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## Evaluation of the Steelhead Fishery in the Betsie River by Volunteer Steelhead Fin Clip Census (Fall 2006 – Spring 2010) and Creel Survey (2010)

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## **Evaluation of the Steelhead Fishery in the Betsie River by Volunteer Steelhead Fin Clip Census (Fall 2006 – Spring 2010) and Creel Survey (2010)**

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**Abstract.**—The Betsie River is one of the more popular steelhead *Oncorhynchus mykiss* fishing rivers in Michigan. In the early 2000s, anglers perceived a decline in the number of steelhead returning to the river and asked Fisheries Division to review the steelhead stocking program for the Betsie River. Beginning in 1991, the sole source of steelhead stocking in the Betsie River was the Orsini Hatchery, which was a privately run hatchery that was funded by the Manistee County Sportfishing Association. Potential issues with the Orsini Hatchery included late stocking dates that may have caused steelhead to abort the smolting process and small fish sizes which may have caused steelhead to stay in the Betsie River instead of smolting. Previous studies of the Betsie River had shown only small numbers of naturally reproduced steelhead smolts. Through electrofishing surveys, a volunteer angler creel census, and a standardized creel census Fisheries Division examined the steelhead population of the Betsie River and compared the performance of steelhead stocked from the Orsini Hatchery and those stocked from state fish hatcheries. Results of the volunteer fin clip census indicated a much higher than expected proportion of naturally reproduced steelhead in the catch and a stronger performance of state hatchery-reared steelhead. Results of the creel survey demonstrated that the Betsie River gets a large amount of angling pressure relative to other rivers in the state of Michigan, it provides a significant fall Chinook Salmon *Oncorhynchus tshawytscha* fishery to local and regional anglers and is very popular with anglers beyond the local community. Eventually due to financial considerations, the Orsini Hatchery operation was discontinued after the spring 2009 stocking event. Since then, state hatchery-reared steelhead have been the only steelhead stocked into the Betsie River. As a result of this study, we recommend the continued stocking of steelhead from state fish hatcheries.

## Introduction

The Betsie River is a major tributary to Lake Michigan in the northwestern part of Michigan's Lower Peninsula. It flows into Lake Michigan through Betsie Lake at Frankfort and Elberta in Benzie County (Figure 1). It is renowned for its salmon fishing, hosting large runs of Chinook Salmon each fall along with smaller numbers of Coho Salmon *Oncorhynchus kisutch*. Neither Chinook nor Coho salmon are stocked in the Betsie, so the returning adults are predominately wild fish. The river is also one of the more popular rivers for steelhead fishing in Michigan, but it produces relatively low numbers of wild steelhead (Newcomb 1998).

Natural recruitment of steelhead in the Betsie River is limited by the hydrology of this system. The Betsie River does not receive the groundwater inputs that other Michigan trout streams like the Little Manistee River or the Platte River do. This lack of groundwater contribution results in summer water temperatures that are warmer than desirable for juvenile steelhead, and cold winter water temperatures that can also inhibit juvenile steelhead survival. While some natural reproduction of steelhead occurs in the mainstem of the Betsie River and some of its tributaries (Newcomb 1998), natural recruitment is not sufficient to meet angler demands. Therefore, stocking is critical for maintaining a steelhead fishery in the Betsie River.

In the late 1990s and early 2000s, anglers brought forth concerns of a perceived decline in the steelhead fishery (Tonello 2004). This caused the Michigan Department of Natural Resources (MDNR) to closely scrutinize the steelhead stocking program for the Betsie River. From 1991 to 2006, all steelhead stocked into the Betsie River came from the Orsini Hatchery (Table 1). During the period from 2007 to 2009, both the Orsini Hatchery and the Wolf Lake State Fish Hatchery (WLSFH) stocked steelhead in the Betsie River (Table 1) with steelhead after 2009 being stocked exclusively by WLSFH.

The Orsini Hatchery was a private cooperative hatchery funded by the Manistee County Sportfishing Association (MCSFA). Each fall the hatchery received steelhead fingerlings from the WLSFH, reared the fish over the winter, and released them in the spring as yearlings. For a number of years the steelhead were not released from the Orsini Hatchery until mid-May. The mid-May release date may have resulted in some of the stocked steelhead missing the "smolting window", and staying in the Betsie River instead of smolting out to Lake Michigan. This was not ideal, as warmer than desirable summer water temperatures in the Betsie River likely resulted in high mortality in juvenile hatchery steelhead that remained in the Betsie River instead of migrating to Lake Michigan. Also, the yearling steelhead released from the Orsini Hatchery were typically smaller than those released from state fish hatcheries (Table 1). According to Seelbach et al. (1994), survival of stocked steelhead smolts is substantially higher when they are larger than 7.9 inches at stocking. The problem of stocked steelhead staying in the Betsie River and not outmigrating was revealed in late summer MDNR electrofishing surveys of the Betsie River in 1996 (Table 2) and 1998 (Table 3). The steelhead with fin clips were those stocked by the Orsini Hatchery that should have migrated out long before these fisheries surveys took place (August). The abundance of clipped steelhead captured in these surveys, which covered a relatively short section of river, indicated that large numbers of the Orsini-reared steelhead were not outmigrating to Lake Michigan like they should have.

In 2004, WLSFH reduced the numbers of fall fingerlings sent to the Orsini Hatchery from 40,000 to 35,000 under the premise that reducing the rearing density might increase the size of the smolts produced at the Orsini Hatchery. However, even in 2007 when only 25,000 steelhead were sent to the Orsini Hatchery, the mean size of the fish released was still smaller than the mean of those produced at WLSFH. Other changes were made at the Orsini Hatchery to address this situation, including the installation of a well to provide groundwater (which is slightly warmer than the surface water at the site), and rerouting some surface water directly into the hatchery instead of through several ponds on the hatchery grounds. MCSFA also installed an emergency generator with sensors that allowed continuous water flow in the event of a power failure. Despite the changes made at the Orsini Hatchery, the Orsini-stocked steelhead were still smaller than those stocked from state fish hatcheries.

