflicts with other user groups.

Individuals that emphasize harvest-related experiences over non-catch aspects, such as relaxation and socialization, could begin to approximate subsistence or commercial fishers, despite participating in a recreational fishery (Wilde and Ditton 1999). Distinguishing between subsistence and recreation may be difficult in rural communities (Glass et al. 1990), but may have significant implications for managers trying to regulate setline fishing, particularly when fisheries with a potential subsistence component exist in a water body such as the New River, which is primarily managed for recreational rod-and-reel fishing for smallmouth bass *Micropterus dolomieu*, muskellunge *Esox masquinongy*, and walleye. Fisheries managers increasingly recognize that they must identify and include many stakeholders, including specialized fishing subcultures (Morgan 2006), and often they seek to satisfy multiple groups, each with their own set of values and expectations (Hahn 1991). Therefore, fisher satisfaction must be central to decision-making processes of fisheries management agencies (Wilde and Ditton 1999), otherwise agencies may fail to provide the variety of fishing opportunities needed to meet stakeholder demands (Fedler and Ditton 1994).

Setline fishers may differ from other angling groups in opinions on management, hold different values regarding catch-related attitudes, fish consumption, or feel strongly about cultural and traditional fishing methods. Some setline fishers may be driven by subsistence fishing needs, as well as recreational and cultural motivations. This lack of information about setline fishers led me to ask several questions regarding setline fishing in the New River, for example:

1. Is setline angling in the New River and elsewhere mainly a subsistence fishing activity, a heritage activity, a recreational sport, or combination of these and other factors?
2. Who are the people that use these passive fishing gears, and what does setline fishing mean to this group of people?
3. How much conflict (both real and perceived) occurs between user groups?

When little is known about a particular topic, or the researcher wishes to determine the scope of an issue, qualitative approaches such as focus groups and interviews can provide an excellent exploratory base from which to advance research (Barbour and Kitzinger 1999). Qualitative techniques can be relatively inexpensive (Baker 2009) for surveying relatively rare, hard-to-define social groups or events with no defined sample frame (Biernacki and Waldorf 1981). In the fisheries field, individual interviews of fishers can provide valuable information such as fisher habits, gear use, long-term efficiency trends, and catch rates (Neis et al. 1999). Using qualitative nonprobability sampling to explore fishing habits and catch-related attitudes among different fisher groups serves as a platform for further research (Baker 2009, Steffen and

Hunt 2011); such information has the potential to improve management decisions and acceptance by fishers (Neis et al. 1999).

Grounded theory methods are ideal qualitative methods for improving understanding of the human dimensions of a small, relatively unstudied population, such as setline fishers. Grounded theory methodology is an inductive inquiry known as “interpretative interactionism”, a research method in which the researcher engages with subjects to develop an understanding of their values, perceptions, and social processes (Denzin 2001). Using interpretive methodology, the researcher collects data concurrent with development of hypotheses and theories (Dellabio 2003), which is somewhat backwards from most deductive scientific methodology (Babbie 1991). Grounded theory and interpretive interactionism allows for the researcher to explain people’s behavior in the context of their own worldviews and perceptions (Denzin 2001), rather than from context derived from values and beliefs of the researcher, which is particularly valuable when investigating complex questions of human behavior (Dellabio 2003). The grounded theory process involves collecting data through conversation and semi-structured interviews (Dellabio 2003). Data collection and analysis are concurrent, which allows researchers to remain adaptive and refine data collection to further pursue and develop theories and concepts as they present themselves (Polit and Hungler 1997). Since data collection and analysis are concurrent, and the goal of grounded theory is to reveal theories implicit in data (Glaser 1992), researchers must keep an open mind to avoid conflating their lived-world with that of interview subjects. Following each interview, researchers take notes, code data, and then sort and link information and concepts to fully describe a phenomenon (Glaser and Strauss 1967, cited by Dellabio 2003). Codes are used to compare interviews; constant interview-to-interview comparison is a major tenet of grounded theory (Dellabio 2003). Although coding generally

involves identifying and quantifying frequently-used terms and phrases, the goal of coding is not quantitative measurement (Polit and Hungler 1997). Rather, researchers use codes to identify common themes and concepts, and link them together in a theory. Data collection ceases when no new concepts arise, a point at which the description and theory are considered saturated, or “thick.” Thick descriptions present context and multi-faceted meaning through capturing the feelings and values of people through interactive data collection and interpretation (Denzin 2001).

Properly investigating the social processes of a group first requires identification of individuals belonging to the group, and then effectively sampling within that group. When researchers have access to a convenient sample frame such as recreational license holders, identifying and gaining access to a particular fishing subgroup may be simple. However, some subgroups are not easily sampled using a license frame, such as the case of hand fishers and setline fishers, activities which generally require no special fishing license. One particularly useful way to identify and sample individuals of a subgroup is the “snowball” technique, appropriate for sampling hard-to-reach populations, social events that are uncommon or not readily visible, or in situations with no defined target population (Biernacki and Waldorf 1981). Snowball techniques result in samples that cannot be generalized to entire populations, but are appropriate when seeking baseline information about a group for further research or management actions (Baker 2009). The snowball technique obtains a sample of individuals through referrals by members of a particular social group. Usually the sample consists of group “insiders” who share certain characteristics; these insiders may serve as de facto research assistants by referring researchers to other group members (Biernacki and Waldorf 1981). Snowball sampling

techniques have been successfully used to sample catfish hand fishers, a group that shares several characteristics with setline fishers (Morgan 2006, Baker 2009, Steffen and Hunt 2011).

The goal of this study was to provide baseline knowledge to increase VDGIF knowledge of the attitudes, opinions, and motivations of setline fishers. By characterizing setline fishing habits and describing the human dimensions of setline fishers, my study provides much-needed information to VDGIF that will guide future management decisions in the face of potential conflict between setline fishers and other users of the New River, changing cultural values, and changing fish populations, both in the New River and statewide. Armed with basic knowledge of setline fisher attitudes, fishing habits, motivations, and opinions, VDGIF can better communicate with all fishermen and user groups on the New River and make more informed policy and management decisions.

Methods

I obtained approval of study methodology from the Virginia Tech Institutional Review Board (approval # 10-454) prior to the interview process. Initial survey contacts were from individuals encountered during my initial exploration of New River setline fishing (Dickinson 2013, Chapter 1, this thesis), from marked setlines discovered in the field, and from setline fishers known to VDGIF biologists. I contacted potential interviewees by phone or in person and asked if they would participate in a short interview regarding fishing with setlines. Before each interview, I explained the study purpose and assured participants that any information gathered was confidential. I chose not to audio-record interviews, because of concerns that it might prevent me from obtaining consent of individuals already hesitant to speak with me. Upon

consent, I engaged them in a semi-structured interview lasting approximately 30-45 minutes. Interviews flowed as a conversation rather than strictly following the survey instrument, which allowed interviewees to answer many questions with their own context, rather than being asked a scripted question. At the conclusion of the interview, I presented each individual with a custom baseball cap that said “New River Catfish” below a depiction of a flathead catfish. I then asked them if they knew any other individuals who used setlines or had used them in the past. In this way, I built a “snowball” sample by expanding my setline user network.

The survey instrument and interview framework contained 35 questions. Initial questions were simple and open-ended, so that interviewees would feel comfortable talking about fishing and setlines before delving into potentially sensitive issues. These initial questions focused on setline fishing habits, such as preferred bait type, number of hooks per line, how often they used setlines and which months they preferred to use setlines, and how many catfish they caught per setline. These mostly-quantitative questions were designed for use in estimating setline effort and catch in conjunction with a creel survey; results from this question subset are reported in Chapter 3. A set of closed-ended questions explored species and gear preferences and overall avidity of setline fishers: interviewees checked off fish species targeted, the proportion of fishing time spent pursuing each species, and the respective gears with which they were targeted. To investigate motivations for setline fishing, a short section asked interviewees to rank various motives for using a setline on an ordinal scale. Another set of questions was designed to investigate the social aspect of using setlines, exploring the means by which interviewees learned to use setlines, if they had taught any others to use setlines, and if they knew others who fished with setlines. To investigate the subsistence nature and harvest preferences of setline fishers, I asked what size catfish they preferred to harvest, how many meals of New River fish they ate,

and if they were aware of any consumption advisories. I also gathered opinions regarding regulations, conflict, and status of the fishery. Finally, I asked several questions to gather information on demographics.

During and after each interview my undergraduate research assistant and I recorded answers to questions, and each of us made notes on our overall impression of the interviewee (including but not limited to how truthful we believed the interviewee to be, observations about their lifestyle and knowledge of fishing, fish identification, and interesting quotes or other observations), in addition to noting important concepts, themes, quotes, and takeaways from the interview. Interview data and notes were analyzed for common themes using the grounded theory approach: comparing interviews using coded terms and phrases, and using these codes to develop concepts and link them together to synthesize and explain human dimensions of setline use. As such, the results presented below are not typical of quantitative studies. They rely on answers and quotes supplied by subjects, and theories developed from linking important phrases and concepts that arose throughout the interview process.

Results and Discussion

Setline users were difficult to track down. Many lived in seasonal campgrounds, and some had no listed phone number or mailing address. Additionally, many of the referring individuals only knew the referred individual by a nickname, and did not actually know the person's full name or place of residence. I interviewed 39 setline users: 24 active setline users and 15 lapsed users (had not used setlines in the previous two years). Active setline users averaged 50 years of age (range 19-80, $SD = 19$); lapsed users were older, averaging 60 years old

(range 48-68, SD=7). Setline anglers were generally poorly educated; 51% of individuals I interviewed possessed high school diploma equivalent or lower (Table 2.1). New River Valley anglers (n=124) surveyed in 1999 and 2000 had similarly low levels of education, with 41% holding a high school diploma equivalent or lower (O'Neill, unpublished data), suggesting that education levels of setline users may not differ substantially from other New River Valley anglers.

Table 2.1. Highest education level achieved by setline fishers (n=39 total) interviewed in 2012

Education Level	N
< High School	5
High School/GED	15
Some College	6
Vocational/Associate Deg.	7
4-year Deg.	5
M.S. Deg.	1

Many of the setline users I interviewed were very proud of their outdoors-oriented lifestyle, in large part because of the traditional nature of their activities, and the satisfaction of being self-reliant. “Setline fishing is a way of life” was a recurring phrase during my interviews. Participation in subsistence or sustenance activities provides psychological, social, and cultural values, satisfactions which may be similar to non-catch motivations of other anglers (Glass et al. 1990). Many individuals referred to using setlines as a part of a lifestyle focused on subsistence activities such as gardening, hunting and gathering, and canning and preserving food at home. The sense of self-reliance and ability to provide for oneself are important motivations for subsistence activities and harvest-driven recreation behavior, as well as an important means with which to solidify relationships of kinship groups (Glass et al. 1990).

Setline users I interviewed were very harvest-oriented. Of 39 setline users interviewed, 30 said they choose to use setlines instead of fishing by rod-and-reel because they could catch and harvest more fish using setlines (Table 2.2). Active setline fishers also ranked catch and harvest-related factors highly when asked for their motivations to go setline fishing (Table 2.3). Such a trend is well-documented in the human dimensions literature on catfish anglers: they often rank non-catch motivations similar to other anglers, yet rank catch and harvest motivations higher, and often are less-supportive of restrictive regulations than other angler groups (Fedler and Ditton 1994, Wilde and Riechers 1994, Schramm et al. 1999, Wilde and Ditton 1999). Setline fishers are known to be even more harvest-oriented than catfish anglers (Quinn 1993, Boxrucker and Kuklinski 2008). Active New River setline fishers reported eating an average of 29 catfish meals per year (SD=33), ranging from a minimum of 2 meals/year to a maximum of 125 meals/year. Many setline fishers were unaware of consumption advisories for New River fish, which is cause for some alarm; given that some of these individuals consume fish far in excess of the advised levels. Better outreach and education about consumption advisories may be necessary.

