GREAT LAKES ANGLER DIARY

Michigan River Steelhead Program

Photo: Dan O'Keefe

2020–2022 Progress Report

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Great Lakes Angler Diary
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The Michigan River Steelhead Program enlists anglers to collect data on all steelhead caught over the course of the fishing season. Program participants use the Great Lakes Angler Diary, an online reporting system, to record data including total length and fin clips. Since 2018, all steelhead stocked in Michigan waters have been fin clipped. The number of steelhead reported in complete data sets increased from 1,380 in Year 1 (October 2020 to May 2021) to 2,945 in Year 2 (June 2021 to May 2022). Spatial and temporal coverage also improved. At least 50 steelhead per year were reported in eight watersheds, seven of which were in the Lake Michigan basin. Contribution of clipped steelhead varied greatly from watershed to watershed, and also within certain watersheds. Angler satisfaction and catch rates improved from Year 1 to Year 2 on Lake Michigan tributaries, while satisfaction declined on the Clinton River. Size structure showed a lack of clipped 15- to 19-inch "skippers" in Year 2 as a result of pandemic restrictions that prevented egg take for Michigan strain steelhead in 2020. Participants noted heavy fishing pressure on steelhead streams and expressed support for more restrictive harvest limits. Angler diary programs are known to exhibit avidity bias, though, and this program included few beginning and intermediate anglers. Advanced and professional anglers were more likely to practice strict catch-and-release and were also more likely to support restrictive harvest limits than anglers with less expertise. The first two years of this study provide a better understanding of the contribution of stocked and wild steelhead to river fisheries facing potential changes due to disruption of stocking during 2020 and 2021, harvest limit changes that went into effect for some waters in March 2021, the spread of new invasive species in rivers and continued impact of Great Lakes invasives, and habitat and fish passage changes in certain rivers.

Results below list 95% confidence intervals from Year 2 data unless otherwise noted.

- The Betsie River had 24–34% clipped steelhead, with good numbers of wild skippers. Results were consistent from Year 1 to Year 2.

- The Lower Manistee River had 14–20% clipped and the Upper Manistee River had 44–53% clipped steelhead. The Upper Manistee River was particularly dependent on stocked fish during the spring run. Although few steelhead were caught in the Bear Creek tributary, all were unclipped and presumed wild.

- The Upper Pere Marquette River had 1–5% clipped and the Lower Pere Marquette River had 6–10% clipped steelhead. This difference was likely due to the migration of stocked fish into the Big South Branch.

- The Muskegon River had 28–45% clipped and very few wild skippers were caught during Year 2. Uneven coverage across river sections and fishing seasons made it difficult to compare results between years.

- The Grand River watershed is large and supports steelhead fisheries in many tributaries that were not sampled. Participants found 7–20% clipped in Prairie Creek and 50–74% clipped in the lower Grand River, where stocked fish accounted for 87% of the spring fishery.

- The Kalamazoo River had 57–75% clipped steelhead with a very similar proportion of stocked fish from Year 1 to Year 2. No wild skippers were captured in the Kalamazoo during Year 2.

- The Black River in Van Buren County was not sampled during Year 2, but relied heavily on stocked fish with 74–99% clipped in Year 1.

- The St. Joseph River had 54–83% clipped steelhead and no wild skippers captured during Year 2. The Dowagiac River is a major tributary with 39–67% clipped steelhead.

- The AuSable River had very low returns during Year 2, and had 47–70% clipped in Year 1. Van Etten Creek is a principal tributary that was dominated by wild steelhead in Year 1, with 11–29% clipped.

- The Clinton River had 64–83% clipped in Year 2. Migrating adult steelhead have been afforded improved access to upstream coldwater tributaries for several years due to erosion of a bypass channel adjacent to a lamprey barrier.

- The Huron River in southeast Michigan had 85–97% clipped and likely supported little to no natural reproduction. Due to the stocking of large numbers of unclipped steelhead by other states in the Lake Erie basin, the Huron River was likely to attract unclipped stocked fish from outside Michigan.

Introduction

Rainbow trout (*Oncorhynchus mykiss*) are native to North America's Pacific Northwest, but their popularity on the table and as a gamefish led to widespread stocking efforts beginning in the late 1800s. By the 1970s, rainbow trout had become established in waters on all continents except Antarctica, with few remaining regions where suitable coldwater habitat could allow further expansion (MacCrimmon 1971).

The first stocking of rainbow trout in Michigan is believed to have occurred in the AuSable River in 1876, with the Michigan Fish Commission initiating their stocking efforts in the Boyne River and North Branch of the Paw Paw River in 1880 (Westerman 1974). During the late 1800s and early 1900s, a wide variety of popular fish species were introduced into waters throughout the United States. Other Pacific salmonines including Chinook salmon (*Oncorhynchus tshawytscha*) were also introduced into Michigan rivers but initially failed to establish successful breeding populations (Latta 1974). However, rainbow trout did become naturalized in certain coldwater streams and spawning behavior was reported as early as 1887 in the Muskegon River watershed (Westerman 1974).

The Little Manistee River (Figure 1) was one of the first Michigan rivers to develop a naturally self-sustaining population of steelhead, a migratory form of rainbow trout (Hay 2003). The McCloud River watershed in northern California was the source of gametes used for early stocking programs in Michigan (Westerman 1974). While rainbow trout from the McCloud River were originally brought to Michigan to provide stream trout fisheries, their descendants in Michigan rivers adapted to feeding and growing in Great Lakes waters before returning to their home river to spawn (Hay and Houghton 1990).

Fishery managers continued to stock steelhead to provide angling opportunities, as well. Many steelhead fisheries developed as a result. Although hatchery programs and natural reproduction sustained Michigan steelhead and rainbow trout fisheries continuously from the first introductions in the late 1800s, stocking of Great Lakes steelhead had virtually ceased by the mid-1960s (Whelan and Johnson 2004). During this time, few large steelhead were returning to Michigan rivers as a result of sea lamprey predation (*Petromyzon marinus*) and the fishery was hanging by a thread (Hay and Houghton 1990). The late 1960s saw a great surge in interest in fish culture and the birth of modern-day Great Lakes salmonine fisheries.

Implementation of successful sea lamprey control, a boom in invasive alewife (*Alosa pseudoharengus*) abundance, and depressed populations of native lake trout (*Salvelinus namaycush*) resulted in ideal conditions for stocking Pacific salmonines to take advantage of abundant invasive forage fish (Whelan and Johnson 2004). The first successful stocking of coho salmon (*Oncorhynchus kisutch*) in the Great Lakes occurred in 1967 and Chinook salmon were reintroduced to the Great Lakes in 1968 (Latta 1974). The result was "salmon fever" that created new fisheries almost overnight.

The genesis of the modern Great Lakes salmon stocking program was accompanied by increased stocking of steelhead in the Lake Michigan basin beginning in the late 1960s (Whelan and Johnson 2004). Construction of new facilities the Little Manistee Weir enabled more efficient egg-take operations for steelhead beginning in 1968, with naturalized steelhead providing gametes (Hay 2003).

Following implementation of sea lamprey control, naturalized steelhead populations were already recovering in the Lake Michigan basin as a result of natural reproduction when increased stocking efforts began (Hay and Houghton 1990). Steelhead stocking in the Lake Huron and Lake Superior began increasing in the mid-1970s as hatchery operations expanded to meet demands (Whelan and Johnson 2004).

Trolling in open waters of the Great Lakes became a preferred method for targeting salmonines, with trollers catching a mixed bag of Pacific salmon, lake trout, brown trout (*Salmo trutta*) and steelhead in Lake Michigan and Lake Huron. Although steelhead have always been a valued component of the open water fishery, they are typically targeted only when fishing is poor for Chinook salmon and other species. This was first noted in the late 1980s, when offshore anglers began targeting scum lines for steelhead following the bacterial kidney disease (BKD) outbreak in Chinook salmon (Hay and Houghton 1990).

Salmon stocking also created terminal fisheries in rivers where salmon returned at the end of their life cycle. From 1969-1973, snagging and harvest of foul-hooked salmon was legal in Michigan rivers. Although restrictions began to limit snagging in 1973 (Carl 1977; Hay and Houghton 1990), harvest of foul-hooked fish and use of weighted treble hooks was not explicitly prohibited on all Michigan waters until *ca.* 1994. There is still a widespread perception that salmon do not bite in rivers, and many anglers have experienced the frustration of casting to huge numbers of visible salmon in clear rivers to no avail (Hay and Houghton 1990).

Although salmon do occasionally strike lures and are now known to feed on eggs while on their upstream journey (Garner et al. 2009), steelhead became the preferred target of many serious river anglers. Timing can vary from river to river and year to year, but river fishing for salmon typically lasts for a month or two in late summer and early fall. By contrast, steelhead can be caught 7-8 months out of the year in many rivers and are typically much more likely to bite than salmon. As a result, steelhead are managed primarily for their contribution to stream fisheries (Hay and Houghton 1990).

Recreational fishing in Michigan generates $2.3 billion in statewide economic impacts (Calantone et al. 2019). A comprehensive assessment of the economic impacts specific to steelhead fisheries in Michigan streams has not been conducted, but the contribution of steelhead to Great Lakes coastal communities can be substantial. A study of steelhead fisheries in Ohio tributaries of Lake Erie found $12–14 million in annual economic impacts generated by a $600,000 stocking program (Kelch et al. 2006). Ohio's steelhead fishery is maintained entirely through stocking, while the contribution of stocked and wild steelhead can vary widely from river to river in Michigan (Seelbach et al. 1994; Swank 2005).

The Pere Marquette River hosts naturalized runs of steelhead and salmon along with stream trout fisheries. Over a six-month period in 2011, the Pere Marquette River fishery generated $1.5 million for local economies (O'Neal and Kolb 2015). Surveyed Michigan rivers with steelhead and salmon runs averaged 3,596 angler-trips per mile over an 8–12-month sample period, while rivers that supported landlocked stream trout without migratory runs averaged 519 angler-trips over a fishing season of approximately five months (O'Neal and Kolb 2015), demonstrating a substantial increase in effort and economic impacts attributable directly to migrating steelhead and salmon.

Despite the importance of these river steelhead fisheries, little information is available when compared to Great Lakes open water fisheries. Creel surveys are conducted annually by Michigan Department of Natural Resources (MDNR) at many Great Lakes ports, but creel surveys are only sporadically conducted at major steelhead river fisheries (O'Neal and Kolb 2015) due to the additional cost and logistical challenges. Many of the smaller river fisheries have never been the subject of a creel survey.

River steelhead fisheries are facing a variety of challenges in the years ahead, with stocked and wild steelhead potentially facing different issues. River fisheries that are highly dependent on stocked steelhead are most likely to notice the impact of a missing year-class. Due to pandemic restrictions, egg take was not conducted at the Little Manistee River weir in 2020, resulting in a lack of fingerlings available for stocking in 2020 and a lack of yearling smolts available for stocking in 2021 (Boomgard 2020).

Survival of stocked steelhead is also thought to have declined in lakes Huron and Michigan in recent years, in part due to the decline in abundance of alewife (*Alosa pseudoharengus*) that can serve as a predation buffer. Although there is little direct evidence that high predation rates are having an impact on stocked steelhead smolts in nearshore environments of the Great Lakes, alewife have been shown to buffer predation on yellow perch (*Perca flavescens*) in northern Lake Michigan (Wagner 1972). Steelhead fry of wild origin have been shown to exhibit stronger prey avoidance behavior than fry of hatchery origin, with the naivete of hatchery stocks having both innate and experiential components (Berejikian 1995).

While decreased survival of hatchery smolts and disruption to stocking operations may impact river fisheries that depend heavily on stocked fish, fisheries that depend on naturally reproducing steelhead face other challenges. Wild steelhead production in Michigan is likely constrained by the availability of suitable spawning and nursery habitat, with both physical and thermal habitat characteristics playing a role. Water temperature influences growth and survival of young steelhead, with extended periods of time with extremely cold temperatures leading to mass mortality events in winter (Seelbach 1986; Rand et al. 1993; Newcomb and Coon 1997) and high temperatures being similarly destructive during summer (Newcomb and Coon 1997; Albrecht 2014). In addition to die-offs, sublethal impacts may result from crowding into limited macrohabitats with suitable temperatures (Newcomb and Coon 1997). In the Muskegon River, summertime temperatures above 21°C (70°F) were associated with steelhead parr die-offs (Godby et al. 2007). Water temperature in streams can be affected by a wide variety of factors including deforestation, land use change, groundwater withdrawal (Allan 1995), and dams (Woldt and Rutherford 2002; Albrecht 2014).

Dams also fragment river systems and block access to spawning and nursery habitat. (Hay and Houghton 1990). Large dams with deep impoundments can increase predation pressure on young steelhead as they move downstream, which was likely the reason for higher survival at downstream vs. upstream stocking sites documented in the St. Joseph and Grand rivers (Seelbach et al. 1994). Dams also typically impound high gradient river reaches, converting high-quality riverine habitat into lacustrine environments (Allan 1995).

High-gradient reaches tend to have physical characteristics that favor spawning steelhead. Moderately high water velocity and clean-swept gravel substrate are necessary for spawning. Large spaces between rocks provide the ideal location for eggs to incubate, and the constant flow of water ensures that eggs are well-oxygenated. Low-gradient river reaches tend to have lower water velocities that allow fine sediments including silt and sand to fall out of suspension (Allan 1995), smothering incubating eggs.

Low-gradient reaches dominated by sandy substrate can provide excellent nursery habitat for young steelhead if groundwater inputs are high, but reproduction cannot occur without patches of gravel substrate (Seelbach 1993). Natural reproduction of salmonids in many coldwater streams of Michigan's northern Lower Peninsula is therefore limited by their lack of gravel. Experiments at Hunt Creek Fisheries Research Station showed the dramatic negative impact of sand on trout populations in a Michigan stream (Alexander and Hansen 1986) and the increase in trout and invertebrate production that can result when sand inputs cease, and sand bed loads are transported downstream over time (Alexander and Hansen 1982). Streambank erosion, stream channelization, deforestation, and changes in land use patterns can potentially increase sedimentation (Striffler 1964; Allan 1995) and have negative impacts on steelhead production if gravel bars are covered with sand bed load (Bjornn and Reiser 1991). Many streams in northern Michigan are still recovering from sedimentation that resulted from clear-cutting of old growth forests in the 1800s, and habitat restoration efforts continue to address the impact (Bassett 1988).

Aquatic invasive species have the potential to impact both naturalized and stocked steelhead. In stream environments, the relatively recent arrival of New Zealand mudsnail (*Potamopyrgus antipodarum*) and didymo (*Didymosphenia geminata*) in Michigan streams has the potential to reduce production of wild steelhead smolts. Didymo is a type of algae that attaches to hard substrate. The invasive form of didymo can carpet the bottom of rivers, smothering spawning habitat and reducing populations of benthic invertebrates that young trout feed upon (Blanco and Ector 2009). The New Zealand mudsnail can also displace native invertebrates and reach extremely high densities (Kearns et al. 2005). One study found that rainbow trout do consume New Zealand mudsnails, but most of the snails pass through the trout's gut tract without being digested; trout that were fed mudsnails actually lost weight during the study (Vinson and Baker 2008).

In open waters of the Great Lakes, invasive species and declining nutrient inputs have decreased productivity. The filtering activity of the quagga mussel (*Dreissena rostriformis bugensis*) led to the disappearance of the spring phytoplankton bloom in southern Lake Michigan (Vanderploeg et al. 2010) and dramatic increases in water clarity in lakes Michigan and Huron (Bunnell et al. 2014). Other invertebrate invaders have also disrupted the food web. The spiny water flea (*Bythotrephes longimanus*) now consumes more zooplankton than native mysis shrimp (*Mysis diluviana*) and fish in Lake Huron (Bunnell et al. 2011) and the fishhook water flea (*Cercopagis pegnoi*) preys on native rotifers in Lake Michigan but does not provide a food source for fish (Witt et al. 2005).

Decreased productivity in the lower food web resulted in "bottom-up" control of prey fish populations in Lake Huron, and subsequent declines in predatory salmonines (Bunnell et al. 2014). High stocking rates coupled with increased natural reproduction of Chinook salmon were also implicated in the crash of Lake Huron alewife in 2004 (Johnson et al. 2010). Alewife continue to serve as the primary forage fish for salmon and steelhead in Lake Michigan (Leonhardt et al. 2020). There is evidence for both bottom-up and top-down effects driving the recent decline of alewife in Lake

Michigan (Bunnell et al. 2014). The disappearance of *Diporeia* following the quagga mussel invasion represents the loss of a high-quality food resource for alewife in Lake Michigan (Nalepa et al. 2006; Bunnell et al. 2014).

Nutrient inputs have also been declining since implementation of the Great Lakes Water Quality Agreement in 1972, but the role of declining nutrient inputs relative to quagga mussel filtering is poorly understood (Hecky and DePinto 2020). Increasing water clarity in Lake Superior, where quagga mussels do not thrive, suggests that non-point source pollution controls have played a role in decreasing productivity throughout the Great Lakes (Bunnell et al. 2014), but problems with excess nutrients and resulting harmful algal blooms continue to plague nearshore waters in places like the Western Basin of Lake Erie, leading to a difficult situation for managers who are facing a nutrient deficit in some areas and continued problems with excess nutrients in others (Hecky and DePinto 2020).

River steelhead fisheries are likely limited by the carrying capacity of salmonines in the Great Lakes, particularly in lakes Huron and Michigan. However, wild smolt production in individual river systems is known to vary considerably from year to year for reasons that are not fully understood in all rivers (Seelbach 1993). Improvements in thermal habitat due to run-of-river dam operation was shown to have a dramatic positive effect on smolt production in the Manistee River (Woldt and Rutherford 2002). It stands to reason that different river fisheries within a Great Lakes basin could exhibit wildly different trends over time if there are major changes to dam operations, land use, habitat, fish passage, stocking, or survival of young steelhead that affect individual watersheds.

All of those changes could affect recruitment, and ultimately impact the number of returning adult steelhead that river fisheries depend upon. However, there is currently little or no evidence to suggest that the number of returning adult steelhead is limiting recruitment to individual river systems (see summary of research on Michigan steelhead at bit.ly/3yRqGK9; second presentation) with the assumption being that spawning and nursery habitats are so limited that even a small number of spawning adults can saturate habitat (Carl 1984). Even so, many river anglers have expressed concerns that excessive steelhead harvest could be detrimental to river fisheries.

Although continuous time series data on river steelhead fishing effort are not available, anecdotal reports suggest a surge in fishing pressure due to the pandemic (Boomgard 2020). With no options for indoor recreation and entertainment outside the home due to government-imposed restrictions, many people took up fishing and other outdoor hobbies resulting in an increase in hunting and fishing license sales. By October of 2020, fishing license sales were up 9% over the past year and license sales to first-time anglers were up 42% (Bingham 2020).

Anecdotal reports suggest that steelhead rivers were particularly affected, perhaps due to the low cost of steelhead fishing and ease of access relative to fishing open waters of the Great Lakes. Increased fishing pressure may or may not have resulted in an increase in steelhead harvest, though. In addition to no-harvest regulations on certain waters, many anglers practice voluntary catch-and-release. The prevalence of voluntary catch-and-release has been increasing over time (Brownscombe et al. 2014) and can vary considerably from river to river. A summary of Michigan DNR creel studies on certain steelhead rivers in select years found steelhead release rates ranging from 38% to 78% (bit.ly/3yRqGK9).

Current estimates of release rates from different river systems and knowledge of factors that influence the decision to harvest fish would help to better understand the mitigating impact of catch-and-release.

Purpose and Objectives

The purpose of the Michigan River Steelhead Program is to engage steelhead anglers in providing biological and social science data relevant to steelhead management and to facilitate communication among stakeholders, scientists, and decision-makers. In doing so, we hope to raise the profile of river fisheries in discussions with fishery managers and stimulate interest in additional research and monitoring activities.

The Michigan River Steelhead Program began in September 2020. The intent was to use electronic angler diary records to begin filling gaps in knowledge of steelhead fisheries around the state. Participants recorded total length, fin clip, and effort data using the Great Lakes Angler Diary in addition to completing annual surveys during the first two years of this program. Through regular Zoom meetings that included participation from anglers, biologists, and fisheries managers, we developed instructions and survey questions to solicit opinions on management issues and address potential sources of bias.

The objectives of this program were to: 1) assess the contribution of stocked and wild steelhead to Michigan stream fisheries, 2) address the potential impact of the missing 2020 stocked year class, 3) determine factors that influence the decision to release or harvest steelhead, 4) gauge angler satisfaction with fishing success and management actions, and 5) continually adapt and improve the program based on evaluation efforts including year-end surveys and regularly scheduled virtual meetings.

Steelhead Strains

According to the Great Lakes Fish Stocking Database (http://fsis.glfc.org/), which is hosted by the Great Lakes Fishery Commission, fifteen different strains of steelhead and rainbow trout were stocked into the Great Lakes, connecting waters, and accessible tributaries from 2018 to 2021 (Table 1; Appendix A). Of these, six strains are unlikely to be encountered and identified by Michigan anglers. Three of these strains (Randolph Hatchery, Seneca Lake, and Washington State) were only stocked in the Lake Ontario basin. The other three strains (Domestic, Lake Ontario, and Shasta) were stocked in Lake Ontario and Lake Erie basins. Ohio relies heavily on Shasta strain steelhead for their stocking program, but steelhead stocked in Ohio did not receive fin clips and cannot be readily identified as stocked fish if they stray into Michigan waters. New York and Pennsylvania also stock a variety of unmarked strains into the Lake Erie basin, including Domestic and Lake Ontario strain fish stocked by New York.

This leaves nine strains that Michigan anglers might encounter and identify as stocked based on fin or maxilla clips. Two strains (Knife River and French River) are only stocked by Minnesota in the Lake Superior basin. Other strains that may be encountered in Michigan waters include the Michigan, Skamania, Ganaraska, Chambers Creek, and Ontario Wild strains of steelhead, along with Arlee and

Eagle Lake strains of rainbow trout. Rainbow trout and steelhead are the same species, but steelhead strains are more likely to migrate between stream and lake or ocean environments while rainbow trout stains are less likely to display migratory behavior. Although stray steelhead stocked in other states may enter Michigan rivers, only two steelhead strains are stocked in Michigan: the Michigan strain and Skamania strain.

Michigan Strain and Naturalized Steelhead

The Little Manistee River has hosted runs of naturalized steelhead since the late 1800s, and the Little Manistee River Weir has served as the primary location for steelhead egg-take since 1968 (Hay 2003). Steelhead are not stocked in the Little Manistee River, which helps to ensure that gametes are not collected from hatchery-reared steelhead. Although steelhead are not native to the Great Lakes region, natural selection has been favoring the success of steelhead with traits beneficial to life in the Great Lakes and tributaries for well over a century. Naturalized fish are the product of natural reproduction in Michigan rivers, and are also referred to as wild steelhead.

Michigan strain steelhead are the hatchery-reared progeny of wild Little Manistee River steelhead. Artificial spawning occurs at the Little Manistee River Weir in late March or April. Fertilized eggs are then transported to hatcheries for rearing. Prior to 1985, most young steelhead were stocked in the autumn of their birth year. Low survival of these fall fingerlings led Michigan DNR to switch to stocking spring yearlings at most locations (Seelbach et al. 1994), although fingerlings are still stocked at some Michigan locations and in Illinois and Indiana waters (Appendix A).

Hatchery-reared yearlings are stocked as smolts or pre-smolts, which allows them to imprint on the stream they are stocked in before they emigrate to open waters of the Great Lakes. Smolting occurs when young river-dwelling steelhead (called parr) grow to an appropriate size, lose their river coloration (parr marks), take on the silvery coloration they will exhibit in the Great Lakes, imprint on olfactory cues that will help them return to their natal stream, and migrate downstream (Seelbach et al. 1994). Hatchery-reared fingerlings are stocked at the parr stage, requiring them to overwinter in river environments where low growth rates, cold water, and predation take their toll before smolting occurs in the spring.

Michigan strain steelhead are stocked in many rivers that host runs of naturalized steelhead. These wild-spawned fish are genetically quite similar to Michigan strain fish, but the steelhead is a very adaptable fish and environmental differences from river to river can result in variations in several life history traits (Swank 2005). It is typical for naturalized steelhead to spend two full years in the stream environment before smolting, but this can range from one to three years (Swank 2005). Although growth in hatcheries is nearly always faster than growth in a stream environment, the size of naturalized smolts can be either larger or smaller than hatchery smolts depending on the combined effects of growth rate and river residence time before smolting (Swank 2005). The survival rate of stocked Michigan strain smolts to adulthood is thought to be lower than naturalized smolts (Dexter and O'Neal 2004) and may have declined further in recent years due to the declining predation buffer and increased water clarity in the Great Lakes.

The Michigan strain of steelhead has also been referred to as the Little Manistee strain, Michigan winter-run strain, or winter-run strain. Adult Michigan strain fish typically ascend rivers in March and April, but a distinct fall run also occurs primarily in October and November (Dexter and O'Neal 2004). River steelhead fisheries persist through the winter months, although the extent of upstream migration during winter is almost certainly less than fall and spring runs. The fall run, and subsequent holdover of winter steelhead in streams, is not well-understood but fall-run fish account for around 30% of steelhead counted at the Little Manistee River Weir on an average year with considerable variation of the strength of the fall run from year to year (Tonello 2005). Fall-run fish are thought to spawn in late winter and post-spawn fall-run fish have been observed migrating out of the Little Manistee River around the same time that spring run fish run upriver (Dexter and O'Neal 2004). Based on similar sex ratios and the lack of genetic differences, fall-run and spring-run wild steelhead in the Little Manistee River are considered a single interbreeding population (Swank 2005).

Michigan strain steelhead spend at least one summer feeding in a Great Lakes environment before returning to the stream, with most reaching maturity after two to three summers in the lake (Swank 2005). Steelhead that return after one summer are often referred to as "skippers." These fish are typically male "jacks" (Seelbach et al. 1994), although females do occasionally spawn after a single summer in the lake (Swank 2005).

Unlike Pacific salmon (*Oncorhynchus* spp.), steelhead do not necessarily die after spawning. Repeat spawning in Great Lake populations is even more prevalent than it is in their native range, with 18–63% of the Little Manistee steelhead run composed of repeat spawners (Seelbach 1993). All told, steelhead can spend up to six summers feeding and growing in the Great Lakes. The majority of Michigan strain steelhead caught in Lake Michigan tributaries are lake-age 2 or 3, with few fish older than lake-age 4 (Seelbach et al. 1994). In the Huron River, a tributary of Lake Erie, Michigan strain steelhead are more likely to mature early and lake-age 1 and 2 fish constitute the majority of the catch (Seelbach et al. 1994). Warm water temperatures in western Lake Erie can cause thermal stress (Seelbach et al. 1994) that may be a factor leading to earlier maturity in Lake Erie (Swank 2005). The smaller average size of Huron River steelhead is attributed to earlier maturity, since growth rates for Lake Erie are not significantly different than Lake Michigan (Swank 2005).

Ages reported for steelhead are typically separated by life stage, with stream age reported before a decimal point and lake age reported after the decimal. Stocked Michigan strain steelhead are all considered stream-age 1. A stocked fish that spent two summers in the Great Lakes could be referred to as age 1.2, lake-age 2, or simply age .2 depending on the author. Naturalized steelhead have more variability in stream age, so a lake-age 2 wild fish could be age 1.2, 2.2, or 3.2.

Although growth rate early in life is variable and dependent on stream or hatchery environment, by lake-age 2 the feeding environment in the Great Lakes is more important in determining length (Swank 2005). For this reason, it makes sense to conceptualize size-classes of steelhead returning to river fisheries as smolt cohorts, as opposed to year-classes. For example, the lack of egg take during 2020 resulted in the loss of the stocked 2021 smolt cohort. Wild smolts from the 2021 smolt cohort may be from the 2020, 2019, or 2018 year-class, but their size and timing of contribution to river fisheries would be most analogous to the stocked 2021 smolt cohort regardless of year-class.

Skamania

The Skamania strain of steelhead is named for the Skamania Hatchery in Skamania County, Washington. A short history of the hatchery and the strain was provided in the North Fork Washougal Weir and Adult Handling Facility, Washington State Joint Aquatic Resources Permit Application, 2015, as quoted below at http://columbiariverimages.com/Regions/Places/skamania_hatchery.html.

> "The Skamania Hatchery was constructed in 1956 on the West Fork Washougal River in order to propagate summer-run steelhead (*Oncorhynchus mykiss*). In 1959, due to low numbers of Washougal summer run steelhead returning, summer steelhead from the Klickitat River were transferred for spawning. In 1963 the two stocks were mixed, resulting in what is now Skamania summer steelhead. The summer steelhead are used as parent stock for runs created at other hatcheries throughout the state.
>
> Since 1986, only hatchery-origin broodstock have been used for propagation, identified by a clipped adipose fin. Natural-run fish are released back to the West Fork Washougal upstream of the fish ladder. Approximately 60,000 Skamania-origin hatchery winter steelhead smolts and 60,000 hatchery summer steelhead smolts are released annually into the Washougal River."

Propagation of Skamania strain steelhead in the Great Lakes region began in Indiana in 1978 (Seelbach et al. 1994). Skamania were introduced in part because hatchery practices selected for late-maturing spawners that could provide a trophy fishery, and also due to growth of young fish in the hatchery setting (Seelbach et al. 1994). Skamania provide unique angling opportunities because of the timing of their upstream migration. Unlike Michigan strain "winter-run" steelhead, Skamania typically ascend rivers in summer months and are alternately referred to as "summer-run" steelhead.

In Michigan, Skamania are stocked in the Manistee River and in the St. Joseph River, which straddles the border of Michigan and Indiana. Indiana also stocks Skamania in the St. Joseph River, with a series of fish ladders allowing for upstream passage (Seelbach et al. 1994). Skamania are also stocked by Indiana in other Lake Michigan tributaries, and by Illinois and Wisconsin in Lake Michigan basin waters (Appendix A).

Skamania are popular with anglers, in part due to their accessibility during summer months. Skamania are also thought to jump more often and fight harder than other steelhead, although it is not clear if this tendency is related to water temperature, genetics, or both. One drawback of Skamania is that summertime water temperature in many rivers often exceeds their tolerance. During the summer run, Skamania seek thermal refuge at coldwater creek mouths. Fishing can be excellent when Skamania are concentrated in small areas, but release mortality is likely very high and anglers have even reported fish dying on the line from thermal stress and exhaustion during the heat of summer.

Evaluation of the contribution of Skamania and Michigan strain steelhead to Michigan fisheries has noted several key differences. Skamania do provide additional fishing opportunities in rivers during summer in the St. Joseph and Manistee Rivers, with few Michigan strain fish being caught during summer months (Prichard et al. 2018). When catch rates were corrected for the number of steelhead stocked, both strains contributed similarly to fishing in these rivers September-November, but the Michigan strain was far more important to the March-April fishery when Skamania catch rates were very low (Prichard et al. 2018).

Skamania do mature later than Michigan strain steelhead, on average. In the St. Joseph River, Skamania matured at an average lake-age of 3.42 while Michigan steelhead matured at an average lake-age of 2.44 (Seelbach et al. 1994). The range of age-at-maturity also differs, with Michigan strain fish maturing at lake-age 1–4 and Skamania maturing at 2–5 (Seelbach et al. 1994). This means that virtually all skippers are either Michigan strain steelhead or naturalized fish.

The later maturity schedule for Skamania does lead to a larger average size of Skamania caught in river fisheries, but it does not translate into higher catch rates of trophy-sized steelhead since longevity and growth are similar for the two strains (Prichard et al. 2018). The rate of return to river fisheries in all seasons combined is much higher for Michigan strain fish, with 2.21 times more Michigan strain steelhead caught per 1,000 stocked in the Manistee River than Skamania (Prichard et al. 2018). Although Michigan strain steelhead are more cost-effective and genetically closer to naturalized steelhead (Bartron and Scribner 2004), Skamania continue to provide unique fishing opportunities during summer months when they contribute to nearshore trolling and pier fisheries in addition to river fisheries noted above.

Interpretation of Fin Clips

Since 2017, the Great Lakes Mass Marking Program (see bit.ly/42L6kjk for description and summary of results) has been working with state agencies to mark steelhead with adipose (AD) fin clips and coded wire tags (CWTs). In 2018 and 2019, all steelhead stocked into U.S. waters of the Lake Michigan and Lake Huron basins were marked with an AD clip, and steelhead stocked in to Michigan waters of the Lake Superior, Lake St. Clair, and Lake Erie basins were also marked with an AD clip (Appendix A). Pandemic restrictions resulted in changes to stocking and marking plans during 2020 and 2021. This resulted in reductions to the number of steelhead stocked in many locations and the stocking of unmarked steelhead in some jurisdictions. The following basin-by-basin summaries of stocking and marking from 2018 to 2021 are based on records in the Great Lakes Fish Stocking Database (fsis.glfc.org; Appendix A), with emphasis on pandemic-related changes in 2020 and 2021.

Lake Michigan Basin: Michigan

Steelhead are stocked into the Lake Michigan basin by four states. Michigan Department of Natural Resources (MDNR) primarily stocks Michigan strain steelhead yearlings into the Lake Michigan basin. Michigan strain yearlings are the only steelhead stocked at most Michigan stocking locations. Skamania yearlings are also stocked in the Manistee River. Fall fingerling Michigan strain steelhead are stocked by MDNR in the Manistee and St. Joseph rivers.

In 2020, restrictions prevented egg take at the Little Manistee River weir, resulting in a missing year-class. Therefore, no fall fingerling Michigan strain steelhead were stocked in 2020 and no yearling

Michigan strain steelhead were stocked in 2021. Skamania yearlings were not planted by MDNR in 2020, but yearling Skamania were again available for stocking by MDNR in 2021.

In Michigan waters of the Lake Michigan basin, all steelhead stocked 2018–2021 were marked. All Michigan strain steelhead were marked with an AD clip, including fingerlings and yearlings. Skamania stocked in the Manistee River were marked with both an adipose and right ventral (ADRV) clip in 2018 and 2019, but those stocked in 2021 bore only a right ventral fin clip (RV).

For Michigan stream anglers, this means that all steelhead stocked in Michigan tributaries of Lake Michigan have been marked since 2018. For the Fall 2022 and Spring 2023 runs, the oldest Michigan-stocked yearling steelhead included in the Great Lakes Mass Marking Program will have spent five summers feeding in the Great Lakes. By Fall 2023, all retuning steelhead stocked in Michigan will be marked since lake-age 6 is the maximum life expectancy.

Eagle Lake rainbow trout are also stocked into some inland waters of the Lake Michigan basin. Although most waters that receive Eagle Lake rainbow trout are landlocked or isolated from Lake Michigan by dams, the Muskegon River does receive stockings of Eagle Lake rainbows downstream of the lowermost dam at Croton. These Eagle Lake rainbows have not been marked in recent years, but they are unlikely to emigrate to Lake Michigan and are unlikely to be mistaken for returning steelhead due to their smaller size. However, it is possible that unmarked stocked Eagle Lake rainbow trout in the Muskegon River under 15 inches in total length could be mistaken for wild steelhead parr.

Lake Michigan Basin: Wisconsin

Yearling Chambers Creek, Skamania, Ganaraska, and Arlee strain fish were stocked by Wisconsin DNR in 2018 and 2019. In 2020, Skamania were not available but yearlings of the other three strains were stocked along with Chambers Creek and Ganaraska fingerlings. In 2021, neither Skamania nor Arlee were stocked by Wisconsin, but Chambers Creek and Ganaraska yearlings and fingerlings were available.

In 2018 and 2019, all steelhead stocked by Wisconsin DNR had an adipose fin clip, and some strains in some rivers had additional clips including right ventral (ADRV), left ventral (ADLV), right maxilla (ADRM), and left maxilla (ADLM). Pandemic restrictions led to the stocking of unmarked fingerling Chambers Creek and Ganaraska strain steelhead in 2020, and the stocking of unmarked yearlings of the same strains in 2021 along with unmarked Chambers Creek fingerlings (Table 2; Appendix A). In 2021, a subset of Chambers Creek yearlings was also marked with only the left maxilla clipped (LM), and a subset of Ganaraska yearlings were marked with only the left ventral fin clipped (LV; Appendix A).