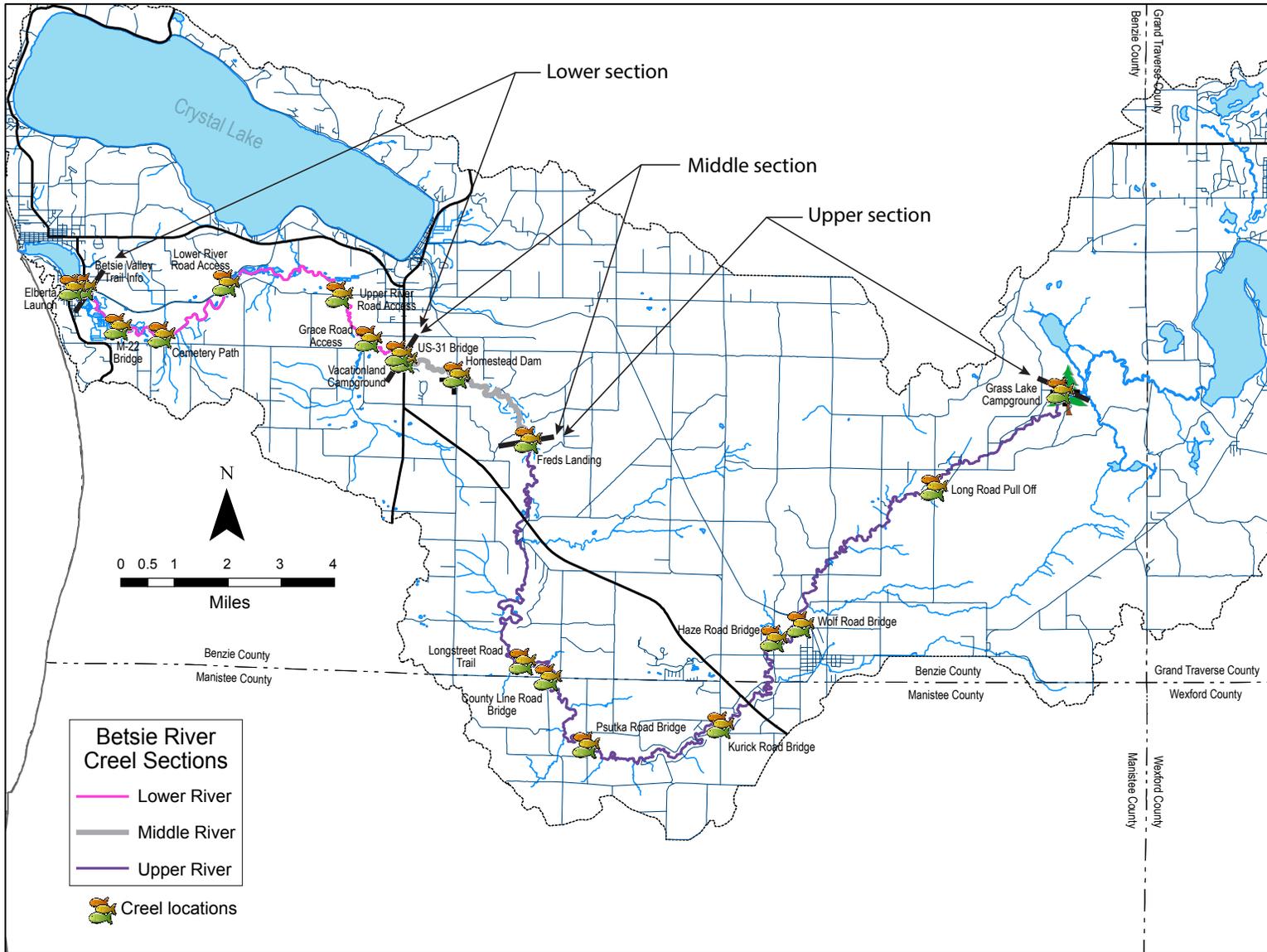


Figure 1.–Betsie River watershed map including 2010 Betsie River creel survey sites.

Table 1.–Steelhead stocking in the Betsie River, 1991–2013. (Fin clip codes: RV = right pelvic, RP = right pectoral, and LV = left pelvic.)

Year	Number stocked	Total length (cm)	Total length (inches)	Date released	Hatchery <sup>a</sup>	Fin clip
1991	29,171	17.4	6.9	5/16	Orsini	
1992	32,141	20.4	8.0	5/14	Orsini	
1993	44,125	15.2	6.0	5/3	Orsini	RV
1994	48,560	13.7	5.4	5/25	Orsini	RV
1995	49,206	17.6	6.9	5/22	Orsini	RV
1996	54,916	15.5	6.1	4/28	Orsini	RP
1997	49,279	16.8	6.6	4/1	Orsini	RP
1998	38,700	17.8	7.0	5/19	Orsini	RP
1999	40,400	18.3	7.2	4/8	Orsini	RP
2000	39,991	18.2	7.2	5/5	Orsini	RP
2001	39,400	17.4	6.9	5/5	Orsini	RP
2002	38,560	18.5	7.3	5/5	Orsini	RP
2003	38,725	16.7	6.6	5/10	Orsini	RP
2004	33,683	16.0	6.3	4/1	Orsini	RP
2005	32,776	15.7	6.2	4/8	Orsini	LVRP
2006	31,711	17.5	6.9	4/6	Orsini	LV
2007	20,735	17.0	6.7	4/6	Orsini	LV
	19,562	18.7	7.4	4/13	WLSFH	RP
2008	20,296	16.0	6.3	4/11	Orsini	LV
	19,417	18.7	7.4	4/16	WLSFH	RP
2009	22,965	17.6	6.9	4/15	Orsini	LV
	20,009	19.4	7.6	4/16	WLSFH	RP
	40,517	10.7	4.2	11/17	WLSFH	
2010	21,015	19.1	7.5	4/26	WLSFH	
2011	20,000	18.0	7.1	4/18	WLSFH	
2012	20,502	17.8	7.0	4/24	WLSFH	
2013	20,821	21.3	8.4	4/22	WLSFH	

<sup>a</sup> WLSFH = Wolf Lake State Fish Hatchery.

Table 2.—Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 9, 1996. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip code: RP = right pectoral.)

Total length (inches)	RBT (unmarked)	RBT (RP clip)	BNT	COS	CHS	BKT
1	6					
2	21					
3	8				3	
4	5	9				
5	16	51				
6	6	81	3			
7		52	6			
8		12	1			
9		1				
Total	62	206	10		3	

Table 3.—Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 7, 1998. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip code: RP = right pectoral.)

Total length (inches)	RBT (unmarked)	RBT (RP clip) <sup>a</sup>	BNT	COS	CHS	BKT
1	8					
2	69					
3	46				2	
4	6	1			1	
5	17	12				
6	16	35				
7	2	60	1			
8		22	3			
9		4				
Total	164	134	4		3	

<sup>a</sup> Also caught one adult steelhead, 24 inch, RP clipped.

MDNR electrofishing surveys conducted during the summers of 2003–2008 continued to reveal that large numbers of Orsini-reared steelhead were not smolting out of the river immediately, as desired (Tables 4–10). In contrast, relatively few WLSFH-raised steelhead were caught in the 2007–2008 electrofishing surveys, leading to the conclusion that the majority of those fish were smolting out shortly after being stocked. One unexpected discovery of the 2003–2008 MDNR electrofishing surveys was the presence of large numbers of wild steelhead parr from multiple year classes, particularly in 2005–2008 (Tables 4–10). According to Newcomb (1998), steelhead natural reproduction in the Betsie River was limited in the early to mid-1990s with only up to several thousand smolts outmigrating each year. In electrofishing surveys conducted during her study, Newcomb observed juvenile steelhead densities substantially lower than those recorded during the 2005–2008 MDNR surveys (T. Newcomb, MDNR Fisheries Division, personal communication).

Table 4.–Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 12, 2003. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip code: RP = right pectoral, DO = dorsal, and LV = left pelvic.)

Total length (inches)	RBT (unmarked)	RBT (RP clip) <sup>a</sup>	BNT <sup>b</sup>	COS	CHS	BKT
1	30					
2	125				1	
3	48		4	26	61	
4	4	12		3	6	
5	30	57				
6	8	52				1
7	3	20	5			
8			8			
9			4			
10						
11						
12						
13						
14						
15						
16			1			
Total	248	141	22	29	68	1

<sup>a</sup> Saw one adult Skamania steelhead (23 inch, DOLV clip) and one adult Chinook Salmon.

<sup>b</sup> All Brown Trout greater than 3 inches in size appeared to be of hatchery origin.

Table 5.–Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 20, 2004. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip code: RP = right pectoral.)

Total length (inches)	RBT (unmarked)	RBT (RP clip)	BNT <sup>a</sup>	COS	CHS <sup>b</sup>	BKT
1	10					
2	146					
3	129		3	35	5	
4	10		6	24	3	
5	18	17	1			
6	17	49	11			
7	2	38	3			
8	1	7	2			
9						
10	1					
11						
12						
13		1				
14			1			
Total	334	112	27	59	8	

<sup>a</sup> Most of the 6–8 inch Brown Trout appeared to be of hatchery origin.

<sup>b</sup> Saw one adult Chinook Salmon.

Table 6.—Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 24, 2005. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip codes: RP = right pectoral, LV = left pelvic, and DO = dorsal.)