Setline fishing appears to be motivated by both catch-related and non-catch related factors. Despite being very-harvest oriented, New River setline fishers reported obtaining satisfaction from the thrill of the catch. Two users likened the anticipation of checking their trotline to unwrapping presents on Christmas morning, and 12 users mentioned the thrill and enjoyment of checking their setlines (Table 2.2), particularly when targeting large flathead catfish. Differentiating between subsistence and recreation can be difficult in rural communities, where residents may rely on hunting and fishing to enhance their economic well-being and reduce their reliance on the cash economy (Glass et al. 1990). Setline fishers who fish often and

harvest and subsequently eat large numbers of catfish from the New River could be considered subsistence fishermen, despite being governed by recreational fishing policies. Interviews with older setline users indicate that setline fishing was in part driven by subsistence or sustenance needs earlier in their lifetimes. Although the most common reason provided for using a setline was for catching and harvesting catfish, setline users still ranked non-catch motivations highly (Table 2.3), indicating that setline fishing is not a purely subsistence-oriented activity. Fishers who rate non-catch motives highly cannot be considered subsistence fishers, because they seek the same fundamental benefits of fishing as other anglers, such as experiencing nature, thrill of catching a fish, relaxation, and so forth (Wilde and Ditton 1999). Although New River setline fishers are not directly “living off the land” in the true subsistence sense, a better term might be “sustenance,” as they supplement their diet in a significant way with wild-caught fish and game (Hunt and Grado 2010).

Table 2.2. Number of responses by category to the question “What are the reasons why you would choose to fish a setline instead of using a rod and reel?” 39 individuals (15 lapsed setline fishers and 24 active setline fishers) were asked this question. Some individuals supplied multiple reasons.

Why use a setline instead of a rod and reel?	N
Catch/harvest more fish than rod-and-reel	30
For enjoyment/thrill of checking line	12
To avoid staying up late fishing with rod-and-reel	9
Frees up time, minimizes time spent fishing	5

Table 2.3. Mean scores 1-5 (Very Unimportant, Somewhat Unimportant, Neutral, Somewhat Important, Very Important, respectively) reported by active setline anglers when asked what motivated them to go setline fishing.

Motivation	Mean Score	Standard Deviation
To be outdoors	4.67	0.64
Experience of the catch	4.33	0.76
To experience nature	4.21	0.78
For the challenge/sport	4.17	1.17
Harvest for personal consumption	4.04	1.12
Relaxation	3.88	1.12
To catch many fish	3.83	1.24
To be with friends	3.63	1.24
Share knowledge	3.54	1.02
Family Recreation	3.50	1.29
To catch a trophy	3.50	1.41
Social Consumption	3.46	1.50

Despite the tradition of learning setline fishing from a family member, setline use on the New River appears to be a rather solitary activity for many individuals. Many (15 of 24) active setline users reported fishing primarily alone, although several others fished occasionally with one friend or family member when they needed help catching bait or setting a line. Despite such a large proportion of solitary setline fishers, only 5 of 24 active users said family recreation was somewhat or very unimportant when fishing with setlines. Such a result suggests that at one point family recreation was important to their setline fishing experience, but they fished alone at the time of the interview. Most (28 of 39, 72%) New River setline fishers learned to use setlines from a close family member, usually a father, grandfather, uncle, or combination thereof. Many interviewees specifically mentioned the family tradition of using setlines. Family members, particularly fathers, uncles, and grandfathers, are known to be important in both recruitment and retention of outdoor recreation such as hunting, fishing, and shooting (Responsive Management

and National Shooting Sports Foundation 2008), and New River setline fishers are no different. Active setline users who learned to use setlines from a family member were more likely to teach others to use setlines. Of the nine active users who had taught another person to fish with setlines, eight had learned to use setlines from a family member themselves. In contrast, of the 11 active users that had not taught others to use setlines, only three were taught by a family member, the remaining eight users were self-taught or learned from a friend. Clearly, the tradition of setline use is largely reliant on being passed down within a family. Setline users may be similar to hand fishers in this respect, passing their folk tradition down orally within the family from generation to generation (Salazar 2002).

New River setline fishers appear to lack well-developed social networks with other setline fishers. Most setline fisher interviewees knew of either one other setline user or none at all. Although both hand fishers and setline fishers pass down their traditions through familial units, human dimensions literature of hand fishers indicates that, unlike New River setline fishing, hand fishing is a socially-centered activity performed in groups (Salazar 2002, Morgan 2008, Brown 2011). Hand fishing may involve life-long partnerships between fellow hand-fishers, potentially a result of the inherent danger and necessity for teamwork when locating and capturing large catfish by hand (Salazar 2002). In contrast, active New River setline users often fished alone, and although some individuals ranked social factors and family recreation as important, social motivators were relatively unimportant compared to other factors (Table 2.3). Salazar (2002) attributed declining participation in hand fishing for catfish in part to ongoing failure to transmit folk traditions from one generation to another. The same phenomenon appears to have happened or is happening with setline fishing in the New River. Individuals I interviewed nearly unanimously agreed that setline use has declined significantly in recent years, and felt

strongly that failure to transmit the tradition between generations is in large part responsible for this perceived decline of setline use in the New River Valley.

Setline use in the New River appears to be an extremely localized endeavor, which may explain why users did not know many other setline fishers. Most users traveled very short distances to use setlines: 16 of 24 active setline users traveled less than one mile to fish setlines, and 32 of 39 interviewees traveled less than five miles. Only one individual had ever used a setline outside the New River. Most of those I interviewed grew up in the New River Valley, and anecdotes suggested that many had never lived outside their current county of residence. It appears that most dedicated setline fishers live near or on the river itself, and fish setlines in only a small section of river, rarely interacting with other setline users. Setline use on the New River appears to be historically rooted in a subsistence tradition, which may have precluded developing social fishing networks through sharing techniques, fishing spots, or fishing time with non-family members. Other individuals indicated that they used to know several setline fishers, but those individuals have since died, or in two cases, were incarcerated.

Many setline fishers appear to have aged and/or died and have not been replaced with new participants. Comments made by interviewees who were unable to refer us to other setline users included the following (grammar not corrected to preserve authenticity of the statements):

Interviewee #22: "Most guys that done it have passed on"

Interviewee #25: "Trotlining was just our way of life. All people I knew that did it are done gone."

Interviewee #30: "I don't care for game wardens and the law. They locked all my fishing buddies up. One of 'em got 22 years for meth and guns"

Interviewee #34: "All the guys I know that did it are 6 feet under"

Setlines have a well-established family tradition in the New River Valley. Comments regarding the family tradition of using setlines included the following:

Interviewee #10: "Running trotlines was a family thing - my dad, grandpa, uncles did it. We fished all day every day as a kid. We depended on the food, kept everything"

Interviewee #27: "It was a family affair. The uncles built the wood boats, and the boys all trotlined."

Interviewee #32: "[Setline fishing is] a family tradition. My dad did it, my grandpa did it, and my great-grandpa did it"

Lack of recruitment and retention appear to be responsible for declines in setline fishing in the New River. The failure to transmit setline tradition between generations has two main components. First, setline fishers of older generations have discontinued participation or feel marginalized, and subsequently failed to teach younger generations to use setlines. Secondly, younger people in the New River Valley may be less likely to learn how to fish than previous generations, due to more demands on time (organized sports, television, internet, for example) and if they do fish, setline fishers I interviewed suggested they often choose to target smallmouth bass, muskellunge, or walleye instead of catfish.

Lapsed setline fishers primarily cited a "lack of time" as the biggest factor in their decision to cease using setlines (Table 2.4). But what exactly does "lack of time" mean? Family and work obligations generally are the primary constraints to fishing (Fedler and Ditton 2001), and lapsed setline fishers I interviewed frequently mentioned grandchildren and work obligations as factors in their decisions to stop setline fishing. Other recreational activities also conflict with

setline use. With long-term declines in fishing and hunting participation (Outdoor Foundation 2010, U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2012) has come increasing participation in non-consumptive outdoor recreation. For example, despite declining or mostly-stagnant participation in fishing and hunting, recreational kayaking grew 32% nationwide (Outdoor Recreation 2012), and has increased markedly over the lifetimes of New River setline fishers. Many setline users complained that their lines were tampered with by other New River recreationists.

Changing recreational use of the New River may have led to a sense of marginalization by some setline fishers. Setline fisher values such as the deeply-ingrained satisfaction of “living off the land” may conflict with the values of other New River users, such as fishing guides, who primarily practice catch-and-release fishing. Increases in recreational use of the New River, such as kayaking and tubing, were frequently cited by interviewees as barriers to practicing and enjoying setline fishing. Many setline fishers grew up on the river when the area was less-populated, before the existence of businesses renting kayaks and tubes, or fishing guides, and before the New River Trail system was built. Two individuals specifically stated that the New River Trail construction in the mid-1980s allowed game wardens to patrol much more of the river and crack down on illegal fishing. Many of the older setline users - both lapsed and active - have a sense of ownership over the New River, and many individuals complained that the river “ain’t what it used to be.”

At the beginning of this study, one initial conflict item between setline users and other river users was the issue of safety. Fishing guides had frequently voiced the opinion that setlines could hook fishermen, swimmers, and boaters, (G. Palmer, VDGIF, personal communication, B. Dickinson, personal observation) suggesting setline safety was a potential source of conflict

between setline fishers and other river users. However, not one person I spoke with from 2010-2012, including fishing guides, rod-and-reel anglers, or sporting goods store owners, could identify a single incident or injury caused by getting hooked or tangled in a setline. Most setline users in the New River use trotlines sunk to the bottom, minimizing the exposure to other river users. It appears that the safety issue of setlines may be a false argument put forth by individuals who already dislike setline fishing for other reasons. Nevertheless, actions taken by river users to remove setlines in the name of improved safety may contribute to setline fishers feeling marginalized.

Feelings of marginalization may be driving declines in recruitment and retention of setline fishers. The ability of individuals to enjoy the benefits of recreational fishing is tied to their perception of the constraints to participating in their hobby (Fedler and Ditton 2001). Many lapsed anglers (and even some active ones) perceive mounting constraints to enjoyment of setline fishing, such as conflict with other user groups and changing values among other angler groups and younger generations. An example of conflicting fishing methods and changing generational values is best exemplified by one individual who rarely trotline fishes anymore and has not taught his three sons to use trotlines (“why bother teaching them an outlaw fishing method?”), preferring instead to fish for smallmouth bass by rod-and-reel. Another individual complained that setline fishers were treated as “second-class citizens” on the New River. These factors likely amplify decisions to cease setline fishing related to “lack of time” and inhibits desire to recruit other participants to the sport. When their setlines are cut by rod-and-reel anglers (whether due to retrieving tangled lures, or out of malice), and they cannot use their preferred fishing methods without getting targeted by other fishermen or law enforcement, setline users may feel that they are not using fishing methods acceptable to other New River users. When

previously quiet sections of the river are subject to flotillas of college students on inner tubes, or jet-boats full of smallmouth bass and muskellunge anglers, they may feel their sense of place eroding, and that their way of life is less-accepted now than compared to past years.

Various reasons were provided for perceived decline in setline use, mostly centered on the failed recruitment of younger generations and changing socioeconomic factors and recreational values over time. Comments included the following:

Interviewee #3: "People that trotlined have died out and didn't pass it down. Increasing recreational traffic is displacing trotlines too"

Interviewee #5: "Kids don't get into [fishing with setlines] nowadays - they got internet, cable TV. I can't find kids to help me out with bait because they're too busy looking at dirty things on the internet. And the old timers have died out"

Interviewee #6: "It is a generational thing - the younger generation is the fast food and computer generation. Knowledge of trotlines hasn't been passed down"

Interviewee #16: "People don't have the know-how, people just as soon buy fish from the store, don't want to mess with doin' it themselves"

Interviewee #18: "Kids are distracted with so many activities these days. [Setline fishing] is a dying art, the same as gardening. Used to be everybody had a garden behind their house, now maybe 1 in 20 has one"

Interviewee #21: "The younger generation lost interest, nobody showed them how to trotline, kids are drinking and doing drugs rather than fishing"

Interviewee #25: "Fishing is hard work - people don't want to do it anymore. People are too busy, and they haven't been taught how to trotline, so they just don't know how"

Interviewee #36: "Trotlines are an old-school way of fishing that people don't use any more. People around here used to grow, catch, and shoot all their food. Now they don't"

Table 2.4. Frequency of reasons cited for ceasing to fish with setlines (n=15 lapsed setline fishers)

Reason for Stopping	n	%
Not enough time	8	53.2
Increased recreational traffic	4	26.7
Regulations and enforcement	3	20.0
Fewer catfish	3	20.0
Prefer fishing for other fish	2	13.3
Health advisory on catfish	2	13.3
No longer rely on catching fish to eat	2	13.3
Too hard to catch bait	2	13.3

Setline fishers strongly believed that younger generations are not interested in outdoor recreation, much less setline fishing. Many individuals stated that the prevalence of television and the internet contributes to younger generations' declining interest in fishing. Their observations are echoed in the literature. Schoolwork and preference for screen media combine to keep children and young adults inside and inhibit participation in outdoor recreation (Outdoor Foundation 2010). Television, internet, and organized sports may now occupy leisure time of children and teenagers that, in the past, would have been available for fishing (Salazar 2002). The ubiquity of videogames, internet, smartphones, and cable television are oft-lamented by those in the natural resource profession. Alarming decreases in youth participation in outdoor recreation and nationwide declines in fishing and hunting during the 1990s and 2000s (Outdoor Foundation 2010, U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2011) frequently are tied to the pervasiveness of technology. Preference for spending free time using screen media was cited by 15% of 6-12 year olds, 27% of 13-17 year olds, and 20% of 18-24 year olds when asked what drove their decision to not participate in outdoor activities (Outdoor Foundation 2010). The concept of technology

being part of a number of factors “stealing” time from outdoor recreation and leading to a general disconnect with the outdoors has been referred to as “nature deficit disorder.” As children spend more and more time inside playing video games, using the internet, and watching television, they become further disconnected from nature, and less likely to pass down an interest in nature to their offspring, which becomes a self-perpetuating cycle (Louv 2005).