For anglers, this means that there is a chance that unclipped steelhead returning to Michigan streams might be stray fish from Wisconsin stocking, and not wild steelhead spawned in Michigan streams as one might assume. Although this cannot be ruled out as a possibility, Wisconsin's use of marks not used in Michigan (ADLV, ADRM, ADLM, LM, LV) will give some indication of straying prevalence (Table 2).

Lake Michigan Basin: Indiana

In 2018 and 2019, Indiana DNR stocked fingerling and yearling Michigan strain and Skamania steelhead. Indiana stocking locations included sites on the St. Joseph River, which flows through Michigan's Berrien County before reaching Lake Michigan. Michigan River Steelhead Program participants are therefore very likely to encounter steelhead stocked by Indiana DNR when fishing at locations in the lower St. Joseph River watershed, and possibly in nearby watersheds that receive strays.

In 2020, Indiana yearling Skamania were the only steelhead stocked in Indiana waters. In 2021, yearling and fall fingerling Skamania were stocked by Indiana DNR but Michigan strain steelhead were not. In addition to disrupting plans for strains and life stages stocked, the pandemic restrictions also resulted in changes to marks used on Indiana steelhead.

In 2018 and 2019, every steelhead stocked in Indiana was marked with both an AD clip and a CWT. In 2020, only yearling Skamania were stocked and all of these fish bore a CWT and AD clip, but some of these fish were additionally marked with a right ventral fin clip (ADRV). In 2021, fall fingerling Michigan strain steelhead stocked in Indiana waters bore both the AD clip and CWT, but yearling Skamania stocked in 2021 did not receive a CWT or an AD clip. Most of the yearling Skamania stocked in 2021 did not receive any fin clip, but around 9% were marked with a right ventral clip (RV; Appendix A).

All of this serves to complicate interpretation of fin clip data from steelhead returning to Indiana streams and Michigan waters that receive migrating steelhead stocked in Indiana waters. While Michigan strain steelhead have all been marked with an AD clip in recent years, Skamania marking has not been consistent. Indiana-stocked Skamania may exhibit an AD clip (for most fish stocked 2018-2020), a combination ADRV clip (for some yearlings stocked in 2020), a RV clip only (for some yearlings stocked in 2021), or no mark at all (for most stocked in 2021).

Lake Michigan Basin: Illinois

Both Skamania summer-run steelhead and Arlee strain rainbow trout are stocked into Illinois waters of the Lake Michigan basin. Fingerlings of both strains were stocked with AD clips in 2018 and 2019 (Illinois does not stock yearlings). In 2020, Skamania fingerlings were stocked into Illinois waters without marks but Arlee rainbow trout did receive an AD clip. In 2021, all Arlee and Skamania stocked by Illinois bore an AD clip. Thus, with the exception of Skamania fingerlings stocked in 2020, all steelhead and rainbow trout stocked by Illinois since 2018 have had an adipose fin clip.

Lake Huron Basin: Michigan

All steelhead stocked into Michigan waters of the Lake Huron basin in recent years have been Michigan strain yearlings. Eagle Lake strain rainbow trout were also stocked at some nearshore locations to provide fishing opportunities. In 2018 and 2019, all Michigan strain steelhead and Eagle Lake rainbow trout stocked into Michigan waters of the Lake Huron basin were marked with an AD clip, except for 130 adult Eagle Lake strain rainbow trout stocked into the St. Mary's River. In 2020, only yearlings of both strains were stocked, and all had an AD clip. In 2021, Michigan strain steelhead yearlings were not stocked due to pandemic restrictions that prevented egg take in 2020. However, 30,000 yearling Eagle Lake rainbow trout were stocked in Lake Huron's Lexington Harbor in 2021 and these fish were not marked.

Thus, since 2018 all steelhead and rainbow trout stocked into Michigan waters of the Lake Huron basin have been yearlings marked with an AD clip, with the exception of 130 adult Eagle Lake rainbows stocked in 2018. Although the pandemic did not result in changes to markings on stocked fish, the loss of the 2021 cohort of yearling Michigan strain steelhead may impact anglers along with changes to stocking locations within the basin that occurred in 2020.

Lake Huron Basin: Ontario

Both Ganaraska and Ontario Wild strain steelhead are stocked in Ontario waters of the Lake Huron basin. Ganaraskas are stocked as yearlings, while Ontario Wild steelhead are stocked as fry, fingerlings, or yearlings. All Ganaraska yearlings were marked with an AD clip before stocking in 2018 and 2019. All Ontario wild steelhead stocked in 2018 were AD clipped, as were 83% of those stocked in 2019 (the remainder were stocked with no marks). Fry and fingerling Ontario Wild steelhead stocked in 2018 and 2019 were also unmarked. In 2020 and 2021, no steelhead were stocked in Ontario waters of Lake Huron due to pandemic restrictions.

Michigan steelhead anglers may encounter stray steelhead planted in Ontario waters, but Ontario fish will not be readily identifiable as fish stocked outside the state based on external marks. Ontario-stocked steelhead may be either AD clipped (for Ganaraskas and Ontario wild steelhead stocked as yearlings) or unmarked (for all Ontario wild steelhead stocked as fry or fingerlings and some yearlings). Furthermore, steelhead stocked in Ontario waters were not marked with CWTs.

Lake Superior Basin: Michigan

In 2018 and 2019, Michigan strain fingerling and yearling steelhead were stocked into Michigan waters of the Lake Superior basin. All yearlings were AD clipped, but none of the fingerlings were marked in 2019 and 37% of fingerlings were unmarked in 2018. In 2020, fingerlings were not stocked and all yearlings were again stocked with AD clips. No steelhead were stocked in Michigan waters of the Lake Superior basin in 2021 due to pandemic restrictions.

Lake Superior Basin: Wisconsin and Ontario

Wisconsin and Ontario do not stock steelhead or rainbow trout into the Lake Superior basin, instead relying on natural reproduction entirely to support steelhead runs and fisheries.

Lake Superior Basin: Minnesota

In 2018, Knife River strain yearlings were stocked with a combination adipose fin and left ventral fin clip (ADLV). In addition, 631 adult Knife River steelhead were stocked with a right maxilla clip (RM), external numbered t-bar tag, and passive integrated transponder (PIT). In 2019, French River strain yearlings were stocked with adipose and right ventral clips (ADRV). In 2020, stocking numbers were reduced but French River yearlings were again stocked, this time with the ADLV clip combo. Due to pandemic restrictions that curtailed egg take in 2020, no steelhead were stocked in Minnesota waters of the Lake Superior basin in 2021.

Michigan stream anglers will know it if they encounter a stray steelhead planted in Minnesota waters. All fish stocked in Minnesota since 2018 bear a clip or clip combination not used for stocking Michigan waters of the Lake Superior basin. While Michigan fish stocked in the Superior basin will have an AD clip or no mark, Minnesota fish will most likely have an ADRV or ADLV clip combination. Since the RM clip and additional tags were used on only a very small number of adult steelhead in 2018 it is very unlikely that Superior basin anglers will encounter an RM clip.

Lake St. Clair Basin: Michigan

Approximately 45,000 AD-clipped Michigan strain yearling steelhead were stocked annually into the Lake St. Clair basin by MDNR from 2018 to 2020. Pandemic restrictions prevented egg take in 2020, so yearling Michigan strain steelhead were not stocked in 2021.

Ontario does not stock steelhead into the St. Clair basin. Since Lake St. Clair is a connecting waterway for Lake Huron and Lake Erie, steelhead from other basins may be encountered in Lake St. Clair and its tributaries. However, all steelhead stocked into the Huron and Erie basins are marked with either the AD clip or no clip at all, so it is not possible for St. Clair and Erie basin anglers to identify steelhead stocked in other adjacent basins on the basis of external marks.

Lake Erie Basin: Michigan

Approximately 64,000 yearling Michigan strain steelhead were stocked into Lake Erie basin waters by MDNR annually from 2018-2020. All of these fish were marked with an AD clip. Due to pandemic restrictions, no steelhead were stocked in Michigan waters of the Lake Erie basin in 2021.

Lake Erie Basin: Ohio, Pennsylvania, New York, and Ontario

Other jurisdictions around the Lake Erie basin do not mark steelhead. Ontario does not stock any steelhead or rainbow trout into the Erie basin. Ohio, Pennsylvania, and New York stocked a combined total of 7.97 million steelhead and rainbow trout of six different strains into Lake Erie and its tributaries, but none of these fish were marked.

For Michigan anglers in Lake Erie tributaries, this means that unmarked steelhead may be stray fish from plantings in other states as opposed to naturally spawned fish returning to natal streams. This will affect interpretation of participant data from the Huron River in southeast Michigan, in particular.

Lake Ontario Basin: New York, and Ontario

From 2018-2021, 4.19 million steelhead and rainbow trout were stocked into Lake Ontario waters and 102,360 of these were marked with an AD clip. The vast majority were stocked without any marks, but New York State Department of Environmental Conservation (NYDEC) has marked 62% of Skamania stocked since 2018 with an AD clip. Although Michigan anglers are unlikely to encounter steelhead stocked in the Lake Ontario basin, the exclusive use of an AD clip on Skamania makes the

Great Lakes Angler Diary recording system a good candidate for use in future strain evaluations in New York waters.

Prevalence of Adipose-Clipped Steelhead Without Coded Wire Tags

In Michigan, there is a history of encouraging anglers to collect heads of adipose-clipped salmonids (Seelbach et al. 19994). Heads can be dropped off at freezer locations around the state (bit.ly/3STGxB8) and a form (bit.ly/3kU4f3G) is filled out by the angler to collect relevant information on the catch. Before mass marking, the adipose fin clip was only used in a subset of stocked salmonids for specific research goals such as comparison of strains. In the past, anglers expected that all adipose-clipped salmonids also contained a coded wire tag (CWT) in the snout. This is no longer the case for steelhead, and the prevalence of CWTs in clipped steelhead varies considerably around the Great Lakes basin.

From 2018 to 2021 in the Lake Michigan basin, the majority of steelhead and rainbow trout stocked with an AD clip also received a CWT, but each state around the basin also stocked some AD-clipped fish without CWTs. Overall, 6.9% of all adipose-clipped steelhead stocked in the Lake Michigan basin from 2018-2021 did not receive a CWT (Appendix B).

In the Lake Huron basin, none of the AD-clipped steelhead stocked by Ontario received a CWT. In Michigan waters of the Huron basin, however, the majority of steelhead with an AD clip also received a CWT. Basinwide, 41.9% of fingerling and yearling steelhead and rainbow trout stocked with an AD clip did not receive a CWT; 30.8% of AD-clipped yearlings stocked in Michigan waters of the Lake Huron basin did not receive a CWT (Appendix C).

None of the steelhead stocked from 2018-2021 in the Lake Superior, Lake St. Clair, and Lake Erie basins received a CWT. However, most steelhead stocked in Michigan waters of these basins did receive adipose fin clips. All of the steelhead stocked by Michigan DNR in the Lake St. Clair and Lake Erie basins were AD-clipped; all yearling steelhead stocked by Michigan DNR in the Lake Superior basin were AD-clipped along with some fingerlings (Appendix A).

Anglers fishing in Michigan streams can therefore expect that some steelhead marked with an adipose fin clip will not be marked with a CWT. In the Lake Michigan basin, the prevalence of AD-clipped steelhead without a CWT is around 7%, while anglers in Lake Huron streams can expect a higher prevalence of clipped steelhead without CWTs. In other basins, none of the AD-clipped steelhead should have CWTs unless they emigrated from Lake Michigan or Lake Huron.

Development of the Michigan River Steelhead Program

The Great Lakes Angler Diary was developed in 2016 by Brenton Consulting, LLC. Initially, a website (www.GLanglerdiary.org) was developed to meet the needs of the Salmon Ambassadors program. Salmon Ambassadors reported data on Chinook salmon (*Oncorhynchus tshawytscha*), with most participants fishing open waters of the Great Lakes and reporting catches on paper.

The Great Lakes Angler Diary app for iOS was beta-tested in 2018 and published in 2019. A similar app for Android devices was published in 2021. These apps featured a simplified data entry screen with fewer data fields than the website (Figure 2). The Great Lakes Angler Diary reporting system was not adopted by a large number of anglers after its initial development and promotion from 2016 through 2019. This was attributed to a variety of factors that informed development of the Michigan River Steelhead Program.

One factor that hindered early adoption of the Great Lakes Angler Diary was the lack of focus for data collection and participant instruction. While the Salmon Ambassadors program had been successful due to simple messaging that instructed participants to collect fin clip and total length data on each and every Chinook salmon caught, the transition to Great Lakes Angler Diary was accompanied by vague messaging.

Anglers who signed up for Great Lakes Angler Diary from 2016-2019 were asked to collect data on any species of salmonine they wished, so long as they collected all fish of the species they chose over the course of the year. This led to some collection of data on species other than Chinook salmon but not enough to draw meaningful conclusions. However, several existing Salmon Ambassadors did switch from paper reporting of Chinook salmon to online reporting using Great Lakes Angler Diary.

Another factor that hindered success early on was the large number of data fields available. The earliest version of the website for data entry included 33 data fields on two separate data entry screens, one for trip data and one for catch data. Although many fields were optional, the number of choices were likely overwhelming and navigation between screens was confusing for some users.

Later versions of the website narrowed the number of required data fields to four on the trip entry screen (trip date, location, hours fished, number of anglers in party) and five on the catch entry screen (species, total length, fate, sex, and fin clip). Other data fields are still available in a pull down menu for optional data, but these are rarely used. In 2022, one optional field (satisfaction) was placed above the pull-down menu to encourage more users to report satisfaction.

Currently, these same ten data fields appear on a single screen in the apps (Figure 2). Users can edit trip and catch data on the website after initial data entry using an app. On the website, an additional five trip and 18 catch data fields are available. In this way, the apps are kept simplistic, and the website retains functions that allow uploading pictures, adding written comments, reporting number of fish hooked, and writing in a specific location not available on dropdown menus among other lesser-used options.

The Michigan River Steelhead Program was initiated in 2020 with the intent of marketing use of the Great Lakes Angler Diary to a more narrowly targeted audience. The timing was also influenced by the Great Lakes Mass Marking Program's shift from mass marking Chinook salmon to mass marking steelhead beginning in 2017. By fall 2020, the majority of returning stocked steelhead had an adipose fin clip.

The constraints imposed by the pandemic and related restrictions prohibited in-person meetings to recruit participants. This, and the increased adoption of software to facilitate virtual meetings, led to development of a River Team structure that leveraged local biologists and highly committed anglers who reached out to their network of contacts to market the program. Each River Team included a local DNR biologist to serve as the Agency Partner and a committed club leader, guide, author, or other dedicated and well-connected angler to serve as the Team Leader (Appendix E). This structure was intended to ensure promotion of the program in key fisheries around the state, but data collection was not limited to rivers that had an associated team (Figure 1; Appendix F)

Previous studies, and our own experience with Salmon Ambassadors, have shown that attrition is common in angler diary programs (Cooke et al. 2000; Lawson 2015) and regular reporting of results is a key to maintaining engagement (Ormeland et al. 2022). Given the wide geographic focus of the Michigan River Steelhead Program, Zoom meetings provided an ideal forum to facilitate ongoing communication among group members. Three virtual meetings were hosted each year, one season kickoff meeting around the beginning of October, a winter meeting in December, and a year-end meeting in May.

The kickoff meeting featured results from the previous year and programmatic changes for the new year, the December meeting featured additional results and a preliminary assessment of the fall run, and the year-end meeting allowed for input on survey question development and pressing management issues. Meetings also featured fishing reports and management updates from River Teams around the state, and occasional longer presentations by guest speakers. Meetings were recorded and made available for participants unable to attend.

Another key aspect of the Michigan River Steelhead Project was a web page on the Michigan Sea Grant website, which serves to catalog educational materials including videos and articles related to the project (www.MichiganSeaGrant.org/GLAD). This resource page also included simplified instructions in text and video formats, along with a more detailed video tutorial and an advertisement that can be reprinted in newsletters. This advertisement (Figure 3) was developed for inclusion in the 2022 Michigan Fishing Guide, which was available online and offered in print form at all fishing license vendors in the state.

Promotion of the program has been successful in large part due to the efforts of our partners. Michigan DNR offered ad space in the fishing guide at no charge. Biologists and existing participants have also posted on several Michigan Sportsman forums (www.michigan-sportsman.com) to promote and explain the program. Jim Bedford, a noted author and our Grand River Team Leader, mentioned the program in several articles for major magazines. Davis Fray, who produces content for the Fish Fray YouTube channel, promoted the program and included basic instructions in two widely viewed videos.

All of these efforts served to direct people to the www.GLanglerdiary.org website and apps where they can register for the program by entering an email address that serves as the username. New users also entered their "home water," which served to auto-populate the location field for every new trip recorded. This saved time scrolling though the location list since the location dropdown menu was also organized in geographical order. New users were also assigned an auto-generated Volunteer Number (VN) that helped to maintain confidentiality. Survey and catch data were stored electronically in files separate from information that links VNs to other user information.

Another key aspect of this program's success has been highlighting confidentiality and other privacy protections. In particular, river anglers are protective of their favorite fishing spots since many steelhead streams are very crowded in well-known locations. When marketing, we often explain that specific holes or access points are not even recorded by the app. We only ask for name of the river or stream being fished, or the section of river for some of the larger systems that have distinct fisheries in the upper, middle, and lower reaches. We also avoid sharing data in any way that allows catches to be linked to individual anglers.

Finally, simplified messaging specific to river steelheaders was instrumental in boosting participation in Great Lakes Angler Diary reporting. Instructions were distilled to four bullet points used on an advertisement (Figure 3) with brief language on how to register, measure, record, and check for fin clips. A link to our resource page was also included for results and full instructions. Providing regular updates and results was important to combat attrition based on the experience of other programs (Ormeland et al. 2022), and the full instructions allowed us to address specifics of data collection in more detail than space on the advertisement allowed (www.MichiganSeaGrant.org/GLAD).

Great Lakes Angler Diary Data Collection

Anyone can use the Great Lakes Angler Diary website and apps to record their own catches. This means that some users opt to collect and analyze their own data with no intention of participating in specific programs such as Salmon Ambassadors and the Michigan River Steelhead Program. Some participants also collect incomplete data sets or decide that they do not wish to share their catch records after they begin. The Great Lakes Angler Diary data therefore includes many data points that are not analyzed by the Michigan River Steelhead Program.

The Michigan River Steelhead Program recruits and instructs participants utilizing simplified messaging. Although anyone can record data using Great Lakes Angler Diary, participants in the steelhead program must demonstrate that they followed instructions when answering questions to the year-end survey in order to have their data included. Participants must also acknowledge their consent to share data before participating in the year-end survey (Appendix D).

Instructions for Michigan River Steelhead Program participants during Year 2 were as follows:

- **REGISTER** at GLanglerdiary.org or download the GL Angler Diary app for iOS or Android
- **RECORD** every river fishing trip that targets steelhead, including skunk trips
- **MEASURE** each and every steelhead caught
- **CHECK** for fin clips and other marks

At the end of the season you will be asked to take a short survey and verify that your information is complete. Providing accurate measurements to the nearest quarter inch is very important, but if it is not possible to measure a steelhead that is caught and released it is acceptable to estimate the length as <15 inches, 15–19 inches, 20–24 inches, 25–28 inches, or 29 inches and above.

Instructions were similar for Year 1, although length ranges were different. Only three length range options were available for estimated fish in Year 1; <20, 20–28 inches, and >28 inches. This was changed for Year 2 in order to better separate year classes and to clarify which length range was intended for steelhead in the 28-inch group.

These instructions were patterned after Salmon Ambassadors instructions, which were developed in consultation with Michigan DNR biologists and fishing club members. The instructions attempt to strike a balance between providing high-quality unbiased data and using simplified language that does not seem overly onerous to prospective participants.

As with Salmon Ambassadors, Michigan River Steelhead Program instructs participants to measure and record each and every fish of the target species caught over the course of the year. This is essential to eliminate bias that would occur if anglers only recorded a subset of catches. For example, anglers may selectively record only the largest fish they catch, measure the fish that are harvested, or take data on only the unclipped fish they catch.

For open-water trollers, measuring fish was relatively easy because most fish were harvested and either measured on the deck of a boat or at a cleaning station after a day of fishing. The Salmon Ambassadors program provided participants with folding measuring boards through a sponsorship with Detroit Area Steelheaders.

For the Michigan River Steelhead Program, measuring boards were too bulky for shore and wading anglers to carry and there is a higher prevalence of released fish in stream fisheries. Measuring tapes were therefore provided to participants instead of measuring boards. A short instructional video on measuring total length was provided on our resource page and in the help menu of the apps and website. However, it is acknowledged that measurements taken with measuring tapes in conditions faced by river steelheaders are likely less precise than those taken using a measuring board on a flat surface. Steelhead are often caught in cold weather by wading anglers and flat, level surfaces are not readily available. Fish can be measured on the river bank, on a log, or while in shallow water. In some cases is not even feasible for an angler fishing alone to handle and measure a steelhead. Such is the case when wading in chest-deep water in large rivers while far from shore.

Because of this, length ranges for estimated lengths were developed. Anglers are still strongly encouraged to measure every fish, but by including the option to estimate length we retained some committed volunteers. The length ranges for estimated lengths were changed slightly after the first full season of data collection, but the ranges listed above will remain unchanged from Year 2 onward.

Participants were also instructed to record data on every trip. The simplified language from our advertisement (Figure 3) did not specify that this includes all river fishing trips that target steelhead, including skunk trips. Skunk trips are those that result in zero steelhead caught. Some participants have not consistently recorded skunk trips, but several of those data sets do include complete catch data.

It should be noted that it can be difficult to define which trips target steelhead, as well. The fall salmon run overlaps with the early fall steelhead migration and both fish are targeted using similar methods in mid-September through late October in most rivers. During Zoom meetings and in email communications, we have clarified that all trips should be recorded if there is a reasonable expectation of catching a steelhead. This is admittedly difficult to determine, though we have suggested mid-October as a reasonable time to begin recording trips that target both salmon and steelhead. Due to complications with effort data, we made separate determinations of completeness for catch data sets and effort data sets as described in catch and effort data methods below.

Fishing location for each trip was chosen from a drop-down menu. For most streams, only the name of the stream appeared in the drop-down menu. Larger rivers were broken down into reaches that were defined within the drop-down menu (Appendix F). For the remainder of this report, these defined reaches will be capitalized to indicate locations that correspond to menu options denoted in Appendix F. For example, "Lower Grand River" refers specifically to the Grand River below Sixth Street Dam in Grand Rapids.

The location options available for data entry were carefully chosen based on fisheries that exist along the mainstem and in key tributaries of each watershed. The Middle Manistee River reach was added after Year 1 based on input from the Manistee River Team, which noted Pine Creek as an important area for natural reproduction at the upstream end of the Middle Manistee River. The River Team noted that significant fishing pressure exists on the mainstem of Manistee River between Pine Creek and Bear Creek, and a higher prevalence of wild steelhead in this reach relative to upstream areas between Pine Creek and Tippy Dam. This led us to split the Upper Manistee River (Tippy Dam to Bear Creek) location from Year 1 into two separate locations—Upper Manistee River (Tippy Dam to Pine Creek) and Middle Manistee River (Pine Creek to Bear Creek).

Locations listed in the menu were important to the success of the program both from a data analysis and a participant recruitment perspective. Locations were intended to be broad enough that anglers would not feel uncomfortable sharing specifics on their favorite fishing spots, but specific enough to allow for meaningful analysis. Efforts to market the program in presentations, videos, forum posts, and conversations frequently included a phrase such as "we never ask for specific fishing holes, only the river you fish." This was identified as an important aspect of marketing early in Year 1 based on comments and criticisms from prospective participants.

Methods

The first data collection season for the Michigan River Steelhead Project began on October 1, 2020 and ended on May 31, 2021. Hereafter, this will be referred to as Year 1 of the study. Year 1 has also been referred to as the 2020–2021 fishing season in previous presentations and articles related to this project. Year 1 encompassed both the Fall 2020 season and the Spring 2021 season. Steelhead fishing seasons, as defined for the purposes of this report, will be capitalized hereafter. The Fall fishing season includes October through December and the Spring season includes January through May.

Data collection for Year 2 began on June 1, 2021 and ended on May 31, 2022. This time period included the Summer 2021 season running from June through September in addition to the Fall 2021 and Spring 2022 seasons. Subsequent project years will always begin on June 1 and end on May 31 of the following year.

Seasons were chosen to reflect the timing of steelhead runs and account for the possibility of variable conditions from year to year. The Summer season represents the peak migration season for Skamania steelhead. During the Fall season, steelhead that enter Michigan rivers typically bite aggressively since spawning will not occur for some time. The strength and timing of Michigan strain and naturalized steelhead autumn runs are thought to vary according to conditions including water temperature, photoperiod, and river discharge. Upstream movement subsides during the coldest days of the year, but warm spells can spur migration even during the middle of winter.

January and February typically represent winter-pattern fishing for steelhead that migrated upstream earlier in the year. However, warm conditions in January and February can bring runs of silver fish into large rivers in some years, particularly in southern Michigan. Early-spawning Skamania have been reported spawning in January, and Michigan strain steelhead that run in the fall may also spawn in winter before the arrival of spring-run fish. Snowmelt and warming temperatures typically trigger peak spring migration in March or April but runs can continue into May, particularly in northern Michigan. The Spring season was defined as January through May to represent the full range of possible timing for fishing patterns closely linked to the spawn.

Year-End Survey

In both Year 1 and Year 2, an electronic survey was sent to all Great Lakes Angler Diary registrants at the end of May. Up to three reminders were sent to non-respondents. Reminders were sent at three-day intervals because response data indicated that new responses tapered off dramatically on the second day after each reminder. Survey responses were coded as "Early" if respondents replied to the survey after the initial invitation or the first reminder and were coded as "Late" if they replied to the second or third reminder (Dillman 1978). For exact language used in questions, refer to separate documents for Year 1 (bit.ly/3kWG9FC) and Year 2 (bit.ly/3ykOV34) year-end survey results.

Comparison of early and late responses was used to address the potential for non-response bias. Chi-squared tests for independence were used during Year 1 to determine if catch-and-release preference was related to timing of response. During Year 2, additional chi-squared tests were used to test for possible non-response bias attributed to age of the participant or level of expertise.

A chi-squared test for independence was also used to compare answers to Q30 and Q31 in Year 2, with "NA/Unsure" responses excluded and other responses grouped into a "Strongly Agree" group and a second group for "Agree," "Neutral," "Disagree," and "Strongly Disagree."

Catch and Effort Data

At the end of May, Great Lakes Angler Diary catch and effort data were downloaded. Volunteer numbers were used to cross-reference downloaded diary data with survey results. Data from participants who did not acknowledge language in the consent letter (Appendix D) were excluded from further analysis. For each consenting participant, separate determinations were then made for completeness of catch and effort data. Only complete (or nearly complete) data sets were included in analyses.

Completeness of catch data was determined using answers to Q5 through Q8 and, in some cases, follow-up email correspondence to verify or clarify data completeness. In both years, Q5 was used as the primary tool for demonstrating completeness of steelhead catch data. If a response indicated that "each and every steelhead" caught during the course of the fishing season was recorded, then the respondent's steelhead catch data entered into Great Lakes Angler Diary was considered complete. Likewise, if a respondent recorded all steelhead caught since registration (for those who registered after the beginning of the season) the catch data set was also considered complete. Respondents who answered "No, but I entered more than 90% of steelhead caught" were also counted as entering complete steelhead catch data.

This answer option was provided based on past experience with the Salmon Ambassadors program, which found that certain anglers with high trip and catch numbers sometimes fell short of complete data collection despite recording a wealth of high-quality data on the vast majority of fish. In Year 1, ten out of 53 catch data sets marked "complete" were, in fact, incomplete but at least 90% complete. Similarly, fourteen of 71 "complete" data sets in Year 2 were determined to be at least 90% complete based on the survey answer. Excluding these partially incomplete catch data sets from analysis would have dramatically reduced sample size, since seven of the fourteen data sets were from participants who took fifty or more fishing trips during the fishing season in Year 2.

In addition to contacting participants through survey invitation and reminder emails, I reached out individually to participants who logged large number of steelhead using Great Lakes Angler Diary in Year 2 if they did not acknowledge the consent letter (Q1 of the survey) or provide an answer to Q5. The consent language was provided in the text of the individualized email along with a question asking if at least 90% of steelhead caught during the last season (or since registration for the program) were recorded.

Separate determinations of completeness were made for effort data in lakes and rivers based in part on responses to Q9 and Q10. These questions ask how many trips were taken during the previous fishing season and how many of those trips resulted in the capture of at least one steelhead. These answers are cross-referenced with data entered by each Great Lakes Angler Diary participant to make sure that trips are regularly recorded regardless of steelhead catch rate. In particular, effort data are not considered complete if there is evidence that "skunk" trips with zero steelhead caught were not recorded. In Year 1, several participants were unclear on instructions to enter all trips, including skunks.

For both Year 1 and Year 2, this cross-referencing was used to exclude several effort data sets that clearly did not contain all trips taken by an individual participant. Remaining effort data sets were considered "complete" although we acknowledge that some of these data sets may, in fact, be mostly complete. In many cases, answers to Q9 and Q10 were estimates written in by respondents. At times this was obvious (e.g., responses of "50+" or "20–25" trips) but at other times a round number was provided that might have been exact or an estimate (e.g., "10" or "50").

Data Analysis

Chi-squared tests for independence were used to compare length distributions for measured total lengths and estimated lengths in Year 2. Chi-squared tests for independence were also used to assess the influence of angler expertise, fish length, sex, and fin clip and the decision to harvest or release fish during Year 2. For all statistical tests $\alpha = 0.05$. Confidence intervals for proportion of fish clipped were calculated using Wilson scores (Wilson 1927).

Catch rates for individual anglers can vary widely due to differences in expertise, preferred fishing methods, timing and location of fishing trips, and other factors. For this reason, we evaluated catch rate trends from Year 1 to Year 2 using only data from individual anglers who submitted complete data sets for both catch and effort in both years.

Ideally, we would have several individuals for each river or location in each year. The only location with sufficient data in Year 1 and Year 2 was the Clinton River, which had three individual anglers reporting complete catch and effort data sets in both years. Eleven individual anglers with home waters in Lake Michigan basin streams provided catch and effort data sets in both years, but no single watershed or location had more than two individual home water anglers reporting.

Average trip catch-per-unit-effort (CPUE; steelhead per angler-hour) was computed for each year for each of these 14 anglers. All trips taken in Lake Michigan basin tributaries were included for the 11 anglers who listed a Lake Michigan tributary as their home water. For the three anglers who listed the Clinton River as their home water, only Clinton River trips were included. A Wilcoxon signed-rank test was used to compare paired samples from Year 1 and Year 2 for the 11 Lake Michigan basin anglers, and a separate Wilcoxon signed-rank test was conducted for the three Clinton River anglers.

Participants recorded angler satisfaction for individual trips using a Likert scale (on a scale of 1 to 9; 1 = Extremely Dissatisfied, 2 = Very Dissatisfied, 3 = Somewhat Dissatisfied, 4 = Slightly Dissatisfied, 5 = Neutral, 6 = Slightly Satisfied, 7 = Somewhat Satisfied, 8 = Very Satisfied, 9 = Extremely Satisfied). Trip satisfaction was not a required field, so analysis was limited to trips when participants elected to record satisfaction. Relationships between trip satisfaction and catch rate (CPUE; steelhead per angler-hour) were determined using Kendall's rank correlation coefficient (τ). Trips with more than one angler present were excluded from analysis.

Results

Participation

Great Lakes Angler Diary registrations have been increasing since the Michigan River Steelhead Project began. By the end of Year 1, 199 volunteer numbers (VNs) had been assigned and 496 VNs had been assigned by the end of Year 2. Some individuals register multiple times and receive multiple VNs. After removal of duplicates there were 572 individual participants registered by the end of 2022.

Survey returns were only counted if survey questions provided answers to at least one question after Q12. This was chosen as the cutoff because several participants provided answers only to earlier questions regarding VN, home water, data completeness, trips taken, and heads or snouts collected. Angler satisfaction questions began on Q13, and participants who made it this far in the survey tended to complete the remainder of questions on topics related to satisfaction, management, catch & release, harvest limits, and demographics. Using this criteria, 83 surveys were returned in Year 1 and 88 surveys were returned in Year 2.

In Year 1, 53 catch data sets were considered complete and all but one of these was accompanied by a complete survey. In Year 2, 71 catch data sets were marked complete and 16 of these were verified by e-mail without corresponding survey answers. In the results that follow, only steelhead recorded in these 124 complete catch data sets are considered for determination of size structure, and percent clipped.

In Year 1, 29 participants submitted river effort data sets that were considered complete along with ten complete lake effort data sets. In Year 2, participants submitted 25 complete river effort data sets and six complete lake effort data sets. Only the 54 complete river effort data sets were used for analysis of catch rates.

Participants recorded 1,380 steelhead in complete data sets in Year 1, with 1,334 steelhead caught in river systems and 46 caught in Great Lakes waters. In Year 2, 2,945 steelhead were recorded in complete data sets with 2,913 caught in river systems and 32 from Great Lakes waters.

Year-End Surveys

Year-end survey results are published as separate documents (bit.ly/3kWG9FC; bit.ly/3ykOV34). For full language for each question and raw data refer to those documents. Analysis of survey results by home water, expertise, and catch-and-release preference is provided below. Non-response bias was not an issue. In Year 1, there was no relationship between response timing and catch-and-release preference (χ^2 = 2.644; df = 2; P = 0.267). In Year 2, timing was not related to catch-and-release preference (χ^2 = 3.319; df = 2; P = 0.190), steelhead fishing expertise (χ^2 = 0.618; df = 2; P = 0.734), or generation (χ^2 = 0.672; df = 2; P = 0.715).

Six questions on the year-end surveys addressed angler satisfaction and the quality of steelhead fishing on an annual basis. A five-point Likert scale was used for response options, with higher numbers indicating greater agreement with a statement related to satisfaction or quality of fishing. For each of these questions, the mean response value increased from Year 1 to Year 2 (Figure 4), indicating greater satisfaction and higher quality of fishing during Year 2.

This trend held true for most watersheds, but not all. All but one Lake Michigan watershed saw an increase in annual satisfaction with steelhead catch rates from Year 1 to Year 2 (Table 3). The exception was the St. Joseph River watershed, which had "Neutral" annual satisfaction for both years. All Lake Michigan watersheds including the St. Joseph had an increase in steelhead fishing quality from Year 1 to Year 2, as well (Table 3).

Sample sizes for most watersheds outside the Lake Michigan basin were very low in one or both years, with the exception of the Clinton River watershed, which flows into Lake St. Clair. The Clinton showed the opposite trend of Lake Michigan watersheds, with a marked decrease in both annual satisfaction and steelhead fishing quality from Year 1 to Year 2 (Table 3).

Seasonal steelhead fishing quality also increased for most Lake Michigan watersheds from Fall of Year 1 to Fall of Year 2 (Table 4). The two exceptions were the St. Joseph River and Pere Marquette River watersheds, which declined slightly. The Clinton River watershed saw a substantial decline in seasonal fishing quality for both Fall and Spring seasons.

Steelhead fishing pressure was not addressed in the Year 1 survey, but anglers reported high fishing pressure in all basins in Year 2 (Table 5). Mean fishing pressure was reported as above average for most watersheds in all basins. The only watershed with below-average fishing pressure was the Carp River watershed, which flows into Lake Superior near Marquette. Participants also reported average fishing pressure on the Betsie River and Galien River watersheds. All other watersheds had above-average fishing pressure reported, with the highest pressure on the Clinton, Huron, Thunder Bay, Boyne, and Kalamazoo watersheds. These watersheds had a mean fishing pressure that fell between "Heavier pressure than average" and "Much heavier pressure than average."