Total length (inches)	RBT (unmarked)	RBT (RPLV clip) <sup>a</sup>	BNT <sup>b</sup>	COS	CHS	BKT
1	4					
2	324					1
3	382		1	26	48	
4	81		3	8	23	
5	7	1	1			
6	9	23				
7	10	17	2			
8	2	3	4			
9		3	1			
10		1	1			
11			1			
12			1			
13						
14						
15						
16						
17			1			
Total	819	48	16	34	72	

<sup>a</sup> Saw one adult Skamania steelhead (30 inch, DOLV clip) and one adult Chinook Salmon.

<sup>b</sup> Most of the 6–8 inch Brown Trout appeared to be of hatchery origin.

Table 7.—Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 24, 2006. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip code: LV = left pelvic.)

Total length (inches)	RBT (unmarked)	RBT (LV clip)	BNT <sup>a</sup>	COS	CHS <sup>b</sup>	BKT
1	56					
2	447				2	
3	324			40	98	
4	25		2	4	13	
5	21	5	7			
6	25	29	7			1
7	8	49	6			
8	5	30	1			
9		12				
10		6				
Total	911	131	23	44	113	

<sup>a</sup> Most of the Brown Trout appeared to be of hatchery origin.

<sup>b</sup> Saw two adult Chinook Salmon.

Table 8.—Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 22, 2007. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip codes: LV = left pelvic and RP = right pectoral.)

Total length (inches)	RBT (unmarked) <sup>a</sup>	RBT (LV clip) <sup>b</sup>	RBT (RP clip) <sup>c</sup>	BNT <sup>d</sup>	COS	CHS	BKT
1	21						
2	367						
3	340			1	8	47	
4	117			3	2	51	
5	12	3	1			1	
6	51	13	4	1			
7	23	31	3	4			
8	1	11	1	9			
9		1	3	6			
10			2				
11		4		1			
12							
13	2						
Total	934	63	14	25	10	99	

<sup>a</sup> The 13-inch unmarked Rainbow Trout appeared to be of hatchery origin, but there were no fin clips.

<sup>b</sup> LV clipped RBT were reared at the Orsini Hatchery.

<sup>c</sup> RP clipped RBT were reared at the Wolf Lake State Fish Hatchery.

<sup>d</sup> Most of the Brown Trout over 4 inches in length appeared to be of hatchery origin.

Table 9.—Salmonids captured during the Michigan Department of Natural Resources electrofishing survey at the Kurick Road station on the Betsie River, August 24, 2008. (Species codes: RBT = steelhead, BNT = Brown Trout, COS = Coho Salmon, CHS = Chinook Salmon, and BKT = Brook Trout. Fin clip codes: LV = left pelvic and RP = right pectoral.)

Total length (inches)	RBT (unmarked)	RBT (LV clip) <sup>a</sup>	RBT (RP clip) <sup>b</sup>	BNT <sup>c</sup>	COS	CHS	BKT
1	23						
2	191						
3	168				3	16	
4	41				8	20	
5	43	26					
6	50	104	11	1			
7	7	86	13	8			
8		53	7	7			
9		18	6	3			
10			2				
11							
12							
13							
Total	523	287	39	19	11	36	

<sup>a</sup> LV clipped RBT were reared at the Orsini Hatchery.

<sup>b</sup> RP clipped RBT were reared at the Wolf Lake Fish Hatchery.

<sup>c</sup> One 25-inch lake run BNT was also captured. All BNT (except for the large one) appeared to be of hatchery origin.

Table 10.—Steelhead captured during Michigan Department of Natural Resources electrofishing surveys at the Kurick Road station on the Betsie River, 1996-2008. (Fin clip codes: RP = right pectoral and LV = left pelvic. TL = total length. U = unmarked.)

TL (in)	1996		1998		2003		2004		2005		2006		2007			2008		
	U	RP	U	RP	U	RP	U	RP	U	RPLV	U	LV	U	LV	RP	U	LV	RP
1	6		8		30		10		4		56		21			23		
2	21		69		125		146		324		447		367			191		
3	8		46		48		129		382		324		340			168		
4	5	9	6	1	4	12	10		81		25		117			41		
5	16	51	17	12	30	57	18	17	7	1	21	5	12	3	1	43	26	
6	6	81	16	35	8	52	17	49	9	23	25	29	51	13	4	50	104	11
7		52	2	60	3	20	2	38	10	17	8	49	23	31	3	7	86	13
8		12		22			1	7	2	3	5	30	1	11	1		53	7
9		1		4						3		12		1	3		18	6
10							1			1		6			2			2
11														4				
13								1						2				
Total	62	206	164	134	248	141	334	112	819	48	911	131	934	63	14	523	287	39

In early 2006, the MDNR contemplated several methods for assessing adult steelhead populations in the Betsie River, including spring/fall electrofishing targeting adult steelhead, a creel census study, and a volunteer fin clip census. Electrofishing was deemed to be impractical due to the time and expense that would have been required to inspect large numbers of adult steelhead. Creel census conducted by MDNR Fisheries Division personnel was the preferred method, but was not possible at the time due to budget constraints. A Betsie River creel census was eventually conducted in 2010 and is summarized in this report. In the fall of 2006, a volunteer fin clip census was implemented because it was a relatively inexpensive method for observing large numbers of adult steelhead compared to other survey methods. The objectives of this report are to summarize the findings and discuss the implications of the results of both creel surveys for the management of the Betsie River steelhead population.

## **Methods**

### ***Volunteer Steelhead Fin Clip Census***

The volunteer fin clip census took place from fall 2006 through spring 2010. A total of nineteen anglers and professional river guides volunteered to participate in the study. Each volunteer was given a folding clipboard and data forms to record the presence or absence of fin clips for each captured steelhead larger than 15 inches. Participants could return their completed forms by mail or electronically. In addition, MDNR personnel visited the Betsie River and conducted informal angler interviews when possible and inspected any steelhead that they encountered.

Seelbach (1993) found that 82% of fall run and 91% of the Little Manistee River spring run steelhead were fish that had spent two or three summers in Lake Michigan, so for any given spawning year, the majority of returning adult steelhead will be those that were stocked two or three years prior (steelhead returning in the fall were considered part of the following spring's spawning run.). This was taken into account when examining the fin clip data gathered in the volunteer creel survey. Steelhead that return after only one summer in the lake are usually males less than 20 inches in length, commonly referred to as "skippers."

### ***Creel Survey***

An on-site creel survey was conducted during March–May and August–December of 2010 along the Betsie River. The river was divided into three segments: lower, middle, and upper (Figure 1). The lower river (site 123A) consisted of the area from Betsie Lake to the US 31 Bridge, including Cemetery path, Elberta launch, M-22 Bridge, Lower River Road access, Upper River Road access, and Grace Road access. The middle river (site 123B) consisted of the area from US-31 Bridge to Fred's Landing, including the US-31 access, Homestead Dam, and Fred's Landing. The upper river (site 123C) consisted of the area from Fred's Landing to Grass Lake Flooding, including Grass Lake State Forest campground, Long Road pull-off, Wolf Road bridge, Haze Road bridge, Kurick Road bridge, Psutka Road bridge, and County Line Road Bridge.

The creel survey was based on a stratified design using three-stage sampling (i.e., the stages are days, shifts, and angling units for interviewing, and days, shifts, and count times for counting) within strata (Su and Clapp 2013). Strata included site fished by month, by day-type (weekday-weekend), and by mode of fishing (Su and Clapp 2013). Catch and effort estimates were made for each stratum and then combined to give monthly and seasonal figures. Both weekend days and three randomly selected weekdays were sampled each week. The entire angling day from dawn to dusk was covered in each month. This was accomplished by breaking each day into two 8-hour work shifts, then randomly

selecting one shift to be worked. The first shift began at daylight and ended in the afternoon; the second shift began in mid-morning and ended at sunset.