Some of the setline users I interviewed believed that improvement in socioeconomic fortunes in the New River Valley is responsible for decreasing participation in subsistence activities such as gardening, hunting, and fishing. According to many of my interviewees, the New River valley was very socioeconomically disadvantaged decades ago. Three individuals stated that they relied on supplementing their income by selling catfish caught on setlines during the 1960s and 1970s, and several other interviewees mentioned that this practice was not uncommon up until the 1970s and 1980s. One individual remarked that his family traded catfish for flour and sugar, and sold furs to pay for dental work when he was a child. Several users said they no longer used setlines because it was simpler and cheaper to buy fish from the store, and they no longer had a need to supplement their diet with wild-caught fish. Two individuals stopped using setlines because of consumption advisories, suggesting that they are both aware of the potential negative consequences and can afford to remove wild-caught catfish from their diet. Others pointed out the dwindling numbers of households that kept gardens, canned their own food, hunted, and trapped, as influences from nearby Virginia Tech grew and the economy of the area improved.

Changes to the economy, demographics, and New River management strategies also appear to be changing values of the fishing public. New River anglers increasingly desire trophy smallmouth bass opportunities, and fewer anglers are harvest-oriented compared to years past

(O'Neill 2001, Copeland et al. 2006). New River smallmouth bass slot length limits were implemented in 1987 and adjusted in 2003 to improve size structure, creating a widely-known fishery that lead to an increasing catch-and-release ethic and angler self-regulation (Copeland et al. 2006). Several setline fishers pointed to the smallmouth fishery as siphoning off prospective setline fishers, saying their children fished, but preferred to target smallmouth bass. The wide acclaim of New River smallmouth bass fishing, combined with the proliferation of fishing media, such as television shows, fishing magazines, and internet fishing forums and websites, may direct new anglers toward rod-and-reel fishing for bass, rather than toward setline fishing, particularly in the absence of a family member who fishes with setlines.

Dismissing setline fishers as unspecialized simply because of their harvest-oriented nature or lack of expensive fishing equipment would be a mistake. The concept of setline fishing as a way of life suggests it may be central to the lives of some individuals. These individuals might be considered specialized fishers, or “insiders.” Insiders participate in their sport with long-term commitment, through good times and bad (Ditton, Loomis, and Choi 1992). Dedicated New River setline fishers (fish >50% of the time with setlines) exhibit several of the characteristics of highly-specialized anglers described by Bryan (1977): they fish often, with specific techniques often refined through years of experience, and may switch their targeted species or techniques seasonally. However, these individuals did not go on vacation specifically to fish in faraway places, and did not possess large amounts of expensive recreational equipment such as high-end fishing rods and/or boats – qualities Bryan (1977) considered typical of highly-specialized fishermen. Many of the older gentlemen I interviewed made and fished out of wooden boats propelled with a wooden pole, and the majority of setline users made their own setlines – potential indicators of high specialization, despite the “low-tech” nature of their gear.

Chipman and Helfrich (1988) described a subgroup of Virginia anglers that fished frequently, yet was more harvest-oriented than expected according to the concept of angler specialization. These anglers were more likely to hail from rural areas, and were less educated than non-consumptive angler groups. Such findings suggest that low socioeconomic status may prevent individuals from progressing along the recreation specialization continuum (Bryan 1979, Chipman and Helfrich 1988).

Setline fishers demonstrated poor awareness of fishing regulations, although had slightly better awareness of consumption advisory for catfish. Less than half of active setline fishers were aware of the specific consumption advisory details for catfish, and many that were aware do not conform to the advisory. However, two lapsed individuals stated they stopped using setlines in part because of the consumption advisory, suggesting that promotion of the advisory may work as intended. Only one individual had a firm grasp of all setline regulations for the New River. Although 10 of 24 active setline fishers said they were dissatisfied with current regulations, most of these individuals expressed dissatisfaction with nonexistent regulations when asked which specific rules they disliked. Support for regulations is directly tied to anglers' perception of how their fishing experience will change as a result of the new regulation (Wilde and Ditton 1999). Since catfish fishing and setline fishing have never been strictly regulated in Virginia, it should not be surprising that many setline fishers are opposed to further regulation, even if they do not fully comprehend the regulations already in place. Many setline fishers expressed some distrust of government in general, which might also contribute to anti-regulation attitudes. A slim majority (54%) of active setline users were satisfied with regulations. Those who wanted regulations changed (41%) overwhelmingly wanted the option to use game fish such as sunfishes (*Lepomis* spp.) and smallmouth bass as bait. Four users (17%) wanted more restrictive

regulations (reduced bag limits, strict hook limits) on setlines and/or harvest of catfish; these individuals were younger (mean age = 32.5) compared to the average age of other active setline users (49.6 years), possibly indicative of changing values between generations. Perhaps these individuals grew up with the dramatically-improved New River smallmouth fishery, populated with self-regulating anglers touting the benefits of catch-and-release (Copeland et al. 2006), and had higher exposure to conservation-oriented values. Two of these individuals were currently enrolled in college and another possessed a double-major degree from a four-year institution; perhaps higher education levels also play a part in desiring more conservation-oriented regulations.

This study provides a foundation for further understanding the human dimensions of setline fishers. Themes quickly emerged during interviews, and reached saturation quickly, at which point responses were very predictable and consistent. However, since I used the snowball method, care must be taken when applying these results to other populations. Individuals who fish with setlines infrequently probably are lesser known to the “setline insider” community that I interviewed, hence I may not have been referred to occasional setline fishers as frequently as I was to dedicated individuals. For example, a small number of the individuals I interviewed had only used a setline once or twice in their lifetime, either with friends, on a camping trip, or just because they were curious about the technique. Such occasional setline fishers may have different fishing habits, preferences, and motivations than dedicated setline fishers. Nevertheless, my study suggests a number of characteristics of setline fishers that should prove useful for managing or studying this fishing subgroup. Setline fishers place high importance on catch- and harvest-related factors, even though they exhibit many characteristics of highly-specialized anglers, who generally are less catch-motivated than other angling groups. Setline fishers may

rely on harvesting fish for varying degrees of sustenance, and feel that setline fishing is a heritage activity that is part of a larger way of life, both now and in the past. Setline fishers in the New River Valley generally are poorly-educated, and some may be socioeconomically disadvantaged. They may not be aware of consumption advisories and are not very knowledgeable about fishing regulations. Most of them favor even fewer regulations governing setline fishing, particularly desiring the ability to use game fish as bait. Although setline fishing appears to have been a family-oriented activity in past years, it may now be a solitary activity with little supporting social network. Although setline fishing appears to be culturally-important to some New River Valley residents, that group is dwindling, and not recruiting new users into the tradition. Reasons for the decline of setline fishing may be changing generational values of New River Valley residents, improving socioeconomic well-being, increasing recreational use of the New River, and reasons that mirror the nation-wide trend of declining participation in consumptive recreation. Decline of setline fishing likely will continue in the future, which may reduce conflict between setline fishers, fishing guides, and other New River users.

CHAPTER 3: Catch Rates, Selectivity, and Directed Effort of Setlines on the New River

Abstract

The New River, Virginia, supports a poorly understood setline fishery for catfish *Ictaluridae* that coexists with a popular recreational and trophy fishery for smallmouth bass *Micropterus dolomieu*, muskellunge *Esox masquinongy*, and walleye *Sander vitreus* (game fish). Virginia Department of Game and Inland Fisheries (VDGIF) managers need information about the setline fishery on the New River in order to properly manage all fish species and those who fish for them, however standard daytime creel surveys often do not adequately measure setline effort. I estimated setline effort by interviewing setline fishers and conducting modified roving creel surveys. I also conducted experimental fishing trials to characterize setline catch rates for catfish and by-catch of game fish. Setline effort was highest during June-August of 2011, and declined significantly by late-September. Several dedicated setline users accounted for a significant portion of total setline effort. Experimental setlines baited with live bait proved an effective method for catching catfish, but caught few game fish. Estimated by-catch of game fish from setlines was small compared with catch by rod-and-reel anglers. My results suggest that setline by-catch of smallmouth bass is not as substantial as perceived by some river users. However, setlines have the potential to cause significant mortality of walleye during fall and winter in the upper New River. Given the recent efforts of VDGIF to bolster native New River walleye stocks upstream from Claytor Lake and the high hooking mortality of walleye during experimental trotline fishing, I recommend that VDGIF consider quantifying fall and winter setline catch of walleye and consider prohibiting setlines during fall and winter in portions of the upper New River to protect walleye stocks.

Introduction

Trotlines, limblines, and juglines (collectively referred to as setlines) are passive fishing gears used primarily to target catfish. Standard creel surveys often do not adequately measure directed catfish effort and catch, particularly that of setline users. Few studies exist estimating recreational setline effort or catch rates, likely due to logistical problems with surveying setline fishers, and because catfish have historically received lower management priority than other species (Michaletz and Dillard, 1999).

The New River, Virginia, supports an undescribed setline fishery for channel catfish *Ictalurus punctatus* and flathead catfish *Pylodictis olivarius* in addition to recreational and trophy fisheries for smallmouth bass, muskellunge, and walleye. Some New River users, such as campground owners, paddlers, and fishing guides have voiced negative opinions regarding setlines (J. Copeland, VDGIF, personal communication, Dickinson 2013, Chapter 1 and 2, this thesis). Perceived social conflict between setline fishers and their critics, in addition to concern for potential overexploitation of New River fish populations led to a desire on the part of VDGIF to improve understanding of the setline fishery on the New River.

Although catfish contribute substantially to the New River fishery, VDGIF knows little about catfish populations and even less about setline fishers. For instance, how much setline effort occurs, and is there a seasonal nature to setline fishing effort? How selective are setlines for catfish, and does bait type affect selectivity or efficiency of setlines? What are setline catch rates? Is by-catch of game fish a management issue? Although anecdotal evidence provided by catfish fishers suggests reduced catfish populations compared to years past, VDGIF lacks reliable information on the population status of catfish in the New River.

Bait choice and type of setline may influence catch rates and composition. Preliminary investigations of setline use in the New River suggested that trotlines comprised the majority of setline effort (Dickinson 2013, Chapter 1, this thesis). Studies of commercial trotline catches in Kentucky, Alabama, and Tennessee generally consisted of 90% or more catfishes, and less than 4% of game fishes (Sanderson 1961, White 1961, Johnson and Timmons 1989, Timmons et al. 1989), most commercial trotlines are usually baited with cut fish or dead baits not likely to attract piscivorous game fish; hence impact on these populations is negligible (Johnson and Timmons 1989). However, live bait is legal on trotlines in the New River, and initial exploration of the fishery showed New River trotline fishers prefer live bait (Dickinson 2013, Chapter 1, this thesis). Piscivorous game fish such as smallmouth bass, walleye, and muskellunge might be more susceptible to setlines baited with live fish, compared to dead baits.

Setline by-catch and mortality of game fish, turtles *Chelonii*, and other animals such as hellbender salamanders *Cryptobranchus alleganiensis* are potential management concerns. Freshwater trotlines are known to catch diving ducks *Aythya* in some areas (Turnbull et al. 1986). Ghost fishing (i.e., abandoned or lost setlines) may account for substantial mortality in commercial riverine fisheries (Bettoli et al. 2009) and, although difficult to quantify, likely occurs to some extent in recreational fisheries. Angling guides in the New River have reported finding large dead walleye and smallmouth bass on abandoned setlines, and VDGIF officials have observed dead snapping turtles *Chelydra serpentina* on abandoned setlines (G. Palmer, VDGIF, personal communication). Some New River smallmouth bass anglers, fishing guides, and other non-consumptive users feel that setlines are responsible for a disproportionate amount of smallmouth bass harvest and do not consider setlines to be recreational fishing gear (G. Palmer, VDGIF, personal communication).