Year-end surveys asked respondents if they gained a better understanding of how stocked and wild steelhead contribute to fisheries as a result of participating in the Michigan River Steelhead Program (Q22). In Year 1, 49 of 82 respondents agreed or strongly agreed that their understanding had increased. In Year 2, 66 of 87 respondents agreed or strongly agreed.

Surveys also asked if participation in the Michigan River Steelhead Program increased understanding of fisheries management policies (Q23). In Year 1, 50 of 82 respondents agreed or strongly agreed that their understanding had increased. In Year 2, 52 of 88 respondents agreed or strongly agreed.

Participants were asked about the perceived impact of management actions including stocking, habitat restoration, and reduced harvest limits on their home waters. Across both years, respondents tended to agree or strongly agree with the benefits of each management action. For Year 1 and Year 2, respectively, agreement with benefits was high for stocking (Q24; 4.07, 3.99), habitat restoration (Q25; 4.18, 4.19), and reduced harvest limits (Q26; 3.78, 3.84). The Likert scale used was as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

In both years, participants were asked about their preferred harvest limit in Great Lakes waters (Q27), most Michigan streams (Q28), and their home water (Q29). The most popular answer for all questions in both years was a one-fish limit, but substantial minorities also preferred a zero-, two- or three-fish limit. Only a single respondent in Year 1 preferred a five-fish limit for steelhead in the Great Lakes and home water. Details are included in year-end survey reports (bit.ly/3kWG9FC; bit.ly/3ykOV34) but those aggregated results do not illustrate the effect of expertise and catch-and-release preference on harvest limit preference.

In Year 2, a series of questions dealt with a proposed amendment to lower the harvest limit from three to one steelhead per day from March 15 until May 15 on select waters (bit.ly/40bAWc2). One question asked if the steelhead limit reduction was appropriate as written (Q39). Additional questions asked if the lower limit should apply to more or fewer waters (Q40) and whether the lower limit should apply to a longer or shorter timeframe (Q41).

Answers to these questions on harvest limits were related to personal approach to steelhead harvest and catch-and-release (Q32). Answers from participants who also work for natural resource management agencies (*n* = 4) were excluded from subsequent analysis of harvest limit preference. Non-agency participants were largely in favor of the proposed harvest limits, with 68.6% believing the new limits were somewhat or extremely appropriate and 20.4% believing the new limits were somewhat or extremely inappropriate. Those who catch-and-release all of the steelhead they catch were most likely to find the new limits extremely appropriate, while those who prefer to keep some of their catch had more mixed opinions (Figure 5).

Participants who practiced strict catch-and-release were also more likely than others to answer that the one-fish limit should apply to all waters of the state and at all times of year (Figure 6). Those who mostly practice catch-and-release while harvesting a few fish were also largely in favor of applying the one-fish limit to more waters, but there was also more diversity of opinion in this group. Our sample size for participants who prefer to harvest most or all of the legal steelhead caught was low (*n* = 5), with 80% answering that the number of waters included in the proposed limit reduction was about right, and 80% answering that the limit should apply to a longer timeframe but not the entire year (Figure 6).

Although there was strong support for the new harvest limits among participants, this program is voluntary and may tend to attract heavily-invested anglers. In Year 2, one question (Q44) asked participants about their level of expertise. Categories included "Beginner" (*n* = 1), "Intermediate" (*n* = 24), "Advanced" (*n* = 40), and "Professional, i.e. guide or charter captain" (*n* = 19). Figure 7 shows the increasing tendency to practice strict catch-and-release as expertise increases from intermediate to professional (note that the single beginner was omitted from this figure along with agency personnel).

Participants tended to agree that lower steelhead harvest limits would be beneficial both in protecting long-term viability of steelhead populations (Q30) and in boosting catch rates (Q31), although some were unsure regarding the benefit to populations (Table 6). These questions were of interest because DNR agency personnel had formally expressed their position that harvest limits might boost catch rates but would not be necessary to protect long-term viability of steelhead populations (bit.ly/3yRqGK9). For this reason, participants who work for natural resource agencies or academic institutions were excluded from Table 6 and subsequent analysis of Q30 and Q31. These non-agency anglers were more likely to "Strongly Agree" that lower limits would protect populations than to boost catch rates (χ^2 = 6.544; df = 1; P = 0.011).

In addition to the one-fish limit, a complete moratorium on harvest of wild (unclipped) steelhead was under consideration in late 2021. The Year 2 survey asked two questions relevant to restricting harvest on wild steelhead, but neither was specifically worded to address the possibility of a zero-fish limit for wild steelhead. In Year 2, 73.6% of respondents thought that restricting harvest of wild steelhead would lead to increased fitness and improved steelhead populations, with 13.8% disagreeing and

12.6% unsure (Q33). Similarly, 81.8% of Year 2 respondents (*n* = 88) supported a more restrictive limit for wild steelhead with 13.6% opposed and 4.6% unsure (Q34).

The one-fish limit (bit.ly/40bAWc2) for certain waters went into effect for the first time on March 15, 2022. Year 2 was therefore the first year when anglers were able to observe fishing conditions with the new restrictions. Respondents whose home watersheds were included in the new restriction were slightly more likely to believe that the restrictions had not led to an increase in catch rates on affected waters, while respondents with home watersheds outside the affected areas were more likely to perceive an increase in catch rates on affected waters (Table 7). However, and regardless of home water, many anglers were unsure of the new regulation's impact.

Millennials comprised 36% of our survey respondents in Year 2, the highest representation of any generation (Figure 8). Gen X (26%) and Baby Boomer (21%) generations were also well-represented. Although sample size was low for those who prefer to harvest fish, most participants who preferred to keep fish were Baby Boomers (Table 8). Gen X participants were more likely to be professional guides or captains than other generations, while other generations were more likely to classify themselves as advanced anglers (Table 8).

Steelhead Catch by Location

Participants recorded 1,380 steelhead in complete data sets in Year 1 and 2,945 in Year 2 (Table 9). The Lake Michigan basin was the only basin with more than 200 steelhead recorded in both years. Participants only occasionally neglected to record fin clip data, with missing fin clip data for 1.1% of Year 1 steelhead and 1.3% of Year 2 steelhead (Table 9).

For subsequent analysis of % clipped, fish with missing fin clip data were omitted. Steelhead less than 15 inches long were also omitted due to the high likelihood that smaller fish had not yet smolted. At least 50 steelhead of at least 15 inches long were recorded in complete data sets during both years for eight watersheds: Clinton River, Betsie River, Grand River, Kalamazoo River, Manistee River, Muskegon River, Pere Marquette River, and St. Joseph River (Table 10).

Total lengths were measured for around 90% of steelhead recorded in Year 1 and in Year 2 (Table 11). Estimated lengths were provided for less than 15% of steelhead in each of the eight watersheds above in both years, with the exception of the Pere Marquette. Participants provided estimated length data on 60% of Pere Marquette watershed steelhead in Year 1 and 20% in Year 2. Estimated lengths did not follow the same distribution as measured lengths ($\chi^2 = 73.542$; df = 4; $P < 0.001$), with participants selectively estimating steelhead in the 25- to 28-inch range and selectively measuring longer and shorter fish during Year 2 (Table 12).

Types of Marks Recorded

During Year 1, 603 steelhead were recorded as bearing an external mark. Of these, 596 had only the adipose fin clipped (AD) with no additional mark. The remaining seven steelhead bore either an adipose clip in combination with a different mark (five fish), or a different mark with no adipose clip (two fish).

One steelhead caught in the Upper Manistee River had a combination adipose and right ventral fin clip (ADRV) and was likely a Skamania from a Manistee River plant. Three marks were likely misidentified. One was recorded as a dorsal fin clip, one was recorded in comments as a combination adipose and possible caudal fin clip, and one was recorded as a pectoral fin clip. Since dorsal, caudal, and pectoral fin clips have not been used by agencies in the Great Lakes basin in recent years, these were likely examples of fin damage early in life that resulted in missing or deformed fins incorrectly identified as fin clips. It is also possible that an angler clipped these fins prior to releasing fish, although this is not condoned by management agencies.

The remaining three marked steelhead captured in Year 1 bore clip combinations only used in Wisconsin waters. Volunteers fishing in Wisconsin waters of Lake Michigan recorded one fish with an adipose fin clip and left maxilla clip (ADLM) along with one fish with an ADLV clip. Since this program is marketed as the Michigan River Steelhead Program and data entry options are limited for Wisconsin rivers, we have low participation in Wisconsin and only seven marked fish were recorded by a single volunteer fishing out of Manitowoc in Wisconsin waters of Lake Michigan. Two of seven (28.57%) marked fish caught in Wisconsin waters during Year 1 bore one of the marks used exclusively in Wisconsin.

A single fish recorded in Michigan waters in Year 1 bore a mark unique to Wisconsin stockings. This was a steelhead caught in the Little Manistee River that was recorded as having an ADLV clip. This fish may have been a stray from Wisconsin (possibly a Ganaraska-Normandale strain steelhead planted in 2017) or it may have been a fish with a damaged ventral fin that was incorrectly identified as being clipped. In either case, the prevalence of Wisconsin-specific marks in Michigan waters in Year 1 was extremely low with one of 589 marked fish (0.17%) possibly bearing a mark used only in Wisconsin.

In Year 2, participants with complete data sets did not record any steelhead caught in Wisconsin waters. In Michigan waters, 887 marked steelhead were recorded. Of these, 880 had only the adipose fin clipped (AD). One steelhead caught in the Upper Manistee River was ADRV clipped and was likely a Skamania planted at that location. Another ADRV steelhead was caught in Plaster Creek, a tributary of the Grand River. One steelhead caught in the Huron River in southeast Michigan was recorded as having an adipose clip and left maxilla clip (ADLM), a mark combination that is only used in Wisconsin. Given the extreme distance from Wisconsin stocking sites and the potential for maxilla damage if previously caught and released, it is possible this fish was an AD clipped fish with a maxilla damaged from a previous injury. As with Year 1, the prevalence of Wisconsin-specific marks was very low with only 1 out of 887 marked steelhead recorded in Michigan waters (0.11%) possibly bearing a Wisconsin-specific mark in Year 2.

One steelhead was also recorded as having an adipose and pectoral fin clip in Year 2, along with three steelhead that were recorded as having a pectoral fin clip with no AD clip. Since pectoral fin clips are not used by agencies in the Great Lakes basin, this is somewhat surprising, although the prevalence of pectoral clips was low (4 out of 887 marked steelhead, 0.45%).

The vast majority of marked steelhead (98.94%) recorded in both Year 1 and Year 2 had a clipped adipose fin and no other mark (AD). For analyses below, any steelhead that had an AD clip either alone or in combination with other marks is considered "Clipped" and steelhead that had no valid marks recorded are considered "Unclipped." Thus, steelhead recorded as having an adipose and pectoral fin clip are considered "Clipped" and steelhead recorded as having a pectoral fin clip and no adipose clip are considered "Unclipped" because the pectoral fin clip is not a valid mark applied by a management agency in the Great Lakes basin. Ventral fin and maxilla clips are valid, but these marks in combination with an adipose fin clip were so rare that they were not considered for separate analysis but rather lumped into the "Clipped" category with other AD-clipped steelhead.

Size Structure of Clipped and Unclipped Steelhead by Basin

Length distributions by inch-group clearly illustrate the absence of stocked steelhead returning as lake-age 1 fish during Year 2. In Lake Michigan streams, stocked steelhead in the 15- to 19-inch range were just as prevalent as wild fish in Year 1, but in Year 2 stocked fish in this size range were virtually absent (Figure 9). Sample size was much lower and allocation of effort by watershed was much more inconsistent for other basins, with the exception of the Clinton River in the Lake St. Clair basin.

Length distributions for Lake Huron streams were radically different from Year 1 to Year 2 (Figure 10), but this is more likely related to the decline in effort in the AuSable watershed and the reporting of a large number of stocked smolts caught by one participant in the Rifle River in Year 2.

Complete data sets were not recorded in Lake Superior during Year 1. In Year 2, all steelhead caught were unclipped fish in the 16- to 26-inch range (Figure 11). This is not reflective of all streams in the Lake Superior basin, however, since only the Rock River and Sucker River watersheds were fished by participants and these two watersheds do not receive stocked steelhead (Table 10).

Size Structure of Clipped and Unclipped Steelhead

In Year 2, length distributions by length range showed that unclipped steelhead in the 15- to 19-inch range were prevalent in some watersheds and absent or nearly absent from others. Clipped "skippers" in this length range were very rare in Year 2 due to the lack of stocked yearlings in 2021. In the northern Lake Michigan basin, good numbers of unclipped skippers were caught in the Betsie watershed and Manistee watershed while few unclipped skippers were caught in the Pere Marquette and Muskegon watersheds (Figure 12). In the southern Lake Michigan basin, no unclipped skippers were caught in the Kalamazoo and St. Joseph watersheds but participants did find fair numbers of unclipped skippers in the Grand (Figure 13). In southeast Michigan, the Clinton River produced fair numbers of unclipped skippers and two unclipped skippers were caught in the Huron River, although these may have been stray fish stocked outside Michigan waters (Figure 14).

The percentage of unclipped returning fish (those 15 inches and longer) that fell within the 15- to 19-inch size rage during Year 2 provides a potential index of year-class strength for wild steelhead that smolted during 2021. In the Lake Michigan basin, this "wild skipper index" ranged from 0% in the Kalamazoo and St. Joseph watersheds to 19% in the Manistee watershed. Low values were seen in the Muskegon watershed (1%) and Pere Marquette watershed (2%), with intermediate wild skipper index for the Grand (5%). The Betsie watershed (13%) had the second highest wild skipper index in Year 2.

Percent clipped for the largest, oldest steelhead (29"+) was expected to increase from Year 1 to Year 2 since steelhead stocked without marks prior to 2018 were aging out of the population over time.

However, percent clipped of large steelhead decreased from 38% to 22% from Year 1 to Year 2. Low returns from certain rivers, and downstream reaches of large rivers, during Year 1 may have influenced this result. The Betsie River has a relatively small watershed with consistent temporal coverage through seasons and strong angler participation in both years. The Betsie River had 19% clipped large steelhead in Year 1, and this declined to 11% in Year 2.

Percent Clipped by Season

The contribution of clipped returning steelhead (those 15 inches and longer) was identical for Fall and Spring seasons for Year 1, with 43% of the catch being clipped in both seasons. Year 2 showed a different trend, with 21% of the steelhead catch being clipped in Fall and 36% of the catch being caught in the Spring (Figure 15).

Since catch and effort were not distributed among watersheds similarly from Year 1 to Year 2, changes in spatial coverage from Year 1 to Year 2 should be accounted for when interpreting data. Table 13 and Table 14 show the seasonal steelhead catch and percent clipped by season for seven Lake Michigan watersheds with at least 50 steelhead captured in each year. Averaging percent clipped across these well-sampled watersheds shows a less-pronounced difference between Fall and Spring in Year 2 than noted above, with an average of 31% clipped in Fall and an average of 39% clipped in Spring.

During Year 1, we recognized that few participants were fishing downstream waters of major rivers including the Manistee, Pere Marquette, Muskegon, and Grand. Efforts to recruit more lower-river anglers were successful, resulting in more fish caught in lower rivers during Year 2 (Table 13, Table 14). This improvement in spatial coverage suggests that results are more representative of both downstream and upstream reaches for these watersheds in Year 2.

Seasonal trends in downstream reaches were not possible to address in Year 1 on the Grand and Pere Maquette watersheds because no steelhead were reported from the Lower Grand in Spring, and no steelhead were reported from the Lower Pere Marquette in Fall or Spring (Table 13). Sample size was also low for the Lower Manistee (n = 6) and Lower Muskegon (n = 7) during Spring of Year 1 (Table 13).

Seasonal sample sizes for upstream and downstream reaches of large rivers were more consistently high during Year 2, with at least 14 steelhead caught in each reach for each season (Table 14). Results indicate that it may be difficult to generalize across watersheds or even across different reaches or tributaries within a watershed. The Lower Grand River showed a dramatic increase in the prevalence of stocked fish during Spring, while the Upper Grand River and its upstream tributary Prairie Creek showed virtually no difference and a much heavier contribution of unclipped steelhead (~90%) in both seasons during Year 2 (Table 14). The Pere Marquette showed a similar trend in Year 2 with the Lower Pere Marquette River receiving an influx of clipped steelhead during the Spring while the Upper Pere Marquette fishery was dominated by a high proportion of unclipped fish (95%) that did not change from Fall to Spring (Table 14).

While both the Grand and Pere Marquette watersheds had a greater contribution of stocked fish in the lower river along with a spring pulse of stockers confined to the lower river, the Manistee watershed saw the opposite trend. The Lower Manistee River and Upper Manistee River both had a low contribution of clipped steelhead in Fall of Year 2, with a dramatic increase of clipped steelhead in Spring that was most pronounced in the Upper Manistee River (Table 14).

The Lower Muskegon River was the only area that saw a decrease in the prevalence of clipped steelhead from Fall to Spring of Year 2, with the Upper Muskegon River showing a higher contribution of clipped fish than the lower river in both seasons, and an increase in the prevalence of clipped fish during the Spring season (Table 14).

Percent Clipped by Year

Clipped steelhead accounted for only a small portion of the catch in the Pere Marquette watershed in both years (Table 15; Figure 16). The Kalamazoo, St. Joseph, and Clinton watersheds had a high contribution of clipped fish (in the 50–80% range) in both years (Table 15; Figure 16). The Grand and Betsie watersheds were around 20% clipped in Year 1 and 30% in Year 2, with confidence intervals overlapping from one year to the next (Table 15; Figure 16). As noted above, results from Year 1 and Year 2 were influenced by the difference in spatial coverage between years, with Year 1 results containing a higher proportion of steelhead catch in upstream areas of certain rivers including the Grand.

The Manistee watershed was also affected by this difference in spatial extent of sampling from one year to the next, with only 24% of steelhead caught in the Lower Manistee during Year 1 and 49% from the Lower Manistee in Year 2. The Muskegon had similar spatial coverage from Year 1 to Year 2, but the Muskegon had a relatively low sample size of steelhead caught during Year 1 (n = 53) with few samples from the Lower Muskegon River in Spring and few samples from the Upper Muskegon River in Fall during Year 1 (Table 13).

For both the Manistee and Muskegon watersheds, percent clipped declined from Year 1 to Year 2 and confidence intervals did not overlap (Table 15; Figure 16). This would suggest either a decline in stocked fish or an increase in wild fish from year to year, but it may also be a result of differences in spatial and seasonal coverage from year to year. For example, the large increase in sample size from the Lower Manistee River, which is dominated by unclipped fish, played a large role in decreasing the percent clipped for the entire Manistee watershed during Year 2.

Percent Clipped by Watershed and Location

The contribution of clipped steelhead to angler catch varies considerably among watersheds (Table 15; Figure 16) and among locations within a watershed (Table 16, Figure 17). In Year 2, when sample sizes for most locations were higher and more representative of effort across seasons, the proportion of clipped steelhead was lower in the Lower Manistee River than in the Middle and Upper Manistee River while the Bear Creek tributary produced only unclipped steelhead (Table 16, Figure 17). The Lower Pere Marquette River had a higher contribution of clipped steelhead than the Upper Pere Marquette River (Table 16, Figure 17), although the prevalence of clipped fish in the lower river was still low in comparison to most other watersheds (Table 13, Table 14). The Lower Grand River had a higher contribution of clipped fish than the upstream tributary Prairie Creek during Year 2 (Table 16, Figure 17).

Although most locations had higher sample sizes during Year 2, there were some locations that were sampled only in Year 1 or produced more steelhead during Year 1. The Upper Grand River is one of these locations, and results from Year 1 suggest that the Upper Grand River is more similar to Prairie Creek than the Lower Grand River in that both the upper river and Prairie Creek produce mostly unclipped steelhead (Table 17, Figure 18). The Black River in Van Buren County (Figure 1) was only sampled during Year 1 and had a higher proportion of clipped steelhead than most other Lake Michigan basin tributaries (Table 17, Figure 18).

In the Lake Huron basin, the AuSable River and its tributary Van Etten Creek showed very different trends during Year 1. Van Etten Creek is a small tributary near the mouth of the AuSable River that produced mostly unclipped steelhead while the mainstem of the AuSable was more reliant on stocked fish (Table 17, Figure 18). The number of steelhead reported by volunteers fishing the AuSable watershed fell dramatically from Year 1 (n = 136) to Year 2 (n = 5). Reports of returning steelhead (those over 15 inches long) also dropped from Year 1 (n = 46) to Year 2 (n = 14) in the Rifle River, where results from Year 1 indicated a roughly even split between clipped and unclipped steelhead contributing to the catch (Table 17, Figure 18).

Catch Rates

For anglers fishing Lake Michigan basin tributaries, individual mean trip catch-per-unit-effort (CPUE) increased by 37% from Year 1 to Year 2 (Wlicoxon signed-rank test: P = 0.032). Of the eleven anglers reporting complete data for both years, eight saw an increase in CPUE while one remained the same and two saw a slight decrease (Table 18).

For anglers fishing the Clinton River in the Lake St. Clair basin, individual mean trip CPUE did not show a significant decrease from Year 1 to Year 2 (Wlicoxon signed-rank test: P = 0.500). Two individuals recorded large declines in Year 2 CPUE, but the third individual had a similar mean CPUE in both years (Table 19).

Influence of Catch Rate on Trip Satisfaction

Trip-based angler satisfaction was an optional data entry field. In Year 1, 15% of trips (135 of 918) with useable CPUE data also contained trip satisfaction data. In Year 2, after strongly recommending that participants record trip satisfaction data, we saw this increase to 28% (272 of 982 trips).

In both years, over 95% of CPUE and trip satisfaction data came from trips with one or two anglers in the fishing party (Table 20). In Year 2 advanced anglers were more likely to fish alone while professional anglers typically fished with a party of two (Table 20). Lake Michigan basin tributaries accounted for 89% of all trips (120 of 135) with both CPUE and trip satisfaction data in Year 1, and 84% (229 of 272) in Year 2.

Anglers with intermediate expertise fished less often and caught fewer steelhead per trip than advanced and professional anglers fishing in Lake Michigan tributaries during Year 2 (Table 21). In Year 2, 56 participants recorded complete catch data with at least one trip taken on a Lake Michigan tributary. These 56 data sets included catch data on 2,644 steelhead (Table 9). Of these 56 complete catch data sets, only 19 had accompanying compete effort data sets from a participant with known expertise (Table 21). These 19 data sets included catch data on 1,404 steelhead. Therefore, 36.5% of participants who submitted complete catch data on Lake Michigan tributaries also submitted complete effort data and answered a question related to expertise, but these participants accounted for 52.7% of steelhead catch data from Lake Michigan tributaries in Year 2. Participants who did not submit complete effort data and/or did not provide expertise information were therefore likely to have less expertise and lower catch rates than those who did.

Only trips taken on Lake Michigan tributaries with a single angler in the fishing party were included in subsequent analysis of catch rates and trip satisfaction. Both years showed a significant positive correlation between CPUE and trip satisfaction (Table 22). Expertise data were not available for Year 1, but in Year 2 stratification by expertise increased the strength of correlation between CPUE and trip satisfaction. The correlation coefficient for advanced anglers ($\tau = 0.532$; $P < 0.001$) was higher than the correlation for all anglers combined ($\tau = 0.457$; $P < 0.001$) during Year 2 (Table 22).

This was also true for professional anglers (i.e., guides and charter captains), but only after two outlier trips were removed. Before removal of outliers, the correlation for professional anglers ($\tau = 0.359$; $P = 0.016$) was weaker than it was for all anglers combined. However, two trips were recorded as "2 = Very Dissatisfied" despite very high catch rates. These may have been data entry errors, or perhaps some factor other than catch rate led to very low satisfaction. When these two trips were removed, the correlation between CPUE and trip satisfaction for professional anglers ($\tau = 0.592$; $P < 0.001$) was stronger than it was for all anglers combined ($\tau = 0.457$; $P < 0.001$) during Year 2 (Table 22).

Catch Rates and Effort by Month

Monthly catch rates were calculated for clipped and unclipped steelhead caught in Lake Michigan tributaries (Figure 19). Although the spatial distribution of fishing effort varied from year to year and several anglers participated in only year of data collection, it was clear that peak catch rates did not necessarily coincide with the timing of peak effort. In Year 1, peak Fall catch rate occurred in October despite low effort. In Year 2, catch rate was highest in December and January, when effort was relatively low. Peaks in effort during October-November and March-April during Year 2 were likely due, in part, to guides booking more trips during these time periods.

Clipped steelhead provided a relatively constant contribution to catch rates during Year 1, but clipped fish catch rates were very low until March and peaked in May during Year 2 (Figure 19). Although this may have been affected by different spatial distribution of effort through the seasons during Year 1 (Table 13), it may also indicate that stocked and wild fish contribute to Fall runs differently from year to year.

The Betsie River watershed had relatively high participation, had consistent temporal coverage from year to year, and is less spatially complex than other watersheds. Monthly catch rates trends from the Betsie River did not show the same Fall decline in contribution of stocked fish during Year 2 that was evident in data pooled across all Lake Michigan tributaries; the contribution of stocked fish to Fall catch rates was actually higher during Year 1 in the Betsie River (Figure 19; Figure 20).

Run Timing by Location

Monthly steelhead catches during Year 2 showed considerable variation among watersheds and among locations within watersheds (Figures 21-23). Peak catch in the Lower Pere Marquette River occurred in December, while catch peaked in March and April in the Upper Pere Marquette River (Figure 21). Catch peaked in October in the Lower Manistee River with a March peak in the Middle Manistee River and an April peak in the Upper Manistee River; the Lower Manistee River catch was dominated by unclipped steelhead in all months, while the upper river saw a distinct peak in clipped fish in March, April and May (Figure 21).

The Kalamazoo River had a strong peak in the catch of clipped fish during March, which was also the peak month for clipped steelhead catch (Figure 22). The Grand watershed showed a striking difference between the November-December peak in the Lower Grand River and the bimodal November and March peaks of primarily unclipped steelhead in Prairie Creek (Figure 22). However, anecdotal reports suggest that our participants were not representative of the true peak in steelhead fishing activity that occurs in the Lower Grand River during March and April. Our sample size for the Muskegon and St. Joseph watersheds improved from Year 1 to Year 2 but remained relatively low with fewer than 100 steelhead per location in Year 2 (Figure 22). As on the Lower Grand River, the true peak of spring fishing activity probably was not captured by participants on the St. Joseph River (Figure 22) or the Upper Muskegon River, which is not shown. Only 38 steelhead were reported from the Upper Muskegon River during Year 2 although it is one of the most popular steelhead fisheries in the state.

In southeast Michigan, temporal coverage on the Clinton River and Huron River was consistent throughout the fishing season. On both rivers, steelhead catch peaked in March (Figure 23). The Clinton River had a greater contribution of unclipped fish, which peaked in December.

Weekly catch of steelhead is shown on Figures 24–26 for locations with more than 80 steelhead reported in Spring 2022 (Year 2). In the Lower Pere Marquette River, the peak catch for both clipped and unclipped steelhead occurred before the new one-fish harvest limit went into effect on March 15 (Figure 24). In contrast, peak catch in the Upper Pere Marquette River for both clipped and unclipped steelhead occurred during the March 15–May 15 time period covered by the new regulation (Figure 24). On the Lower Manistee River, peak steelhead catch occurred in early February while peak catches on the Upper Manistee River corresponded closely to the March 15–May 15 timeframe; peak catch on the Middle Manistee occurred during the week of March 13 (Figure 25). The Betsie River was not covered by new harvest regulations, but the Betsie River showed a peak catch of unclipped steelhead during the week of March 6 while clipped steelhead catch did not peak until the week of April 17 (Figure 24). On the Kalamazoo River, which also was not covered by the new harvest regulations, catches of clipped and unclipped steelhead both peaked during the week of March 13 (Figure 26).

Factors Influencing the Decision to Harvest or Release Steelhead

Anglers of intermediate experience were more likely to harvest fish than advanced or professional anglers, although intermediate anglers still released the majority of steelhead caught (Table 23). Fish were also selectively harvested according to size, with steelhead in the 20-24-inch range being the most popular size to harvest (Table 23).

If size had not played a role in determining harvest, we would have expected all size ranges to have an 11% harvest rate. Steelhead in the 20–24-inch range were harvested 15% of the time, while only 6% of smaller skippers (15–19 inches long) and 5% of large steelhead (29 inches and above) were harvested (Figure 27).

Clipped (stocked) steelhead were preferentially harvested over unclipped (presumably wild) steelhead (Table 23). When all Michigan streams were included, 19% of clipped steelhead were harvested and only 6% of unclipped steelhead were harvested. A separate analysis was also conducted to account for the possible influence of catch-and-release regulations on certain reaches of productive wild-steelhead streams, and the potential influence of the newly implemented harvest limit reduction. When the Pere Marquette, Muskegon, and Manistee watersheds were excluded due to harvest restrictions, we still saw a strong preference to harvest stocked fish (Table 23) with 20% of clipped steelhead harvested versus 8% of unclipped steelhead.

Anglers harvested a slightly higher percentage of female (11%) vs. male (8%) steelhead (Table 23). Although this difference was significant, it was not as pronounced as differences in harvest according to angler expertise, steelhead length, or fin clip. Female steelhead may be preferentially harvested because some anglers harvest female steelhead for both meat and roe that is used for bait.

Skippers

Peak catches of wild skippers occurred in October and December of Year 2, which was in stark contrast to peak catches of larger wild steelhead during the spring spawning run (Figure 28). Wild skippers were nearly absent from catches during April in Year 2, despite the high numbers of larger wild steelhead being caught (Figure 24) and high levels of effort and overall steelhead catch rates during April 2022 (Figure 19). However, during Year 1 catches of unclipped skippers and larger steelhead showed very similar trends from month to month (Figure 29). Since skippers were preferentially released by participants (Figure 24) it is unlikely that skippers experienced high mortality while in rivers.

Discussion

Steelhead fishing is available in a wide range of riverine environments around the Great Lakes state, providing anglers the opportunity to pursue their quarry using a variety of strategies for accessing productive fishing locations. Michigan strain steelhead are available in most steelhead streams from October through May, and Skamania provide additional opportunities through the summer months on rivers like the St. Joe and Manistee. As a result, river steelhead fishing in Michigan can take on many forms depending on the season and location.

Tailwater fisheries concentrate both fish and anglers below dams. Access is often excellent and some of the best tailwater fishing is located in large urban areas or in the center of rural communities. Sixth Street Dam on the Grand River in Grand Rapids provides an example of an urban fishery that offers ample shoreline access in addition to boating and wading access when water levels permit. Anglers who are new to steelheading can watch to see what techniques are working, pick up tips from successful anglers as they leave the river, or learn the safest paths for wading by following others. Specialized anglers may employ gear like drop nets that enable them to land steelhead from high bridges and walls, jet boats that can navigate downstream low-head dams when water is high, or two-handed fly rods for swinging flies when water is low. During the peak of the spring run, fishing pressure can be intense and "combat fishing" with shoulder-to-shoulder crowds is the norm.

In contrast, public lands such as the Huron-Manistee National forest in the northern Lower Peninsula offer a variety of access options in less densely populated areas. Two-tracks and hiking trails provide access to remote streams where the adventurous angler can attempt to escape the crowd, while more popular named access sites on rivers like the Manistee, Pere Marquette, and AuSable offer easy bank, wading, and boating access to well-known fishing holes. Anglers also use a variety of state lands, bridge crossings, road ends, rail trails, municipal parks, and private lands to access thousands of miles of steelhead streams around Michigan.

Although steelhead fishing is available in Michigan streams year-round, conditions for peak fishing on any individual section of river may be limited to a matter of weeks or even days. Many anglers adjust their fishing habits accordingly, targeting a variety of different streams that peak at different times or during different environmental conditions. For example, mainstems of large, turbid southern rivers like the Grand are often difficult to fish during high water while smaller tributaries actually benefit from a pulse of water that encourages fish to move upstream into relatively clear, shallow waters. Temperature also plays a major role in the timing of productive steelhead fishing, and some anglers switch streams to avoid the effects of harsh winter conditions or time peak runs in summer, fall, and spring.

The diversity of Michigan river steelhead fisheries is, in part, due to the diversity of stocked strains (i.e., Skamania and Michigan) and also in part to the different life history strategies employed by naturalized runs of steelhead (Swank 2005). Rand et al. (1993) noted, "because of the life history variability exhibited by steelhead in the Great Lakes, fishing pressure is effectively distributed more equitably in space and time." This same variability provides challenges for fisheries researchers who attempt to characterize the full extent of steelhead fisheries. A review of 46 angler diary programs in Ontario found that diaries provided a useful approach to monitoring spatially diffuse and specialized fisheries, but also noted that many programs did not succeed due to low commitment from anglers and agency partners and lack of review and adaptive changes over time (Cooke et al. 2000). This progress report represents one facet of our ongoing review of the Michigan River Steelhead Program, which will likely continue for several years.

Objectives for Year 1 and Year 2 were to: 1) assess the contribution of stocked and wild steelhead to Michigan stream fisheries, 2) address the potential impact of the missing 2020 stocked year class, 3) determine factors that influence the decision to release or harvest steelhead, 4) gauge angler satisfaction with fishing success and management actions, and 5) continually adapt and improve the program.

Contribution of Stocked and Wild Steelhead

Over the course of two years, the Michigan River Steelhead Program provided biological data from at least 50 angler-caught steelhead annually from the Betsie, Manistee, Pere Marquette, Muskegon, Grand, Kalamazoo, St. Joseph, and Clinton watersheds. Observed trends in percent clipped were largely consistent with expectations for most watersheds, but some watersheds had more precise estimates than others. While the majority of stocked steelhead returning to Michigan rivers by Year 2 were fin-clipped, out-of-state stocking of unclipped steelhead does influence interpretation of percent clipped in some waters.

For the eight watersheds mentioned above, confidence interval width for the proportion clipped ranged from 0.04 to 0.21 (4%–21%) in Year 2. Confidence intervals for proportions are dependent upon both sample size and the point estimate of the proportion, with values close to 0.50 having the widest intervals and more extreme values having narrower intervals (Wilson 1927). Watersheds such as the Pere Marquette (which has a very high proportion of wild fish) and watersheds such as the Huron (which has a very high proportion of clipped fish) would therefore have narrower confidence intervals than watersheds with a mix of stocked and wild fish if sample sizes were equal.

Estimates of percent clipped are therefore most precise for systems with a combination of high sample size and/or extreme contribution of either wild or stocked fish. In Year 2, estimates of percent clipped were most precise for the Pere Marquette and Manistee rivers, which had 4% and 5% confidence intervals, respectively (Table 15). Estimates are less precise for systems like the St. Joseph, Kalamazoo, Muskegon, and Clinton, where a more even mix of stocked and wild fish coupled with lower sample sizes led to confidence interval widths in the 17% to 21% range during Year 2 (Table 15). Even so, confidence intervals for these systems were narrow enough to differentiate them from other watersheds and draw relevant conclusions in some cases.

For example, confidence intervals for the Clinton River (64%–83%) and Huron River (85%–97%) did not overlap in Year 2 (Table 15), suggesting that the fishery in the Clinton River is more dependent upon unclipped steelhead. The Huron River is heavily impounded, with no coldwater tributaries accessible to migrating steelhead and no known evidence of successful natural reproduction. The presence of unclipped steelhead is therefore likely to be the result of straying wild or, more likely, stocked unclipped fish.