River sections were randomly selected each day for sampling by the creel clerk. Two types of data were collected for each area sampled: angler party interviews for catch rates and angler (or boat) counts for effort. An angler party was defined as one or more anglers who fished together. The clerk interviewed each individual angler or boat that returned to the access site during the scheduled shift. Date, time and interview site were recorded for all interviews. If the boater did not fish, that was recorded on the form as a non-fishing party and the interview was ended. If fishing did take place, anglers were queried as to their mode of fishing (i.e., boat or shore), where they fished, how long they fished, the target species, the numbers (by species) of fish they caught and numbers kept or released, and the number of fishing trips they made or intended to make that day. Additional data were collected for one member of each party such as age and sex, zip code or county of residence, and the angling method used (casting, still fishing, trolling, etc.). If the anglers had adult steelhead in their possession, biological data were collected and the fish were inspected for fin clips.

Fishing effort was determined through instantaneous counts of trailers (as proxies for boats) and vehicles (as proxies for shore anglers) made by the clerk. One count was made each day at randomly selected starting times. The proportion of boaters interviewed by creel clerks who indicated they were not fishing was used to adjust the trailer counts for non-fishing effort. Effort estimates were made for each river segment by month. Three measures of fishing effort were calculated: angler hours, angler trips and angler days. An angler trip is one completed fishing excursion. An angler day is composed of one or more fishing excursions during a 24-hour period.

Harvest and release estimates were made for each river segment by month for all fish species observed in the harvest by creel clerks. Standard mathematical formulas for creel survey (Lockwood et al. 1999) were used to calculate all estimates. Uncertainty estimates for all catch and effort estimates in this report are defined as two standard errors of their mean estimates (2 times the square root of the variance for an estimate).

## **Results**

### ***Volunteer Steelhead Fin Clip Census***

#### ***Fall 2006 through Spring 2007***

In the first season of the volunteer angler study (fall 2006–spring 2007) 239 steelhead were observed (Table 11). Of those, 173 (72.4%) were unmarked and presumably wild, 48 (20.1%) had right pectoral (RP) fin clips (fish stocked in or prior to 2004), 13 (5.4%) had right pectoral/left ventral (RPLV) fin clips (fish stocked in 2005), and three (1.3%) had left ventral (LV) fin clips (smaller “skipper” males stocked in the spring of 2006). Other fin clips recorded in the 2006–2007 steelhead run included a left ventral/right ventral (LVRV) fin clip combination, and a left pectoral/dorsal (LPDO) combination. These combinations are not used by any stocking agencies anywhere in the Lake Michigan basin. The most striking feature of the fall 2006 – spring 2007 data was the abundance of unmarked (and presumably wild) steelhead. Until this point, it was assumed that the adult steelhead run in the Betsie River was primarily based upon stocking from the Orsini Hatchery. While substantial numbers of Orsini-stocked fish were present in the survey, wild fish were predominant. This result corroborates the electrofishing data collected by MDNR, which indicated that large numbers of wild juvenile steelhead were present starting in the summer of 2005.

Table 11.—Steelhead observed during the volunteer creel survey on the Betsie River, fall 2006 through spring 2007. (Fin clip codes: RP = right pectoral, LV = left pelvic, RV = right pelvic, LP = left pectoral, and DO = dorsal.)

Clip type	Number	Percentage
Unmarked	173	72.4
RP	48	20.1
RPLV	13	5.4
LV	3	1.3
LVRV	1	0.4
LPDO	1	0.4
Total fish	239	

#### *Fall 2007 through Spring 2008*

A total of 275 steelhead were observed during this study period (Table 12). Of those, 211 (76.7%) were unmarked and presumably wild. Of the remainder, 33 (12%) had RP fin clips (fish that were stocked prior to 2004 or were WLSFH fish just stocked the previous spring), 14 (5%) had LV fin clips (Orsini fish stocked in either 2006 or 2007), 10 (3.6%) had RPLV fin clips (Orsini fish stocked in 2005). Other clips recorded in small numbers included LP, LVRV, left pectoral/adipose (LPAD), and right maxillary (RM). As in the previous run, unmarked and presumably wild steelhead dominated the catch. Four of the RP fin clipped steelhead were “skipper” males, indicating that they were likely WLSFH fish stocked in the spring of 2007. The presence of Orsini-reared fish with both LV and RPLV fin clips indicated that at least some of the Orsini-reared fish were smolting out to Lake Michigan, surviving there, and returning as adults.

Table 12.—Steelhead observed during the volunteer creel survey on the Betsie River, fall 2007 through spring 2008. (Fin clip codes: RP = right pectoral, LV = left pelvic, LP = left pectoral, RV = right pelvic, AD = adipose, and RM = right maxillary.)

Clip type	Number	Percentage
Unmarked	211	76.7
RP	33	12.0
LV	14	5.0
RPLV	10	3.6
LP	4	1.5
LVRV	1	0.4
LPAD	1	0.4
RM	1	0.4
Total fish	275	

### *Fall 2008 through Spring 2009*

The volunteer creel census yielded information on 287 steelhead during this period (Table 13). Of those, 196 (68.3%) were unmarked and presumably wild. Of the remainder, 45 (15.7%) had RP fin clips (Orsini fish stocked prior to 2004 or WLSFH fish stocked in 2007 or 2008), 37 (12.9%) had LV fin clips (Orsini fish stocked 2006–2008), and nine (3.1%) had LVRP fin clips (Orsini fish stocked in 2005). As in the previous two runs, unmarked and presumably wild steelhead made up the majority of the run. Stocked steelhead composed nearly 32% of the catch, with Orsini-reared steelhead making up more than half of that total.

Table 13.—Steelhead observed during the volunteer creel survey on the Betsie River, fall 2008 through spring 2009. (Fin clip codes: RP = right pectoral and LV = left pelvic.)

Clip type	Number	Percentage
Unmarked	196	68.3
RP	45	15.7
LV	37	12.9
RPLV	9	3.1
Total fish	287	

### *Fall 2009 through Spring 2010*

In this fourth and final year of the volunteer creel survey, 456 steelhead were observed (Table 14). Of those, 290 (63.6%) were unmarked and presumably wild. Of the remainder, 109 (23.9%) had RP fin clips (WLSFH fish released 2007–2009), 52 (11.4%) had LV fin clips (Orsini fish released 2006–2009) and three had RPLV fin clips (Orsini-reared fish released in 2005). Other clips observed in 2009 were one LP fin clip and one AD fin clip. As in the previous three runs examined in the volunteer study, unmarked and presumably wild steelhead made up the majority of the run. Stocked steelhead made up 36% of the catch, with the majority of those being RP fin clipped and likely reared at WLSFH. While a few of the RP fin clipped steelhead may have been Orsini-reared fish stocked in 2004, most steelhead encountered in Michigan streams are younger than age-6 (Seelbach 1993). Fish positively identified as Orsini-reared steelhead made up about 12% of the catch during this run.

Table 14.—Steelhead observed during the volunteer creel survey on the Betsie River, fall 2009 through spring 2010. (Fin clip codes: RP = right pectoral, LV = left pelvic, LP = left pectoral, and AD = adipose.)