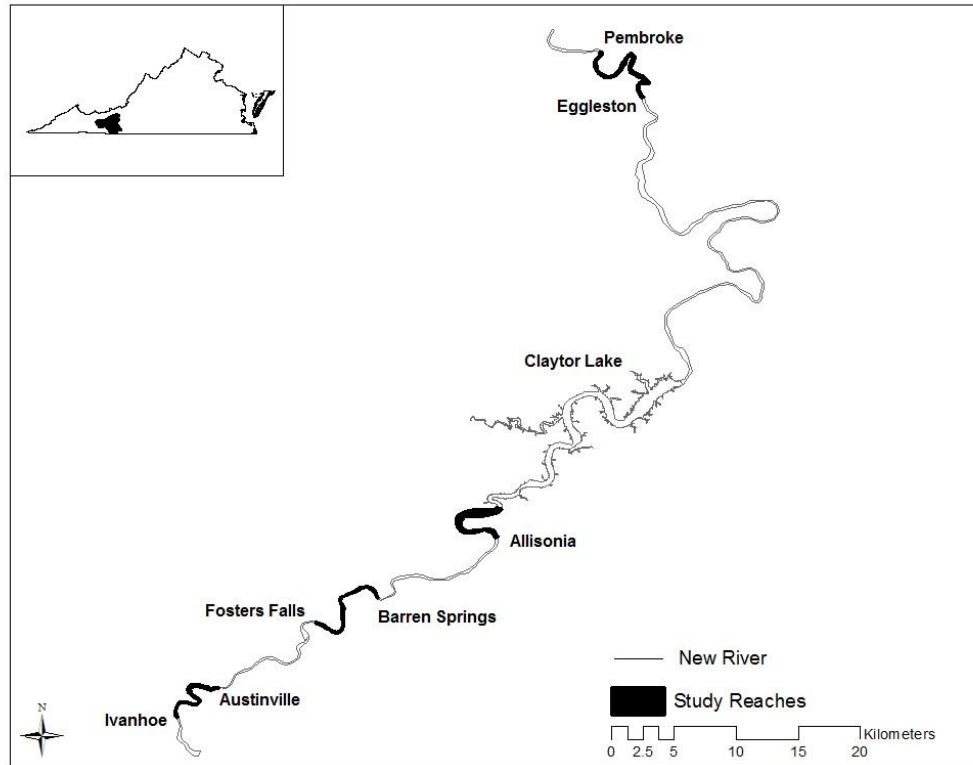
If setlines indeed catch many game fish, VDGIF might want to regulate setlines to mitigate effects on these highly-desired species. Knowing how much setline effort occurs, what setlines catch, and how much they catch will assist VDGIF with future management decisions. This study used experimental fishing to determine catch rates of catfish and by-catch, and an effort survey to characterize effort and estimate setline catch.

Methods

Effort Survey Methods

I chose four river reaches to conduct an effort survey and experimental fishing trials (Figure 3.1). River reaches are identified by the name of their respective boat launches: Ivanhoe (Ivanhoe boat launch downstream to the Austinville boat launch), Foster Falls (New River State Trail State Park boat launch at Foster Falls downstream to the Route 100 bridge-crossing), Allisonia (Allisonia boat launch downstream to the Sloan Branch/Waterfront Farms area of Claytor Lake), and Eggleston (Eggleston Campground boat launch downstream to the Pembroke boat launch). I selected these sites after soliciting information regarding setline fishing “hotspots” from regional fisheries biologists and from river users interviewed in 2010 during preliminary setline surveys.

Figure 3.1. Map of study area and specific study reaches on the New River.



I estimated effort using a combination of on-site field surveys and off-site interview data. Given that New River setline fishers appeared to frequently leave their lines deployed even when not fishing (Dickinson 2013, Chapter 1, this thesis), I decided I could accurately quantify setline effort by counting the number of lines using kayak surveys, even though their owners might not be present during the survey. Given the difficulty of lifting a weighted setline to check the number of hooks, and the likelihood that the setline owner would not be present during the survey, I used data from interviews of setline fishers (Dickinson 2013, Chapter 2, this thesis) to determine catch rates and how frequently setline users fished their lines. For the purposes of estimating effort and catch, interviewees were asked how many hooks they used on their setlines, how frequently they fished, and how many catfish they caught on an average setline.

When designing a creel survey, investigators must decide how to allocate sampling effort in spatiotemporal frames (Pollock et al. 1994). Since I had no prior knowledge of how setline fishing effort varied by time, I chose sampling units with equal probability, rather than stratifying by weekdays and weekends. I used a random number generator (www.random.org) to determine the order in which I systematically surveyed the four sites each month. I generated a new systematic random survey order for each month. I calculated the absolute latest day of each month in which I could begin the first survey and still complete all surveys before the end of the month. Then I randomly selected the survey start date for each month (between the 1st of the month and the latest possible start date). I surveyed every other day until each site had been surveyed three times in each month. This method of equal probability sampling without replacement is appropriate when nothing is known about a fishery (Pollock et al. 1994).

Effort surveys consisted of scanning each river bank, edge of the water, and under the water's surface for evidence of setlines. Surveys were generally performed from kayaks, except for the Allisonia survey reach, which I surveyed by slowly idling a jet-drive motorboat close to shore, because the lack of river current and easy shuttle-access necessitated a round trip instead of a one-way kayak float. During each survey, I documented all setlines and classified them as active or inactive. Active lines needed to meet one or more of the following requirements: deployed in an untangled manner, line (and hooks, if present) in good condition, or currently baited. Since some setline users tie their line to a root wad or tree trunk, and then cut the line to remove it, rather than untying, I considered line remnants in these locations to be evidence of active setlines. To prevent routinely classifying inactive setline remnants as active setlines, surveyors removed setline remnants immediately after documentation. Setline location was marked using GPS coordinates, and surveyors recorded notes about each setline, such as what

the line was affixed to, and the construction material, in order to uniquely identify each setline whenever possible. To evaluate the success rate of finding setlines in the field, I calculated our detection efficiency rate (D). I randomly selected six dates to conduct a test during the scheduled effort survey. Prior to the scheduled survey, I had assistants place dummy setlines (similar in construction and placement to methods used by New River setline fishers) for the surveyors to encounter during their survey. After the survey, I calculated a detection rate (D) for that survey (number of dummy lines found/ number of dummy lines placed).

I calculated setline effort using information from both my field survey and interviews of setline fishers. Similar to Winkelman (2011), I calculated monthly setline effort (E) in hook-nights by multiplying the number of unique setlines (L) found in a given river reach by the number of hooks per line (H) and by the frequency with which lines were fished (F). I corrected for the possibility of surveyors missing lines by dividing the number of unique setlines discovered by the detection rate (D; Equation 3.1).

$$\text{Equation 3.1: } E = \left(\frac{L}{D}\right) \times H \times F$$

Since the effort survey only measured unique active setlines (L), and not the number of hooks (H) or frequency with which these lines were fished (F), I obtained values for H and F from setline user interviews (Dickinson 2013, Chapter 2, this thesis). Because I did not measure detection rates at each site in each month, and because I could not obtain values for H and F for each individual river reach (some setline users fished in reaches I did not survey) or for specific setlines (many were unmarked), I pooled these data across all sites and months. This approach assumes that H and F did not vary significantly either spatially or temporally.

I chose to estimate total effort using bootstrapping techniques, given my small sample size. Bootstrapping is a nonparametric re-sampling method used to generate a large sampling distribution by independently sampling with replacement from the original sample (Efron 1981). Bootstrapping is useful because it does not involve distributional assumptions and can be used with small samples (Preacher and Selig 2012). A percentile-based confidence interval is derived from the resample distribution (B) for any degree of precision desired, defined as $100(1 - \alpha)\%$ (Efron 1981, Bollen and Stine 1990). For example, with a bootstrap sample of $n=10,000$, for a 95% confidence interval ($\alpha=2.5$), one would use the 2.5th percentile (250th value, sequentially) as the lower bound of the CI, and the 97.5th percentile (9750th value) as the upper bound. Efron (1981) recommended using $B \geq 1000$ for accurate CI results. Bootstrap CIs are easy to calculate, and are asymmetric (Bollen and Stine 1990). I randomly re-sampled 10,000 times (with replacement) from my original samples of L (varied by month, but ranged from 0-6), D (six rates, pooled over months and sites), H (48 observations, combination of interview and field observations, pooled over sites), and F (24 rates, from interviews of active setline users, pooled over sites). Then I entered each of those combinations into Equation 2.1 to get a distribution of possible setline effort (in hook-nights) for that month and river reach. I also randomly re-sampled 10,000 times (with replacement) from my sample of catch rates ($N=24$, from interview data), and calculated potential catch by multiplying total effort (derived by Equation 3.1) by catch rate. I then calculated the mean and a 95% confidence interval (2.5th percentile and 97.5th percentile) of this bootstrap distribution. I report catch rates as fish per 100 hook-nights to use whole integers rather than decimals.

Experimental Fishing Methods

I used experimental fishing with trotlines to determine setline catch rates of both catfish and game fish. Experimental fishing procedures followed Arterburn and Berry (2002), although I used 26 hooks per trotline rather than the 10 used by Arterburn and Berry, to better mirror local trotline fishing techniques. I conducted experimental fishing once per month at each site (the same sites as the effort survey) from May 15 to October 15, 2011, for a total of 6 trotline sets at each of my 4 sites (n=24 setting events total). I randomly selected the experimental fishing day each month from the three randomly selected setline effort survey days scheduled at each site.

Trotlines were constructed using approximately 30 m of #18 tarred nylon mainline, with #9 twisted nylon droppers approximately 40 cm in length, spaced 1.2 m apart. After the first month of sampling, droppers were changed to #18 tarred nylon mainline material, because several droppers were broken by large fish. To evaluate catch rates and catch composition as a function of hook type, I used both circle hooks (Size 3/0 Eagle Claw Lazer Sharp L198F, offset circle, large eye for trotline) and J-style hooks (Size 2/0 Eagle Claw Lazer Sharp L254, O'Shaugnessy sea guard, non-offset, trotline and trailer hook, ringed eye). Although hook sizes differed, the hook gap (hook point to shank) is equal between these two hook types. I alternated hook types every other dropper on each trotline. Each line had an even number of hooks (n=26) to ensure equal numbers of both hook types on every trotline.

During each trotline set, I set six lines, three baited with live bait, and three with dead bait. I randomly determined which lines would be baited with live bait (assorted fishes such as bullheads *Ameiurus* and minnows *Cyprinidae* approximately 8-15 cm total length) or dead bait (3-cm pieces of cut gizzard shad *Dorosoma cepedianum*). Final hook-night totals are not quite equal between bait types or hook types, because some droppers or portions of lines were not

retrievable due to line breakage. Lines were set at the head and tails of pools, along current breaks between fast- and slow-moving water, and near large woody debris by tying one end to a secure object such as an exposed root, and stretching the line between 45 and 90 degrees cross-current. Lines were held to the bottom by three weights placed equally along the length of the line. Lines were baited in late afternoon and early evening, and checked early the next morning. I recorded the date, location, species, length, weight, and hook and bait type for each fish caught. Fish were measured to the nearest mm and weighed to the nearest 20 g for fish under 2000 g, and to the nearest 50 g for fish over 2000 g. Location of hook penetration on the body of the fish was recorded for all fish.

I used backwards stepwise logistic regression in SPSS to predict the presence or absence of fish on trotlines using flow (cubic feet/second) at the hour of trotline deployment, month (May-October), hook type (circle hook, J-hook) and bait type (live, dead) as predictors. Regressions were run independently for each channel catfish, flathead catfish, and game fish (smallmouth bass, walleye, muskellunge, rock bass). I also calculated catch per unit effort (CPUE), which I express as the number of fish caught per 100 hook-nights. I calculated relative weight of flathead and channel catfish captured by trotline. I also calculated proportional size distribution (PSD) and length frequencies for channel and flathead catfish caught on trotlines, and compared them to flathead and channel catfish captured by VDGIF high-frequency electrofishing between 1996 and 2010 (VDGIF, unpublished data).