The Lake Erie basin was stocked with 7.97 million unclipped steelhead from 2018–2021. All of these unclipped steelhead were stocked in Ohio, Pennsylvania, and New York waters with only 64,000 clipped steelhead stocked in Michigan waters of the Lake Erie basin over the same timeframe (Appendix A). The Huron River therefore provides the most extreme case of a river that is unsuitable for natural reproduction while also being likely to receive stray unclipped stocked steelhead. High rates of straying from state to state have been noted in the Lake Erie basin (Budnik et al. 2018), and 1988–1990 smolt cohorts contributing to Huron River runs were 40–50% strays from other states (Seelbach et al. 1994).

The Clinton River may also receive some stray unclipped stocked steelhead from the Lake Erie basin, but since the percent clipped is lower in the Clinton River than the Huron River it is likely that natural reproduction is making a substantial contribution to the fishery of the Clinton River. A 2005 creel study used scale samples in conjunction with fin clips to determine wild versus hatchery origin. At that time, all steelhead stocked in the Clinton River had received pectoral fin clips. Unclipped steelhead accounted for 43% of the catch, but based on scale analysis, 10 of 12 unclipped steelhead were of hatchery origin (Francis 2009). Our results suggest that the proportion of unclipped steelhead in the Clinton River has not changed much since 2005, but additional scale sampling would be helpful to determine if the proportion of unclipped fish that are wild spawned has increased.

An increase in wild steelhead reproduction would not be surprising in Clinton River, and could be a result of enhanced fish passage in recent years. Yates Dam is 31 miles upstream from the mouth of the Clinton River and serves as the lowermost barrier to fish migration (Francis and Haas 2006). Historically, some steelhead ascend the six-foot head of Yates Dam and spawn in Paint Creek, a coldwater upstream tributary (Francis and Haas 2006). However, it was assumed that many steelhead also failed to ascend the barrier, which also supports a popular tailwater fishery for steelhead. Around March 2018, erosion created a bypass channel that enabled fish to migrate upstream of Yates Dam without leaping over the dam (Eric Lemaux, personal communication February 12, 2023). Due to sea lamprey concerns, the bypass channel was filled in during 2020 (Barber and Steeves 2021). However, continued erosion re-opened the bypass channel around July 2021(Eric Lemaux, personal communication February 12, 2023). As a result, steelhead migration and natural reproduction likely benefited from increased fish passage in every spring spawning run since 2018, with the exception of 2021.

In the Lake Michigan basin, nearly 7.0 million steelhead and rainbow trout were stocked from 2018 through 2021; 5.4 million (78%) of these were marked with an adipose fin clip and no other external mark and 0.8 million (12%) were marked with a different clip or combination of external marks (Appendix A). No unmarked steelhead were stocked in Michigan waters of the Lake Michigan basin, but 0.7 million unmarked steelhead (10%) were stocked into the basin by other states.

Although 10% of stocked Lake Michigan steelhead and rainbow trout were unmarked, the number of unmarked stocked steelhead returning to Michigan rivers is likely much lower than this. Of the 67.0 million marked steelhead stocked in the Lake Michigan basin, 0.6 million (9%) were stocked with marks or combination marks that were specific to Wisconsin. Our participants did not record any evidence of fish with Wisconsin-specific marks (ADLM, ADLV, ADRM, ADRV, LM, LV) returning to Michigan rivers of the Lake Michigan basin.

Seelbach and Whelan (1998) found a lower rate of straying into two Lake Michigan tributaries than the Huron River. Bartron et al. (2004) used scale pattern analysis and genetics to identify steelhead strains in Michigan rivers and found that Wisconsin-specific strains can be overestimated when relying on marks alone, in part because hook wounds are sometimes mistaken for maxilla marks. Even when relying on genetics and scale patterns, some straying of Wisconsin-stocked steelhead was noted, with the Ganaraska strain accounting for 5% of the spring steelhead run in Bear Creek and 3% of the fall and spring runs in the Pere Marquette River (Bartron et al. 2004). Although it is likely that some unmarked steelhead stocked in Wisconsin during 2020 will ascend Michigan rivers, the lack of Wisconsin-specific marks recorded by volunteers in Year 1 and Year 2 and previous research suggests that unmarked strays from Wisconsin will be a minor component of future runs.

Aside from Wisconsin stockings, the remaining 293,017 unmarked steelhead that were stocked into the Lake Michigan basin were Skamania from the 2020 year class. Most (204,720) of these were stocked in Indiana waters as yearlings in 2021 and the remainder (88,297) were stocked in Illinois waters as fingerlings in 2020. These fish may be more likely to contribute to Michigan river angler catches than unmarked fish stocked in Wisconsin, particularly the 112,965 unmarked yearling Skamania that were stocked into Indiana waters of the St. Joseph River in 2021.

Steelhead returning to the St. Joseph River must pass through Michigan waters, ascending fish ladders at dams in Berrien Springs and Niles before reaching Indiana waters. Fish stocked in Indiana are therefore very likely to contribute to fishing success in Michigan waters, including these popular tailwater fisheries. However, interpretation of percent clipped was not affected by Indiana fish during the first two years of this study because most returning skippers from the 2021 stocking would have been in the 15- to 19-inch range during Year 2, and no fish in this size range were reported by participants (Figure 13). Since Skamania typically do not mature at lake-age 1, unmarked fish from the 2021 stocking were not expected to begin entering rivers until summer 2022.

Participants did report two unclipped steelhead under 15 inches long from the St. Joseph watershed in Year 2, but these were wild-spawned parr. Both were caught in the Dowagiac River, and both were under 8 inches long. The Dowagiac River has been the focus of many habitat projects including removal of Pucker Street Dam in 2021 and re-meandering of some channelized areas. Steelhead spawning activity in the coldwater reach above Pucker Street was reported the first spring after dam removal (Jay Anglin, personal communication March 28, 2023) and natural reproduction is likely to be increasingly important to the Dowagiac River fishery in the future.

Although the Dowagiac River has not been stocked in recent years, clipped fish accounted for roughly half of steelhead caught by participants in Year 2, with many likely strays from St. Joseph River stocking. Results from Year 1 and Year 2 provide a useful baseline to assess future improvement, but interpretation of data from the Dowagiac and St. Joseph rivers will be complicated by returns of unmarked Skamania and the apparent high, and possibly variable, straying rate in the Dowagiac.

Moving north from the St. Joseph River watershed, the Black River in Van Buren County is the next closest river to Indiana that was sampled by our participants. In Year 1, 17 out of 18 steelhead reported from the Black River were marked with only an AD clip and the remaining fish was unmarked. The Black River is stocked with steelhead, but it is not known to support natural reproduction due to suboptimal temperatures and limited spawning gravel (Fuller 2005). The Black River therefore provides a clear example of a Lake Michigan tributary fishery that should be dominated by stocked fish. Since 6% of returning fish were unclipped, this provides a rough idea of possible contribution from wild steelhead straying from other watersheds (Table 17; 95% confidence interval suggests 1–26% of steelhead unclipped).

At the other end of the spectrum, the Upper Pere Marquette River provides an example of an unstocked, undammed, coldwater river that should be dominated by wild steelhead. With high returns in both years, confidence intervals were narrow suggesting 1–5% clipped in Year 1 (Table 15) and 3-8% clipped in Year 2 (Table 16). None of these returning clipped steelhead had been stocked in the Upper Pere Marquette River. The Big South Branch, which does receive stocked steelhead, flows into the Lower Pere Marquette River and may be the source of some strays into the Upper Pere Marquette River. Bartron et al. (2004) found some straying of stocked steelhead into the Pere Marquette but reported similar results to ours with 97% classified as wild steelhead based on scale patterns and genetics. Straying of stocked fish from other watersheds has also been noted in the Little Manistee River from 1991-2004, with an average of 18% stocked in the fall run and 25% stocked in the spring run despite the lack of stocking in the Little Manistee River (Tonello 2005). Straying rate of stocked fish from outside the watershed seems to be highest in river systems that are close to other river systems that receive high numbers of stocked steelhead, with the Pere Marquette being relatively isolated from other rivers with high stocking rates (Bartron et al. 2004).

Differences in spatial coverage from Year 1 to Year 2 greatly affected interpretation of angler diary fin clip data in certain watersheds. In Year 1, all steelhead caught in the Pere Marquette watershed were caught in the upper river. By encouraging existing program participants to recruit downstream anglers, we were able to improve steelhead returns from downstream reaches in Year 2. This led to an apparent increase in percent clipped for the Pere Marquette watershed in Year 2 (Table 15), but separation of the river into upper and lower reaches showed that most of this difference was due to the inclusion of the lower river in Year 2. In Year 1, confidence intervals suggested 3–8% clipped in the Upper Pere Marquette River and 8–16% clipped in the Lower Pere Marquette River (Table 16). This is consistent with expectations due to the greater contribution of steelhead stocked in the Big South Branch to the lower river fishery.

The Manistee, Muskegon, and Grand watersheds also had differences in spatiotemporal coverage from Year 1 to Year 2 that affected interpretation of % clipped. Sample size, spatial coverage, and seasonal coverage improved during Year 2, so Year 2 provides better baseline assessment of conditions in these rivers than Year 1 in most cases.

The Manistee and Muskegon watersheds both saw a decline in percent clipped from Year 1 to Year 2. On the Manistee, this was due to overrepresentation of steelhead from the upper river's Spring season during the first year. In Year 1, Spring season steelhead from the Upper Manistee River accounted for 45 of 74 (61%) of all steelhead reported from the Manistee watershed (Table 14). In Year 2, 430 out of 1,146 (38%) of Manistee watershed steelhead were from the Spring season in the Upper Manistee River. Better spatial coverage and higher sample sizes during Year 2 showed that unclipped fish accounted for a higher proportion of the catch in the Lower Manistee River, particularly during the Fall season.

Reasons for the apparent decline of percent clipped on the Muskegon River from Year 1 to Year 2 were not as apparent, though an increase in returns from the Lower Muskegon River in Spring of Year

2 did play a role. Although sample size increased over time in the Muskegon, returns remained far below the Manistee with only 118 steelhead reported in Year 2.

The Grand River watershed is the most spatially complex watershed included in this program, with 149 miles of mainstem river accessible to migrating steelhead (Seelbach et al. 1994). Steelhead are stocked in the mainstem of the Grand in addition to tributaries including Crockery Creek, Rogue River, Flat River, Prairie Creek, Fish Creek, and Red Cedar River (see Seelbach et al. 1994 for map). Spatial coverage by angler diary participants in Year 1 was limited, with Prairie Creek accounting for most steelhead reported and only six steelhead reported from the Lower Grand River where the largest concentration of steelhead fishing activity in the watershed occurs below Sixth Street Dam. Coverage in the lower river improved in Year 2 and returns from Prairie Creek remained high, but Year 2 returns remained low from other tributaries and the Upper Grand River.

Prairie Creek showed consistently high contribution of unclipped steelhead in both years, and is known to support natural reproduction (Seelbach et al. 1994). The much higher proportion of stocked fish in the Lower Grand River, particularly during spring, illustrates how stocked and wild steelhead can contribute differently to fisheries within the same watershed.

The Betsie and Kalamazoo rivers were not subdivided into upper and lower reaches for reporting. Both rivers had strong returns and consistent percent clipped from Year 1 to Year 2. All steelhead reported from the Betsie watershed were caught in the mainstem of the Betsie River, where the majority of steelhead were unclipped and presumably wild (Table 15; 17–28% clipped in Year 1, 24–34% clipped in Year 2).

The vast majority of returns from the Kalamazoo watershed also came from the mainstem, with only two unclipped and one clipped steelhead reported from the Rabbit River tributary in Year 2. Results therefore primarily reflect the Kalamazoo River mainstem fishery. The majority of Kalamazoo watershed steelhead were clipped, but unclipped fish also made important contributions to the fishery (Table 15; 55–73% clipped in Year 1, 57-74% clipped in Year 2). Natural reproduction in the mainstem is unlikely since the Calkins Bridge Dam near Allegan limits steelhead migration to 26 miles of the lower river (Wesley 2005). However, tributaries including the Rabbit River and several small creeks do support some natural reproduction of anadromous salmonines (Wesley 2005).

In all watersheds, comparison of percent clipped from Year 1 to Year 2 was influenced by two factors. The missing 2020 stocked year-class was expected to reduce the percent clipped in Year 2, and the aging-out of unclipped fish stocked prior to 2018 was expected to increase the percent clipped in Year 2. The near-absence of stocked fish in the 15- to 19-inch range clearly indicated the impact of the missing year-class in Year 2, as expected. However, for steelhead 29 inches and above in Lake Michigan tributaries, percent clipped actually decreased in Year 2, counter to expectations.

Spatial and temporal differences in coverage from year to year likely played a role, but the decline in percent clipped for large steelhead (29"+) on the Betsie suggests that declining survival of stocked fish relative to wild fish, or increasing wild reproduction, may also play a role. Additional years of sampling with consistent spatiotemporal will be needed to determine if this pattern will continue.

Skippers and the Potential Impact of the Missing Year Class

During Year 2, the missing 2020 stocked year class was clearly indicated by the lack of clipped steelhead in the 15- to 19-inch range. However, wild skippers in this size range were common in some rivers. The Manistee and Betsie rivers had higher wild skipper index values of 13% and 19%, respectively, which suggests that these rivers may have produced stronger wild 2021 smolt cohorts than other Lake Michigan Basin rivers. However, due to the complex and variable life history of steelhead this may not prove to be a reliable predictor of future fishing success.

Naturalized steelhead are known to exhibit variability in the prevalence of early-returning fish. Swank (2005) found that the percentage of steelhead returning as "jacks" varied considerably from one river to another within individual Great Lakes basins. The term "jack" refers specifically to an early-maturing precocious male salmonine while older "hooknose" males develop a hooked jaw or "kype" that aids in fighting (Gross 1991). Spawning male steelhead are territorial and aggressive, with males competing for position near females as they excavate their redds and prepare to spawn. Large male steelhead have an obvious competitive advantage when adopting a fighting strategy, but the smallest males also have an advantage in that they can often spawn successfully without being noticed by the largest male steelhead.

This sneaking strategy should be most effective in rivers with plenty of cover available to serve as refugia for jacks to avoid detection by larger hooknose males (Gross 1991). At the population level, fast growth rates early in life and high mortality rate of adult fish should favor a higher percentage of jacks. A relatively low density of adults can be both the result of a high adult mortality rate and a cause of low juvenile density resulting in a high juvenile growth rate (Gross 1991). Thus, a relatively low density of adults should theoretically favor a high percentage of returning jacks.

Swank (2005) noted that the percentage of jacks in naturalized Great Lakes steelhead populations varied not only from river to river, but also within a river from year to year. The prevalence of jacks was indeed higher in rivers with high adult mortality (Swank 2005). Even so, adult mortality rate only explained 43% of the variation in percent jacks (Swank 2005) and it is reasonable to assume that year-class strength could have explained some of the remaining variation. On the Manistee River, the 1999 spawning run of naturalized steelhead consisted of 11.5% jacks and this fell to 3.7% in 2000 (Swank 2005). All other Lake Michigan tributaries ranged from 0% to 28.9% jacks in all years, with one exception; the Black River in the Upper Peninsula's Mackinaw County ranged from 29.2–50.0% jacks from 1998–2002 (Swank 2005).

During Year 2, the Michigan River Steelhead Program found wild skipper index values ranging from 0%–19%, which was consistent with the range Swank (2005) reported for percent jacks in Lake Michigan streams other than the Black River in the U.P., which was not fished by our program participants. The wild skipper index is not identical to percent jacks, though. Swank (2005) only sampled during the spring spawning run and only counted mature male lake-age 1 steelhead as jacks, although the presence of mature female lake-age 1 steelhead was also noted, particularly in historic data from the Black River 1950–1959.

The term "skipper" is used more broadly than "jack" for the purposes of this report to include all steelhead in the 15- to 19-inch range, in part because age data are not available for our fish but also because we include fish caught during non-spawning months and these fish may not be mature. Swank (2005) noted that fall-run fish were not included in calculation of percent jacks and noted unresolved questions regarding fall-run fish. Specifically, it is not clear whether fall-run steelhead in Great Lakes tributaries will all mature by spring or whether all fall-run fish remain in the river until spring (Swank 2005).

In some northern California rivers, ocean-age 1 steelhead return to streams as "half-pounders." In the Klamath River, half-pounders were found to be mostly immature fish with around 8% being early-maturing males (Hodge et al. 2016) and all of the females being immature (Kesner and Barnhart 1972). Unlike larger returning steelhead the half-pounders fed heavily when in the river environment (Kesner and Barnhart 1972). The timing of Klamath River runs is similar but slightly earlier than Michigan strain fish, which were derived from the McCloud River in northern California. The fall run in the Klamath River occurs from August through October, with half-pounders contributing to the early phase of the run and larger steelhead arriving later in the fall (Kesner and Barnhart 1972).

Although timing of the fall run is later in Lake Michigan tributaries, the catch of skippers was similarly highest at the beginning of the fall run of Year 2. However, the same was not true for Year 1. This may be due to the outsized influence of the Manistee River during Year 2, which accounted for 70% of all unclipped skippers reported. During Year 1, few participants were fishing the Manistee River and records were particularly sparse from the Lower Manistee River in Fall, which was a top producer of unclipped skippers in Year 2.

During Year 1, 70% of all unclipped skippers were classified as male and during Year 2, this dropped to 31%. In March and April of Year 1, all of the unclipped skippers were classified as male, suggesting that these were, indeed, early-maturing jacks. It is possible that immature skippers more akin to the half-pounders of the Klamath River contributed to runs in Year 2, particularly in the Manistee River. Determination of sex in immature steelhead based on external characteristics is not possible.

Training materials available in videos, printed materials, and the help menu of the app provided clear instructions on measuring total length and identifying fin clips, but did not cover sex determination. For mature steelhead approaching spawning, sex determination is quite easy and well-understood by most anglers who can distinguish the hooked jaw and dark coloration of the male from the less pronounced coloration and egg-laden belly of the female. For some mature fish early in the fall run, and for immature fish, participants were expected to use the "NA – Not Assessed" data entry option for sex. During Year 2, it is possible that some immature skippers were classified incorrectly as female since 30% of all unclipped skippers were recorded as female during Year 2. Even so, the low prevalence of skippers classified as males during Year 2 (30%) and prevalence of skippers recorded as "NA" (29%) suggests that many of these fish were not early-maturing jacks that develop obvious spawning characteristics.

In summary, the prevalence of skippers in Michigan rivers is related factors other than year-class strength, although year-class strength may also play a role. The wild skipper index calculated for rivers in Year 2 will provide a metric to evaluate in the future as it relates to changes in catch rates and angler satisfaction. The missing stocked 2021 smolt cohort should have the most dramatic impact on catch rates and satisfaction in watersheds that produce few wild steelhead, making percent clipped a potentially more useful predictor of future impacts than the wild skipper index. Additionally, future trends in the wild skipper index through time on different river systems may provide further insight into life history strategies of naturalized steelhead in Great Lakes tributaries. Providing more explicit training on sex determination should help toward this end.

Catch-and-Release

Expertise was closely related to a participant's personal approach to harvesting fish, with professional anglers being more likely to practice strict catch-and-release. However, some participants with intermediate expertise also released all steelhead. Most advanced anglers reported a preference for releasing most of their catch, but a few (3 of 37) reported keeping most of the steelhead they catch (Figure 7). Expertise was also a strong predictor of harvest trends noted in catch data. Over the course of Year 2, advanced anglers reported harvesting 9% of steelhead and intermediate anglers reported harvesting 28% of steelhead caught (Table 23). Although advanced anglers harvested a lower percentage of steelhead they caught, they also caught far more steelhead than anglers with less expertise. As a result, advanced anglers harvested more steelhead over the course of the year than intermediate. On average and across all basins, intermediate anglers reported keeping 2.8 steelhead out of 10.1 caught during Year 2 and advanced anglers reported keeping 4.9 out of 52.2 steelhead caught.

The relationship between expertise and approach to harvesting fish has been noted in other studies (Chipman and Helfrich 1988; Lewin et al 2023). A survey of stream anglers in Virginia characterized anglers into six categories and attempted to simplify the number of useful variables that separate anglers into meaningful groups; frequency of fishing, harvest behavior, and investment in fishing were most important (Chipman and Helfrich 1988). The Year 2 survey was able to address both frequency of fishing and harvest behavior, but did not address investment in fishing. Similar to the findings of the Virginia study, Michigan steelhead anglers showed a strong tendency to practice more catch-and-release as the frequency of fishing increased along with some anglers who did not fit this general trend. Chipman and Helfrich (1988) suggested that a simplified typology of anglers could be developed with frequency of fishing on one dimension and factors including harvest preference, investment in fishing, and centrality to fishing in one's lifestyle representing the second dimension. The advantage of this would be a simplified survey instrument that captures factors that predict an angler's opinions on management issues.

The Michigan River Steelhead Program was able to attract a dedicated group of participants, but the over-representation of advanced and professional anglers is likely due to correlation between frequency of fishing and centrality of fishing to lifestyle (Chipman and Helfich 1988). This contributes to avidity bias that has been noted in other angler diary programs (Cooke et al. 2000; Lawson 2015; Lewin et al. 2023). In an attempt to recruit angler diarists in a manner that would circumvent this known bias, Lewin et al. (2023) used a list of license holders as the basis for recruitment but found that anglers who elected to participate were still more likely to display high avidity and low harvest rates despite other demographic similarities to the angling public. Although recruitment strategies may be helpful in attracting more casual anglers to the Michigan River Steelhead Program, the experience of other angler diary programs suggest that this may not be successful.

Michigan river steelhead diarists preferentially harvested mid-sized steelhead and stocked fish. Females were also harvested at a slightly higher rate. One of the unique benefits of angler diary programs is that they are able to provide data on released fish that cannot be measured by creel technicians or biotechs who only encounter harvested fish (Musick et al. 2022). Although angler diaries cannot typically be used to estimate overall catch and effort as a traditional creel survey would (Lawson 2015), they have been used to tracking changes in catch rates over time (Johnston et al. 2021), measuring catch-and-release rates (Gaeta et al. 2013), and track capture locations of marked and recaptured fish (Pierce et al. 2021; Musick et al. 2022).

Potential biases associated with angler diaries include recall bias, avidity bias, prestige bias, nonresponse bias, deliberate misreporting, terminal digit preference, species misidentification, and participant attrition that can lead to changes in demographics of the participant base (Lawson 2015). Although angler diary programs are known to have biases, all fisheries sampling gears have their own biases, as well. Appropriate interpretation of data in light of known biases and continued adaptation of the year-end survey to address potential biases will help to put results into the appropriate context as the project evolves.

The number of scientific publications involving citizen science increased exponentially from 2005 to 2015, in part due to mass adoption of mobile technology but also because citizen science can provide a cost-effective means of collecting data over a large spatial scale and provide opportunities to engage with stakeholders and build relationships (Oremland et al. 2022). With this recent expansion of angler diaries and other fisheries citizen science programs, our collective understanding of strengths and limitations of these programs should steadily improve over time.

Directions for the Future

Steelhead fisheries are facing several potential challenges in the Great Lakes and tributary streams. Fisheries that rely heavily on stocked fish are most likely to be affected by the missing 2021 smolt cohort and a decline in survival of stocked steelhead. Fisheries that rely more heavily on naturally reproduced steelhead will be facing the possibility of impacts from newly arrived invasive species including didymo and New Zealand mudsnail. Some rivers may face land use and other environmental changes that could negatively impact physical and thermal characteristics of habitat. In other cases, dam removal, fish passage enhancement, and habitat restoration could have positive impacts on natural steelhead populations. Both wild and stocked steelhead continue to contend with changes to Great Lakes food webs caused by invasive species, and many anglers are also concerned that fishing pressure and harvest may have increased in recent years.

Based on input from concerned anglers, a proposal to reduce the steelhead harvest limit was developed in 2021. At the November 10, 2021 meeting of the Natural Resources Commission (NRC), the Michigan DNR presented data from Great Lakes fisheries and select rivers and stated their position that a harvest limit reduction was not needed to sustain steelhead populations (bit.ly/3yRqGK9). Although the long-term viability of steelhead populations was not a concern, steelhead catch rates could potentially be affected by a lower limit since individual fish could be caught multiple times if released. Commissioners voted to approve the harvest limit reduction but added a five-year sunset clause to allow for collection of additional data to inform future management direction. The harvest limit for steelhead was subsequently decreased from 3/day to 1/day on certain rivers from March 15 to May 15 beginning in 2022 (bit.ly/40bAWc2).

The harvest limit reduction was generally popular with Michigan River Steelhead Program participants, but angler diary programs are known to attract highly specialized anglers who tend to favor catch-and-release and support restrictive harvest policies (Chipman and Helfrich 1988). A social-ecological framework for fisheries management has been proposed, with explicit consideration of desired outcomes being a critical component (Hunt et al. 2013). In the case of Michigan river steelhead fisheries, it is fairly clear that specialized, highly invested, and avid anglers tend to place a high value on maximizing catch rate with less emphasis on harvest. However, it is possible that less specialized anglers who did not participate in this program place a higher value on harvest that could lead to lower satisfaction with the reduced harvest limit.

Over the next few years, recruitment efforts will attempt to enroll more casual anglers and include a variety of perspectives. Data collection, year-end surveys, and data analysis will adapt as needed to develop reliable indicators of change. Specific improvements will include:

- Recruit anglers at an outdoors show seminar geared toward novice steelhead anglers.
- Offer gift card reward drawing to attract participants who may not be strongly motivated by a desire to protect the resource.
- Develop recruitment handout that emphasizes ease of participation and reward drawing.
- Shorten the year-end survey and place questions related to expertise near the beginning of the survey to increase proportion of respondents with known expertise.
- Add questions related to years of experience to better define how expertise categories related to frequency of fishing and lifetime experience.
- Develop standardized catch rate metrics that serve as adequate indicators of the quality of steelhead fishing, if not actual steelhead abundance. This may involve limiting analysis to catch rates from anglers with advanced expertise since professional anglers typically record data from clients of unknown expertise.
- Use percent clipped in conjunction with catch rates to interpret trends in abundance of wild and stocked fish in each watershed. Without some indication of stable population abundance, any increase in percent clipped could result from either an increase in stocked fish or a decrease in wild fish, and vice versa.
- Evaluate the influence of the missing year-class on fisheries by tracking changes in length-frequency distributions and catch rates of stocked and wild steelhead over time.

- Determine if the wild skipper index calculated for certain watersheds in Year 2 has any relationship to future catch rates of wild steelhead, particularly fish in size ranges that likely correspond to the 2021 smolt cohort.
- Investigate the potential for participants to collect scale samples to be used for aging to better understand age structure of steelhead populations.
- Clarify instructions for sex determination and communicate this to participants in virtual meetings and emails to ensure that steelhead are recorded as "NA" if fish are immature and/or sex is unclear.
- Include presentations from other research programs in future virtual meetings to educate participants and aid in the interpretation of data from all sources.

Conclusion

Angler diary data documented differences in the contribution of stocked and wild fish among watersheds, among locations within a watershed, and from season to season. This demonstrated the unique value of stocked and wild steelhead in maintaining diverse river fishing opportunities. Survey data found that average annual angler satisfaction was close to neutral but improved from one year to the next on Lake Michigan tributaries. Average catch rates also increased on Lake Michigan tributaries, but not on the Clinton River.

Catch-and-release was very prevalent in Michigan rivers, with 90% of steelhead being released by program participants. Clipped steelhead, mid-sized fish, and (to a lesser extent) females were preferentially harvested. This selective harvest has the potential to influence interpretation of data collected by other programs that only collect biodata from harvested fish.

Participants in most areas of the state indicated heavier fishing pressure than normal and expressed support for more restrictive harvest limits. However, more advanced steelhead anglers were more likely to practice catch-and-release and express support for stricter harvest limits. Angler diary programs tend to attract anglers with a high level of specialization, so this program may not reflect the views of less specialized anglers. In the future, the Michigan River Steelhead Program will target less specialized anglers with new marketing tools and refine the year-end survey and catch rate analysis to better understand the strengths and limitations of angler diary data.

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Literature Cited

Albrecht, N. C. 2014. Evaluation of natural steelhead recruitment in the Muskegon River, Michigan. Grand Valley State University, Allendale, MI. 117 pp.

Alexander, G. R., and E. A. Hansen. 1982. Sand sediments in a Michigan trout stream. Part II. Effects of reducing sand bedload on a trout population. Michigan Department of Natural Resources. Fisheries Division, Research Report No. 1902. Ann Arbor, MI. 20 pp.

Alexander, G. R., and E. A. Hansen. 1986. Sand bed load in a brook trout stream. North American Journal of Fisheries Management 6:9–23.

Allan, J. D. 1995. Stream ecology: structure and function of running waters. Chapman and Hall. London, England. 388 pp.

Bassett, C. E. 1988. Rivers of sand: Restoration of fish habitat on the Hiawatha National Forest. Pages 43–48 *in* T. W. Hoekstra and J. Capp, editors. Integrating Forest Management for Wildlife and Fish. United States Forest Service. North Central Forest Experiment Station. General Technical Report NC-122. St. Paul, MN.

Barber, J. and M. Steeves. 2021. Sea lamprey control in the Great Lakes 2020. Annual report to the Great Lakes Fishery Commission. Ann Arbor, MI. 93 pp.

Bartron, M. L., D. R. Swank, E. S. Rutherford, and K. T. Scribner. 2004. Methodological bias in estimates of strain composition and straying of hatchery-produced steelhead in Lake Michigan tributaries. North American Journal of Fisheries Management 24:1288–1299.

Berejikian, B. A. 1995. The effects of hatchery and wild ancestry and experience on the relative ability of steelhead trout fry (*Oncorhynchus mykiss*) to avoid a benthic predator. Canadian Journal of Fisheries and Aquatic Sciences 1995:2476–2482.

Bingham, E. 2020. Michigan sees 95% increase in new hunters since March. Mlive (Oct 22).

Bjornn, T.C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83–138 *in* W. Meehan, W. Influences of forest and rangeland management of salmonid fishes and their habitat. American Fisheries Society Special Publication 19. Bethesda, MD.

Blanco, S., and L. Ector. 2009. Distribution, ecology and nuisance effects of the freshwater invasive diatom *Didymosphenia geminata* (Lyngbye) M. Schmidt: a literature review. Nova Hedwigia 88(3-4):347–422.

Boomgard, J. 2020. Michigan coronavirus prevention measures could mean fewer fish in years ahead. MiBiz (April 12).

Brownscombe, J. W., S. D. Bower, W. Bowden, and L. Nowell. 2014. Canadian recreational fisheries: 35 years of social, biological, and economic dynamics from a national survey. Fisheries 39(6):251–260.

Budnik, R. R., C. T. Boehler, J. E. Gagnon, J. R. Farver, and J. G. Miner. 2018. Application of otolith chemistry to investigate the origin and state-straying of steelhead in Lake Erie tributaries. Transactions of the American Fisheries Society 147:16–30.

Bunnell, D. B., R. P. Barbiero, S. A. Ludsin, C. P. Madenjian, G. J. Warren, D.M. Dolan, T. O. Brenden, O. T. Gorman, J. X. He, T. H. Johengen, B. F. Lantry, B. M. Lesht, T. F. Nalepa, S. C. Riley, C. M. Riseng, T. J. Treska, I. Tsehaye, M. G. Walsh, D. M. Warner, and B. C. Weidel. 2014. Changing ecosystem dynamics in the Laurentian Great Lakes: Bottom-up and top-down regulation. BioScience 64:26–39.

Bunnel, D. B., B. M. Davis, D. M. Warner, M. A. Chriscinske, and E. F. Roseman. 2011. Planktivory in the changing Lake Huron zooplankton community: *Bythotrephes* consumption exceeds that of *Mysis* and fish. Freshwater Biology 56(7):1281-1296.

Calantone, R. S. K. Vickery, F. J. Wang, and A. Bengal. 2019. Economic impact of hunting, fishing, and trapping (HF&T) in Michigan. Michigan State University, East Lansing, MI. 198 pp.

Carl, L. M. 1977. Attitudes and behavior of anglers fishing for salmon on Michigan streams. Michigan Department of Natural Resources, Fisheries Division, Research Report No. 1848. 49 pp.

Carl, L. M. 1984. Chinook salmon (*Oncorhynchus tshawytscha*) density, growth, mortality, and movement in two Lake Michigan tributaries. Canadian Journal of Zoology 62(1):65–71.

Chipman, B. D. and L. A. Helfrich. 1988. Recreational specializations and motivations of Virginia River anglers. North American Journal of Fisheries Management 8(4):390–398.

Cooke, S. J., W. I. Dunlop, D. MacClennan, and G. Power. 2000. Applications and characteristics of angler diary programmes in Ontario, Canada. Fisheries Management and Ecology 7:473–487.

Dexter, J. L., Jr. and R. P. O'Neal, editors. 2004. Michigan fish stocking guidelines II: With periodic updates. Michigan Department of Natural Resources, Fisheries Division, Special Report No. 32. Ann Arbor, MI. 68 pp.

Dillman, D. A. 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley and Sons, New York, NY. 325 pp.

Francis, J. 2009. Clinton River steelhead creel survey. Michigan Department of Natural Resources, Fisheries Division, Lake Erie Management Unit. 16 pp.

Francis, J. T. and R. C. Haas. Clinton River assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report No. 39. 227 pp.

Fuller, E. M. 2005. Black River watershed management plan. Master's thesis. Western Michigan University, Kalamazoo, MI.170 pp.

Gaeta, J. W., B. Beardmore, A. W. Latzka, B. Provencher, and S. R. Carpenter. 2013. Catch-and-release rates of sport fishes in northern Wisconsin from an angler diary survey. North Americal Journal of Fisheries Management 33(3):606–614.

Garner, S. R., J. W. Heath, and B. D. Neff. 2009. Egg consumption in mature Pacific salmon (*Oncorhynchus* spp.). Canadian Journal of Fisheries and Aquatic Sciences 66:1546–1553.

Godby, N. A., E. S. Rutherford, and D. M. Mason. 2007. Diet, feeding rate, growth, mortality, and production of juvenile steelhead in a Lake Michigan tributary. North American Journal of Fisheries Management 27:578–592.

Gross, M. R. 1991. Salmon breeding behavior and life history evolution in changing environments. Ecology 72(4):1180–1186.

Hay, R. 2003. Little Manistee River Weir steelhead egg-take report, 1967–92. Michigan Department of Natural Resources, Technical Report No. 96-1, Lansing, MI. 17 pp.

Hay, R., and W. Houghton. 1990. Stream management. Pages 46–54 *in* M. Keller, K.D. Smith, and R. W. Rybicki, editors. Review of salmon and trout management in Lake Michigan. Michigan Department of Natural Resources, Fisheries Special Report No. 14.

Hecky, R., and J. DePinto. 2020. Understanding declining productivity in the offshore regions of the Great Lakes. International Joint Commission, Science Advisory Board Report. Windsor, ON, Canada. 59 pp.

Hodge, B. W., M. A. Wilzbach, W. G. Duffy, R. M. Quinones, and J. A. Hobbs. 2016. Life history diversity in Klamath River steelhead. Transactions of the American Fisheries Society 145:227–238.

Hunt, L. M., S. G. Sutton, and R. Arlinghaus. 2013. Illustrating the role of human dimensions research for understanding and managing recreational fisheries within a social-ecological system framework. Fisheries Management and Ecology 20:111–124.

Johnson, J. E., S. P. DeWitt, and D. J. A. Gonder. 2010. Mass-marking reveals emerging self-regulation of the Chinook salmon population in Lake Huron. North American Journal of Fisheries Management 30:518–529.

Johnston, F. D., S. Simmons, B. van Poorten, and P. Venturelli. 2021. Comparative analyses with conventional surveys reveal the potential for an angler app to contribute to recreational fisheries monitoring. Canadian Journal of Fisheries and Aquatic Sciences79(1):31–46.

Kelch, D., F. Lichtoppler, B. Sohngen, and A. Daigneault. 2006. The value of steelhead (*Oncorhynchus mykiss*) angling in Lake Erie tributaries. Journal of Great Lakes Research 32(3):424–433.