Clip type	Number	Percentage
Unmarked	290	63.6
RP	109	23.9
LV	52	11.4
RPLV	3	0.7
LP	1	0.2
AD	1	0.2
Total fish	456	

## Creel Survey

Anglers spent approximately 117,952 angler hours (or 23,201 days) fishing the Betsie River during 2010 (Table 15). Effort was the highest in the middle section with 81,842 angler hours (69% of total effort, Table 16), followed by the lower section with 22,558 angler hours (19% of total effort, Table 17), and finally the upper section with 13,552 angler hours (11% of total effort, Table 18). Effort also varied seasonally with over 78% of all effort being expended in the months of September (61%) and October (17%). The total harvest estimate for all sections was 15,032 fish, with Chinook Salmon making up 90% of the harvest, followed by steelhead (7%), White Suckers *Catostomus commersonii*, Brown Trout *Salmo trutta*, and Coho Salmon (<1% each). Chinook Salmon harvest took place primarily in September and October (86%), while most of the steelhead harvest occurred in April and May (94%). We estimated that an additional 13,353 fish were released (Tables 19–22), with Chinook Salmon making up 74% of the fish released, followed by steelhead (19%), White Sucker (6%), Brown Trout, and Creek Chubs *Semotilus atromaculatus* (<1% each). The majority of effort was targeted towards salmon (67,133 hours, 57%) or steelhead (41,003 hours, 35%). There was less effort targeted at trout in general (3,279 hours, 3%), salmon and trout in general (3,239 hours, 3%), White Suckers, Brown Trout, Northern Pike *Esox lucius*, Smallmouth Bass *Micropterus dolomieu*, Walleye *Sander vitreus*, and Yellow Perch *Perca flavescens* (Table 23).

Over 90% of anglers sampled were Michigan residents, but nonresident anglers from twelve other states (Alaska, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, New York, Ohio, South Dakota, Texas, and Wisconsin) also fished the Betsie River. Demographic data collected during the survey revealed that the river is popular beyond the local level, with only 42% of anglers originating from the river's surrounding counties and the rest coming from counties across the state (Figure 2).

## Discussion

Although the volunteer creel study admittedly was not a rigorous scientific evaluation, it was effective in a number of ways. It was the only method that MDNR could implement to examine large numbers of adult steelhead for fin clips without expensively and intrusively sampling the river with electrofishing equipment. In addition, the volunteer creel study improved relationships between anglers and MDNR. Directly involving anglers in the study gave them a sense of ownership in the fishery, and resulted in increased candid communication between anglers, professional river guides, and MDNR.

Three main conclusions can be drawn from the data collected in the volunteer creel survey:

1. Steelhead natural reproduction expanded on the Betsie River in the 2000s. The abundance of unclipped and presumably wild adult steelhead observed during electrofishing surveys and the volunteer creel study (870 out of 1,257 adult steelhead observed, or 69.2%) was unexpected. Fisheries managers had previously assumed that Betsie River steelhead runs consisted of more hatchery fish than wild fish. Why so many more wild steelhead have been produced in recent years is unknown.
2. Despite its issues, the Orsini Hatchery did contribute to the Betsie River fishery. Nearly 15% (186) of the adult steelhead observed in the volunteer creel study likely came from the Orsini Hatchery.
3. WLSFH-reared steelhead have also contributed greatly to the Betsie River steelhead fishery. In the 2009/2010 run, 109 (23.9%) steelhead likely came from WLSFH. The success of this stocking effort is not a surprise. Large yearling steelhead reared at state fish hatcheries are a proven product, and have produced outstanding fisheries in many different types of rivers throughout the state of Michigan for many years.

Table 15.—Estimated harvest per hour, number harvested, and effort (angler hours, trips and days) from sport fishing for the Betsie River by all modes and at all segments in 2010. Two standard errors of the mean are in parentheses.

Species	Harvest rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Trout	0.0006 (0.0038)	48 (95)	6 (12)	21 (57)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	75 (164)
Chinook Salmon	0.0115 (0.2071)	0 (0)	0 (0)	0 (0)	377 (797)	10,496 (6,115)	2,495 (1,860)	252 (248)	0 (0)	13,620 (9,020)
Coho Salmon	0.0005 (0.0030)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	63 (132)	0 (0)	0 (0)	63 (132)
White Sucker	(0.0015) (0.0074)	0 (0)	121 (242)	56 (79)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	177 (321)
Steelhead	0.0093 (0.0190)	840 (499)	189 (203)	31 (42)	0 (0)	0 (0)	0 (0)	37 (79)	0 (0)	1,097 (824)
Angler hours		10,750 (4,771)	5,938 (2,828)	613 (476)	6,030 (2,624)	72,074 (22,063)	20,634 (9,451)	1,520 (1,321)	393 (0)	117,952 (43,533)
Angler trips		3,460 (1,293)	1,593 (829)	347 (251)	2,587 (1,241)	16,744 (7,163)	5,889 (3,147)	587 (475)	184 (0)	31,391 (14,399)
Angler days		2,730 (1,057)	1,191 (648)	335 (242)	2,028 (1,048)	11,866 (5,203)	4,316 (2,308)	551 (466)	184 (0)	23,201 (10,971)

Table 16.—Estimated harvest per hour, number harvested, and effort (angler hours, trips and days) from sport fishing for the middle Betsie River by all modes in 2010. Two standard errors of the mean are in parentheses. (See Figure 1 for site location.)

Species	Harvest rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Trout	0.0007 (0.1108)	48 (95)	6 (12)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	54 (107)
Chinook Salmon	0.0992 (0.2520)	0 (0)	0 (0)	0 (0)	78 (104)	5,538 (2,687)	2,253 (1,543)	252 (248)	0 (0)	8,121 (4,582)
Coho Salmon	0.0008 (0.0482)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	63 (132)	0 (0)	0 (0)	63 (132)
White Sucker	0.0022 (0.1664)	0 (0)	121 (242)	56 (79)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	177 (321)
Steelhead	0.0117 (0.2200)	816 (461)	105 (97)	0 (0)	0 (0)	0 (0)	0 (0)	37 (79)	0 (0)	958 (637)
Angler hours		9,779 (4,281)	4,586 (2,059)	184 (141)	3,687 (1,826)	45,624 (10,575)	16,069 (6,192)	1,520 (1,321)	393 (0)	81,842 (26,393)
Angler trips		2,817 (1,255)	1,198 (651)	123 (106)	1,578 (896)	10,906 (3,548)	4,468 (1,900)	587 (475)	184 (0)	21,861 (8,831)
Angler days		2,188 (1,020)	920 (517)	111 (98)	1,206 (703)	7,786 (2,633)	3,400 (1,520)	551 (466)	184 (0)	16,346 (6,956)

Table 17.—Estimated harvest per hour, number harvested, and effort (angler hours, trips and days) from sport fishing for the lower Betsie River by all modes in 2010. Two standard errors of the mean are in parentheses. (See Figure 1 for site location.)

Species	Harvest rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chinook Salmon	0.1963 (0.2576)	0 (0)	0 (0)	0 (0)	299 (692)	4,021 (2,530)	109 (181)	0 (0)	0 (0)	4,429 (3,403)
Coho Salmon	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White Sucker	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Steelhead	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Angler hours		613 (188)	261 (212)	58 (84)	2,301 (798)	16,790 (6,836)	2,535 (1,643)	0 (0)	0 (0)	22,558 (9,760)
Angler trips		519 (0)	114 (0)	43 (0)	988 (345)	3,297 (1,823)	772 (702)	0 (0)	0 (0)	5,733 (2,870)
Angler days		461 (0)	98 (0)	43 (0)	801 (345)	2,498 (1,440)	510 (435)	0 (0)	0 (0)	4,411 (2,219)

Table 18.—Estimated harvest per hour, number harvested, and effort (angler hours, trips and days) from sport fishing for the upper Betsie River by all modes in 2010. Two standard errors of the mean are in parentheses. (See Figure 1 for site location.)