Results

Experimental Fishing Results

Trotlines collected 12 snapping turtles and 338 fish, 83% of which were catfish. (Trotlines also caught several rock bass (RCB) *Ambloplites rupestris*, smallmouth bass (SMB), walleye (WAE), and muskellunge (MUE), which I collectively refer to as “game fish” in the context of the New River. Live bait (n=1,853 hook-nights) caught all fish at higher rates than dead bait (n=1,820 hook-nights). Approximately 80% of all fish were caught on live bait, including 45 of 46 game fish and 91 of 93 flathead catfish (FCF). Catch rates using live bait (per 100 hook-nights) were highest for CCF (7.2), FCF (4.9), and WAE (0.5), (Table 3.1). Dead bait was largely ineffective, catching few fish of any species, with CCF (3.5 fish per 100 hook-nights) the sole exception (Table 3.1).

Trotline catches of CCF and FCF remained fairly consistent by month (Table 3.2); the majority of game fish were caught in June (11) and in October (17). Excluding rock bass, the highest catch of game fish occurred in October with five smallmouth bass, eight walleye, and one muskellunge (Table 3.2).

Table 3.1. New River experimental trotline fishing catch rates, May-October 2011, per unit effort (CPUE, per 100 hook-nights) of flathead catfish, channel catfish and game fish (walleye, smallmouth bass, muskellunge, rock bass) by hook type and bait type. Numbers in parentheses are total hooks fished per category. Catch rates were rounded to nearest tenth.

CPUE, per 100 hook-nights	Total (n=3673)	Dead Bait (n=1820)	Live Bait (n=1853)	Circle Hook (n=1837)	J Hook (n=1836)
Flathead Catfish	2.5	0.1	4.9	2.8	2.2
Channel Catfish	5.4	3.5	7.2	7.1	3.7
All Catfish	7.9	3.6	12.1	9.9	5.9
Walleye	.5	0	.5	.25	.25
Smallmouth Bass	.4	0	.4	.25	.25
Muskellunge	.1	0	.1	0	.1
Rock Bass	.3	0.1	.3	.2	.2
Combined Game ^a	1.3	0.1	2.4	1.2	1.3
Overall	9.1	3.7	14.5	11.1	7.2

^a includes rock bass, smallmouth bass, walleye, and muskellunge

Table 3.2. Summary of 2011 New River experimental trotline catches of channel catfish (CCF), flathead catfish (FCF), rock bass (RCB) smallmouth bass (SMB), and walleye (WAE) by month.

	May	June	July	August	September	October	TOTAL
CCF	27	42	37	26	29	36	197
FCF	6	12	21	20	20	14	93
RCB	1	5	0	1	1	3	11
SMB	0	5	2	1	1	5	14
WAE	3	1	2	0	4	8	18
MUE	1	0	0	0	0	1	2

Logistic regression confirmed that FCF (odds ratio 44.37, $P < 0.0001$), and game fish (odds ratio 45.84, $P < 0.0001$) were almost exclusively caught by live bait, and that CCF (odds ratio 2.03, $P < 0.0001$) were more likely to be caught with live bait rather than dead (Table 3.3).

Flathead catfish were significantly more likely to be caught in July and August than other

months. Game fish were almost three times more likely to be caught in June than other months, and four times more likely to be caught in October (Table 3.3).

Table 3.3 Significant factors predicting the likelihood of catching of fish on 2011 New River experimental trotlines, derived through backwards stepwise logistic regression. An odds ratio >1 means that the listed factor increased the likelihood of catching a fish (e.g., odds ratio of 2.07 for “Circle Hook” means that the odds a channel catfish was caught by a circle hook are more than twice as likely as getting caught by a J-hook).

	Factor	Odds Ratio	P-value
CCF	Circle Hook	2.07	<0.0001
	Live Bait	2.03	<0.0001
FCF	August	1.88	0.031
	Live Bait	44.37	<0.0001
Game Fish	June	2.83	0.007
	October	4.08	<0.0001
	Live Bait	45.84	<0.0001

Circle hook CPUE was much higher than J-hook CPUE (Table 3.1), yet only CCF were significantly more likely to be caught on circle hooks compared to J-hooks; hook type was not a significant predictor for the catch of FCF or game fish (Table 3.3). Game fish were almost equally likely to be caught with either hook type; circle hooks (56%) and J-hooks (44%) caught similar numbers of FCF (Table 3.2).

Location of hook penetration on the bodies of captured fish was influenced by hook type and fish species. More game fish (44%) were hooked in the stomach or esophagus (“swallowed the hook”) than FCF (14%) and CCF (1%). Catfish rarely swallowed either hook type; though CCF were more prone to getting hooked through the eye with circle hooks (Table 3.5). Game fish were much more prone to swallowing J-hooks (67%) than circle hooks (18%) (Table 3.4).

Table 3.4. Location of hook penetration for fish caught on circle and J-hooks during 2011 experimental trotline fishing. Rows are for each grouping of fish, columns are hooking locations for each fish grouping. For example, 22 CCF were hooked in the eye, which was 17% of all CCF hooked with circle hooks.

Circle Hooks	Eye	Lip	Stomach or Esophagus	External	N fish
CCF	22 (17%)	105 (81%)	1 (1%)	2 (2%)	130
FCF	3 (6%)	46 (88%)	3 (6%)	0 (0%)	52
GAME	1 (5%)	17 (77%)	4 (18%)	0 (0%)	22
Total	26(13%)	168 (82%)	8(4%)	2(1%)	204

J hooks	Eye	Lip	Stomach or Esophagus	External	N fish
CCF	4 (6%)	58 (87%)	1 (1%)	4 (6%)	67
FCF	1 (2%)	30 (73%)	0 (0%)	10 (24%)	41
GAME	1 (4%)	7 (29%)	16 (67%)	0 (0%)	24
Totals	6 (4%)	95(72%)	17(13%)	14(11%)	132

Mean relative weight (W_r) of FCF captured with trotlines was 91 ± 1.6 , and mean W_r of CCF was 94 ± 1.3 . Trotlines sampled larger CCF and FCF than VDGIF electrofishing (Table 3.5). All catfish were very lively and in good health when removed from trotlines. Game fish did not fare as well on trotlines: 14 of 46 game fish were dead when removed from the line, including nine of 18 walleye. A large portion of those game fish not dead when retrieved were in poor condition (excessive skin abrasions from trotline, unable to maintain orientation, discolored gills).

Table 3.5. Proportional size distribution (PSD), PSD-Preferred, PSD-Memorable, and PSD-Trophy by species and sampling method. Electrofishing data is from VDGIF high-frequency electrofishing samples (1996-2010), trotline data were collected in 2011 only.

Species	Collection Method	PSD	PSD-P	PSD-M	PSD-T
CCF	High Frequency Electrofishing	82	8	1	0
CCF	Trotline	100	27	8	0
FCF	High Frequency Electrofishing	33	6	0	0
FCF	Trotline	75	25	11	0

Setline Effort Survey Results

I discovered 32 unique active setlines, many of which were found repeatedly throughout the study duration. I also found over 100 setline remnants during the initial surveys of each site, some of which appeared to be very old. The number of unique setlines found by surveyors was fairly consistent from June-September, but I found no active setlines during October (Table 3.6).

Table 3.6. Unique active setlines documented by monthly surveys, June-October 2011.

	June	July	August	September	October
Allisonia	3	4	4	4	0
Eggleston	2	1	0	4	0
Foster Falls	6	4	4	4	0
Ivanhoe	2	1	1	0	0
TOTAL	13	10	9	12	0

Active setline users (n=24) interviewed in 2012 (Dickinson, 2013, Chapter 2, this thesis) provided information regarding setline construction and fishing habits. These users fished with setlines averaging 30 hooks per line, but hooks per line ranged from 1 to 105. Setline users fished their lines an average 8.9 trips/month (during the period of year in which they actively set lines), and number of setline fishing days ranged from 1 to 25 per month.

Note that although I could identify individual active setlines, I could not in most cases ascertain the number of hooks on these lines, or how frequently their owners fished them. I determined those two factors from interviews with setline fishers (Dickinson 2013, this thesis). Since many interviewees did not fish in my specific study reaches, I pooled the interview data for hooks per line and frequency of fishing and assumed they were representative of setlines in my study reaches. When calculating effort in the riverine sections (Eggleston, Foster Falls, Ivanhoe), I removed all hooks/line >60 from the data pool, since the only place I documented lines with >60 hooks (both from field surveys and during interviews) was in the Allisonia study reach.

Estimated total mean effort from the setline survey (all sites) was 11,006 hook-nights (Table 3.7). The Allisonia (4,429 hook-nights) and Foster Falls (3,391) reaches had the highest total effort, followed by Eggleston (1,879) and Ivanhoe (767). Estimated setline effort was inversely correlated with experimental setline catch rates in the same river reach; sites with higher estimated setline effort showed lower catch rates during experimental fishing (Table 3.8).

Table 3.7. Estimated mean setline effort (hook-nights) by site and month, June-October, 2011. Numbers in parentheses are 95% confidence interval bounds of effort as derived by the bootstrapping percentile method.

Month	Allisonia	Eggleston	Foster Falls	Ivanhoe	Total Effort (Month)
June	495 (34, 2,160)	547 (11, 3,168)	683 (10, 3,024)	228 (3, 1,056)	1,953 (24, 8,751)
July	1,319 (18, 6,336)	270 (4, 1,238)	1,079 (19, 4,800)	269 (4, 1,238)	2,937 (27, 13,612)
August	1,315 (21, 6,400)	0	1,083 (18, 4,901)	270 (4, 1,210)	2,668 (22, 12,439)
September	1,300 (24, 6,336)	1,062 (16, 4,800)	1,086 (16, 5,000)	0	3,448 (32, 16,136)
October	0	0	0	0	0
Total Effort (Site)	4,429 (97, 21,232)	1,879 (31, 8,513)	3,931 (63, 17,625)	767 (11, 3,532)	11,006 (202, 50,902)
Mean effort/KM	591	198	393	110	324

Table 3.8. Catch per unit effort (fish/100 hook-nights) of all catfish and PSD-preferred for channel catfish (CCF) and flathead catfish (FCF) during experimental trotline fishing, May-October 2011, compared to estimated mean effort (hook-nights) from setline surveys conducted June-October, 2011. Numbers in parentheses are confidence intervals for PSD derived from Gustafson (1988).

Site	Catch/100 hooks during experimental trotline fishing	Mean Setline Effort (hook-nights) Per Km	PSD-P of CCF from experimental trotline fishing	PSD-P of FCF from experimental trotline fishing
Allisonia	9.4	591	29(±14)	33*
Foster Falls	9.6	393	23 (±18)	26 (±22)
Eggleston	12.5	198	50(±17)	22(±19)
Ivanhoe	16.9	110	9 (±10)	26(±17)

*Sample size insufficient for confidence interval, according to Gustafson (1988)

Mean self-reported CPUE of active setline users (N=24) was 13.2 catfish per 100 hook-nights, and ranged from 7.7 to 22.2 fish per 100 hook-nights (Dickinson 2013, Chapter 2 of this thesis). Experimental fishing trials caught 12.2 catfish per 100 hook-nights using trotlines with live bait (Table 3.9). Most New River setline fishers use live bait (Dickinson 2013, Chapter 2, this thesis) so experimental fishing results with dead bait were eliminated for comparative purposes.

Table 3.9. Mean CPUE (catfish per 100 hook-nights) of active setline users interviewed in 2012 (N=24) (Dickinson 2013, Chapter 2, this thesis), and from 2011 experimental fishing with live-baited trotlines (N=24 trotline sets with live bait)

	Mean	SD
User-reported	13.2	4.0
Experimental Fishing	12.2	5.9

Estimated catch of catfish by setline fishers far exceeded estimated catch of game fish. Bootstrap estimates of total catch suggest that setline users caught approximately 1,400 catfish (41.6/km) across all sites from June-October 2011 (Table 3.10), and approximately 160 game fish (4.71/km, Table 3.11). Estimated game fish catches by setline fishers was much lower than setline catch of catfish, and lower than VDGIF estimates of game fish catches by rod-and-reel anglers. Several VDGIF creel surveys (2002, 2007, and 2010) estimate catches of rod-and-reel anglers (Tables 3.12 and 3.13); game fish catches by rod-and-reel anglers averaged >150/km above Claytor Dam, and >3,000/km below Claytor Dam.