Kesner, W. D. and R. A. Barnhart. 1972. Characteristics of the fall-run steelhead trout (*Salmo gairdneri garidneri*) of the Klamath River system with emphasis on the half-pounder. California Fish and Game 58(3):204–220.

Kerans, B.L., M.F. Dybdahl, M.M. Gangloff, and J.E. Jannot. 2005. *Potamopyrgus antipodarum*: distribution, density, and effects on native macroinvertebrate assemblages in the Greater Yellowstone ecosystem. Journal of the North American Benthological Society 24(1):123–138.

Latta, W. C. 1974. The introduction of fishes into Michigan. Pages 83–96 *in* Michigan Department of Natural Resources, editors. Michigan Fisheries Centennial Report 1873–1973. Michigan Department of Natural Resources, Fisheries Division, Fisheries Management Report No. 6.

Lawson, A. 2015. An investigative analysis of Queensland's statewide recreational fishing surveys: Identifying bias in self-reported catch and effort data. Queensland Department of Agriculture and Fisheries. Queensland, Australia. 26 pp.

Leonhardt, B.S., A. Happel, H. Bootsma, C. R. Bronte, S. Czesny, Z. Feiner, M. S. Kornis, J. Rinchard, B. Turschak, and T. Höök. 2020. Diet complexity of Lake Michigan salmonines: 2015–2016. Journal of Great Lakes Research 46(4):1044–1057.

Lewin, W., M. S. Westerbach, K. Haase, C. Riepe, and H. V. Strehlow. 2023. Potential biases in angler diary data: The impact of diarist recruitment process on participation rates, catch, harvest, and effort estimates. Fisheries Research 258:106551.

MacCrimmon, H. R. 1971. World distribution of rainbow trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 28(5):663–704.

Musick, S., L. Gillingham, M. Perkinson, and T. Teears. 2022. Viginia Game Fish Tagging Program: A nontraditional data source for fisheries management. Fisheries 47(11):478–481.

Nalepa, T. F., D.L. Fanslow, A. J. Foley III, G. A. Lang, B. J. Eadie, and M. A. Quigley. 2006. Continued disappearance of the benthic amphipod *Diporeia* spp. in Lake Michigan: Is there evidence for food limitation? Canadian Journal of Fisheries and Aquatic Science 63:872–890.

Newcomb, T. J., and T. G. Coon. 1997. Environmental variability and survival of steelhead parr in a thermally diverse watershed. Michigan Department of Natural Resources, Fisheries Division, Research Report No. 2046. 53 pp.

O'Neal, R. P., and T. Kolb. 2015. 2011 Pere Marquette River angler survey report. Michigan Department of Natural Resources, Fisheries Division. Lansing, MI. 54 pp.

Ormeland, L., A. Furnish, J. Byrd, and R. Cody. 2022. How fisheries managers can harness the power of the crowd: Using citizen science and nontraditional data sources in fisheries management. Fisheries 47(11):459–468.

Pierce, J.L., M. V. Lauretta, R. J. Rezek, and J. S. Rehage. 2021. Survival of Florida Largemouth Bass in a coastal refuge habitat across years of varying drying severity. Transactions of the American Fisheries Society 150(4):435–451.

Prichard, C. G., J. L. Dexter, N. D. Ledet, R. O'Neal, M. Walgamood, J. P. VanAmberg, and J. L. Jonas. 2018. Comparison of lake and river fishery performance between two strains of steelhead in eastern Lake Michigan. North American Journal of Fisheries Management 38:1138–1151.

Rand, P. S., D. J. Stewart, P. W. Seelbach, M. L. Jones, and L. R. Wedge. 1993. Modeling steelhead population energetics in lakes Michigan and Ontario. Transactions of the American Fisheries Society 122(5):977–1001.

Seelbach, P. W. 1986. Population biology of steelhead in the Little Manistee River, Michigan. Doctoral dissertation. University of Michigan, Ann Arbor, MI. 145 pp.

Seelbach, P. W. 1993. Population biology of steelhead in a stable-flow, low-gradient tributary of Lake Michigan. Transactions of the American Fisheries Society 122:178–198.

Seelbach, P. W., J. L. Dexter, Jr., and N. D. Ledet. 1994. Performance of steelhead smolts stocked in southern Michigan warmwater rivers. Michigan Department of Natural Resources, Fisheries Division, Research Report No. 2003. 42 pp.

Striffler, W. D. 1964. Sediment, streamflow, and land use relationships in Northern Lower Michigan. United States Forest Service, Research Paper LS-16. 12 pp.

Swank, D. R. 2005. Life-history variation and management of wild Great Lakes steelhead populations. Doctoral dissertation. University of Michigan, Ann Arbor, MI. 192 pp.

Tonello, M. 2005. Little Manistee River. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resource Report 2005-8. Lansing, MI. 33 pp.

Vanderploeg, H. A., J. R. Liebig, T. F. Nalepa, G. L. Fahnenstiel, and S. A. Pothoven. 2010. *Dreissena* and the disappearance of the spring phytoplankton bloom in Lake Michigan. Journal of Great Lakes Research 36:50–59.

Vinson, M.R., and M.A. Baker. 2008. Poor growth of rainbow trout fed New Zealand mudsnails *Potamopyrgus antipodarum*. North American Journal of Fisheries Management 28:701–709.

Wagner, W. C. 1972. Utilization of alewives by inshore piscivorous fishes in Lake Michigan. Transactions of the American Fisheries Society 101:55–63.

Wesley, J. K. 2005. Kalamazoo River Assessment. Department of Natural Resources, Fisheries Division, Special Report No. 35. 234 pp.

Westerman, F. A. 1974. On the history of trout planting and fish management in Michigan. Pages 15–38 *in* Michigan Department of Natural Resources, editors. Michigan Fisheries Centennial Report 1873–1973. Michigan Department of Natural Resources, Fisheries Management Report No. 6. Lansing, MI.

Whelan, G. E., and J. E. Johnson. Successes and failures of large-scale ecosystem manipulation using hatchery production: The upper Great Lakes experience. Pages 3–32 *in* Nickum, M. J., P. M. Mazik, J. G. Nickum, and D. D. MacKinlay, editors. Propagated Fish in Resouce Management. American Fisheries Society Symposium 44, Bethesda, MD.

Wilson, E. B. 1927. Probable inference, the law of succession, and statistical inference. Journal of the American Statistical Association 22(158): 209–212.

Witt, A. M., J. M. Dettmers, and C. E. Cáceres. 2005. *Cercopagis pengoi* in southwestern Lake Michigan four years following invasion. Journal of Great Lakes Research 31(3):245–252.

Woldt, A. P. and E. S. Rutherford. 2002. Production of juvenile steelhead in two central Lake Michigan tributaries. Michigan Department of Natural Resources, Fisheries Division, Research Report No. 2060. 43 pp.

TABLE 1.—Steelhead and rainbow trout strains stocked into public waters of the Great Lakes basin, as recorded in the Great Lakes Fish Stocking Database.

Strain	Lake Michigan Basin	Lake Huron Basin	Lake Superior Basin	Lake St. Clair Basin	Lake Erie Basin	Lake Ontario Basin
Arlee	x					
Chambers Creek	x				x	x
Domestic/Aquaculture					x	x
Eagle Lake		x				
French River			x			
Ganaraska	x	x				x
Knife River			x			
Lake Ontario					x	x
Michigan	x	x	x	x	x	x
Randolph Hatchery						x
Seneca Lake						x
Shasta					x	x
Skamania	x				x	x
Washington State, winter run						x
Ontario Wild		x				

TABLE 2.—Number of steelhead and rainbow trout of four strains stocked in Wisconsin's Lake Michigan basin waters 2018-2021, as recorded in the Great Lakes Fish Stocking Database (AD = adipose, ADLM = adipose and left maxilla, ADLV = adipose and left ventral, ADRM = adipose and right maxilla, ADRV = adipose and right ventral, LM = left maxilla, LV = left ventral).

Strain	AD	ADLM	ADLV	ADRM	ADRV	LM	LV	No Mark	Total
Arlee	336,024								336,024
Chambers Creek	337,327	194,431				66,477		184,149	782,384
Ganaraska	164,152		134,893		57,390		66,715	216,120	639,270
Skamania				140,144					140,144
Total	837,503	194,431	134,893	140,144	57,390	66,477	66,715	400,269	1,897,822

TABLE 3.—Annual satisfaction and steelhead fishing quality relative to the past five years for home waters in Year 1 (2020–2021) and Year 2 (2021–2022). Mean Likert scale values are reported, with higher values indicating higher agreement with satisfaction or quality of fishing (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree).

	Steelhead Annual Satisfaction (Q13)				**Quality of Fishing vs. Last Five Years (Q15)**			
	Year 1 *n*	Year 1 Mean	Year 2 *n*	Year 2 Mean	Year 1 *n*	Year 1 Mean	Year 2 *n*	Year 2 Mean
Lake Erie/St. Clair Tributaries	**8**	**3.13**	**10**	**2.10**	**8**	**3.38**	**10**	**2.00**
Clinton	7	2.86	6	1.83	7	3.14	6	1.67
Huron	1	5.00	4	2.50	1	5.00	4	2.50
Lake Huron Tributaries	**3**	**3.33**	**7**	**3.14**	**3**	**2.67**	**7**	**3.29**
AuSable	2	3.00	3	2.00	2	3.00	3	2.67
Rifle	1	4.00	2	4.50	1	2.00	2	4.50
Thunder Bay	NA	NA	2	3.50	NA	NA	2	3.00
Lake Michigan Tributaries	**56**	**2.56**	**61**	**3.30**	**56**	**2.02**	**61**	**3.10**
Betsie	7	2.14	5	3.60	7	1.29	5	3.80
Black (Van Buren)	3	1.50	NA	NA	3	1.50	NA	NA
Boardman	NA	NA	1	4.00	NA	NA	1	4.00
Boyne	2	2.00	3	3.67	2	2.00	3	3.00
Galien	NA	NA	1	2.00	NA	NA	1	1.00
Grand	10	2.22	7	3.29	10	2.00	7	2.86
Kalamazoo	5	3.60	6	4.17	5	2.60	6	3.33
Manistee	7	2.71	17	3.12	7	2.00	17	3.06
Muskegon	6	2.17	8	2.75	6	1.50	8	2.50
Pentwater	1	4.00	NA	NA	1	2.00	NA	NA
Pere Marquette	9	3.00	9	3.56	9	2.89	9	3.56
St. Joseph	3	3.00	2	3.00	3	2.33	2	3.00
White	3	2.00	2	2.50	3	1.33	2	3.00
Lake Superior Tributaries	**1**	**2.00**	**3**	**2.67**	**1**	**1.00**	**3**	**2.33**
Carp	NA	NA	1	1.00	NA	NA	1	1.00
Chocolay	1	2.00	NA	NA	1	1.00	NA	NA
Sucker	NA	NA	1	4.00	NA	NA	1	4
Two Hearted	NA	NA	1	3.00	NA	NA	1	2.00

TABLE 4.—Seasonal steelhead fishing quality for home waters in Year 1 (2020–2021) and Year 2 (2021–2022). Mean Likert scale values are reported, with higher values indicating higher agreement with quality fishing (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree).

	Quality of Fishing in Fall (Q17)				**Quality of Fishing in Spring (Q18)**			
	Year 1 *n*	Year 1 Mean	Year 2 *n*	Year 2 Mean	Year 1 *n*	Year 1 Mean	Year 2 *n*	Year 2 Mean
Lake Erie/St. Clair Tributaries	**8**	**3.38**	**10**	**2.50**	**8**	**3.25**	**10**	**2.60**
Clinton	7	3.14	6	2.17	7	3.00	6	2.33
Huron	1	5.00	4	3.00	1	5.00	4	3.00
Lake Huron Tributaries	**3**	**3.00**	**7**	**3.43**	**3**	**2.67**	**7**	**3.57**
AuSable	2	3.00	3	2.67	2	2.50	3	3.33
Rifle	1	3.00	2	4.50	1	3.00	2	3.50
Thunder Bay	NA	NA	2	3.50	NA	NA	2	4.00
Lake Michigan Tributaries	**56**	**2.69**	**61**	**2.90**	**56**	**2.70**	**61**	**3.44**
Betsie	7	2.29	5	2.60	7	2.29	5	3.80
Black (Van Buren)	3	1.50	NA	NA	3	2.50	NA	NA
Boardman	NA	NA	1	3.00	NA	NA	1	4.00
Boyne	2	2.50	3	2.67	2	3.50	3	3.67
Galien	NA	NA	1	2.00	NA	NA	1	4.00
Grand	10	2.78	7	3.14	10	2.33	7	3.14
Kalamazoo	5	3.20	6	4.17	5	3.00	6	3.33
Manistee	7	2.43	17	2.71	7	2.86	17	3.35
Muskegon	6	2.67	8	2.75	6	2.33	8	2.88
Pentwater	1	4.00	NA	NA	1	4.00	NA	NA
Pere Marquette	9	3.11	9	2.78	9	2.89	9	4.00
St. Joseph	3	3.67	2	3.00	3	3.33	2	4.00
White	3	1.33	2	2.50	3	2.67	2	3.00
Lake Superior Tributaries	**1**	**2.00**	**3**	**2.33**	**1**	**2.00**	**3**	**3.00**
Carp	NA	NA	1	1.00	NA	NA	1	2.00
Chocolay	1	2.00	NA	NA	1	2.00	NA	NA
Sucker	NA	NA	1	2.00	NA	NA	1	4
Two Hearted	NA	NA	1	4.00	NA	NA	1	3.00

TABLE 5.—Steelhead fishing pressure during October 2021 through May 2022, as reported on Q20 of the Year 2 year-end survey. Mean Likert scale values are reported, with lower values indicating higher fishing pressure (1 = Much heavier pressure than normal, 2 = Heavier pressure than normal, 3 = Average pressure, 4 = Lighter pressure than normal, 5 = Much lighter pressure than normal).

	Fishing Pressure (Q20)	
	Year 2 *n*	Year 2 Mean
Lake Erie/St. Clair Tributaries	**10**	**1.80**
Clinton	6	1.83
Huron	4	1.75
Lake Huron Tributaries	**7**	**2.00**
AuSable	3	2.00
Rifle	2	2.50
Thunder Bay	2	1.50
Lake Michigan Tributaries	**61**	**2.26**
Betsie	5	3.00
Black (Van Buren)	NA	NA
Boardman	1	2.00
Boyne	3	1.33
Galien	1	3.00
Grand	7	2.57
Kalamazoo	6	1.50
Manistee	17	2.06
Muskegon	8	2.38
Pere Marquette	9	2.56
St. Joseph	2	2.50
White	2	2.50
Lake Superior Tributaries	**3**	**2.67**
Carp	1	4.00
Sucker	1	2.00
Two Hearted	1	2.00

TABLE 6.—Year 2 survey results found that respondents were more likely to “Strongly Agree” that a lower harvest limit would ensure viable steelhead populations than to “Strongly Agree” that the reduced limit would boost catch rates. Participants who were employed by a natural resource agency or academic institution were excluded.

	Reduced Limit Would Ensure Viable Steelhead Populations (Q30)		**Reduced Limit Would Boost Catch Rates (Q31)**	
	n	Percent	*n*	Percent
Strongly Agree	40	47.6%	26	31.0%
Agree	22	26.2%	37	44.0%
Neutral	8	9.5%	13	15.5%
Disagree	6	7.1%	7	8.3%
Strongly Disagree	3	3.6%	1	1.2%
NA or Unsure	5	6.0%	0	0.0%
Total	84		84	

TABLE 7.—Year 2 survey respondents were asked if the recently implemented one-fish limit had increased catch rates in waters where it applied. Results are shown for respondents whose home watershed were included in the new harvest limit reduction and for those whose home watersheds were not covered.

	Home Water Covered		**Home Water Not Covered**	
	n	Percent	*n*	Percent
Yes	10	26%	15	31%
Not Sure	16	41%	26	54%
No	13	33%	7	15%
Total	39		48	

TABLE 8.—Number and percentage of participants by generation, level of expertise, and approach to harvesting steelhead.

	Intermediate & Beginner	Advanced	Professional	Total	Intermediate & Beginner	Advanced	Professional
Silent	1	2	0	3	33%	67%	0%
Baby Boomer	5	9	3	17	29%	53%	18%
Gen X	8	6	7	21	38%	29%	33%
Millennial	8	16	5	29	28%	55%	17%
Gen Z	2	6	2	10	20%	60%	20%

	Catch and Release Only	Mostly Catch and Release	Keep All or Most	Total	Catch and Release Only	Mostly Catch and Release	Keep All or Most
Silent	2	1	0	3	67%	33%	0%
Baby Boomer	8	5	4	17	47%	29%	24%
Gen X	8	11	1	20	40%	55%	5%
Millennial	7	21	1	29	24%	72%	3%
Gen Z	2	9	0	11	18%	82%	0%

TABLE 9.—Number of steelhead recorded in complete catch data sets from Year 1 (October 2020 – May 2021) and Year 2 (June 2021 – May 2022), including steelhead and rainbow trout under 15 inches long.

	Year 1				Year 2			
	Unclipped	Clipped	Not Recorded	Total	Unclipped	Clipped	Not Recorded	Total
Lake Erie/St.Clair Basin	**74**	**147**	**4**	**225**	**27**	**135**	**0**	**162**
River	74	147	4	225	27	135	0	162
Lake Huron Basin	**116**	**85**	**2**	**203**	**18**	**38**	**0**	**56**
Lake	3	9	0	12	1	2	0	3
River	113	76	2	191	17	36	0	53
Lake Michigan Basin	**573**	**368**	**9**	**950**	**1,942**	**711**	**38**	**2,691**
Lake	5	27	2	34	10	14	3	27
River	568	341	7	916	1,932	697	35	2,664
Lake Superior Basin	**0**	**0**	**0**	**0**	**36**	**0**	**0**	**36**
Lake	0	0	0	0	2	0	0	2
River	0	0	0	0	34	0	0	34
Other	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**0**
Total	765	600	15	1,380	2,023	884	38	2,945

TABLE 10.—Number of steelhead recorded by watershed during Year 1 (October 2020 – May 2021) and Year 2 (June 2021 – May 2022). Steelhead under 15 inches long are excluded.

	Year 1				Year 2			
	Unclipped	Clipped	Not Recorded	Total	Unclipped	Clipped	Not Recorded	Total
Lake Erie/St.Clair Basin	**72**	**141**	**4**	**217**	**27**	**135**	**0**	**162**
Clinton	72	141	4	217	21	61	0	82
Huron	0	0	0	0	6	74	0	80
Lake Huron Basin	**111**	**74**	**2**	**187**	**13**	**8**	**0**	**21**
AuGres	2	1	0	3	0	0	0	0
AuSable	84	52	2	138	4	1	0	5
Ocqueoc	0	0	0	0	1	0	0	1
Rifle	25	21	0	46	8	6	0	14
Thunder Bay	0	0	0	0	0	1	0	1
Lake Michigan Basin	**560**	**336**	**7**	**903**	**1,895**	**692**	**33**	**2,620**
Bear	0	0	0	0	2	4	1	7
Betsie	167	46	0	213	232	94	2	328
Black	1	17	0	18	0	0	0	0
Boyne	1	0	0	1	11	2	1	14
Grand	78	21	0	99	121	57	1	179
Kalamazoo	34	62	0	96	39	76	0	115
Manistee	36	38	1	75	834	312	11	1,157
Muskegon	18	35	0	53	76	42	5	123
Pentwater	8	1	0	9	0	2	0	2
Pere Marquette	161	3	4	168	521	42	9	572
St. Joseph	40	112	0	152	32	50	1	83
White	16	1	2	19	27	11	2	40
Lake Superior Basin	**0**	**0**	**0**	**0**	**34**	**0**	**0**	**34**
Rock	0	0	0	0	21	0	0	21
Sucker	0	0	0	0	13	0	0	13
Other/Unknown	**2**	**0**	**0**	**2**	**4**	**3**	**0**	**7**
Total	745	551	13	1,309	1,973	838	33	2,844

TABLE 11.—Number of measured and estimated steelhead lengths recorded in complete catch data sets from rivers during Year 1 (October 2020 – May 2021) and Year 2 (June 2021 – May 2022).

	Year 1				Year 2			
	Measured Total Length	Estimated Length	Length Not Recorded	Percent Estimated	Measured Total Length	Estimated Length	Length Not Recorded	Percent Estimated
Lake Erie/St.Clair Basin	**221**	**0**	**0**	**0%**	**135**	**27**	**0**	**17%**
Clinton	221	0	0	0%	73	9	0	11%
Huron	0	0	0	0%	62	18	0	23%
Lake Huron Basin	**178**	**13**	**0**	**7%**	**52**	**0**	**0**	**0%**
AuGres	3	0	0	0%	0	0	0	NA
AuSable	136	2	0	1%	5	0	0	0%
Ocqueoc	0	0	0	NA	2	0	0	0%
Rifle	39	11	0	22%	44	0	0	0%
Thunder Bay	0	0	0	NA	1	0	0	0%
Lake Michigan Basin	**790**	**124**	**2**	**14%**	**2,432**	**225**	**1**	**8%**
Bear	0	0	0	NA	0	7	0	100%
Betsie	215	0	0	0%	325	3	0	1%
Black	18	0	0	0%	0	0	0	NA
Boyne	0	1	0	100%	0	15	0	100%
Grand	103	1	0	1%	164	16	0	9%
Kalamazoo	96	0	1	0%	114	2	0	2%
Manistee	74	3	0	4%	1,170	17	0	1%
Muskegon	46	7	1	13%	105	19	0	15%
Pentwater	9	0	0	0%	2	0	0	0%
Pere Marquette	68	100	0	60%	456	117	0	20%
St. Joseph	153	0	0	0%	85	0	1	0%
White	8	12	0	60%	11	29	0	73%
Lake Superior Basin	**0**	**0**	**0**	**NA**	**34**	**0**	**0**	**0%**
Rock	0	0	0	NA	21	0	0	0%
Sucker	0	0	0	NA	13	0	0	0%
Other/Unknown	**6**	**0**	**0**	**0%**	**7**	**0**	**0**	**0%**
Total	1,195	137	2	10%	2,660	252	1	9%

TABLE 12.—Number of measured and estimated steelhead lengths by length range from complete catch data sets during Year 2 (June 2021 – May 2022), including fish caught in rivers and Great Lakes waters.

Length Range	Total	Estimated Length	Measured Total Length	Percent Estimated	Percent Measured
<15	68	3	65	4%	96%
15–19	242	16	226	7%	93%
20–24	626	38	588	6%	94%
25–28	1,471	188	1,283	13%	87%
29+	505	7	498	1%	99%
Total	2,912	252	2,660	9%	91%

TABLE 13.—Number of steelhead caught and percent clipped by season for select Lake Michigan tributaries during Year 1 (Fall 2020 and Spring 2021). Only returning steelhead of 15 inches and longer are included. Note that Manistee watershed results do not include the Little Manistee River.

	Year 1							
	Fall Unclipped	Fall Clipped	Fall Total	Spring Unclipped	Spring Clipped	Spring Total	Fall Percent Clipped	Spring Percent Clipped
Watershed								
Betsie	64	6	70	103	40	143	9%	28%
Grand	49	16	65	29	5	34	25%	15%
Kalamazoo	15	37	52	19	25	44	71%	57%
Manistee	5	15	20	28	22	50	75%	44%
Muskegon	11	23	34	7	12	19	68%	63%
Pere Marquette	75	2	77	86	1	87	3%	1%
St. Joseph	23	38	61	17	74	91	62%	81%
Watershed Total	242	137	379	289	179	468		
Watershed Mean							45%	41%
Dowstream Locations								
Lower Grand R	1	5	6	0	0	0	83%	NA
Lower Manistee R	4	7	11	5	1	6	64%	17%
Lower Muskegon R	8	20	28	1	6	7	71%	86%
Lower PM River	0	0	0	0	0	0	NA	NA
Downstream Total	13	32	45	6	7	13		
Downstream Mean							73%	51%
Upstream Locations								
U Grand R and Prairie Cr	48	11	59	28	4	32	19%	13%
Upper Manistee R	0	8	8	42	21	45	100%	47%
Upper Muskegon R	3	3	6	6	6	12	50%	50%
Upper PM River	75	2	77	85	1	86	3%	1%
Upstream Total	126	24	150	161	32	175		
Upstream Mean							43%	28%

TABLE 14.— Number of steelhead caught and percent clipped by season for select Lake Michigan tributaries during Year 2 (Fall 2021 and Spring 2022). Only returning steelhead of 15 inches and longer are included. Note that Manistee watershed results do not include the Little Manistee River, and reaches defined as "Middle Manistee R" and "Upper Manistee R" were grouped together for Year 2 since they align with the single location option "Upper Manistee R" from Year 1.

	Year 2							
	Unclipped	Clipped	Fall Total	Unclipped	Clipped	Spring Total	Fall Percent Clipped	Spring Percent Clipped
Watershed								
Betsie	77	17	94	155	77	232	18%	33%
Grand	73	30	103	47	22	69	29%	32%
Kalamazoo	11	9	20	28	67	95	45%	71%
Manistee	439	62	501	340	245	585	12%	42%
Muskegon	42	27	69	34	15	49	39%	31%
Pere Marquette	158	13	171	363	29	392	8%	7%
St. Joseph	9	17	26	23	33	56	65%	59%
Watershed Total	809	175	984	990	488	1478		
Watershed Mean							31%	39%
Dowstream Locations								
Lower Grand R	20	24	44	2	13	15	55%	87%
Lower Manistee R	335	45	380	105	42	147	12%	29%
Lower Muskegon R	29	18	47	27	8	35	38%	23%
Lower PM River	101	10	111	77	14	91	9%	15%
Downstream Total	485	97	582	211	77	288		
Downstream Mean							28%	38%
Upstream Locations								
U Grand R and Prairie Cr	52	5	57	43	5	48	9%	10%
Upper Manistee R	99	17	116	227	203	430	15%	47%
Upper Muskegon R	13	9	22	7	7	14	41%	50%
Upper PM River	57	3	60	286	15	301	5%	5%
Upstream Total	221	34	255	563	230	793		
Upstream Mean							17%	28%

TABLE 15.—Percentage of clipped steelhead by watershed in Year 1 (2020–2021) and Year 2 (2021–2022).

	Year 1				Year 2			
			95% Confidence Interval				95% Confidence Interval	
	n	Percent Clipped	Lower Bound	Upper Bound	*n*	Percent Clipped	Lower Bound	Upper Bound
Lake Michigain Basin								
Betsie	213	22%	17% –	28%	326	29%	24% –	34%
Grand	99	21%	14% –	30%	178	32%	26% –	39%
Kalamazoo	96	65%	55% –	73%	115	66%	57% –	74%
Manistee	74	51%	40% –	62%	1,146	27%	25% –	30%
Muskegon	53	66%	53% –	77%	118	36%	28% –	45%
Pere Marquette	164	2%	1% –	5%	563	7%	6% –	10%
St. Joseph	153	73%	66% –	80%	82	61%	50% –	71%
White	17	6%	1% –	27%	38	29%	17% –	45%
Lake Erie/St. Clair Basin								
Clinton	215	66%	59% –	72%	82	74%	64% –	83%
Huron	0				80	93%	85% –	97%

TABLE 16.—Percentage of clipped steelhead by location for Lake Michigan watersheds with multiple locations sampled in Year 2 (2021–2022).

	n	Year 2 Percent Clipped	95% Confidence Interval Lower Bound		95% Confidence Interval Upper Bound
Manistee Watershed					
U Manistee R	394	48%	44%	–	53%
M Manistee R	157	20%	15%	–	27%
L Manistee R	527	17%	14%	–	20%
Bear Cr	13	0%	0%	–	23%
Little Manistee R	55	4%	1%	–	12%
Muskegon Watershed					
U Muskegon R	36	44%	30%	–	60%
L Muskegon R	82	32%	23%	–	42%
Pere Marquette Watershed					
U PM River	361	5%	3%	–	8%
L PM River	202	12%	8%	–	17%
Grand Watershed					
U Grand R	6	33%	9%	–	71%
L Grand R	59	63%	50%	–	74%
Prairie Cr	105	12%	7%	–	20%
Kalamazoo Watershed					
Kalamazoo R	111	67%	57%	–	75%
Rabbit R	3	33%	4%	–	82%
St. Joseph Watershed					
St Joe R	37	70%	54%	–	83%
Dowagiac R	45	53%	39%	–	67%

TABLE 17.—Percentage of clipped steelhead over 15 inches long from select locations sampled in Year 1 (2020–2021).

	n	Percent Clipped	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Lake Huron Basin				
AuSable Watershed				
Van Etten Cr	70	0.19	0.11	0.29
AuSable R	66	0.59	0.47	0.70
Rifle Watershed				
Rifle R	46	0.46	0.32	0.60
Lake Michigan Basin				
Grand Watershed				
Prairie Cr	45	0.13	0.06	0.26
U Grand R	46	0.20	0.11	0.33
L Grand R	6	0.83	0.42	0.97
Black Watershed				
Black R	18	0.94	0.74	0.99

TABLE 18.—Average catch-per-unit-effort (CPUE, steelhead per angler-hour) for trips taken in Lake Michigan tributaries by participants who provided complete catch and complete effort data for both Year 1 (2020–2021) and Year 2 (2021–2022).

	Year 1 CPUE	Year 1 Trips	Year 2 CPUE	Year 2 Trips	Year 2 –Year 1 CPUE
Participant 1	0.16	6	0.20	7	0.04
Participant 2	0.13	5	0.08	7	-0.05
Participant 3	0.33	94	0.39	107	0.06
Participant 4	0.33	7	0.32	9	-0.01
Participant 5	0.24	27	0.34	18	0.10
Participant 6	0.45	65	0.76	51	0.31
Participant 7	0.04	8	0.17	21	0.13
Participant 8	0.39	111	0.56	110	0.17
Participant 9	0.08	22	0.04	38	-0.04
Participant 10	0.05	4	0.09	4	0.04
Participant 11	0.27	3	0.45	5	0.18
Average	0.22		0.31		0.08

TABLE 19.—Average catch-per-unit-effort (CPUE, steelhead per angler-hour) for trips taken in Clinton River by participants who provided complete catch and complete effort data for both Year 1 (2020–2021) and Year 2 (2021–2022).

	Year 1 CPUE	Year 1 Trips	Year 2 CPUE	Year 2 Trips	Year 2– Year 1 CPUE
Participant 1	0.21	46	0.22	58	0.01
Participant 2	0.43	32	0.25	41	-0.18
Participant 3	0.09	68	0.02	49	-0.07
Average	0.24		0.16		-0.08

TABLE 20.—Number of trips from complete data sets with catch-per-unit-effort (CPUE, steelhead per angler-hour) data and trip satisfaction data for trips Year 1 (2020–2021) and Year 2 (2021–2022) by number of anglers in the fishing party. For Year 2, trips are further subdivided by participants with a known level of expertise.

	Year 1		Year 2				
					Trips with Known Expertise		
					Intermediate	Advanced	Professional
Number of Anglers in Party	Trips with CPUE Data	Trips with CPUE & Satisfaction Data	Trips with CPUE Data	Trips with CPUE & Satisfaction Data	Trips with CPUE & Satisfaction Data	Trips with CPUE & Satisfaction Data	Trips with CPUE & Satisfaction Data
1	638	99	524	160	12	95	42
2	248	29	426	110	9	31	60
3	25	4	28	2	0	0	1
4	6	2	2	0	0	0	0
5	1	1	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	1	0	0	0	0
8	0	0	1	0	0	0	0
Total	918	135	982	272	21	126	103

TABLE 21.—Average number of trips per year, steelhead caught per year, and steelhead caught per trip by level of expertise for Lake Michigan tributary anglers with known expertise who recorded complete catch and complete effort data sets in Year 2 (2021–2022).

	n	Trips Taken	Steelhead Caught	Mean Trips Per Year	Steelhead Caught Per Year	Steelhead Caught Per Trip
Intermediate	6	67	58	11.2	9.7	0.9
Advanced	6	319	717	53.2	119.5	2.2
Professional	7	319	629	45.6	89.9	2.0
Total	19	705	1,404			

TABLE 22.—Correlations between catch-per-unit-effort (CPUE; steelhead per angler-hour) and trip satisfaction for trips taken on Lake Michigan tributaries with a single angler fishing. For Year 2 (2021–2022), correlations are shown for all trips and for anglers with advanced or professional expertise. Year 2 correlations are also shown with and without two outliers from professional angler trips that had very low satisfaction and high catch rates. Trip satisfaction was recorded on a nine-point Likert scale (1 = Extremely Dissatisfied, 2 = Very Dissatisfied, 3 = Somewhat Dissatisfied, 4 = Slightly Dissatisfied, 5 = Neutral, 6 = Slightly Satisfied, 7 = Somewhat Satisfied, 8 = Very Satisfied, 9 = Extremely Satisfied).

	n	τ	*P*
Year 1			
All trips	90	0.329	<0.001
Year2			
All trips	123	0.426	<0.001
Outliers removed	121	0.457	<0.001
Advanced	78	0.530	<0.001
Professional	27	0.359	0.016
Professional, outliers removed	25	0.592	<0.001

TABLE 23.—Effect of angler expertise, steelhead size, sex, and fin clip on angler decision to release or harvest steelhead 15 inches and longer in Michigan rivers during Year 2 (2021–2022). Watersheds with harvest restrictions were excluded from a separate analysis of the effect of fin clip on steelhead harvest; Pere Marquette, Manistee, and Muskegon watersheds were excluded from this analysis because anglers were more likely to be required to release fish from these waters. Results of χ^2 tests for independence are shown, with italicized *P*-value denoting a significant result.

	Released	Harvested	Total	Percent Harvested	χ^2	df	*P*-value
Expertise					120.462	2	*<0.001*
Intermediate	80	31	111	28%			
Advanced	805	83	888	9%			
Professional	1100	29	1129	3%			
Total Length (inches)					38.661	3	*<0.001*
15-19	231	11	242	5%			
20-24	531	95	626	15%			
25-28	1335	136	1471	9%			
29+	476	29	505	6%			
Sex					3.882	1	*0.049*
Female	1389	167	1556	11%			
Male	1060	98	1158	8%			
Fin Clip (all waters)					113.356	1	*<0.001*
Unclipped	1859	114	1973	6%			
Clipped	681	157	838	19%			
Fin Clip (excluding harvest-restricted waters)					30.256	1	*<0.001*
Unclipped	499	43	542	8%			
Clipped	354	88	442	20%			

FIGURE 1.—Map of Lower Peninsula streams with at least nine steelhead over 15 inches long reported in Year 1 or Year 2. Only the sections of river downstream of the first impassible barrier to fish migration are shown highlighted in dark blue.

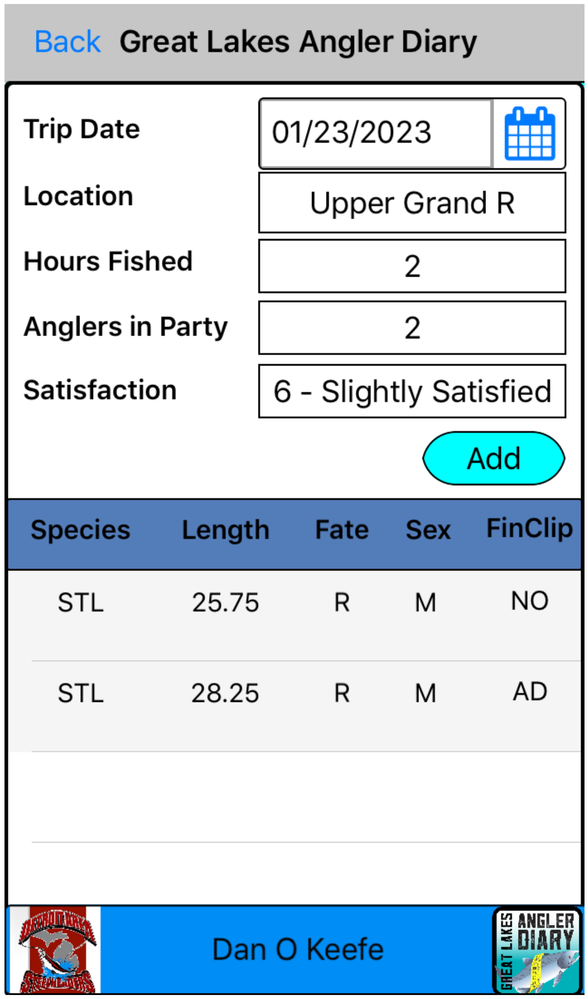


FIGURE 2.—Data entry screen for Great Lakes Angler Diary iOS app.