Species	Harvest rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Trout	0.0015 (0.1156)	0 (0)	0 (0)	21 (57)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	21 (57)
Chinook Salmon	0.0790 (0.2149)	0 (0)	0 (0)	0 (0)	0 (0)	937 (898)	133 (137)	0 (0)	0 (0)	1,070 (1,035)
Coho Salmon	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White Sucker	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Steelhead	0.0103 (0.3430)	24 (38)	84 (106)	31 (42)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	139 (186)
Angler hours		358 (302)	1,091 (558)	371 (251)	42 (0)	9,660 (4,652)	2,030 (1,616)	0 (0)	0 (0)	13,552 (7,379)
Angler trips		124 (38)	281 (178)	181 (144)	21 (0)	2,541 (1,792)	649 (545)	0 (0)	0 (0)	3,797 (2,698)
Angler days		81 (38)	173 (131)	181 (144)	21 (0)	1,582 (1,130)	406 (353)	0 (0)	0 (0)	2,444 (1,796)

Table 19.—Estimated releases per hour, number released, and effort (angler hours, trips and days) from sport fishing for the Betsie River by all modes and at all segments in 2010. Two standard errors of the mean are in parentheses.

Species	Release rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0004 (0.0023)	0 (0)	48 (102)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	48 (102)
Brown Trout	0.0012 (0.0048)	24 (48)	112 (160)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	136 (208)
Chinook Salmon	0.0840 (0.1800)	0 (0)	0 (0)	0 (0)	148 (74)	6,970 (5,803)	2,426 (1,474)	351 (473)	6 (11)	9,901 (7,836)
Coho Salmon	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White Sucker	0.0064 (0.0189)	0 (0)	707 (729)	0 (0)	44 (94)	0 (0)	0 (0)	0 (0)	0 (0)	751 (823)
Other <sup>a</sup>	0.0004 (0.0019)	0 (0)	0 (0)	0 (0)	44 (84)	0 (0)	0 (0)	0 (0)	0 (0)	44 (84)
Steelhead	0.0210 (0.0525)	1,358 (903)	701 (838)	0 (0)	0 (0)	0 (0)	305 (519)	12 (27)	97 (0)	2,473 (2,286)
Angler hours		10,750 (4,771)	5,938 (2,828)	613 (476)	6,030 (2,624)	72,074 (22,063)	20,634 (9,451)	1,520 (1,321)	393 (0)	117,952 (43,533)
Angler trips		3,460 (1,293)	1,593 (829)	347 (251)	2,587 (1,241)	16,744 (7,163)	5,889 (3,147)	587 (475)	184 (0)	31,391 (14,399)
Angler days		2,730 (1,057)	1,191 (648)	335 (242)	2,028 (1,048)	11,866 (5,203)	4,316 (2,308)	551 (466)	184 (0)	23,201 (10,971)

<sup>a</sup> Creek Chubs

Table 20.—Estimated releases per hour, number released, and effort (angler hours, trips and days) from sport fishing for the lower Betsie River by all modes in 2010. Two standard errors of the mean are in parentheses. (See Figure 1 for site location.)

Species	Release rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chinook Salmon	0.0692 (0.0000)	0 (0)	0 (0)	0 (0)	148 (74)	1,414 (1,243)	0 (0)	0 (0)	0 (0)	1,562 (1,317)
Coho Salmon	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White Sucker	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Steelhead	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Angler hours		613 (188)	261 (212)	58 (84)	2,301 (798)	16,790 (6,836)	2,535 (1,643)	0 (0)	0 (0)	22,558 (9,760)
Angler trips		519 (0)	114 (0)	43 (0)	988 (345)	3,297 (1,823)	772 (702)	0 (0)	0 (0)	5,733 (2,870)
Angler days		461 (0)	98 (0)	43 (0)	801 (345)	2,498 (1,440)	510 (435)	0 (0)	0 (0)	4,411 (2,219)

Table 21.—Estimated releases per hour, number released, and effort (angler hours, trips and days) from sport fishing for the middle Betsie River by all modes in 2010. Two standard errors of the mean are in parentheses. (See Figure 1 for site location.)

Species	Release rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Trout	0.0009 (0.1109)	24 (48)	48 (62)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	72 (110)
Chinook Salmon	0.0861 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	4,142 (3,020)	2,386 (1,426)	351 (473)	6 (11)	6,879 (4,919)
Coho Salmon	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White Sucker	0.0094 (0.0000)	0 (0)	707 (729)	0 (0)	44 (94)	0 (0)	0 (0)	0 (0)	0 (0)	751 (823)
Other <sup>a</sup>	0.0021 (0.0000)	0 (0)	0 (0)	0 (0)	44 (84)	0 (0)	0 (0)	0 (0)	0 (0)	44 (84)
Steelhead	0.0291 (0.2243)	1,358 (903)	653 (756)	0 (0)	0 (0)	0 (0)	305 (519)	12 (27)	97 (0)	2,328 (2,204)
Angler hours		9,779 (4,281)	4,586 (2,059)	184 (141)	3,687 (1,826)	45,624 (10,575)	16,069 (6,192)	1,520 (1,321)	393 (0)	81,842 (26,393)
Angler trips		2,817 (1,255)	1,198 (651)	123 (106)	1,578 (896)	10,906 (3,548)	4,468 (1,900)	587 (475)	184 (0)	21,861 (8,831)
Angler days		2,188 (1,020)	920 (517)	111 (98)	1,206 (703)	7,786 (2,633)	3,400 (1,520)	551 (466)	184 (0)	16,346 (6,956)

<sup>a</sup> Creek Chubs

Table 22.—Estimated releases per hour, number released, and effort (angler hours, trips and days) from sport fishing for the upper Betsie River by all modes in 2010. Two standard errors of the mean are in parentheses. (See Figure 1 for site location.)

Species	Release rate	Month								Season
		March	April	May	August	September	October	November	December	
Brook Trout	0.0035 (0.0000)	0 (0)	48 (102)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	48 (102)
Brown Trout	0.0047 (0.0000)	0 (0)	64 (98)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	64 (98)
Chinook Salmon	0.1073 (0.2173)	0 (0)	0 (0)	0 (0)	0 (0)	1,414 (1,541)	40 (48)	0 (0)	0 (0)	1,454 (1,590)
Coho Salmon	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White Sucker	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	0.0000 (0.0000)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Steelhead	0.0035 (0.0000)	0 (0)	48 (82)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	48 (82)
Angler hours		358 (302)	1,091 (558)	371 (251)	42 (0)	9,660 (4,652)	2,030 (1,616)	0 (0)	0 (0)	13,552 (7,379)
Angler trips		124 (38)	281 (178)	181 (144)	21 (0)	2,541 (1,792)	649 (545)	0 (0)	0 (0)	3,797 (2,698)
Angler days		81 (38)	173 (131)	181 (144)	21 (0)	1,582 (1,130)	406 (353)	0 (0)	0 (0)	2,444 (1,796)

Table 23.—Angler targeting preference for all months, modes, and segments of the Betsie River in 2010. Targeting preference is organized by descending percentage.