Table 3.10. Estimated mean catch of catfish (channel and flatheads combined) by setline fishers during the 2011 setline effort survey, by site and month. Numbers in parentheses are 95% confidence interval bounds as derived by the bootstrapping percentile method

Month	Allisonia	Eggleston	Foster Falls	Ivanhoe	Total Catch (Month)
June	62 (3, 300)	71 (1, 321)	89 (1, 392)	30 (0, 137)	251 (3, 854)
July	168 (2, 871)	35 (0, 161)	140 (2, 623)	35 (1, 161)	377 (4, 945)
August	167 (2, 865)	0	140 (2, 623)	35 (1, 161)	342 (3, 785)
September	166 (2, 853)	138 (2, 623)	141 (2, 649)	0	444 (4, 1,273)
October	0	0	0	0	0
Total Catch (Site)	562 (9, 2,890)	286 (4, 1,104)	510 (8, 2,286)	99 (1, 458)	1,414 (14, 3,857)
Mean Total Catch/Km	75	30.1	51	14.1	41.6

Table 3.11. Estimated total catch of game fish by setlines for all sites, June-October 2011. Catch was estimated by summing the product of the monthly catch rate from experimental fishing for each respective species multiplied by the estimated setline effort at each site during that respective month.

	Total Estimated Setline Catch	Lower Bound	Upper Bound	Mean catch/Km
Smallmouth bass	59	1	268	1.73
Walleye	52	2	243	1.53
Muskellunge	6	0	28	0.18
Rock Bass	43	1	194	1.26
Total	160	4	733	4.71

Table 3.12. VDGIF creel survey estimates of effort, catch, and harvest from 2002 and 2007 in a 47-km reach of the Upper New River from the town of Fries downstream to Allisonia, which includes my Foster Falls and Ivanhoe study reaches. Numbers in parentheses are relative standard errors. (VDGIF, unpublished data)

			SMB	WAE	CATFISH
2002	Jun 8 –Aug 23	Effort (hours)	9,996 (43)	0	499 (96)
		Catch	11,647(56)	183 (507)	72 (1288)
		Harvest	100 (66)	47 (99)	4 (0)
		Catch/Km	248	3.9	1.5
		Harvest/Km	2.1	1.0	0.1
2002	Aug 24-Nov 8	Effort (hours)	2,751 (40)	132 (150)	1,784 (46)
		Catch	1,544 (54)	9 (97)	46 (314)
		Harvest	0	9 (97)	31 (0)
		Catch/Km	33	0.2	1.0
		Harvest/Km	0	0.2	0.7
2007	Feb-Jul	Effort (hours)	11,498 (25)	6,719 (40)	940 (185)
		Catch	9,131(34)	2,247(67)	410 (400)
		Harvest	0	189 (65)	9 (350)
		Catch/Km	194	48	8.7
		Harvest/Km	0	4.0	0.2

Table 3.13. VDGIF creel survey estimates of effort, catch, and harvest from 2002-2010 in a 20-km reach of the Lower New River, which includes the Eggleston study reach. Numbers in parentheses are relative standard errors.

			SMB	MUE	CATFISH
2002	Jun 8 – Aug 23	Effort (hours)	37,660 (26)	463 (92)	718 (81)
		Catch	70,898 (38)	0	0
		Harvest	237 (54)	0	0
		Catch/Km	3,545	0	0
		Harvest/Km	12	0	0
2002	Aug 24 – Nov 8	Effort (hours)	15,247 (40)	0	0
		Catch	24,144 (47)	0	0
		Harvest	366 (69)	0	0
		Catch/Km	1,207	0	0
		Harvest/Km	18	0	0
2007	May – August	Effort (hours)	61,933 (28)	1,226 (177)	1,129 (137)
		Catch	95,869 (22)	0	0
		Harvest	835 (75)	0	0
		Catch/Km	4,793	0	0
		Harvest/Km	42	0	0
2010	May - August	Effort (hours)	52,184 (26)	3,326 (90)	1,855 (145)
		Catch	89,178 (21)	431 (629)	742 (600)
		Harvest	1,910 (54)	0	0
		Catch/Km	4,459	22	37
		Harvest/Km	96	0	0

Discussion

Trotlines proved effective for catching catfish during experimental fishing. Trotline bait type and hook type influenced the catch rate and catch composition. Live bait was particularly effective for all species. Dead bait caught channel catfish almost exclusively, but at rates nearly 50% lower than live bait. Flathead catfish are highly piscivorous (Roell and Orth 1993, Jackson 1999), and previous research shows that setlines with live bait are superior to dead bait for flathead catfish (White 1961, Quinn 1993, Arterburn and Berry 2002). Although circle hook and J-hook catch rates for game fish and flathead catfish did not significantly differ, circle hooks caught channel catfish at significantly higher rates than J-hooks, regardless of bait type. This result differs from the results of Arterburn and Berry (2002), who found no significant difference in catch rates between modified circle hooks and O'Shaughnessy J-style hooks for either flathead or channel catfish. Differences in specific brand of modified circle hook may explain such a disparity, although small methodological differences in bait choice or how bait was placed upon hooks could also explain these results.

The potential for significant setline harvest of catfish exists under current Virginia regulations, which have no hook limits and a liberal 20 catfish per day bag limit. Yet, catfish harvest appears to be limited not by bag limits but instead by the relatively low number of dedicated setline fishers, and the frequency with which those individuals fish setlines. Kuklinksi and Boxrucker (2008) found that only 1.6% of Oklahoma catfish fishers harvested daily limits of catfish, regardless of fishing method. I documented a similar pattern throughout the duration of my study: few individuals harvested even 10 catfish per day and most individuals reporting catching fewer than five catfish per trotline (Dickinson 2013, Chapter 2, this thesis). If setline fisher numbers were to increase, they might heavily exploit catfish populations under current

regulations – however, the low (and declining) number of setline fishers (Dickinson 2013, Chapter 2, this thesis) probably exert minimal effects on current catfish populations. Although my estimated setline catches of catfish are similar to catches by rod-and-reel anglers (Tables 3.12 and 3.13), rod-and-reel catch of catfish likely far exceeds that of setlines. Standard daytime creel surveys, such as the ones utilized by VDGIF, consistently underestimate effort by catfish anglers because catfish anglers often fish at night (Michaletz and Dillard 1999).

New River catfish may be more heavily exploited in river sections with high setline use. My experimental trotline catch rates were inversely correlated to estimates of setline effort in the same river reaches (Table 3.8). Alternative explanations exist that may explain the inverse correlation between experimental trotline catch rates and estimated setline effort. One possibility is that I was forced to set my lines in less-favorable locations in river reaches with higher setline effort, because the best setting locations (that might yield higher catch rates) were already occupied by other setlines. The Foster Falls reach in particular had several setlines that were almost always active, routinely preventing the placement of my experimental trotlines in several areas. Another possibility is that individuals fished with multiple setlines (rather than just a single line) in the river reaches containing fewer catfish, since setlines presumably catch catfish in proportion to their abundance and anglers would want to maximize chance of catching catfish by increasing their number of hooks and lines. Further research would be needed to estimate catfish exploitation rates and population dynamics in different river reaches. However, since preferred-size channel and flathead catfish were present at all experimental fishing sites, and showed no apparent correlation to estimated setline fishing effort (Table 3.8), catfish exploitation by setlines should not be of immediate concern to VDGIF managers.

Setline effort showed seasonal trends. Effort was relatively uniform between June and August, 2011, but declined precipitously in September and October. Many setline fishers reported ceasing setline activity when the water cooled down; they subsequently turned their outdoor recreation effort to hunting beginning in October (Dickinson 2013, Chapter 2, this thesis). Setline fishing effort showed a similar decline in Oklahoma: only 168 individuals fished with setlines during November 1st- May 15th, compared to 942 individuals using setlines May 16th-October 31st, despite higher catch rates of blue and channel catfish during November-May (Kuklinski and Boxrucker 2008). Unpleasant conditions such as cold air and water temperatures likely prompt all but the most-dedicated setline fishers to stop for the season, particularly those fishing for flathead catfish, which often become sedentary during winter months (Stauffer et al. 1996, Weller and Winter 2001, Daugherty and Sutton 2005), and cease feeding when water temperatures fall below 11 Celsius (Bourret et al. 2008). Although I documented no setline effort in my study reaches during October, 8 of 24 individuals I interviewed (Dickinson 2013, Chapter 2, this thesis) indicated they fished with setlines at least occasionally between November and March, suggesting that low levels of effort occur during fall and winter months.

Setline by-catch of smallmouth bass should not significantly concern VDGIF managers. Estimated catch of smallmouth bass by setlines in my study was small compared with VDGIF-estimated catch and harvest of smallmouth bass by rod-and-reel anglers (Tables 3.12 and 3.13). Care must be taken when comparing my results directly and quantitatively with VDGIF creel surveys; months surveyed varied between each survey, and surveys took place over a time period of 10 years. Hooking mortality of smallmouth caught by rod-and-reel likely exceeds the total catch by setlines. Hooking mortality rates for smallmouth bass in the literature range between 0% for individuals caught on artificial lures (Clapp and Clark 1989, Dunmall et al. 2001) to 11%

of smallmouth bass caught on live minnows (Clapp and Clark 1989). Wilde (1998) estimated total mortality of black bass in tournament events to be between 20 and 30% in the 1990s. Black bass tournaments occur both above and below Claytor Dam on a regular basis (J. Copeland, VDGIF, personal communication); these tournaments could be a significant source of angling mortality in some river reaches. However, given that the 2002, 2007, and 2010 VDGIF creel surveys documented catches of >3,500 smallmouth/km on average by rod-and-reel anglers below Claytor Dam and >150 smallmouth/km upstream from Claytor Dam (Tables 3.12 and 3.13), a conservative estimate of 1% hooking mortality rate (>35 bass/km below Claytor and >1.5 bass/km above Claytor) by rod-and-reel angling would exceed total catch of smallmouth bass by setlines, which I estimated at approximately 1.5 bass/km below Claytor Dam and 0.6 bass/km above Claytor Dam. In addition to hooking mortality of released fish, VDGIF creel surveys estimate an average harvest of smallmouth at >40 bass/km below Claytor Dam and >1/km above Claytor, suggesting smallmouth bass mortality from setline fishing is a minor component of total fishing mortality, particularly below Claytor Dam. Given lower catch rates of smallmouth bass by rod-and-reel anglers in the upper New River, setline by-catch of smallmouth bass may be of more concern above Claytor Dam, as it may comprise a higher proportion of total fishing mortality than below Claytor Dam.

Setline fishing during fall and winter has the potential to negatively affect walleye populations in the Upper New River. I observed the highest setline catch rates of walleye in September and October, at 2.56 walleye/100 hook-nights. Although I did not continue my experimental fishing into winter months, the best walleye fishing generally occurs between November and April (Palmer 2013), suggesting that setline by-catch of walleyes could increase during this time period. Further research would be needed to quantify walleye catch rates using

setlines during fall and winter months. Setline effort is highest in the New River upstream from Claytor Dam, an area in which VDGIF recently conducted significant efforts to bolster native New River walleye populations. These native walleye stocks are particularly vulnerable during coldwater periods and during their spawning run in the river upstream of Claytor Lake. Most fishing effort occurs February-May (Palmer et al. 2005), with 80% of all walleye caught between February and April (Palmer 2013). Recent slot and bag limit regulations changes designed to protect spawning of native New River walleye have been successful and spurred angler interest (Palmer et al. 2005, Palmer 2013), and many walleye anglers release large portions of their catch (Palmer 2013). Rod-and-reel anglers may immediately release slot-size walleye not legal to harvest, likely minimizing the risk of hooking mortality for slot-size walleye. However, setlines are only required to be tended once every 24 hours, which may increase hooking mortality of non-target species such as walleye. I observed 50% initial hooking mortality of walleye during experimental trotline fishing. Given that experimental trotline catch rates of walleye trended upward in September and October, setlines may have the potential to catch and subsequently subject significant numbers of native New River walleye to hooking mortality (in addition to illegal harvest) throughout the fall and winter. However, I documented declining setline effort in September and October, and interviews (Dickinson 2013, Chapter 2, this thesis) suggested only one-third of setline fishers use setlines between November and March. Therefore, walleye mortality may be limited by declining setline effort during fall and winter months.

Encouraging the use of circle hooks might decrease hooking mortality of game fish. Game fish were caught at equal rates by both hook types, but 67% of game fish caught by J-hooks swallowed the hook, compared to 18% caught with circle hooks, suggesting that hooking mortality might be lower with circle hooks. Circle hooks were significantly more effective for

channel catfish compared to J-style hooks. Setline fishers might be receptive to increasing their use of circle hooks because of increased catch rates, and smallmouth bass and walleye anglers would likely be pleased with potentially lower hooking mortalities of game fish caught by setline fishers using circle hooks.