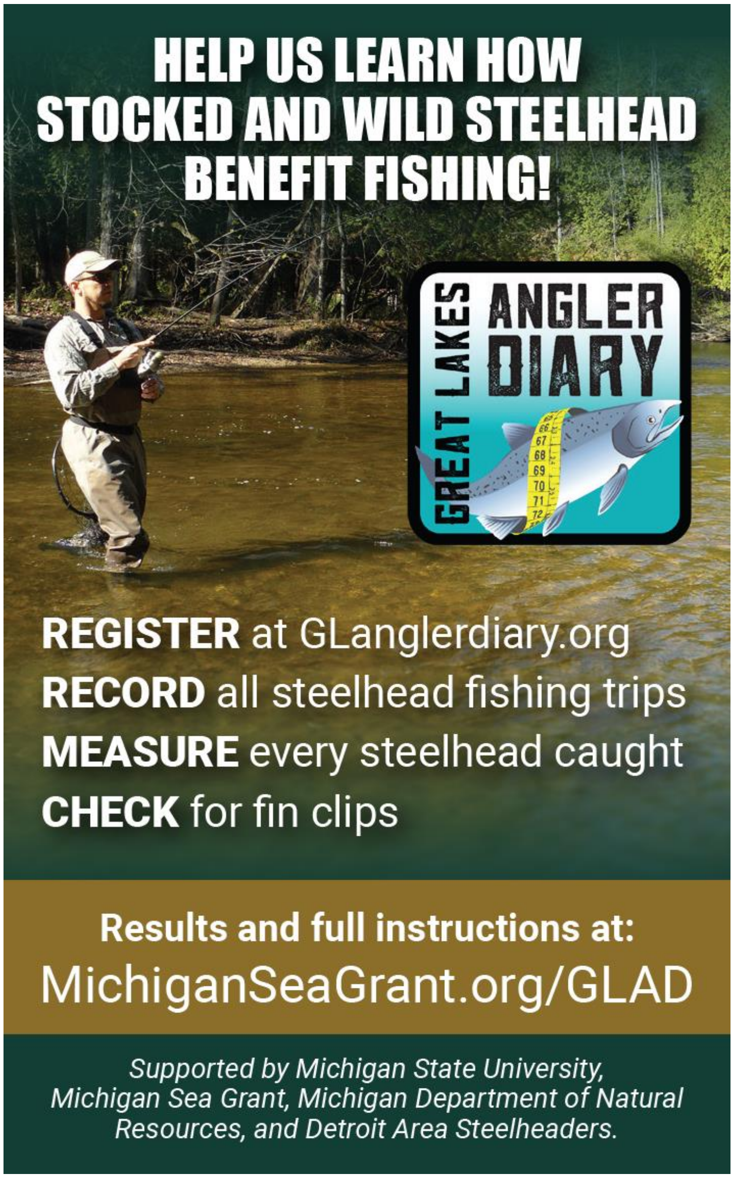


FIGURE 3.—Advertisement published in Michigan Department of Natural Resources 2022 Michigan Fishing Guide.

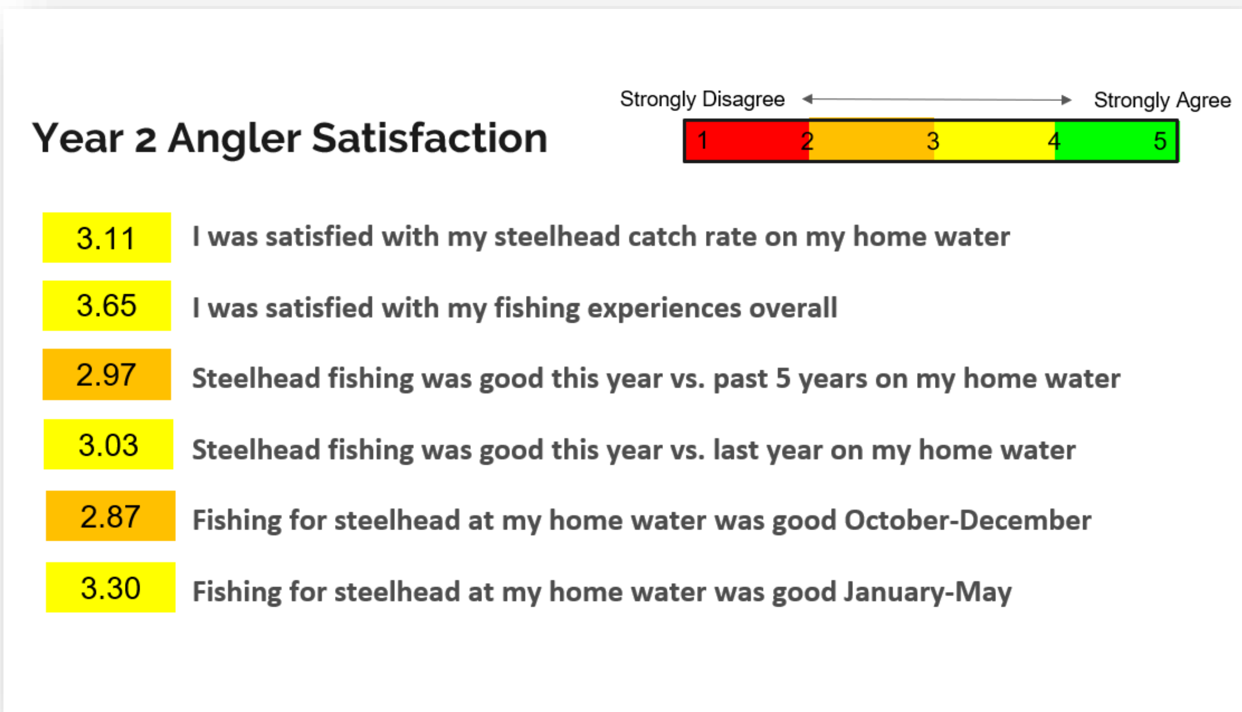


FIGURE 4.—Average responses to year-end survey questions (Q13 through Q18) dealing with angler satisfaction and quality of fishing during Year 1 (2020–2021) and Year 2 (2021–2022).

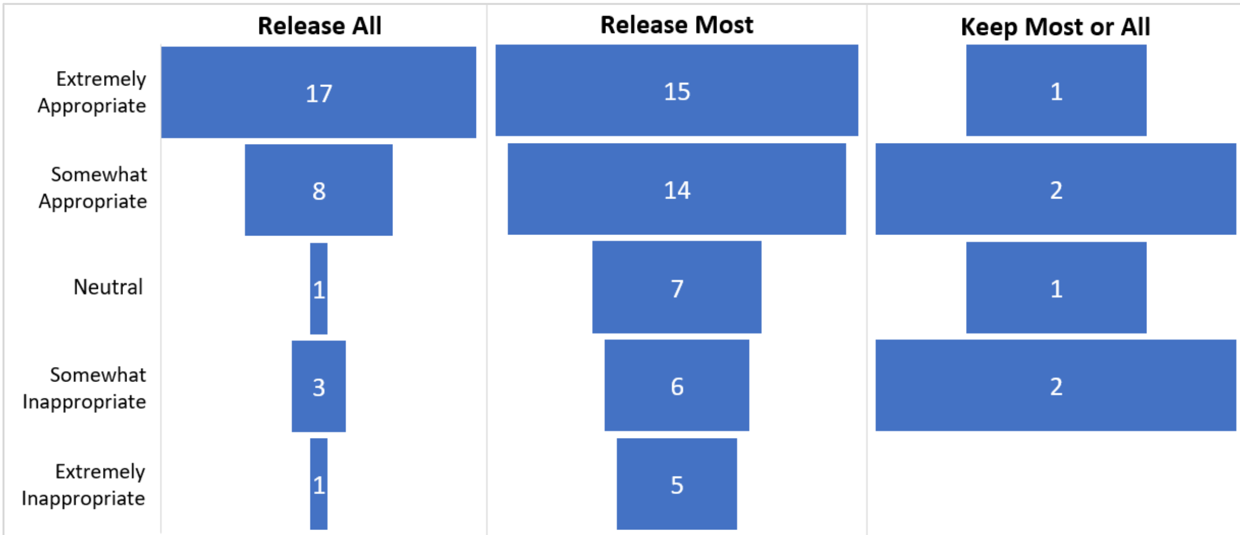


FIGURE 5.—Belief in the appropriateness of new harvest limits by participants' personal approaches to harvesting or releasing steelhead. Number of participants in each category is shown on funnel plots based on answers to questions (Q32, Q39) on the Year 2 (2021–2022) year-end survey.

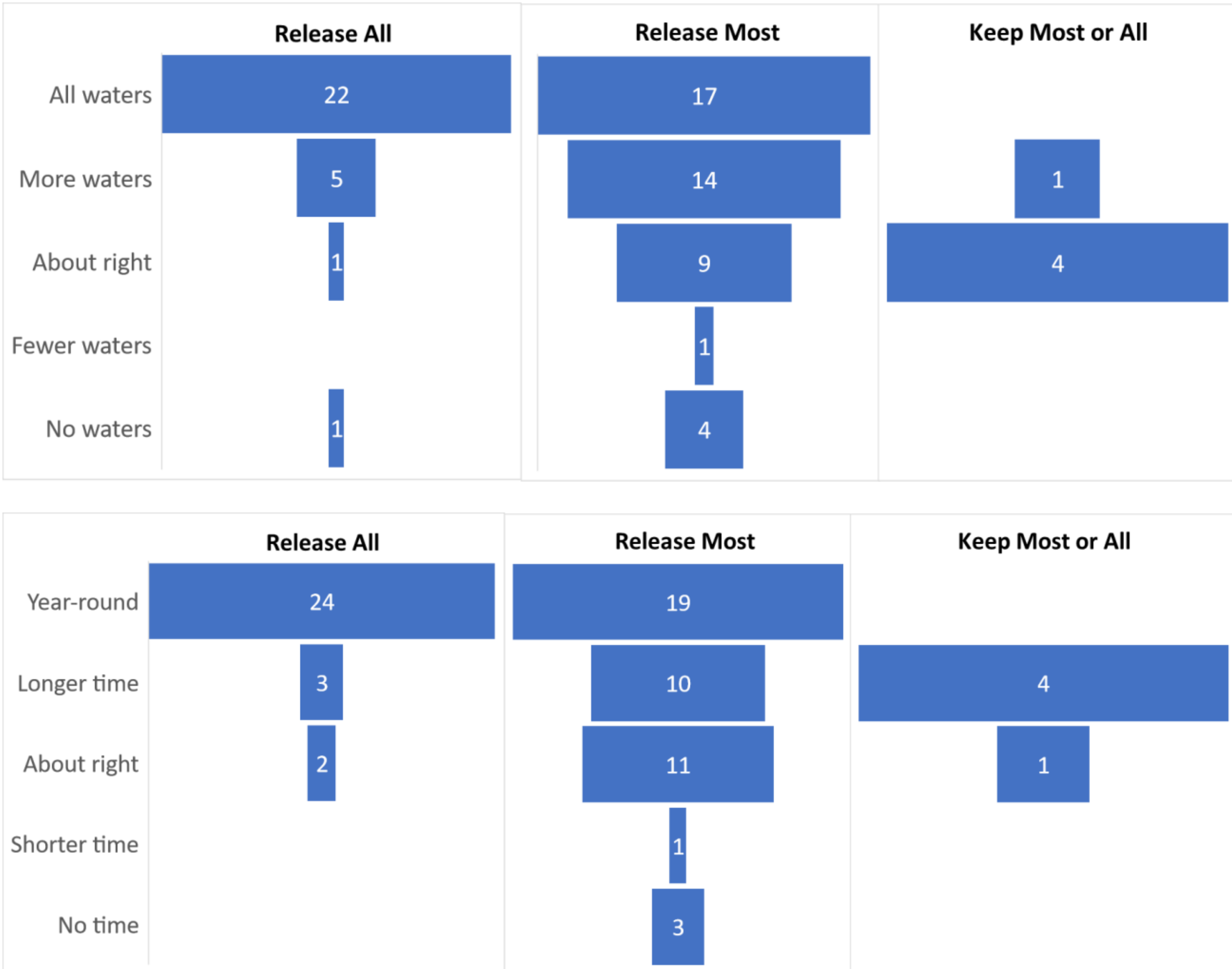


FIGURE 6.— Preference for expansion or retraction of newly implemented harvest limits by participants' personal approaches to harvesting or releasing steelhead. Number of participants in each category is shown on funnel plots based on answers to questions (Q32, Q40, Q41) on the Year 2 (2021–2022) year-end survey.

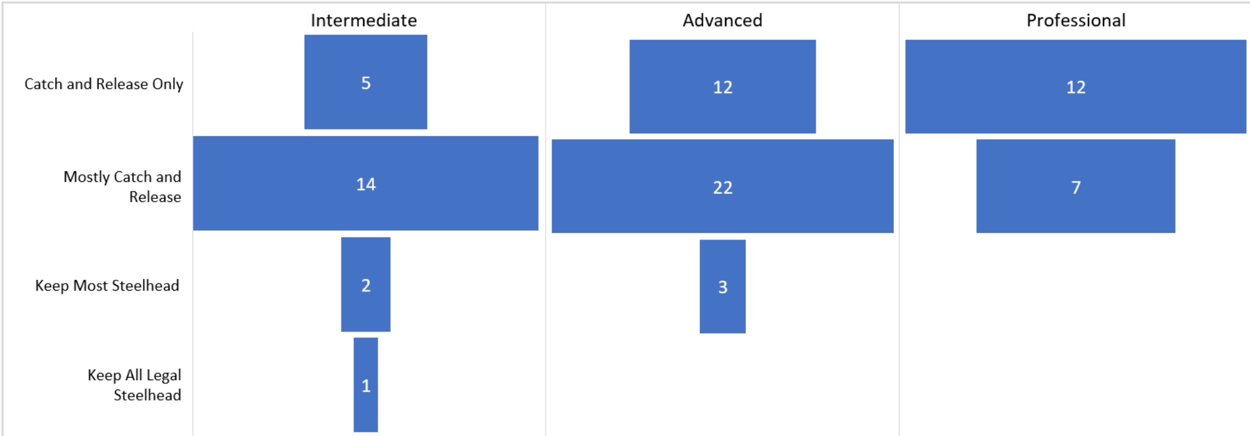


FIGURE 7.—Participants' personal approaches to harvesting or releasing steelhead according to level of expertise. Number of participants in each category is shown on funnel plots based on answers to questions (Q32, Q44) on the Year 2 (2021–2022) year-end survey.

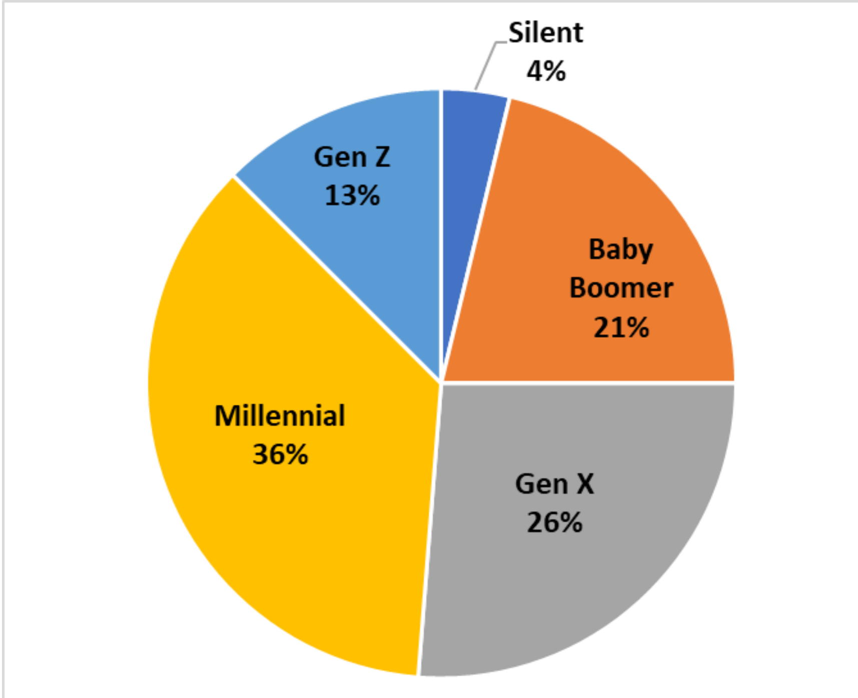
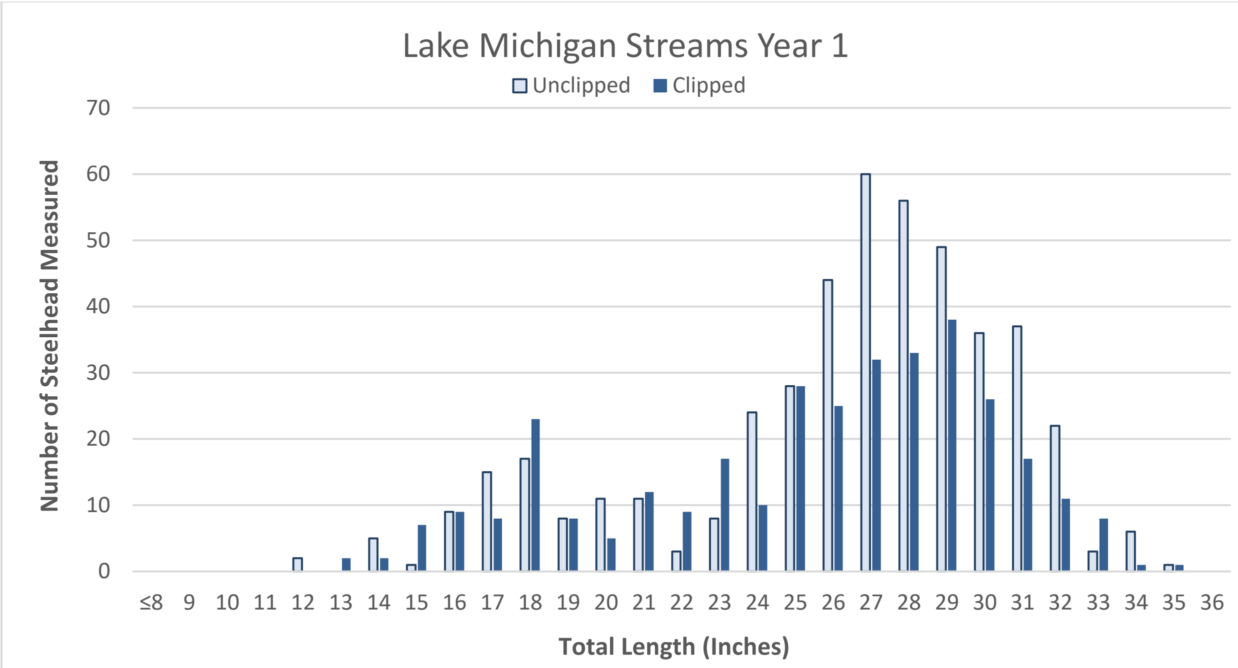


FIGURE 8.—Breakdown of participants by generation based on birth year as reported on the Year 2 year-end survey (Q45; n = 80).



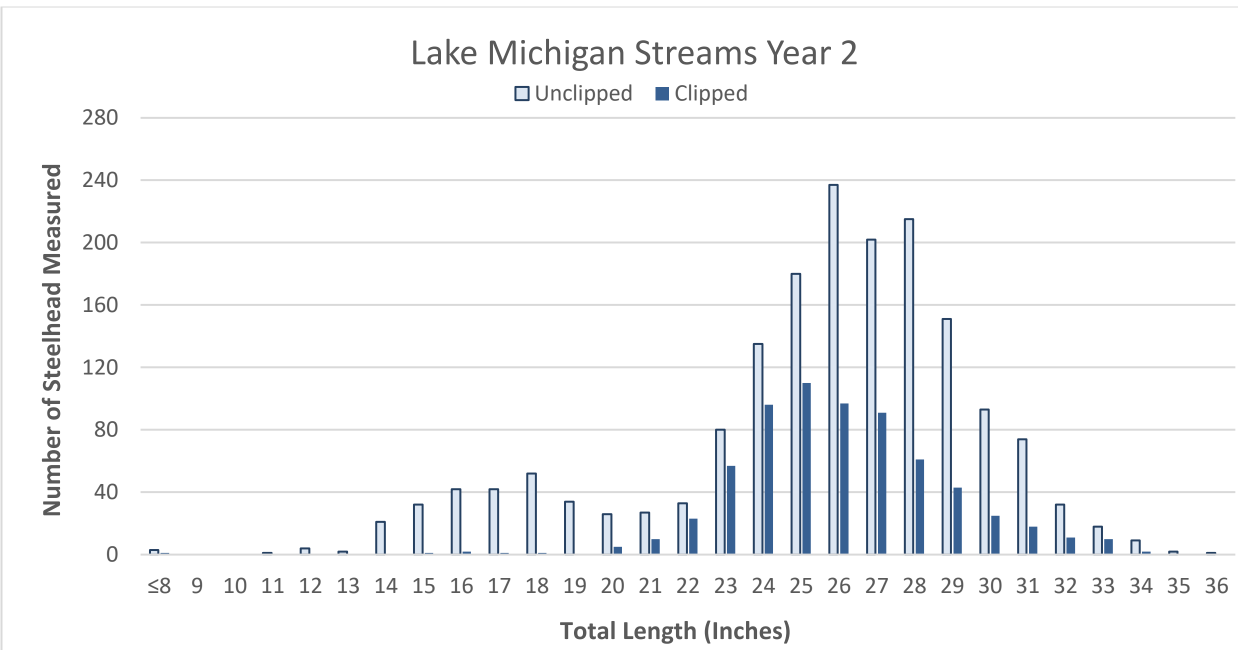
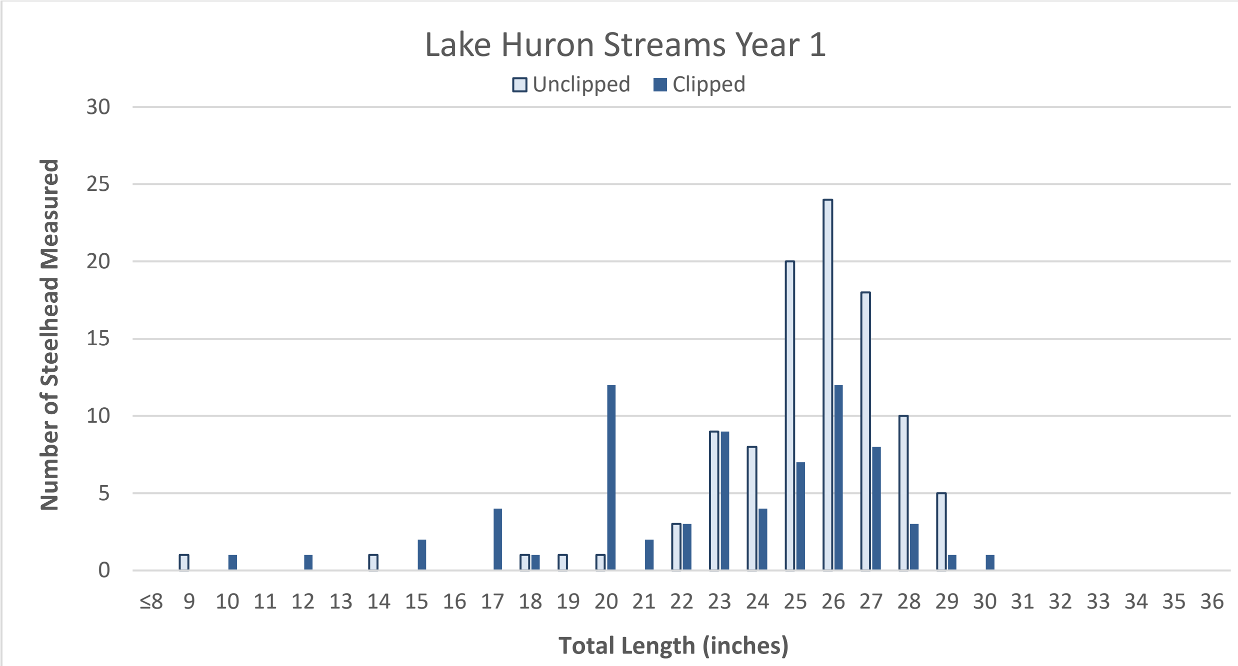


FIGURE 9.—Steelhead length distribution for Lake Michigan basin streams in Year 1 (2020–2021; *n* = 788) and Year 2 (2021–2022; *n* = 2,629). Steelhead with estimated lengths are omitted.



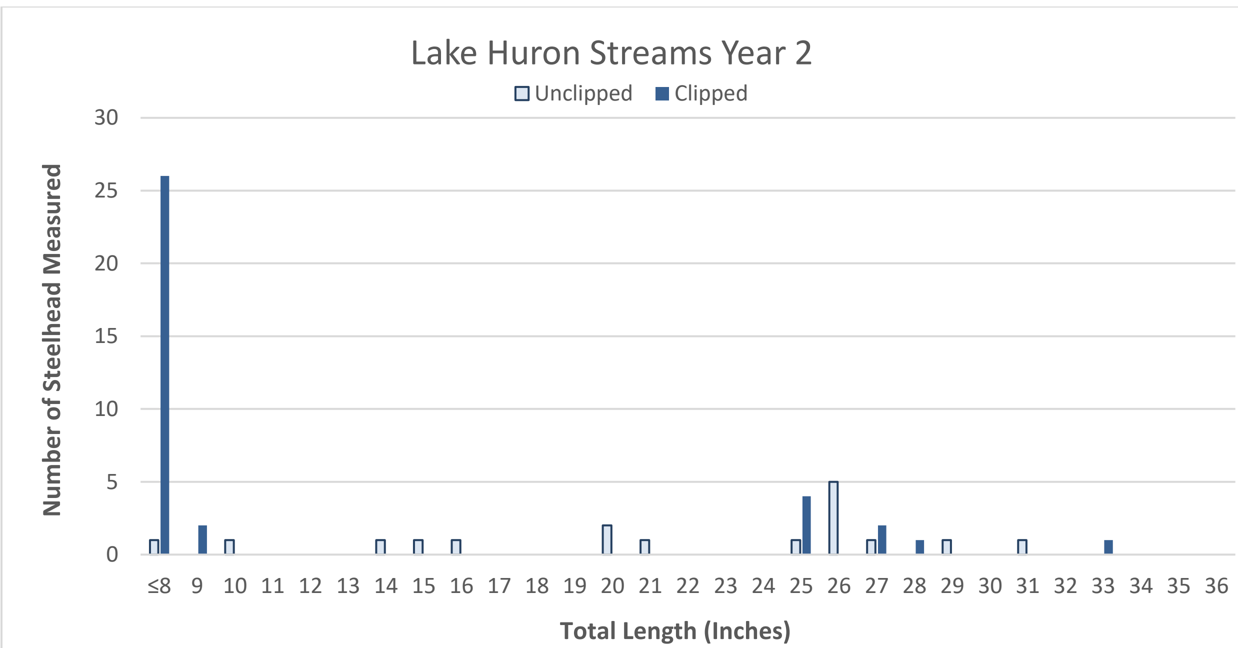


FIGURE 10.—Steelhead length distribution for Lake Huron basin streams in Year 1 (2020–2021; *n* = 173) and Year 2 (2021–2022; *n* = 53). Steelhead with estimated lengths are omitted.

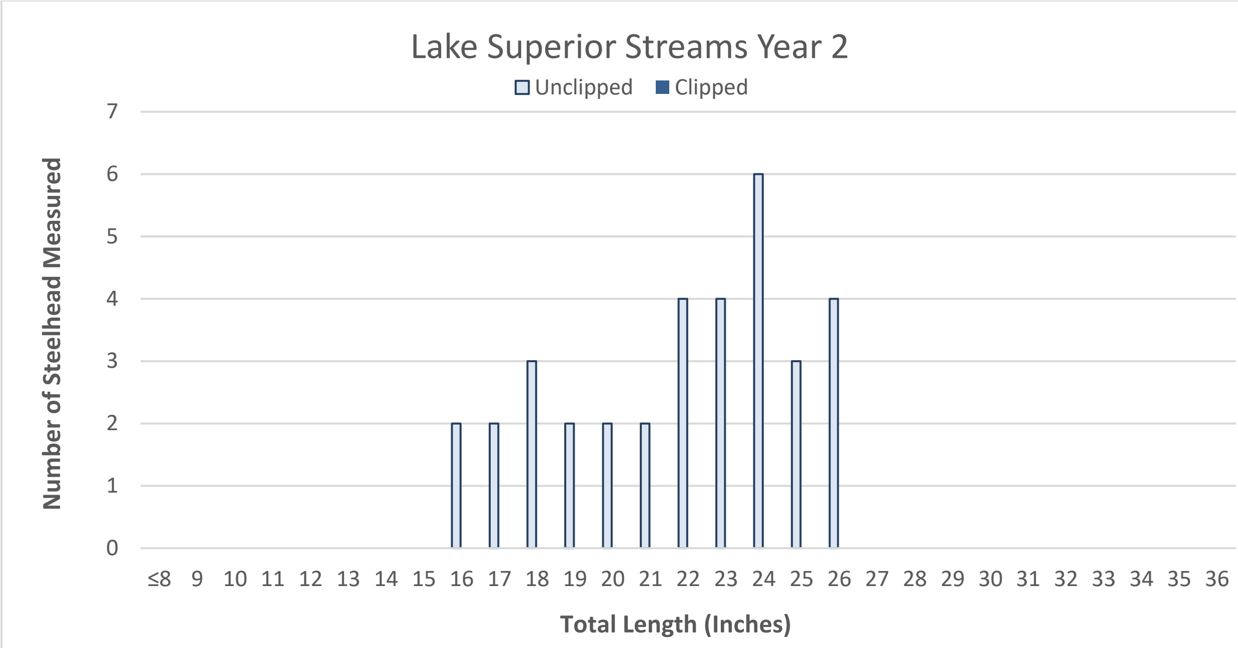


FIGURE 11.— Steelhead length distribution for Lake Superior basin streams in Year 2 (2021–2022; *n* = 34).

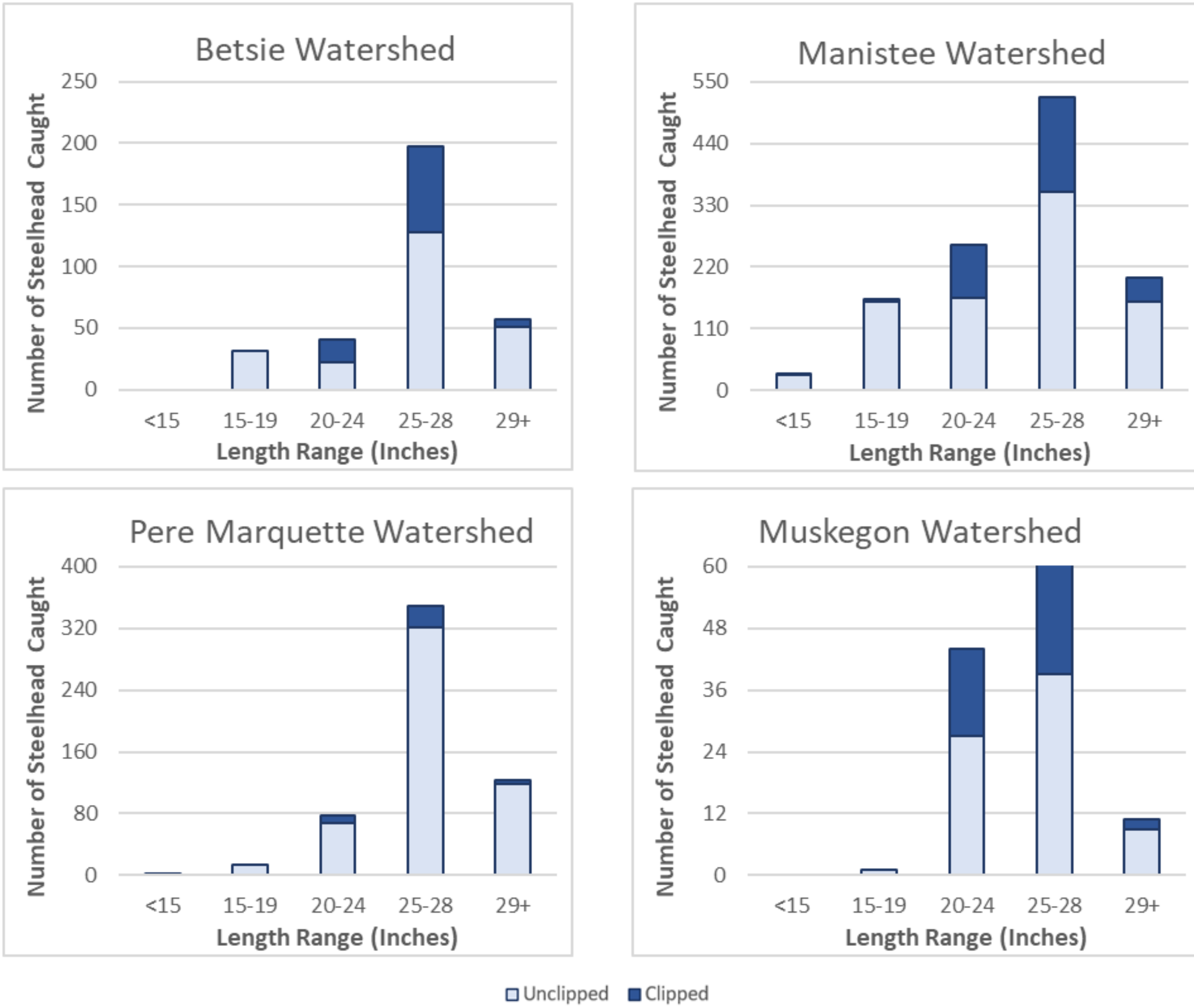


FIGURE 12.—Total lengths of steelhead caught in northern Lake Michigan watersheds June 1, 2021, through May 31, 2022 (Year 2), including Betsie watershed (*n* = 326), Manistee watershed including Little Manistee River (*n* = 1,175), Pere Marquette watershed (*n* = 564), and Muskegon watershed (*n* = 118).