Targeted species	Number of targeted hours	Percentage of targeted hours
Salmon	67,133	57
Steelhead	41,003	35
Trout	3,279	3
Salmon and trout	3,239	3
Any species	2,271	2
White Suckers	395	0.3
Brown Trout	217	0.2
Smallmouth	198	0.2
Northern Pike	119	0.1
Walleye and Yellow Perch	99	0.1

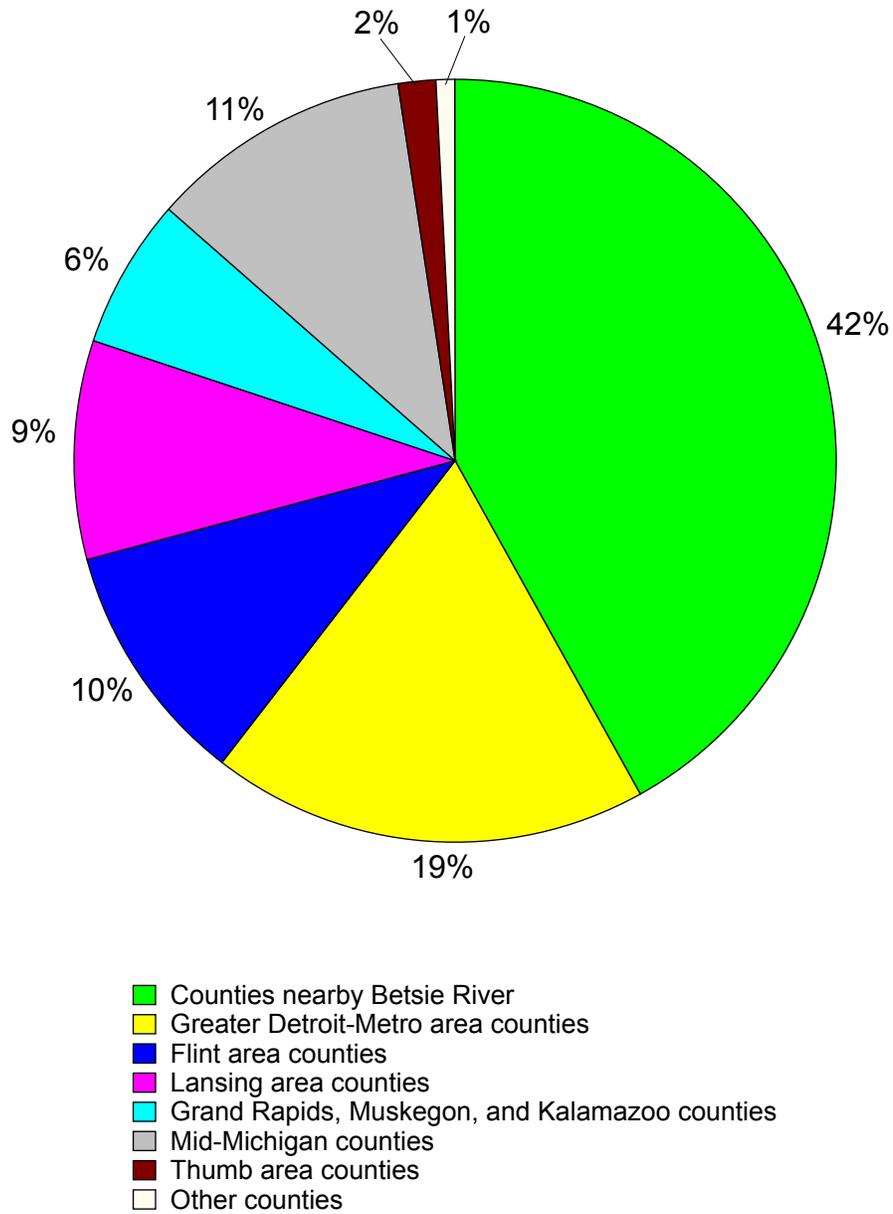


Figure 2.—County of origin for anglers fishing the Betsie River in 2010. All months, modes, and river segments are combined.

The results of the standardized creel survey demonstrated the importance of the Betsie River to Michigan’s anglers. Although the annual fishing effort on the Betsie River was less than has been estimated for other Michigan rivers, including the Manistee, Muskegon, and St. Joseph rivers<sup>1</sup> (Figure 3), the fishing effort on the Betsie River during the fall salmonid runs (September and October) is comparable to both the Muskegon and St. Joseph rivers (Figures 4 and 5). Furthermore, approximately 58% of Betsie River anglers were not from the immediate area, demonstrating that the Betsie River fishery is important both regionally and statewide and brings over \$900,000 annually to the local community using an angler day value of \$39 (US Department of Interior et al. 2011).

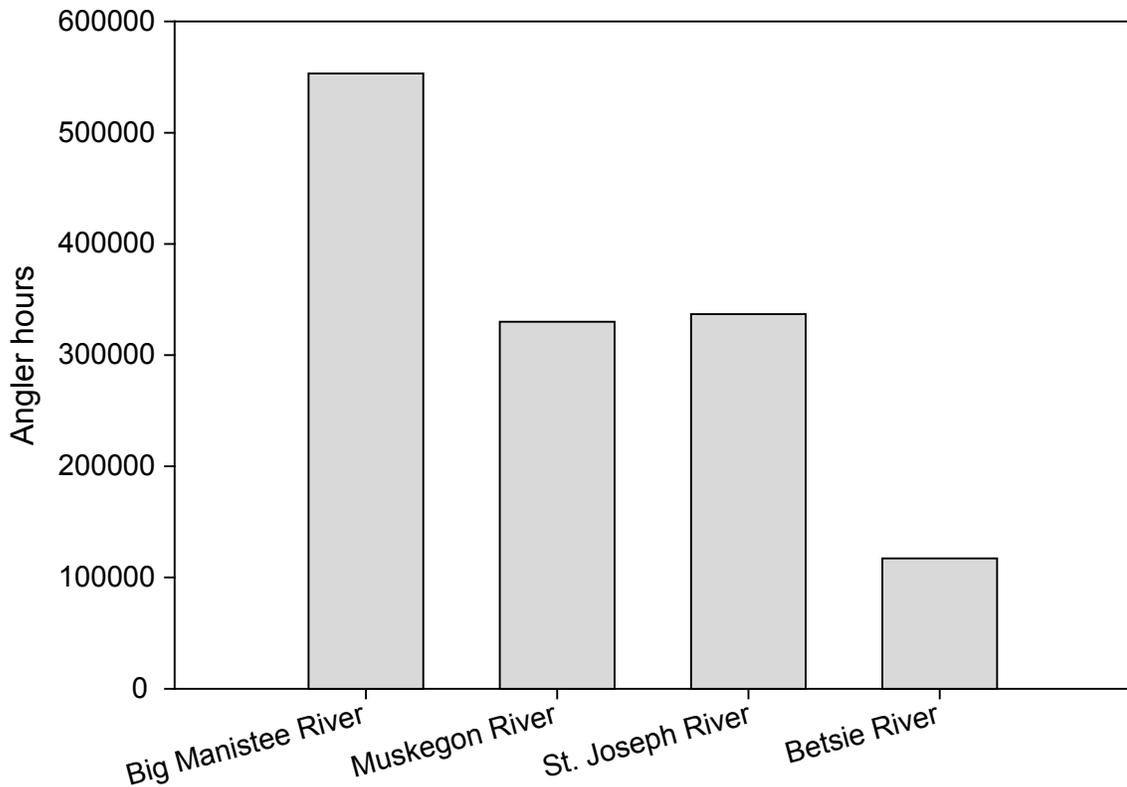


Figure 3.—Mean annual total fishing effort for the Big Manistee, Muskegon and St. Joseph rivers, 1999–2004 and the Betsie River in 2010. The St. Joseph River includes the area from Benton Harbor, Michigan to the Twin Branch Dam in Indiana. The Manistee River includes the area from Tippy Dam to Bear Creek, and the Muskegon River includes the area from Croton Dam to the Newaygo public access site.

<sup>1</sup> Creel surveys were done on the Manistee, Muskegon, and St. Joseph rivers throughout 1999–2004, but not in 2010 when the Betsie River was, therefore all comparisons between rivers do not take into account year effects on angler effort.