Chapter 4: Management Implications

Although the New River was the focus of my study, it shares several characteristics common to many other Virginia rivers: a popular smallmouth bass fishery, and a poorly-sampled catfish fishery, along with a recreational boating component. Findings from this study should be relevant outside of the New River, particularly anywhere with an undescribed setline fishery. This study is one of few to describe catch and effort of recreational setlines, particularly trotlines. Trotlines are difficult to enumerate because they are usually submerged, whereas juglines and limblines are easily visible. Quantifying trotline effort is difficult both on-site (users not present, lines hard to find) and off-site (clandestine user base, limited sample frame, low response to mail surveys). Given that accurately quantifying setline catch and effort is time and money intensive, quantifying setline effort and catch may not be prudent unless prompted by concerns over high by-catch of game fish or endangered species, or frequent reports of conflict with other anglers.

Setline fishing appears to be a culturally-important, yet declining activity in the New River Valley. Setline fishers place high importance on catch-related and harvest-related factors, even though they exhibit many characteristics of highly-specialized anglers. They may rely on harvesting fish for varying degrees of sustenance, and feel that setline fishing is a heritage activity and part of a larger “way of life”, both now and in the past. This lifestyle often may be centered upon outdoor activities such as hunting, trapping, fishing, and gardening. Setline users may not be aware of or follow consumption advisories, and are not very knowledgeable about fishing regulations. Most of them favor less-restrictive regulations, particularly the ability to use game fish as bait. Therefore, they would likely react negatively to any new regulatory restrictions proposed.

Although setline fishing may have been a family-oriented activity in years past (often subsistence-driven), it appears now more often to be a solitary activity with little supporting social network. Many New River recreationists believe that setline fishing is in steep decline. Possible reasons for declining setline use include but are not limited to: changing generational values of New River Valley residents, improving socioeconomic well-being of the region compared to the mid-1900s, lack of social network between setline users and resultant failure to pass down the oral tradition from one generation to the next, and increasingly non-consumptive recreational use (e.g., kayaking, tubing, catch-and-release fishing) of the New River. Some active setline fishers feel marginalized and that setline fishing has become an unacceptable fishing method. Such individuals are unlikely to recruit new setline users. This information, when considered in conjunction with the apparent steep decline of setline fishing effort, suggests that effects of setlines on the New River fishery may further decline in the future, which should be considered during future management discussions. Anglers are beginning to recognize the trophy potential of some catfish populations; large shifts in angler attitudes toward catfish might be expected if setline use declines in the future and trophy catch-and-release fisheries increasingly develop.

I found little evidence to support the belief that setlines pose a significant safety issue to river users. Setline fishers generally sink all their trotlines to the river bed, given that catfish are bottom feeders. Additionally, they have incentives to place their setlines in inconspicuous areas, to avoid other recreational users from tampering with their lines. None of the fishing guides, campground owners, or rod-and-reel anglers I spoke with could name an incident in which they or others had been hurt or endangered by setlines. It appears the New River supports multiple recreational uses without significant safety issues.

My research suggests setlines may have the potential to catch and subsequently subject significant numbers of native New River walleye to hooking mortality (in addition to illegal harvest) throughout the fall and winter. Most setline effort occurs in a distinct season from May to September. However, a subset of setline users use them in late fall and winter: 33% of active setline fishers interviewed indicated that they fish with setlines in fall and winter months, which is cause for some concern if these individuals fish setlines frequently during this time period. I observed the highest setline catch rates of walleye in September and October, at 2.56 walleye/100 hook-nights. Although I did not continue my experimental fishing into winter months, the best walleye fishing generally occurs between November and April (Palmer 2013), suggesting that setline by-catch of walleyes could increase during this time period. Walleyes were subjected to 50% mortality during experimental trotline fishing, suggesting that even if setline fishers did not illegally harvest walleyes caught on setlines, substantial mortality would still occur. Before taking regulatory action, VDGIF should confirm the assumption made here that setline catch rates of walleye are highest in fall and winter months. Assuming that setline catch rates of walleye remain higher ($>2.5/100$ hook nights), VDGIF should consider prohibiting setlines between Buck Dam and Claytor Dam during fall and winter months to protect native New River walleye stocks. Such a setline ban would not prohibit most setline fishers from targeting catfish during spring and summer months (when most of the setline effort occurs), yet protect walleye populations during a time period in which they are highly vulnerable to angling. Such a regulation would also send a message to concerned stakeholders that VDGIF is actively and appropriately managing an important and highly-valuable game fish fishery. However, given that only 33% of setline fishers use setlines outside spring and summer months, setline effort during periods of high walleye vulnerability probably offset higher catch rates.

In order to consider a regulation, managers should first decide if there is a substantial problem that requires regulatory action. Second, such a regulation should be one which will be accepted by a user group, otherwise compliance with the new regulation could be an issue. Finally, any regulation should be enforceable; otherwise non-compliance might render the regulation useless. Managers should recognize that subsistence factors, lifestyle centrality, and other potential social and health factors (consumption advisories for example) are important considerations when crafting future setline regulations or outlining management goals.

Setline fishing in the New River likely does not pose a substantial problem requiring immediate regulatory action. Although my effort study likely missed quantifying some setlines, particularly those of individuals intent on illegal activity, setline effort and catch is low compared to rod-and-reel angling. Although by-catch of smallmouth bass and walleye certainly occurs, it probably does not substantially harm these fisheries. Furthermore, compliance with new regulations might be low and enforcement difficult. Setline users would likely react negatively to a year-round live bait ban, particularly since many want regulations liberalized to include panfish as legal bait for setlines. Setline fishers already commonly (and illegally) use New River panfish (rock bass *Ambloplites rupestris*, bluegill *Lepomis macrochirus*, and redbreast sunfish *Lepomis auritus*) as setline bait. There is no reason to believe setline fishers would change behavior to comply with restrictive bait regulations or a trotline ban given the current amount of illegal activity observed during this study and by VDGIF personnel. Additionally, if setline use is declining as rapidly as many New River setline users believe, passing stricter setline regulations may not be necessary, as setline effort will in all likelihood continue to diminish with time. Given that setline fishing is culturally important to some individuals and part of local Appalachian culture, one could argue that setline fishing has

intrinsic value as part of Americana culture. Any conversation considering banning setline fishing should consider the cultural value of setline fishing.

Regulations might be relaxed and simplified by allowing use of panfish on setlines, in areas where live-baited setlines currently are legal. Virginia anglers can already use game fish for bait, provided they catch them (and use them) with rod-and-reel. Allowing setline users to bait their lines with panfish (within daily bag limits) would bring setline bait regulations almost in accordance with rod-and-reel regulations. However, allowing panfish for live bait might negatively affect redbreast sunfish, rock bass, and bluegill populations in the New River if enough setline fishers used them for bait.

Given the widespread ignorance of setline regulations, simplifying or clarifying the regulations regarding possession of baitfish also could be beneficial. The 2013 Virginia fishing regulations state that an angler may possess up to 50 minnows, although a few species used as setline bait have no limits: stonerollers (*Campostoma* spp.), common carp (*Cyprinus carpio*), bullheads (*Ameiurus* spp.), white sucker (*Catostomus commersonii*), northern hogsucker (*Hypentelium nigricans*), and gizzard shad *Dorosoma cepedianum*. Few of the setline users I spoke with had a good understanding of this regulation, and few (if any) had the fish identification skills to differentiate between species with a total aggregate limit of 50 (e.g., mountain redbelly dace *Phoxinus oreas*, rosieside dace *Clinostomus funduloides* and various other Cyprinids) and those with no possession limit.

Given the recent restrictions limiting Virginians to 20 jug lines, restricting fishers to 50 hooks total might also seem reasonable. Most New River setline users would be unaffected – indeed, many already believe there is a 50-hook limit, and only a few individuals set more than 50 hooks at a time. This hook-limit would align with the baitfish limit, reduce confusion among

setline users by institutionalizing current thinking, and possibly even alleviate concerns among those who feel setline users are harming the New River fishery.

Fishing guides and smallmouth bass anglers likely will continue complaining about the negative effects of setlines on game fish populations, because seeing an occasional large game fish dead on a setline can cause a strong negative reaction among hook-and-line anglers, even though empirical evidence shows that such events are not common. Regardless of potential regulation changes, educating New River stakeholders about the results of my research may alleviate some of their concerns. I observed no setline users specifically targeting game fish, and even when my experimental trotlines were set in excellent smallmouth bass habitat in the Eggleston reach of the river, I caught very few bass. Individuals who fish frequently with trotlines generally are interested in efficiently maximizing harvest; smallmouth bass are not nearly as big (or as desired for table fare) as catfish. Some setline users admitted to harvesting walleye caught on setlines, which may be of a concern for managers, although few setline anglers reported harvesting incidentally-caught smallmouth bass. Potential outreach efforts to stakeholders such as fishing guides and rod-and-reel anglers targeting walleye and smallmouth bass could utilize digital and print media, such as distributing a fact sheet to interested groups, publishing an article in Virginia Wildlife Magazine or similar publication, and presenting results of this research at stakeholder meetings.

Moving outside the New River Valley, VDGIF could legalize live bait on setlines as a management tool to increase harvest of invasive blue and flathead catfish. However, if waters with invasive catfish problems also have well-established fisheries for popular game fish, such actions might encounter resistance from rod-and-reel anglers. Outreach to anglers worried about setline by-catch of smallmouth bass should focus on the benefits of removing large flathead

catfish, which would likely reduce direct and indirect competition with smallmouth bass.

Initiating and maintaining a setline tradition would be difficult in areas where setlines are not heavily used. Setline use is declining in the New River Valley, a region with firmly-established setline traditions, suggesting culturing a new tradition in areas without strong setline presence might be difficult. Factors influencing this decline are probably no different in other areas of Virginia. For setline angling to have significant effects on invasive catfish populations, VDGIF would likely have to launch an intensive effort to teach and encourage setline use.

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Appendix A: 2012 Review of State Setline Regulations

State	Catfish as gamefish?
Alabama	No
Alaska	N/A - no catfish
Arizona	yes
Arkansas	yes
California	no
Colorado	yes
Connecticut	yes
Delaware	no
Florida	no
Georgia	yes*
Hawaii	yes
Idaho	yes
Illinois	yes
Indiana	unclear
Iowa	yes*
Kansas	yes
Kentucky	no
Louisiana	no
Maine	no channel/flat/blues in maine
Maryland	unclear
Massachusetts	unclear
Michigan	yes*
Minnesota	yes*
Mississippi	no
Missouri	yes
Montana	yes
Nebraska	yes
Nevada	yes
New Hampshire	no
New Jersey	unclear
New Mexico	yes
New York	no
North Carolina	no
North Dakota	yes
Ohio	yes*
Oklahoma	yes
Oregon	yes
Pennsylvania	unclear
Rhode Island	no
South Carolina	no

South Dakota	yes
Tennessee	yes
Texas	yes
Utah	yes
Vermont	no
Virginia	no
Washington	yes
West Virginia	yes
Wisconsin	yes
Wyoming	yes

State	* Gamefish notes
Alabama	Not officially designated as gamefish, but absent from "non-game" list
Alaska	n/a
Arizona	explicitly define catfish as gamefish
Arkansas	explicitly define catfish as gamefish
California	restrict quite a bit in some waters but general statewide treated as nongame
Colorado	explicitly define catfish as gamefish
Connecticut	say they are "game fish" but include them in panfish reg section, no limit
Delaware	introduced in tidal waters, classify flatheads and blues as invasive
Florida	specifically designated as nongamefish
Georgia	no limit, invasive flatheads in some systems
Hawaii	define as introduced gamefish
Idaho	explicitly define catfish as gamefish
Illinois	designate catfish as both game and commercial fish
Indiana	don't explicitly state as game fish
Iowa	don't explicitly state as game fish
Kansas	define as sportfish
Kentucky	define as roughfish
Louisiana	not included in game fish definition
Maine	Few catfish in Maine, no blue/flathead/channel
Maryland	define blues and flatheads as invasive threats, don't really say for channel cats
Massachusetts	Unsure of distribution of catfish in MA
Michigan	do not explicitly label as gamefish, but include with gamefish in regs
Minnesota	did not explicitly label as gamefish but manage as such
Mississippi	explicitly define catfish as NONgame
Missouri	explicitly define catfish as gamefish
Montana	channel cats are game fish
Nebraska	explicitly defined as "sport fish"
Nevada	defined as warmwater gamefish
New Hampshire	not mentioned in regulations, but listed CCF and WCF in state records
New Jersey	included in game fish table, but not specifically defined