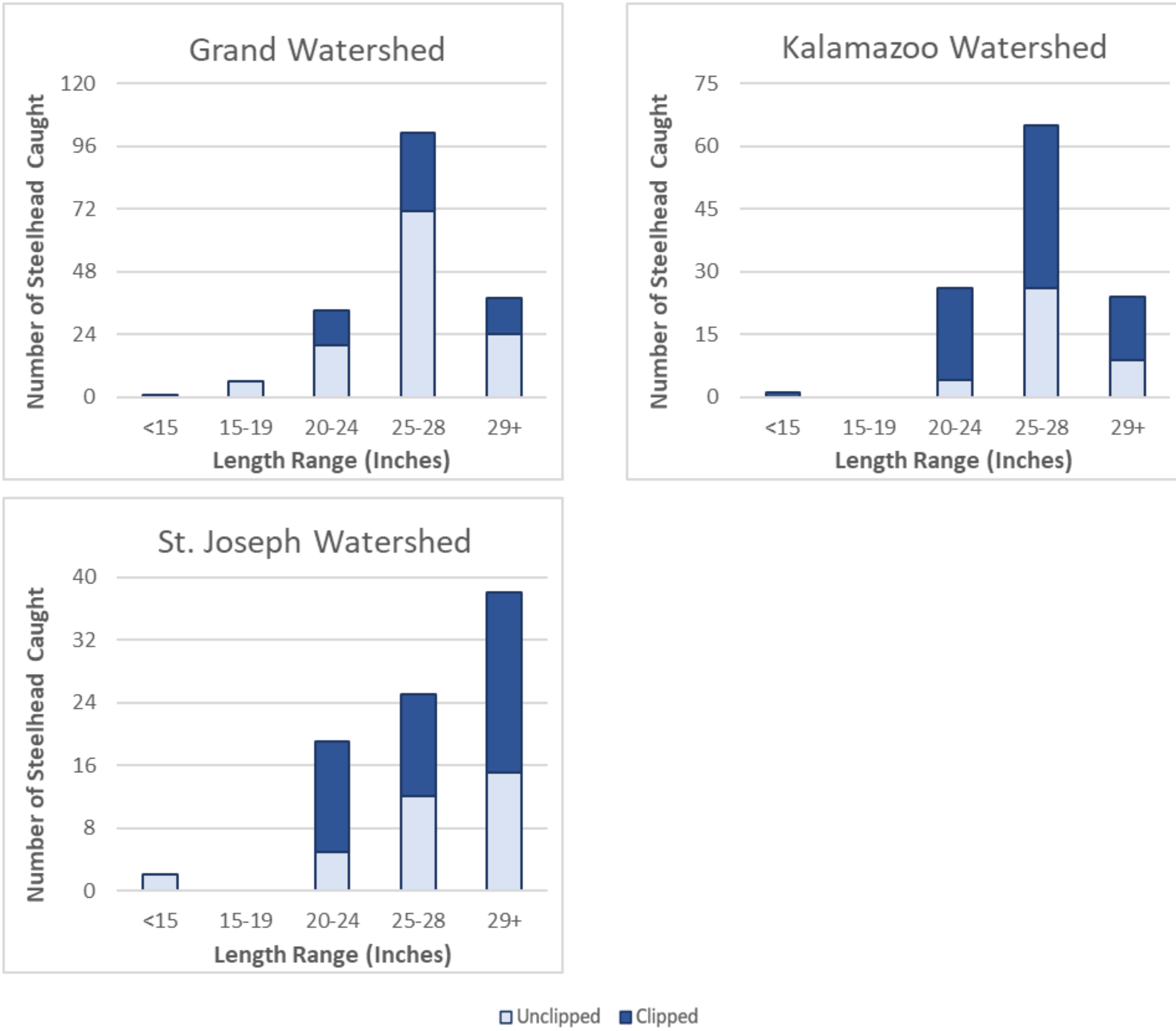


FIGURE 13.—Total lengths of steelhead in southern Lake Michigan basin watersheds June 1, 2021, through May 31, 2022 (Year 2), including Grand watershed (*n* = 179), Kalamazoo watershed (*n* = 116), and St. Joseph watershed (*n* = 84).

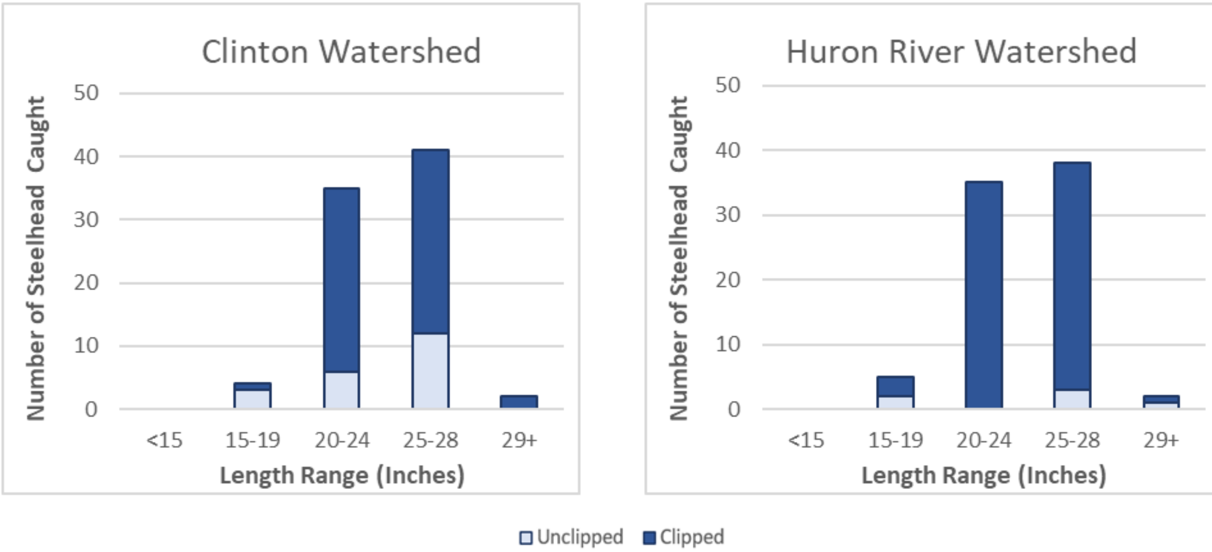


FIGURE 14.—Total lengths of steelhead in Lake St. Clair and Lake Erie basin watersheds June 1, 2021, through May 31, 2022 (Year 2), including Clinton watershed (*n* = 82), and Huron watershed (*n* = 80).

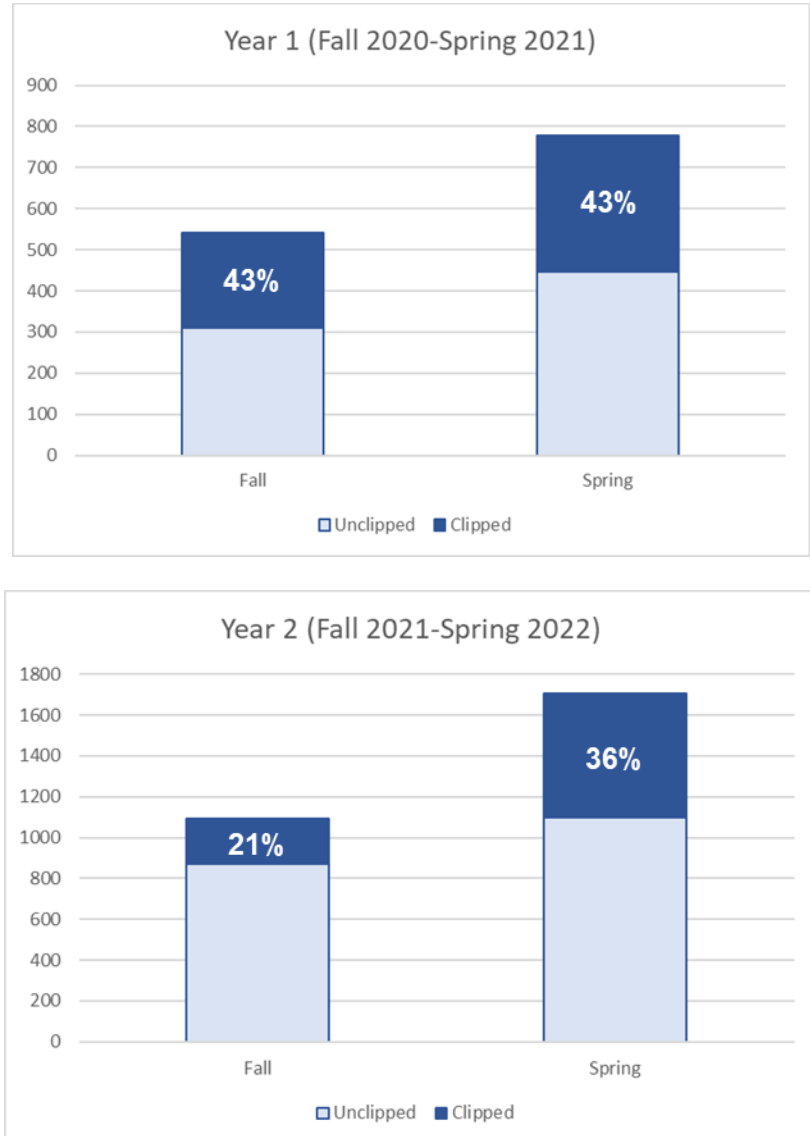
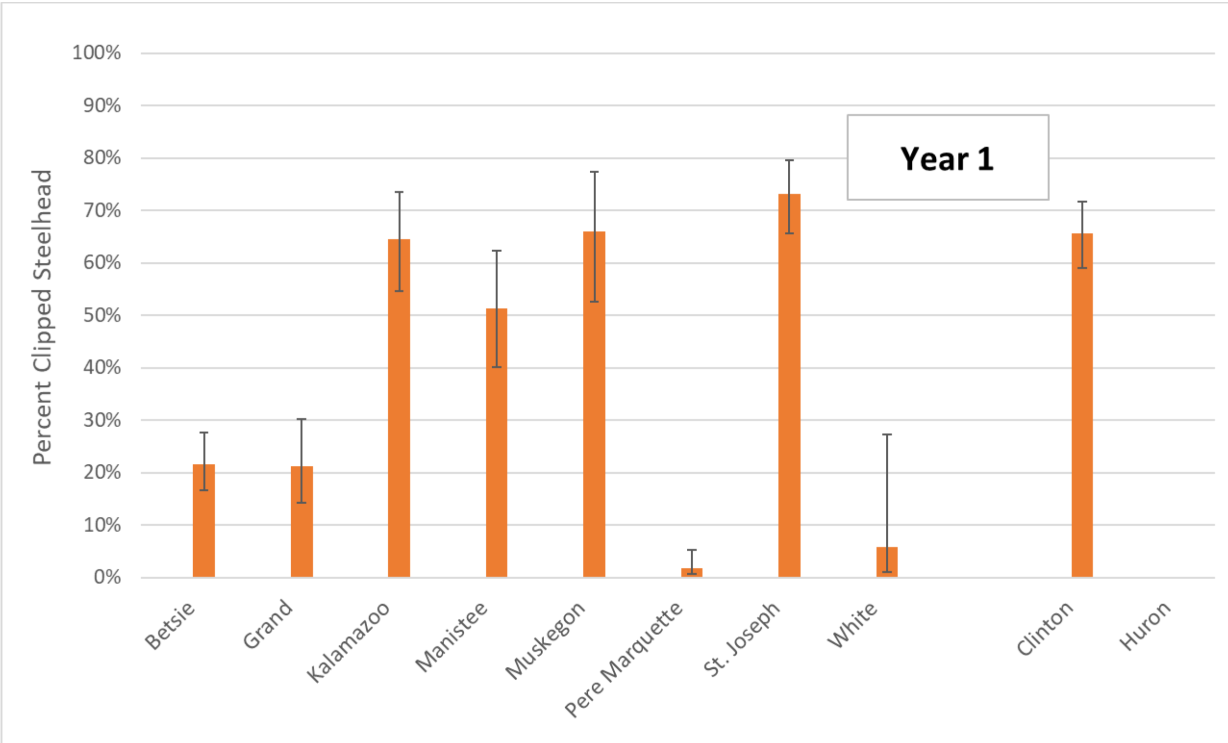


FIGURE 15.—Clipped and unclipped steelhead 15 inches and longer caught in Michigan rivers Fall 2020 (*n* = 542), Spring 2021 (*n* = 779), Fall 2021 (*n* = 1,095), and Spring 2022 (*n* = 1,704).



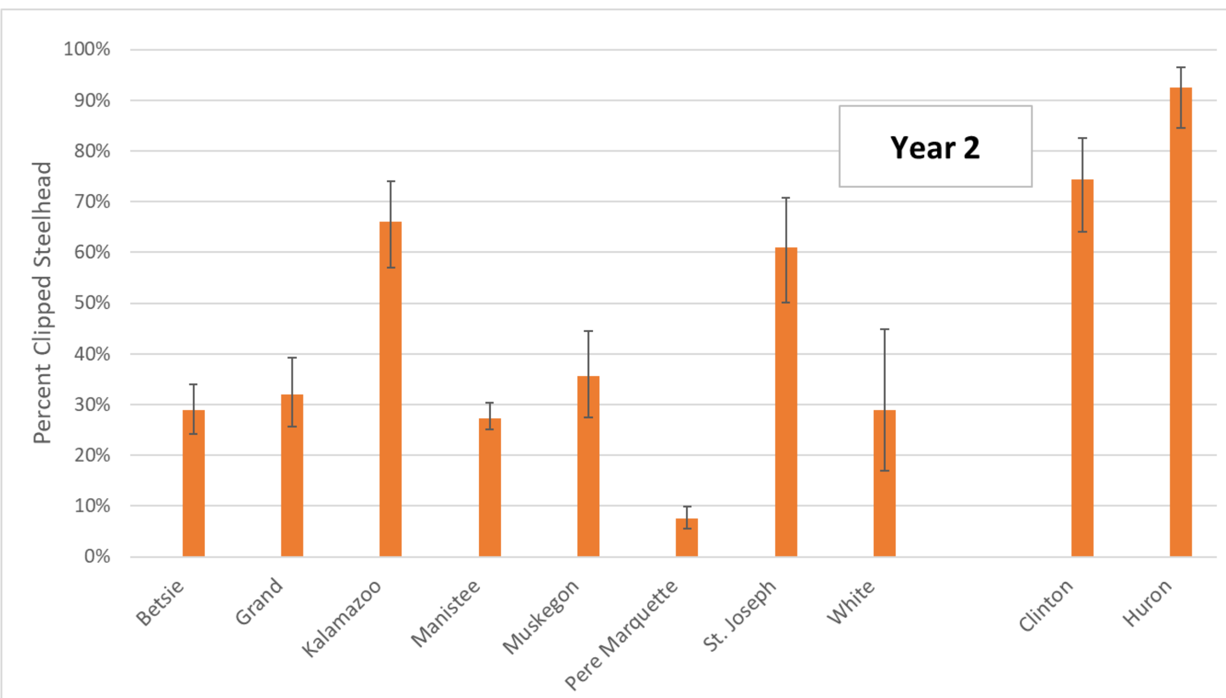


FIGURE 16.—Percentage of clipped steelhead by watershed in Year 1 (2020–2021) and Year 2 (2021–2022). Steelhead under 15 inches long are excluded. See Table 15 for point estimates, upper and lower bounds for 95% confidence intervals, and *n* for each watershed.

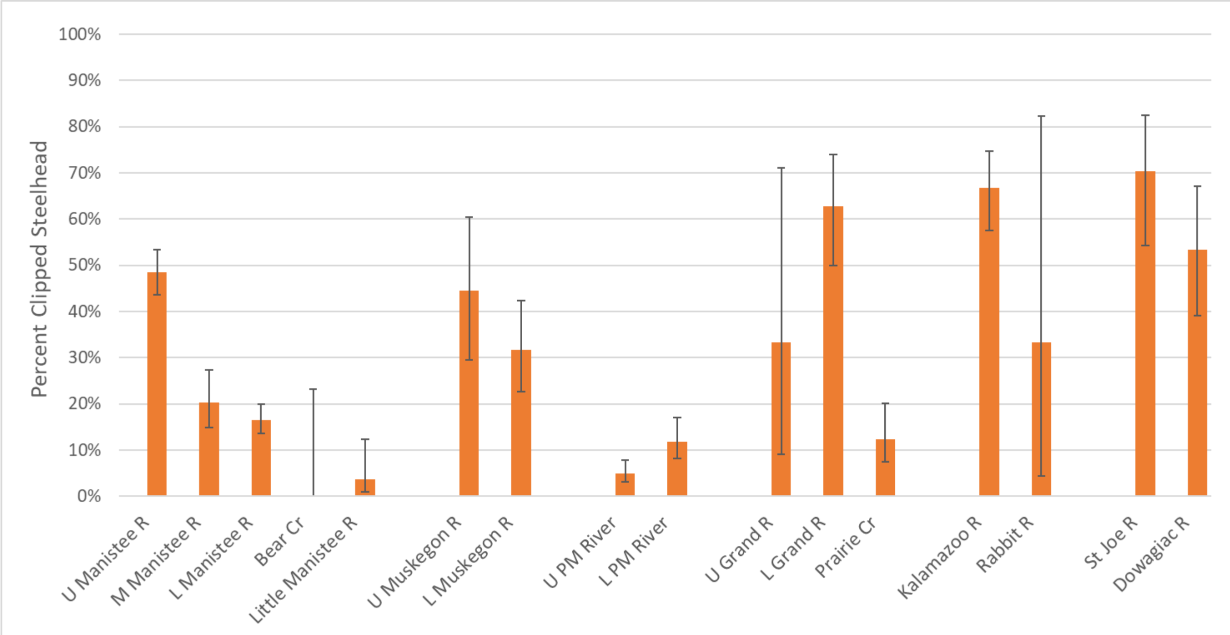


FIGURE 17.—Percentage of clipped steelhead by location in Year 2 (2021–2022) for Lake Michigan watersheds with multiple reporting locations. Steelhead under 15 inches long are excluded. See Table 16 for point estimates, upper and lower bounds for 95% confidence intervals, and *n* for each location.

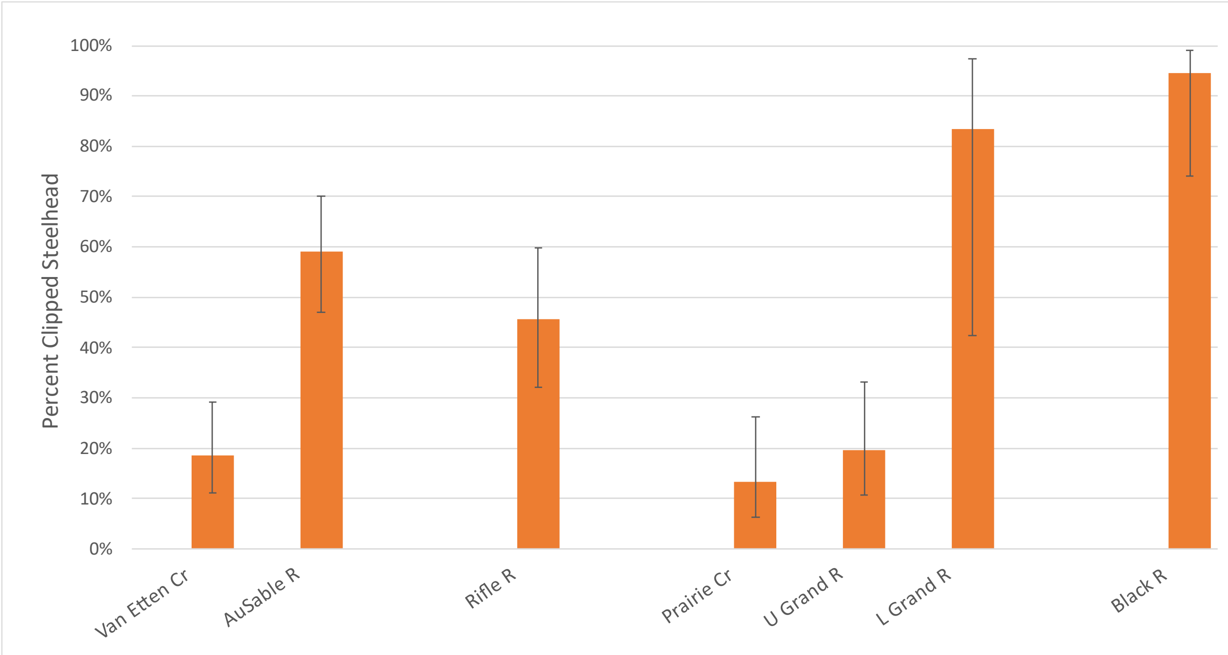


FIGURE 18.—Percentage of clipped steelhead for select locations in Year 1 (2020–2021). Steelhead under 15 inches long are excluded. See Table 17 for point estimates, upper and lower bounds for 95% confidence intervals, and *n* for each location.

FIGURE 19.—Monthly catch rates and effort for Lake Michigan tributaries during Year 1 (2020–2021) and Year 2 (2021–2022) for participants who submitted complete catch and complete effort data sets. This includes data from 26 participants who submitted catch and effort data from 405 trips in Year 1 and 23 participants who submitted catch and effort data from 781 trips in Year 2.

FIGURE 20.—Monthly catch rates and effort for the Betsie River during Year 1 (2020–2021) and Year 2 (2021–2022) for participants who submitted complete catch and complete effort data sets. This includes data from three participants who submitted catch and effort data from 100 trips in Year 1 and six participants who submitted catch and effort data from 127 trips in Year 2.

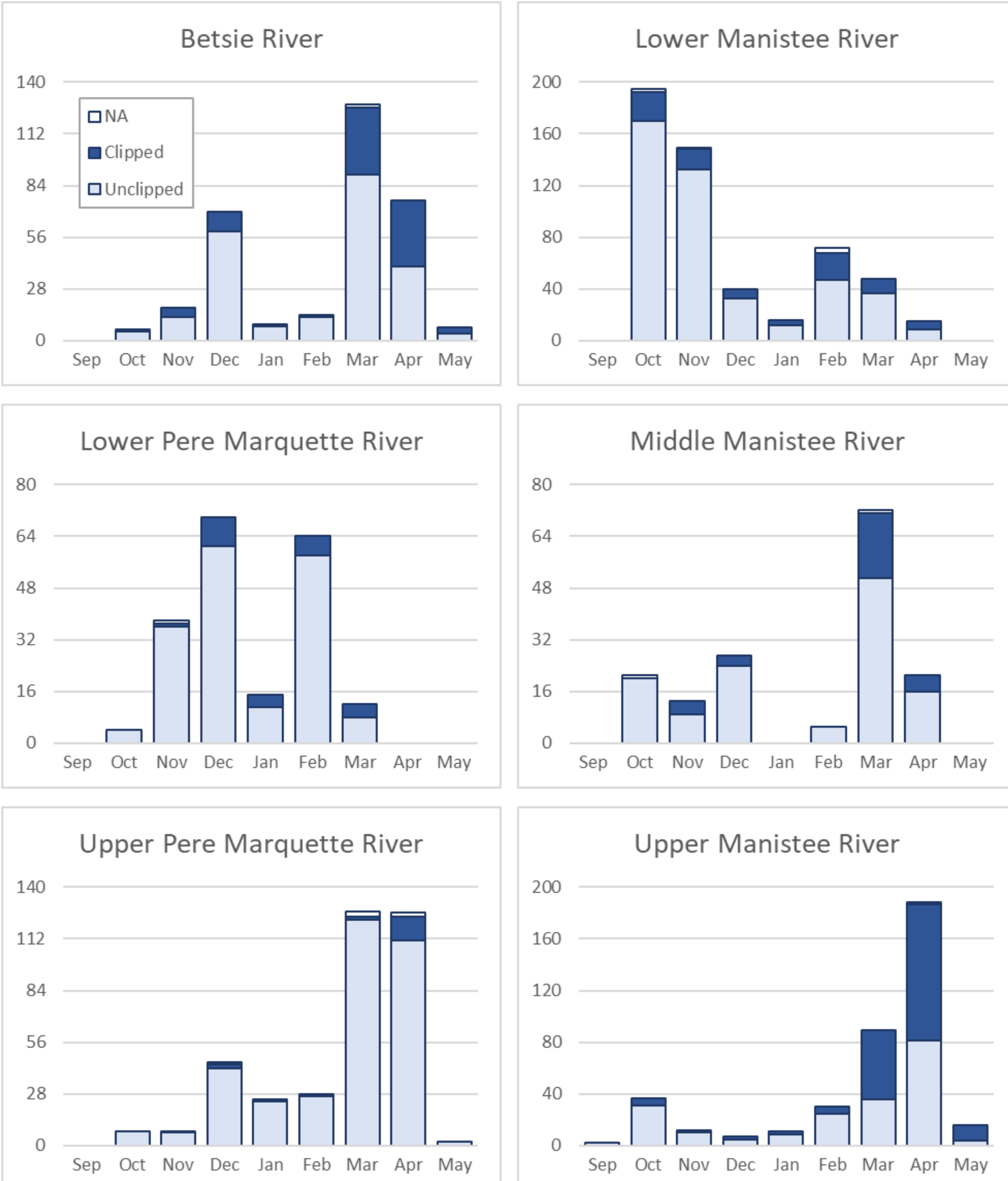


FIGURE 21.—Number of steelhead caught per month during Year 2 (2021–2022). Fish under 15 inches long are excluded. Locations shown include Betsie River (*n* = 328) Lower Pere Marquette River below Indian Bridge (*n* = 203), Upper Pere Marquette River above Indian Bridge (*n* = 369), Lower Manistee River below Bear Creek (*n* = 535), Middle Manistee River from Bear Creek to Pine Creek (*n* = 159), and Upper Manistee River from Tippy Dam to Pine Creek (*n* = 392).

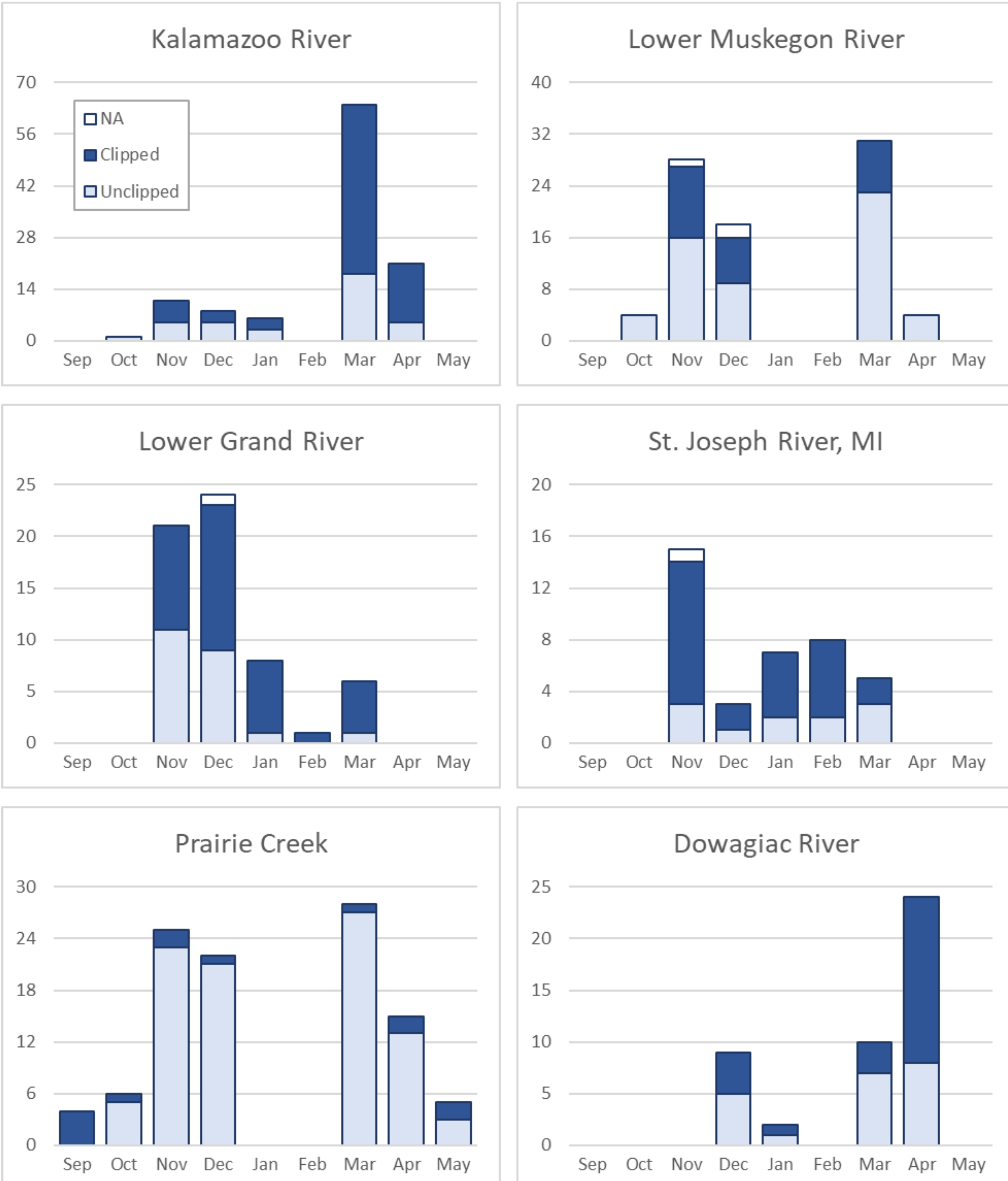


FIGURE 22.—Number of steelhead caught per month during Year 2 (2021–2022). Fish under 15 inches long are excluded. Locations shown include Kalamazoo River (n = 111) Lower Grand River below Sixth Street (n = 60), Prairie Creek (n = 105), Lower Muskegon River below Newaygo (n = 85), St. Joseph River downstream of Indiana border (n = 38), and Dowagiac River (n = 45).

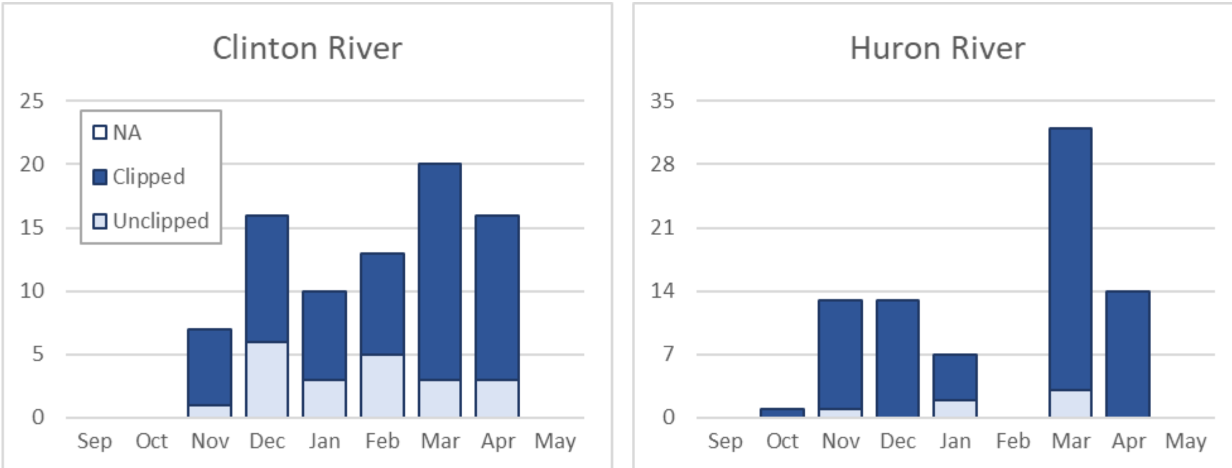


FIGURE 23.—Number of steelhead caught per month during Year 2 (2021–2022). Fish under 15 inches long are excluded. Locations shown include Clinton River (*n* = 82) and the Huron River in southeast Michigan (*n* = 80).

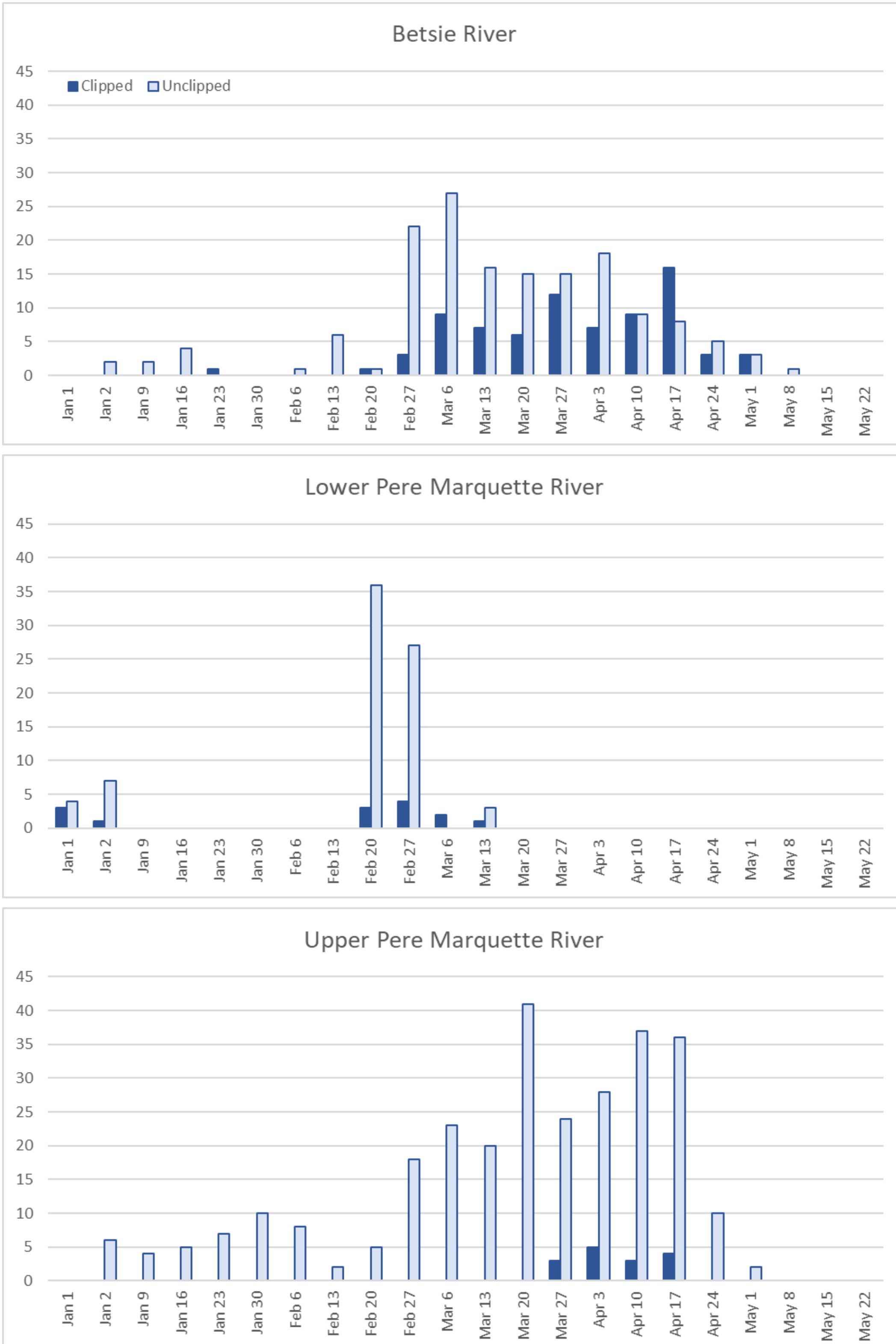


FIGURE 24.—Number of steelhead caught per week during the Spring 2022 season (Year 2). Fish under 15 inches long are excluded. Locations shown include Betsie River (*n* = 232) Lower Pere Marquette River below Indian Bridge (*n* = 91), and Upper Pere Marquette River above Indian Bridge (*n* = 301).