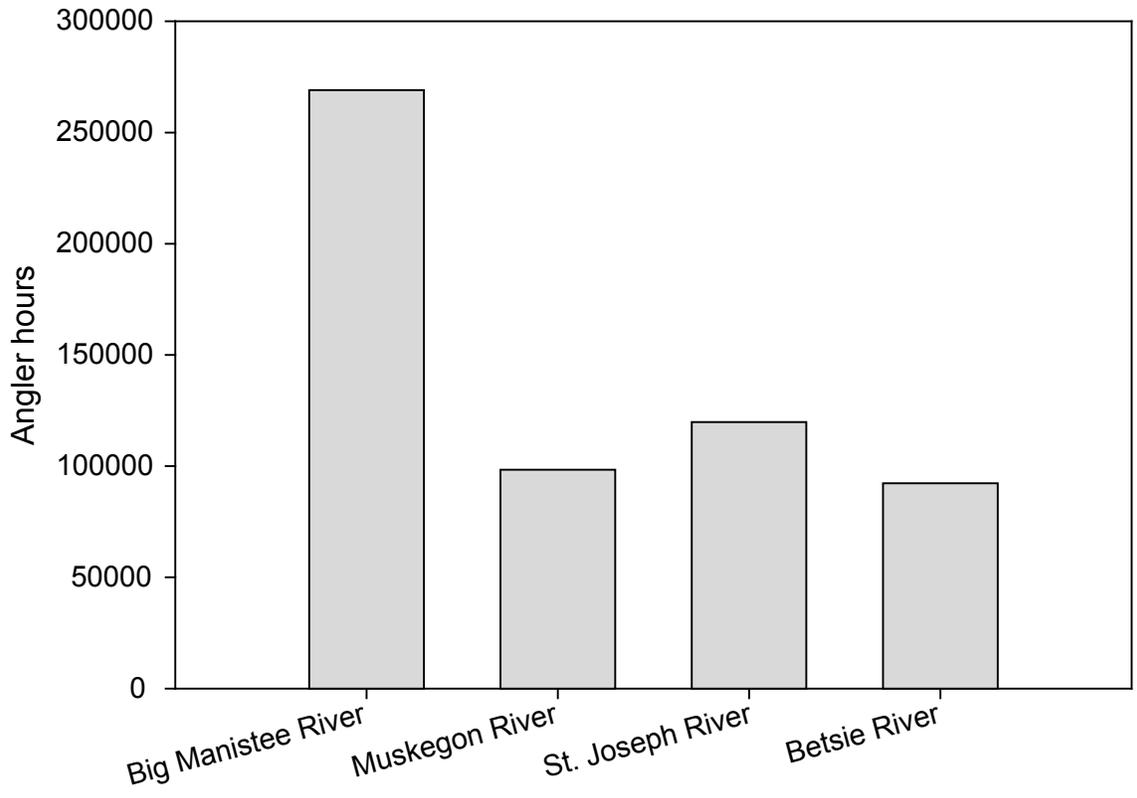


Figure 4.—Mean fall (September and October combined) fishing effort for the Big Manistee, Muskegon and St. Joseph rivers, 1999–2004 and the Betsie River in 2010. The St. Joseph River includes the area from Benton Harbor, Michigan to the Twin Branch Dam in Indiana. The Manistee River includes the area from Tippy Dam to Bear Creek, and the Muskegon River includes the area from Croton Dam to the Newaygo public access site.

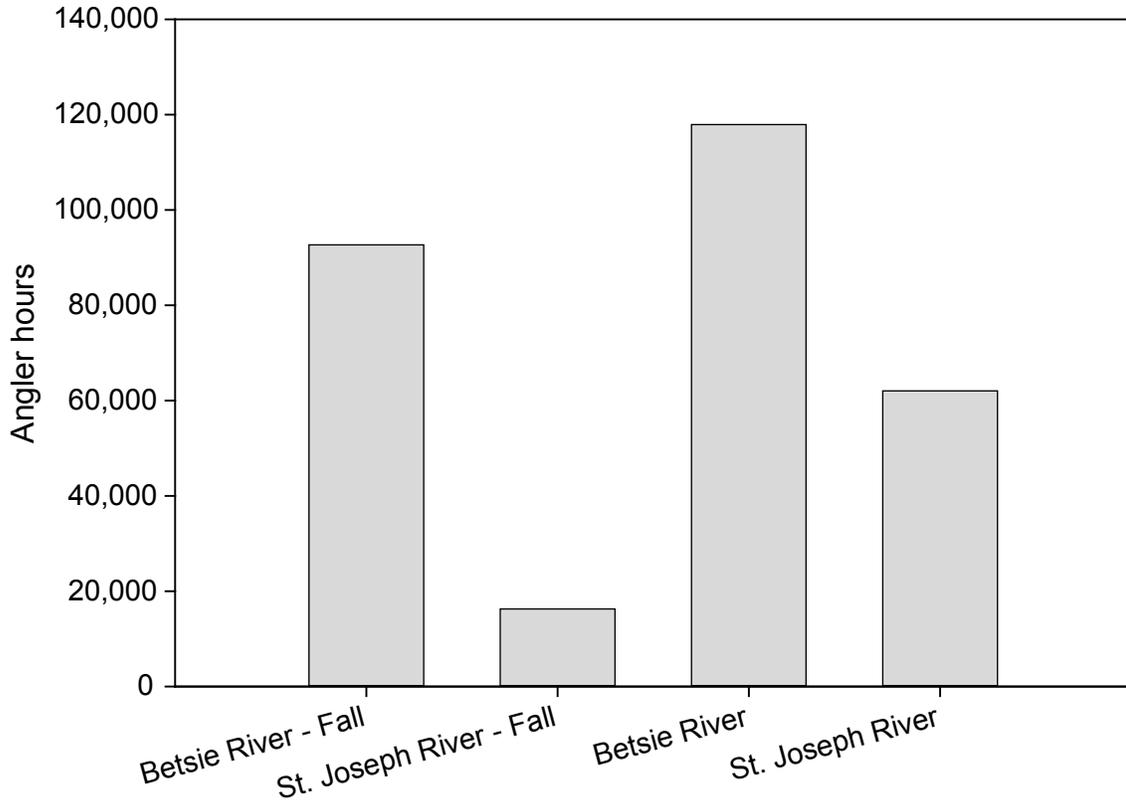


Figure 5.–Fall (September and October combined) and total sampled fishing effort for the St. Joseph and Betsie rivers in 2010. The St. Joseph River includes the area downstream from the Berrien Springs Dam.

Due to budgetary issues, the Manistee County Sportfishing Association discontinued operating the Orsini Hatchery after the 2009 stocking. If operating the Orsini Hatchery had remained a viable option, our recommendation would have been to continue with the effort because of the popularity of the fishery with anglers. Despite the less-than-ideal conditions at the Orsini Hatchery, fish raised there did contribute to the Betsie River steelhead catch. We commend the Manistee County Sportfishing Association and the Orsini family for their long term commitment to the Betsie River steelhead stocking program. This program resulted in over 700,000 juvenile steelhead being stocked into the Betsie River between 1991 and 2009.

We recommend that 20,000 state-reared steelhead continue to be stocked into the Betsie River on an annual basis. The creel estimates demonstrated that the Betsie River is a “destination fishery” for salmon and steelhead, and one of the most popular steelhead rivers in Michigan. Therefore, we believe the Betsie River is deserving of a MDNR steelhead stocking effort. Continued stocking is expected to maintain the existing steelhead fishery and reduce fluctuations in catch rates caused by variations in natural recruitment.

## Acknowledgements

This study would not have been possible without the assistance of a large number of Betsie River anglers and professional river guides. The creel census data was collected mostly by Joe Thomas, assisted by Heather Hettinger and Gene Duncil. Editorial suggestions were provided by Heather Hettinger, Brian Gunderman, Zhenming Su, and Dave Clapp.

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