New Mexico	explicitly defined
New York	not mentioned in regs (but reg guide cover photo is an angler with a catfish)
North Carolina	not included in game fish definition
North Dakota	define CCF as game fish (no flats/blues?)
Ohio	included in game fish table, but not specifically defined
Oklahoma	CCF and blues, not flats
Oregon	defined as gamefish
Pennsylvania	lumped in with panfish and suckers/carp, they never define gamefish
Rhode Island	not even mentioned in regs
South Carolina	not included in game fish definition
South Dakota	defined explicitly as gamefish
Tennessee	says "taking nongame fish AND catfish", wording indicates catfish are gamefish
Texas	defined as gamefish
Utah	defined as gamefish
Vermont	not mentioned in regs but do have a state record CCF. Not widely distributed
Virginia	not defined as game fish even though included in gamefish reg section
Washington	defined as game fish
West Virginia	ccf and flats, not blues
Wisconsin	defined as game fish
Wyoming	defined as game fish

State	Possession and Size Limits
Alabama	No bag limit, only 1 catfish over 34"
Alaska	n/a
Arizona	25 any combination (no size limit)
Arkansas	10 combined (no size limit)
California	no limit
Colorado	10 combined (no size limit)
Connecticut	none (interestingly they include them in "panfish")
Delaware	none
Florida	in general, bag limit of 6 channel catfish, otherwise unregulated
Georgia	no limit
Hawaii	channel catfish, bag limit of 3
Idaho	none
Illinois	no limit (recreational)
Indiana	Streams: no bag limit, 10 inch minimum. Lakes and reservoirs: 10 combined, no size limit
Iowa	lakes: 8 bag limit, 30 possession. Streams/reservoirs: 15 combined daily, 30 possession. No length limits
Kansas	Channels and Blues: 10 in combination, 30 possession. Flatheads: 5 daily, 15 possession
Kentucky	no limits or size restrictions
Louisiana	100 in aggregate, 25 under the min length limit. Min lengths: Flathead 14", Blue 12", Channel 11"
Maine	none (no blues, flats, channels)

Maryland	5 channel cats, 10 possession. No size limit
Massachusetts	none
Michigan	15" min flatheads (5 combined with pike, bass, walleye), 12" min ccf (bag limit 10).
Minnesota	5 combined channels and flatheads, only 1 over 24"
Mississippi	none general statewide
Missouri	10 channel, 5 blue, 5 flathead
Montana	10 daily 20 possession
Nebraska	5 CCF, 10 possession. 5 flatheads, 2 30" or longer. 1 Blue cat, 2 possession
Nevada	no statewide, only regional limits
New Hampshire	n/a
New Jersey	CCF 5 fish, 12 inch minimum
New Mexico	15 combined
New York	no limit
North Carolina	no limit
North Dakota	5 daily, 5 possession in eastern part, no limit in western (nonnative?)
Ohio	CCF: 6 fish, 1 over 28". FHC/BCF: no limit, 1 over 35"
Oklahoma	15 blues/channels, one blue over 30". 10 flatheads, 20" minimum
Oregon	no statewide, only regional limits
Pennsylvania	50 combined, no minimum size
Rhode Island	no limit
South Carolina	no limit
South Dakota	10 daily 20 possession
Tennessee	No bag limit, only 1 catfish over 34"
Texas	25 combined, 12 inch minimum for CCF and blues. 5 flatheads, 18" minimum
Utah	8 ccf, no minimum size
Vermont	no limit
Virginia	CCF, WCF, FCF: 20 per day, no minimum length. Blue catfish: 20 per day, 1 over 32 inches
Washington	5 catfish per day, no minimum
West Virginia	Blues - 2 per day, 24" minimum. CCF: 4 per day, 16 possession. Flatheads: no limit
Wisconsin	25 combined, no length limits
Wyoming	6 ccf

State Live bait on setlines?

Alabama	yes
Alaska	n/a
Arizona	n/a
Arkansas	yes
California	n/a
Colorado	yes
Connecticut	n/a
Delaware	unclear
Florida	no

Georgia	yes
Hawaii	n/a
Idaho	no (live bait prohibited in state?)
Illinois	yes
Indiana	yes
Iowa	yes
Kansas	yes
Kentucky	yes
Louisiana	yes
Maine	n/a
Maryland	n/a
Massachusetts	n/a
Michigan	n/a
Minnesota	no
Mississippi	yes
Missouri	yes
Montana	yes
Nebraska	yes
Nevada	n/a
New Hampshire	n/a
New Jersey	n/a
New Mexico	yes
New York	n/a
North Carolina	no
North Dakota	n/a
Ohio	yes
Oklahoma	yes
Oregon	no live bait statewide
Pennsylvania	n/a
Rhode Island	n/a
South Carolina	no
South Dakota	no
Tennessee	yes
Texas	yes
Utah	yes
Vermont	n/a
Virginia	not statewide, only in Clinch and New Rivers
Washington	n/a
West Virginia	yes
Wisconsin	yes
Wyoming	n/a

State	Setlines allowed?
Alabama	yes
Alaska	no
Arizona	no
Arkansas	yes
California	no
Colorado	yes
Connecticut	no
Delaware	unclear
Florida	yes
Georgia	yes
Hawaii	no
Idaho	no
Illinois	yes
Indiana	yes
Iowa	yes
Kansas	yes
Kentucky	yes
Louisiana	yes
Maine	no
Maryland	not statewide
Massachusetts	no
Michigan	no
Minnesota	no
Mississippi	yes
Missouri	yes
Montana	yes
Nebraska	yes
Nevada	no
New Hampshire	no
New Jersey	no
New Mexico	yes
New York	no
North Carolina	yes
North Dakota	no
Ohio	yes
Oklahoma	yes
Oregon	no
Pennsylvania	no
Rhode Island	no
South Carolina	yes
South Dakota	not statewide

Tennessee	yes
Texas	yes
Utah	not statewide
Vermont	no
Virginia	yes
Washington	no
West Virginia	yes
Wisconsin	yes
Wyoming	no

State	Hook restrictions?
Alabama	no
Alaska	yes (one line, one hook)
Arizona	yes (2 hooks)
Arkansas	100 hooks between levees on Miss R, otherwise no restrictions
California	yes (3 hooks)
Colorado	25 hooks per trotline, only 1 trotline/person, 10 jugs, 1 hook per
Connecticut	6 total
Delaware	2 lines total, 3 hooks per line
Florida	25 hooks total for setlines
Georgia	50 total
Hawaii	2 total hooks
Idaho	one line, 5 hooks total
Illinois	50 total hooks
Indiana	10 limb lines, one hook per. One trotline/ 50 hooks. 5 jugs but may not be used on lakes/reservoirs
Iowa	up to 5 trotlines, 15 hooks total. 4 trotlines/200 hooks in Miss, Mizz, and Big Sioux R. 2 jugs, 2 hooks per.
Kansas	one trotline up to 25 hooks, or 8 setlines (jugs/limb/whatever) with 2 hooks each
Kentucky	50 hooks per trotline, 1 hook per limb or jug line, 50 jugs total, 25 limb lines total
Louisiana	no
Maine	n/a
Maryland	n/a
Massachusetts	n/a
Michigan	6 hooks total (up to 3 lines)
Minnesota	yes (one line, one hook)
Mississippi	100 hooks total, but only 25 jugs with 2 hooks each
Missouri	33 hooks (50 in Miss R)
Montana	yes - 6 lines with max of between 2 and 6 hooks per line depending on district
Nebraska	15 hooks total, no more than 5 hooks/line
Nevada	one rod, can buy 2nd rod permit
New Hampshire	2 hooks per line, 2 lines max
New Jersey	9 hooks total, 3 rods
New Mexico	25 hooks, one trotline

New York	15 hook points (including trebles). 3 lines
North Carolina	70 jugline hooks per boat.
North Dakota	2 poles, 2 "lures" each
Ohio	3 trotlines, 50 hooks each. 50 limb/banklines, 1 hook each.
Oklahoma	100 hooks total, no more than 3 trotlines. 20 juglines , 5 hooks per jug. 20 limblines, 2 hooks/line
Oregon	n/a
Pennsylvania	3 lines with 3 hooks each
Rhode Island	2 lines total, 3 hooks per line
South Carolina	1 trotline with 50 hooks, 50 jugs, 50 limblines
South Dakota	2 setlines 10 hooks each, no live bait
Tennessee	100 trotline hooks, 50 jug lines (1 hook) 25 limb lines (1 hook)
Texas	juglines 5 hooks or less. 50 hooks/trotline. 100 hooks total regardless of methods
Utah	15 hooks on one setline
Vermont	2 lines with 2 hooks each
Virginia	no hook limits for trotlines or limblines, only 20 jugs with 1 hook per jug
Washington	n/a
West Virginia	juglines are illegal
Wisconsin	1 line with 25 hooks in most waters
Wyoming	n/a

State	Species restrictions?
Alabama	did not explicitly state you couldn't fish for gamefish - a little unclear on "ordinary hook and line" because they also distinctly state elsewhere "with reel attached"
Alaska	n/a
Arizona	n/a
Arkansas	no
California	n/a
Colorado	no
Connecticut	n/a
Delaware	no
Florida	game fish taken by rod and reel only
Georgia	catfish and nongame fish
Hawaii	n/a
Idaho	n/a
Illinois	no
Indiana	
Iowa	
Kansas	no
Kentucky	
Louisiana	no
Maine	n/a
Maryland	

Massachusetts	n/a
Michigan	
Minnesota	n/a
Mississippi	no
Missouri	no
Montana	no
Nebraska	
Nevada	n/a
New Hampshire	n/a
New Jersey	
New Mexico	warmwater gamefish
New York	n/a
North Carolina	
North Dakota	n/a
Ohio	no
Oklahoma	no
Oregon	n/a
Pennsylvania	
Rhode Island	n/a
South Carolina	nongame fish
South Dakota	catfish and nongame fish
Tennessee	no
Texas	catfish and nongame fish
Utah	no
Vermont	n/a
Virginia	catfish and nongame fish
Washington	n/a
West Virginia	no
Wisconsin	catfish and nongame fish
Wyoming	n/a

State	Other setline regs
Alabama	Must check at least every 48 hours, untreated cotton to tie point on bank for trotlines
Alaska	n/a
Arizona	n/a
Arkansas	30 Yo-Yos, 20 free-floating jug/noodles, check every 24 hours,
California	n/a
Colorado	Sink at least 3 feet below surface. Mark trotlines at ends with floats
Connecticut	not technically setlines because lines must be attended
Delaware	n/a
Florida	
Georgia	must check every 24 hours, and remove trotlines after each trip, submerged at least 3 feet

Hawaii	n/a
Idaho	n/a
Illinois	hooks must be 2 feet apart
Indiana	must check every 24 hours
Iowa	check every 24 hours, may not stretch entirely across river
Kansas	extra permit for "floatlines" (jugs). Marking reqs, and must attend floatlines
Kentucky	check every 24 hours, remove when not baited/fishing
Louisiana	some areas require cotton leader, marked, 24 hours, no more than 3 trots with 50 hooks each
Maine	n/a
Maryland	allowed in Potomac and Monocacy Rivers
Massachusetts	n/a
Michigan	
Minnesota	n/a
Mississippi	hooks must be 2 feet apart
Missouri	Must check every 24 hours, trotline hooks at least 2 feet apart
Montana	I think they are really calling setlines tip-ups for ice fishing
Nebraska	must have lines attached to shore. Can only use setlines in rivers/streams
Nevada	n/a
New Hampshire	n/a
New Jersey	
New Mexico	must label, check every 24 hours
New York	n/a
North Carolina	must be checked daily, marked with floats at both ends. Trotlines must be parallel to shore
North Dakota	n/a
Ohio	
Oklahoma	set 3 feet below surface, labeled, hooks 2 feet apart, non-metallic line, checked once every 24 hours
Oregon	n/a
Pennsylvania	
Rhode Island	n/a
South Carolina	required to have a nongame fishing license to use setlines. Mark and float. Sink 4 feet during daytime
South Dakota	allowed in Mizz R drainage only, need separate license
Tennessee	
Texas	
Utah	extra permit for setlines, \$15
Vermont	n/a
Virginia	marking, check every 24 hours
Washington	n/a
West Virginia	can't use steel/metal lines
Wisconsin	separate setline license. In rivers and river systems only
Wyoming	n/a