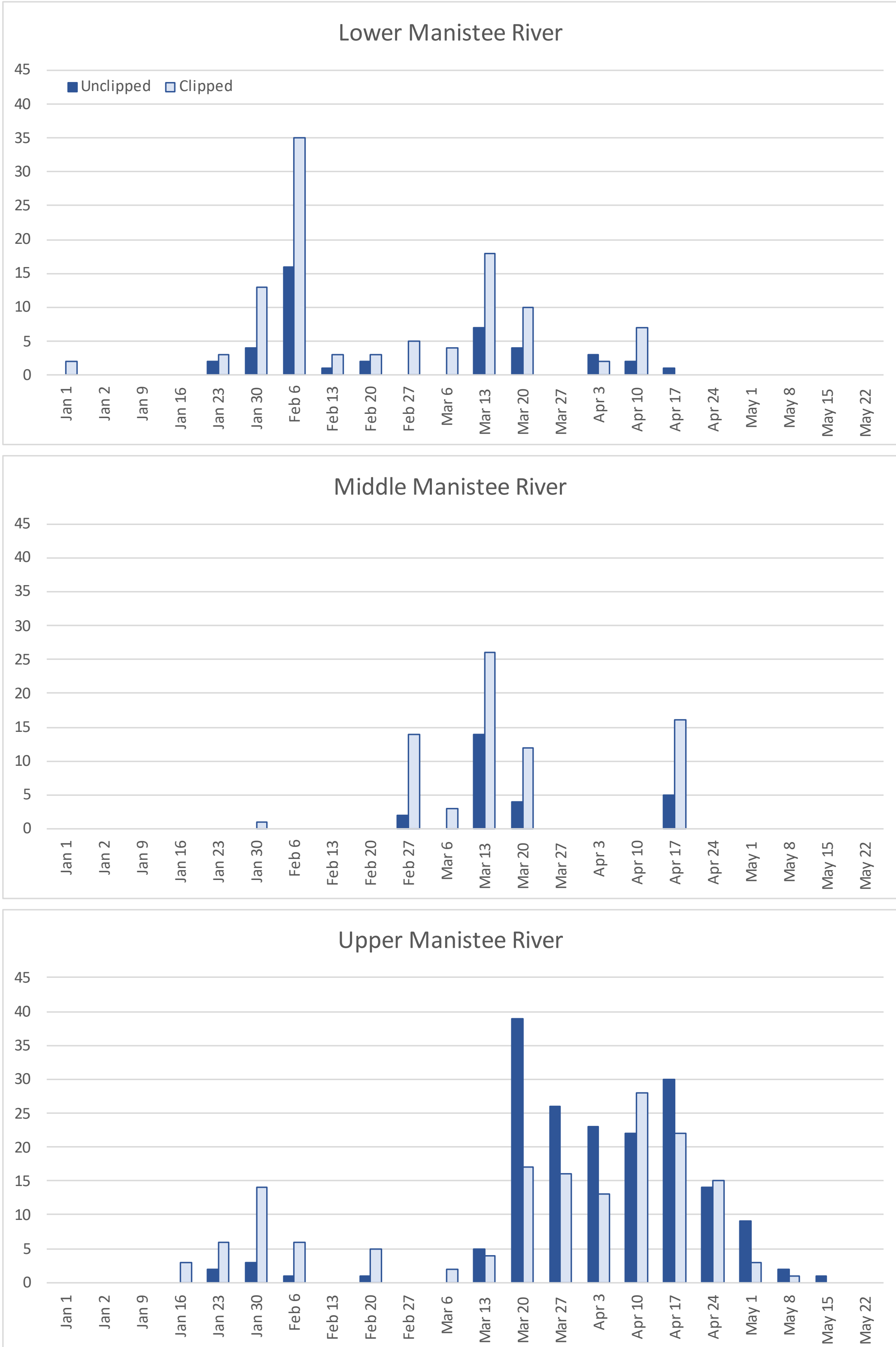


FIGURE 25.—Number of steelhead caught per week during the Spring 2022 season (Year 2). Fish under 15 inches long are excluded. Locations shown include Lower Manistee River below Bear Creek (*n* = 147), Middle Manistee River from Bear Creek to Pine Creek (*n* = 97), and Upper Manistee River from Tippy Dam to Pine Creek (*n* = 333).

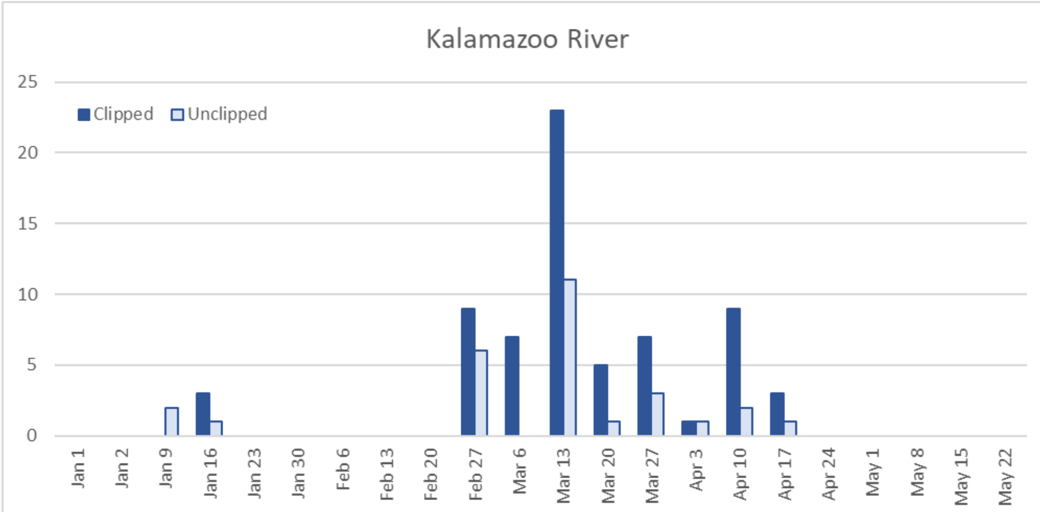


FIGURE 26.—Number of steelhead caught per week during the Spring 2022 season (Year 2) in the Kalamazoo River (n = 95). Fish under 15 inches long are excluded.

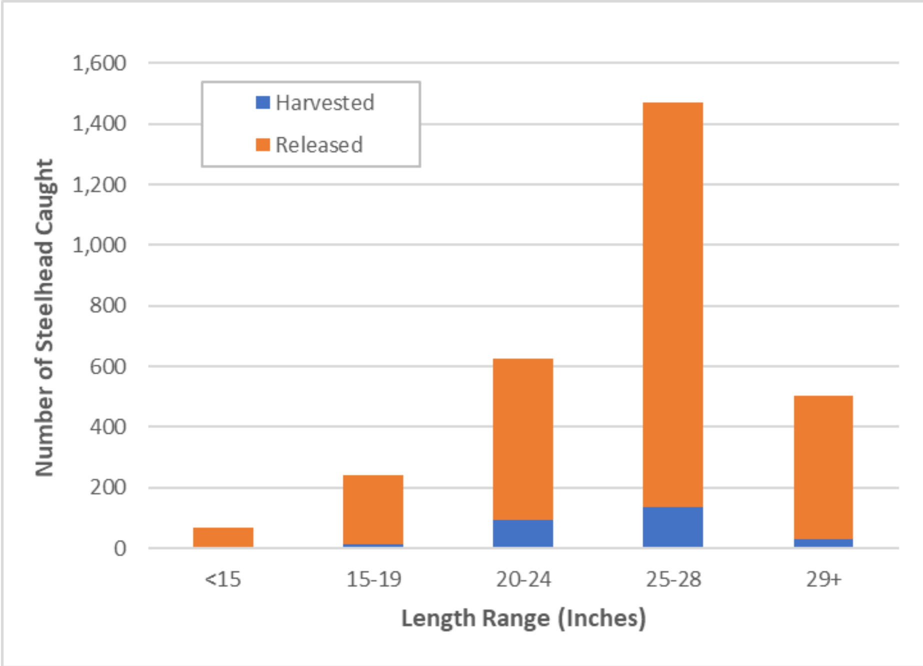
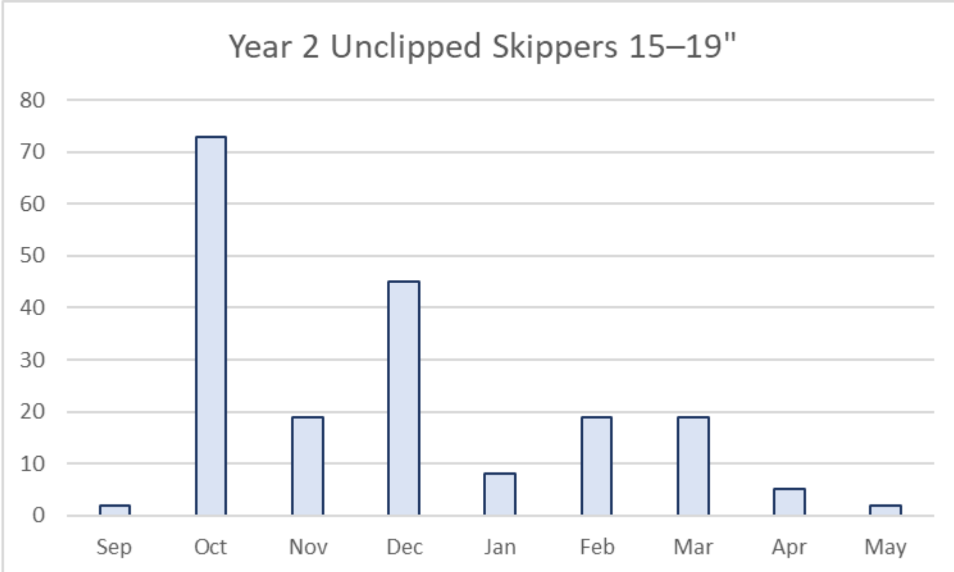


FIGURE 27.—Total length of harvested and released steelhead caught during Year 2 (2021–2022).



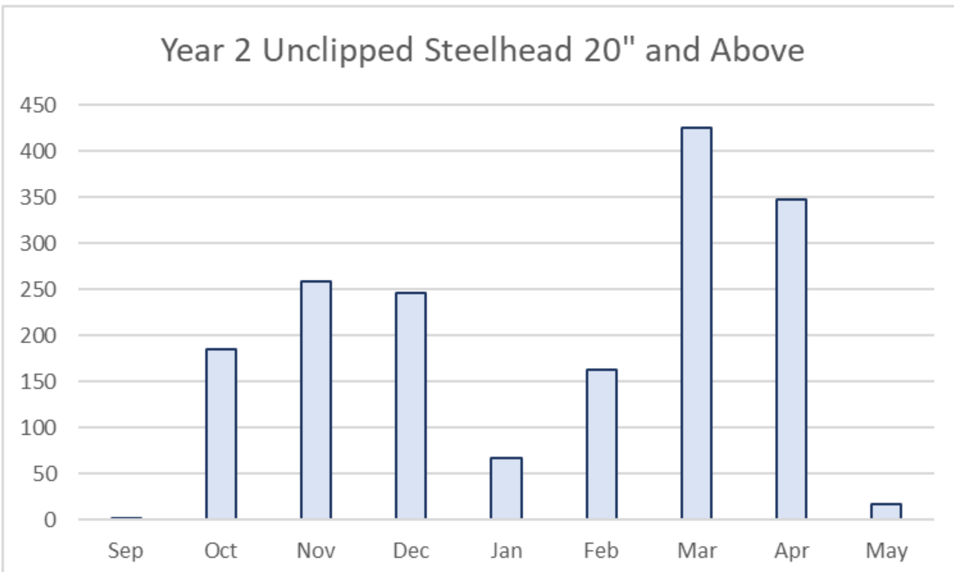


FIGURE 28.—Number of unclipped skippers 15–19 inches long (n = 192) and unclipped steelhead ≥20 inches long (n = 1,712) caught per month during Year 2 (2021–2022) on Lake Michigan tributaries, excluding the Little Manistee River due to spring fishing closure.

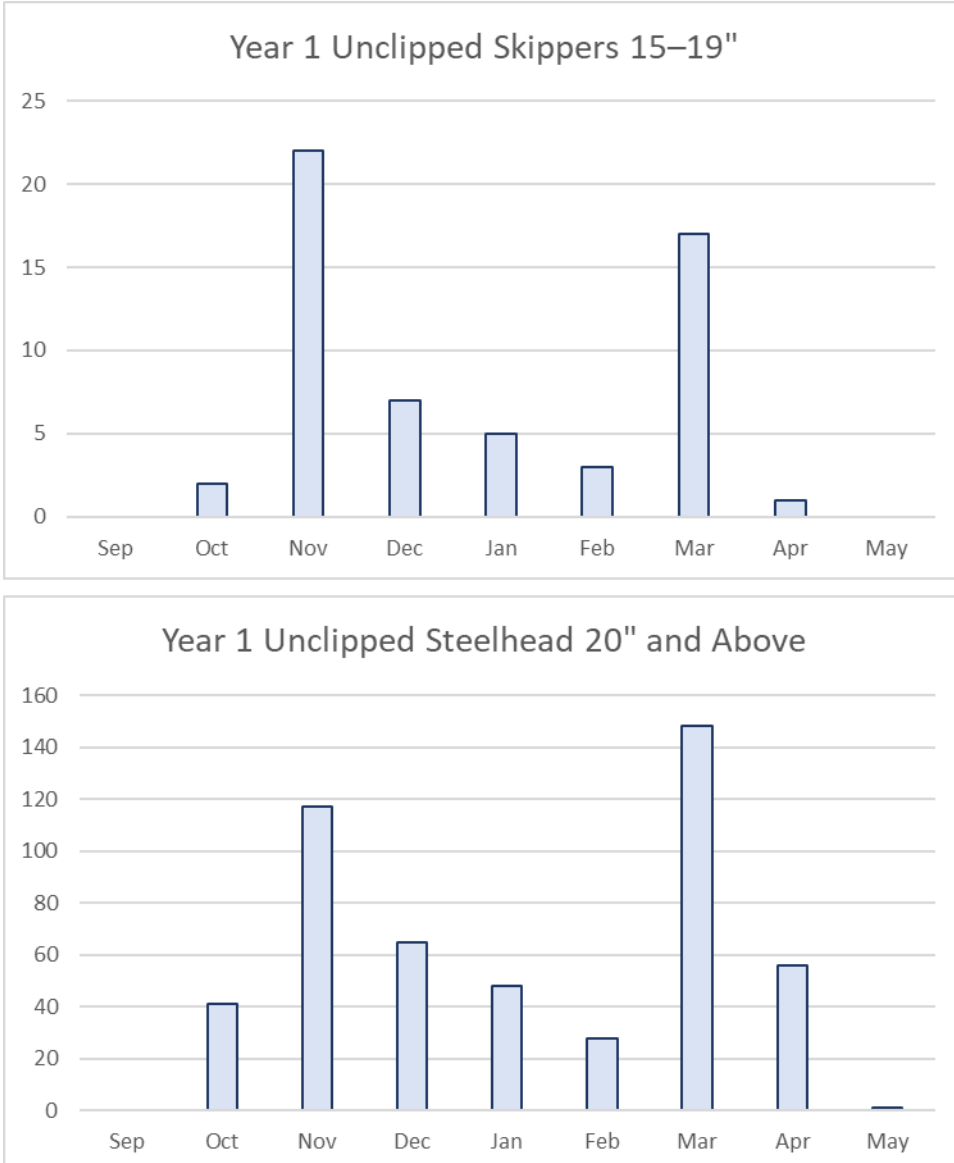


FIGURE 29.—Number of unclipped skippers 15 to 19 inches long (n = 57) and unclipped steelhead ≥ 20 inches long (n = 504) caught per month during Year 1 (2020–2021) on Lake Michigan tributaries, excluding the Little Manistee River due to spring fishing closure.

Appendix A:

Great Lakes Basin Steelhead and Rainbow Trout Stocking 2018–2021

Year	State or Province	Basin	Strain	Life Stage	No Marks	AD	ADLV	ADRV	RV	LV	ADLV	ADLM	ADRM	RM	LM
2018	MI	Erie	Michigan	Yearling	0	64,376	0	0	0	0	0	0	0	0	0
2019	MI	Erie	Michigan	Yearling	0	64,374	0	0	0	0	0	0	0	0	0
2020	MI	Erie	Michigan	Yearling	0	64,374	0	0	0	0	0	0	0	0	0
2018	MI	Huron	Eagle Lake	Adult	130	0	0	0	0	0	0	0	0	0	0
2018	MI	Huron	Eagle Lake	Yearling	0	61,079	0	0	0	0	0	0	0	0	0
2018	MI	Huron	Michigan	Yearling	0	453,952	0	0	0	0	0	0	0	0	0
2019	MI	Huron	Eagle Lake	Yearling	0	61,146	0	0	0	0	0	0	0	0	0
2019	MI	Huron	Michigan	Yearling	0	415,575	0	0	0	0	0	0	0	0	0
2020	MI	Huron	Eagle Lake	Yearling	0	60,000	0	0	0	0	0	0	0	0	0
2020	MI	Huron	Michigan	Yearling	0	340,955	0	0	0	0	0	0	0	0	0
2021	MI	Huron	Eagle Lake	Yearling	30,000	0	0	0	0	0	0	0	0	0	0
2018	ON	Huron	Ontario Wild	Fingerling	115,535	0	0	0	0	0	0	0	0	0	0
2018	ON	Huron	Ontario Wild	Fry	81,000	0	0	0	0	0	0	0	0	0	0
2018	ON	Huron	Ganaraska	Yearling	0	22,815	0	0	0	0	0	0	0	0	0
2018	ON	Huron	Ontario Wild	Yearling	0	87,452	0	0	0	0	0	0	0	0	0
2019	ON	Huron	Ontario Wild	Yearling	26,666	0	0	0	0	0	0	0	0	0	0
2019	ON	Huron	Ontario Wild	Fingerling	66,750	0	0	0	0	0	0	0	0	0	0
2019	ON	Huron	Ontario Wild	Fry	72,000	0	0	0	0	0	0	0	0	0	0
2019	ON	Huron	Ganaraska	Yearling	0	8,062	0	0	0	0	0	0	0	0	0
2019	ON	Huron	Ontario Wild	Yearling	0	127,584	0	0	0	0	0	0	0	0	0
2018	MI	St. Clair	Michigan	Yearling	0	45,522	0	0	0	0	0	0	0	0	0
2019	MI	St. Clair	Michigan	Yearling	0	45,511	0	0	0	0	0	0	0	0	0
2020	MI	St. Clair	Michigan	Yearling	0	44,988	0	0	0	0	0	0	0	0	0
2018	MI	Superior	Michigan	Fingerling	35,966	61,034	0	0	0	0	0	0	0	0	0
2018	MI	Superior	Michigan	Yearling	0	97,773	0	0	0	0	0	0	0	0	0
2019	MI	Superior	Michigan	Fingerling	50,000	0	0	0	0	0	0	0	0	0	0
2019	MI	Superior	Michigan	Yearling	0	96,434	0	0	0	0	0	0	0	0	0
2020	MI	Superior	Michigan	Yearling	0	102,033	0	0	0	0	0	0	0	0	0
2018	MN	Superior	Knife River	Adult	0	0	0	0	0	0	0	0	0	631	0
2018	MN	Superior	Knife River	Yearling	0	0	0	0	0	0	113,371	0	0	0	0
2019	MN	Superior	French River	Yearling	0	0	0	140,069	0	0	0	0	0	0	0
2020	MN	Superior	French River	Yearling	0	0	0	0	0	0	35,994	0	0	0	0

Year	State or Province	Basin	Strain	Life Stage	No Marks	AD	ADLV	ADRV	RV	LV	ADLV	ADLM	ADRM	RM	LM
2018	IL	Michigan	Skamania	Fingerling	0	52,422	0	0	0	0	0	0	0	0	0
2018	IL	Michigan	Arlee	Fingerling	0	57,284	0	0	0	0	0	0	0	0	0
2019	IL	Michigan	Arlee	Fingerling	0	55,330	0	0	0	0	0	0	0	0	0
2019	IL	Michigan	Skamania	Fingerling	0	61,126	0	0	0	0	0	0	0	0	0
2020	IL	Michigan	Skamania	Fingerling	88,297	0	0	0	0	0	0	0	0	0	0
2020	IL	Michigan	Arlee	Fingerling	0	60,092	0	0	0	0	0	0	0	0	0
2021	IL	Michigan	Arlee	Fingerling	0	60,033	0	0	0	0	0	0	0	0	0
2021	IL	Michigan	Skamania	Fingerling	0	77,953	0	0	0	0	0	0	0	0	0
2018	IN	Michigan	Skamania	Fingerling	0	51,107	0	0	0	0	0	0	0	0	0
2018	IN	Michigan	Michigan Strain	Yearling	0	83,954	0	0	0	0	0	0	0	0	0
2018	IN	Michigan	Michigan Strain	Fingerling	0	124,196	0	0	0	0	0	0	0	0	0
2018	IN	Michigan	Skamania	Yearling	0	230,321	0	0	0	0	0	0	0	0	0
2019	IN	Michigan	Michigan Strain	Yearling	0	38,481	0	0	0	0	0	0	0	0	0
2019	IN	Michigan	Michigan Strain	Yearling	0	40,924	0	0	0	0	0	0	0	0	0
2019	IN	Michigan	Skamania	Fingerling	0	81,749	0	0	0	0	0	0	0	0	0
2019	IN	Michigan	Michigan Strain	Fingerling	0	123,050	0	0	0	0	0	0	0	0	0
2019	IN	Michigan	Skamania	Yearling	0	231,409	0	0	0	0	0	0	0	0	0
2020	IN	Michigan	Skamania	Yearling	0	243,219	0	35,628	0	0	0	0	0	0	0
2021	IN	Michigan	Skamania	Yearling	204,720	0	0	0	21,056	0	0	0	0	0	0
2021	IN	Michigan	Michigan	Fingerling	0	121,743	0	0	0	0	0	0	0	0	0
2018	MI	Michigan	Skamania	Yearling	0	0	0	30,972	0	0	0	0	0	0	0
2018	MI	Michigan	Michigan Strain	Fingerling	0	301,040	0	0	0	0	0	0	0	0	0
2018	MI	Michigan	Michigan Strain	Yearling	0	605,984	0	0	0	0	0	0	0	0	0
2019	MI	Michigan	Skamania	Yearling	0	0	0	34,000	0	0	0	0	0	0	0
2019	MI	Michigan	Michigan Strain	Fingerling	0	301,230	0	0	0	0	0	0	0	0	0
2019	MI	Michigan	Michigan Strain	Yearling	0	611,924	0	0	0	0	0	0	0	0	0
2020	MI	Michigan	Michigan Strain	Yearling	0	674,467	0	0	0	0	0	0	0	0	0
2021	MI	Michigan	Skamania	Yearling	0	0	0	0	49,063	0	0	0	0	0	0
2021	MI	Michigan	Michigan Strain	Fingerling	0	299,882	0	0	0	0	0	0	0	0	0
2018	WI	Michigan	Skamania	Yearling	0	0	0	0	0	0	0	0	70,626	0	0
2018	WI	Michigan	Ganaraska	Yearling	0	61,032	0	57,390	0	0	0	0	0	0	0
2018	WI	Michigan	Arlee	Yearling	0	130,742	0	0	0	0	0	0	0	0	0
2018	WI	Michigan	Chambers Creek	Yearling	0	58,153	0	0	0	0	0	63,946	0	0	0
2019	WI	Michigan	Skamania	Yearling	0	0	0	0	0	0	0	0	69,518	0	0
2019	WI	Michigan	Ganaraska	Yearling	0	50,440	68,597	0	0	0	0	0	0	0	0
2019	WI	Michigan	Arlee	Yearling	0	101,700	0	0	0	0	0	0	0	0	0
2019	WI	Michigan	Chambers Creek	Yearling	0	96,173	0	0	0	0	0	66,720	0	0	0
2020	WI	Michigan	Chambers Creek	Fingerling	24,058	0	0	0	0	0	0	0	0	0	0
2020	WI	Michigan	Ganaraska	Fingerling	70,200	0	0	0	0	0	0	0	0	0	0
2020	WI	Michigan	Ganaraska	Yearling	0	52,680	66,296	0	0	0	0	0	0	0	0
2020	WI	Michigan	Arlee	Yearling	0	103,582	0	0	0	0	0	0	0	0	0
2020	WI	Michigan	Chambers Creek	Yearling	0	183,001	0	0	0	0	0	63,765	0	0	0
2021	WI	Michigan	Chambers Creek	Yearling	130,408	0	0	0	0	0	0	0	0	0	66,477
2021	WI	Michigan	Ganaraska	Yearling	145,920	0	0	0	0	66,715	0	0	0	0	0
2021	WI	Michigan	Chambers Creek	Fingerling	29,683	0	0	0	0	0	0	0	0	0	0

Appendix B:

Marked and Unmarked Steelhead and Rainbow Trout Stocked in the Lake Michigan Basin*

Yearlings Stocked in Lake Michigan Basin 2018–2021

	CWT	NO CWT	Total
AD only	3,142,797	414,465	3,557,262
ADLM, ADRM, ADLV, ADRV	627,458	0	627,458
LM, RM, LV, RV	0	203,311	203,311
No Fin Clip	0	481,048	481,048
Yealing total	3,770,255	1,098,824	4,869,079
Percentage of AD only without CWT	11.7%		
Percentage of AD or AD in combo without CWT	9.9%		
Percentage stocked without fin clip	9.9%		

Fingerlings Stocked in Lake Michigan Basin 2018–2021

	CWT	NO CWT	Total
AD only	1,828,237	0	1,828,237
ADLM, ADRM, ADLV, ADRV	0	0	0
LM, RM, LV, RV	0	0	0
No Fin Clip	0	212,238	212,238
Fingerling total	1,828,237	212,238	2,040,475
Percentage of AD only without CWT	0.0%		
Percentage of AD or AD in combo without CWT	0.0%		
Percentage stocked without fin clip	10.4%		

Yearlings and Fingerlings Stocked in Lake Michigan Basin 2018–2021

	CWT	NO CWT	Total
AD only	4,971,034	414,465	5,385,499
ADLM, ADRM, ADLV, ADRV	627,458	0	627,458
LM, RM, LV, RV	0	203,311	203,311
No Fin Clip	0	693,286	693,286
Yearling and finglerling total	5,598,492	1,311,062	6,909,554
Percentage of AD only without CWT	7.7%		
Percentage of AD or AD in combo without CWT	6.9%		
Percentage stocked without fin clip	10.0%		

* These figures include Arlee rainbow trout stocked at nearshore locations in Lake Michigan but do not include Eagle Lake rainbow trout stocked in tributaries.

Appendix C:

Marked and Unmarked Steelhead and Rainbow Trout Stocked in the Lake Huron Basin*

Yearling Steelhead Stocked in Lake Huron Basin 2018–2021

	CWT	NO CWT	Total
AD only	984,360	710,926	1,695,286
ADLM, ADRM, ADLV, ADRV	0	0	0
LM, RM, LV, RV	0	0	0
No Fin Clip	0	56,666	56,666
Yearling total	984,360	767,592	1,751,952
Percentage of AD only without CWT	41.9%		
Percentage of AD or AD in combo without CWT	41.9%		
Percentage stocked without fin clip	3.2%		

Fingerling Steelhead Stocked in Lake Huron Basin 2018–2021

	CWT	NO CWT	Total
AD only	0	0	0
ADLM, ADRM, ADLV, ADRV	0	0	0
LM, RM, LV, RV	0	0	0
No Fin Clip	0	182,285	182,285
Fingerling total	0	182,285	182,285
Percentage of AD only without CWT	NA		
Percentage of AD or AD in combo without CWT	NA		
Percentage stocked without fin clip	100.0%		

Yearling and Fingerling Steelhead Stocked in Lake Huron Basin 2018–2021

	CWT	NO CWT	Total
AD only	984,360	710,926	1,695,286
ADLM, ADRM, ADLV, ADRV	0	0	0
LM, RM, LV, RV	0	0	0
No Fin Clip	0	238,951	238,951
Yearling and finglerling total	984,360	949,877	1,934,237
Percentage of AD only without CWT	41.9%		
Percentage of AD or AD in combo without CWT	41.9%		
Percentage stocked without fin clip	12.4%		

* These figures include Eagle Lake rainbow trout stocked at nearshore locations in Lake Huron but do not include Eagle Lake rainbow trout stocked in tributaries. Figures do not include 153,000 steelhead fry stocked without marks in Ontario waters or 130 unmarked adult Eagle Lake rainbows stocked in Michigan waters.

Appendix D:

Consent Letter

Thank you for using the *Great Lakes Angler Diary* to record information about your fishing trips. Michigan State University and Michigan Sea Grant would like to access the information you recorded. This will allow us to analyze trends in catches from around the Great Lakes and share the information you collected with state and federal agencies.

If you do wish to share data from your fishing trips, I will download and save your trip and catch information from the *Great Lakes Angler Diary*. Note that your name and e-mail address will NOT be saved in the same file as your catch data. In this way, we strive to maintain the confidentiality of your data.

If you wish to proceed, please review your *Great Lakes Angler Diary* data entries to make certain they are complete and accurate before taking the electronic survey. The survey should take approximately 20 minutes.

Your survey answers and downloaded data will be stored in files that are stored separately on a password-protected Michigan State University computer to ensure confidentiality. Catch data files will include your Volunteer Number and no other identifying information.

Your results will be analyzed along with results from other volunteers. These aggregated results will be shared with management agencies including Michigan Department of Natural Resources and the U.S. Fish & Wildlife Service. The aggregated results will not be linked to your personal identifying information.

The primary purpose of this program is to allow anglers to record and share their catch data with other anglers, biologists and managers in a way that is useful for answering questions related to the Great Lakes and stream fisheries. The benefits of this include better understanding of how stocked and wild-spawned fish contribute to fisheries over the course of the season, which may influence management decisions and contribute to the well-being of fisheries. However, there is no guarantee that your data will influence stocking decisions as biologists and managers rely on a variety of data sets when assessing fisheries.

Possible risks to you as a participant include any that might result from sharing your catch data. Reasonable precautions are being taken to prevent linking your catch data with your identity, but if your catch data includes evidence of any illegal activity or if you feel they could damage your reputation in any way you should consider these risks before proceeding.

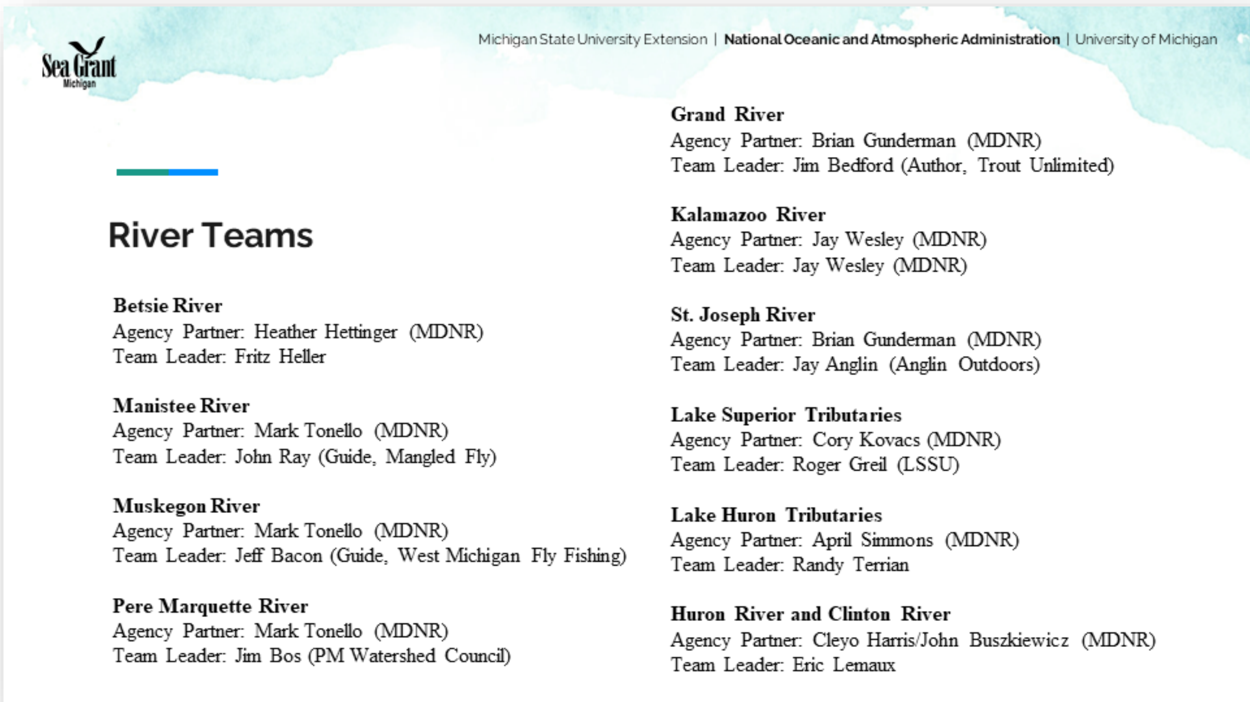
If you have any questions regarding survey items, why this survey is being conducted, or how to complete the survey and submit data sheets do not hesitate to call me at (616) 994-4580. Questions regarding your rights as a participant in this survey can be directed to the Human Research Protection Program at (517) 355-2180.

Your participation in this survey is strictly voluntary, and you must be at least 18 years old to participate. You can refuse to complete any or all of the questions in this survey; you have the right to withdraw at any time. You must provide your Volunteer Number and click on the button to demonstrate your informed consent if you wish to participate in this survey and share the information you recorded during the past fishing season.

Dan O'Keefe
Michigan Sea Grant
Michigan State University Extension

Appendix E:

River Teams Slide from Year 2 Kickoff Meeting



Appendix F:

Location Drop-down Menu Options

Drop-down Menu Display	Data Entry Screen Display	Notes
Huron River (Wayne Co, LP)	Huron River, LP	
Huron River (Baraga Co, LP)	Huron River, UP	
Other Lk Erie Tributary	Other Erie Trib	
Carp River (Marquette Co, UP)	Carp River, MQT	
Chocolay River	Chocolay River	
Firesteel River	Firesteel River	
Rock River	Rock River	Added after Year 1
Sucker River	Sucker River	Added after Year 1
Two Hearted River	Two Hearted River	
Anna River	Anna River	
Other Lk Superior Tributary	Other Superior Trib	
Carp River (Mackinac Co, UP)	Carp River, MAC	
Cheboygan River	Cheboygan River	
Ocqueoc River	Ocqueoc River	
Thunder Bay River	Thunder Bay River	
AuSable River	AuSable River	
Van Etten Creek	Van Etten Creek	Added after Year 1
AuGres River	AuGres River	
E Br AuGres River (Whitney Dr)	Whitney Dr	Added after Year 1
Rifle River	Rifle River	
Other Lk Huron Tributary	Other Lk Huron Trib	
Betsie River	Betsie River	
Manistee R above Pine Cr	Upper Manistee R	Redefined after Year 1
Manistee R Bear Cr to Pine Cr	Middle Manistee R	Added after Year 1
Manistee R below Bear Cr	Lower Manistee R	
Bear Creek	Bear Creek	
Little Manistee River	Little Manistee R	
PM River above Indian Br	Upper PM River	
PM River below Indian Br	Lower PM River	
Big South Branch PM River	BSB PM River	
Pentwater River	Pentwater River	
White River	White River	Eliminated after Year 1
White River Hesperia to N Br	Upper White R	
White River N Br to Mouth	Lower White R	
N Br White River	N Br White R	
Muskegon R above Newaygo	Upper Muskegon R	M-37 cutoff
Muskegon R below Newaygo	Lower Muskegon R	M-37 cutoff
Grand R above Grand Rapids	Upper Grand R	Sixth Street Dam cutoff
Grand R below Grand Rapids	Lower Grand R	Sixth Street Dam cutoff
Red Cedar River	Red Cedar River	
Prairie Creek	Prairie Creek	
Fish Creek	Fish Creek	
Rogue River	Rogue River	
Flat River	Flat River	
Crockery Creek	Crockery Creek	
Plaster Creek	Plaster Creek	
Buck Creek	Buck Creek	
Kalamazoo River	Kalamazoo River	
Rabbit River	Rabbit River	
Black River (Van Buren Co)	Black River	
St Joseph River, MI	St Joe R, MI	
St Joseph River, IN	St Joe R, IN	
Paw Paw River	Paw Paw River	
Dowagiac River	Dowagiac River	
Galien River	Galien River	
Trail Creek	Trail Creek	
Other Lk Michigan Trib, MI	Other Lk MI Trib, MI	
Other Lk Michigan Trib, IN	Other Lk MI Trib, IN	
Other Lk Michigan Trib, IL	Other Lk MI Trib, IL	
Other Lk Michigan Trib, WI	Other Lk MI Trib, WI	