Michigan Department of Natural Resources
Status of the Fishery Resource Report
No. 2004-3, 2004

Betsie River

Benzie County (T25N, R13W, Section 17 and T25N, R14W, Sections 24, 35) and
Manistee County (T24N, R14W, Section 2, 8)
Surveyed August, 1996; August, 1998; and August, 2003

Mark A. Tonello

Environment

The Betsie River watershed is located in Grand Traverse, Manistee, and Benzie counties (Figure 1), and drains roughly 155,026 acres (MDNR Wildlife Bureau, 1994). The Betsie River watershed begins with several small Designated Trout Streams, Horton Creek, Brigham Creek, and Mason Creek, that flow into Duck Lake in western Grand Traverse County. Duck Lake empties into Green Lake, and the Betsie River originates from Green Lake as the outflow. Shortly thereafter the Betsie River flows into Grass Lake Flooding. Below the Grass Lake Dam, the Betsie River flows for approximately 48 miles before entering Betsie Lake and then Lake Michigan at Frankfort and Alberta. The two largest tributaries are the Little Betsie River and Dair Creek (Figure 2). Both of these streams are top-quality trout streams with very cold, stable, flows and each contributes about 10% and 6%, respectively, of the total baseflow to the main channel (Newcomb 1998).

Two dams remain on the mainstem Betsie River, Grass Lake Dam, and Homestead Dam (Figure 2). Grass Lake Dam is approximately four miles downstream of Green Lake near the Grand Traverse County Line, and creates a 90 acre impoundment. Grass Lake Dam was constructed in 1951, primarily to improve waterfowl habitat and northern pike fishing (Newcomb and Coon 1997). Homestead Dam was largely removed in 1974, currently acts as a lamprey barrier, impounds little water, and does not impede salmonid migrations. A third dam, the Thompsonville Dam, failed in the spring of 1989 and was subsequently removed. Before that, it acted as the upstream barrier for most salmonids and warmed the river. Migrating salmon and trout currently have access to the entire river, even above Grass Lake Dam. Bonham (1976) studied the temperature effects of Grass Lake Dam and concluded that removing the dam would not significantly improve the temperature regime of the Betsie River. In contrast, Newcomb and Coon (1997) predicted that removal of the Grass Lake Dam would reduce water temperatures in the Grass Lake to Thompsonville reach by 2.2 ^{0}F in a typical flow year and 1.0 ^{0}F in low flow years.

Of the 155,026 acres that comprise the Betsie River watershed, about 55% of the land is forested, primarily with deciduous or mixed deciduous/coniferous forests. Other significant land uses for the portion of the watershed below the Grass Lake Dam include shrub/openlands (18%) and agriculture (11%). Only about 4% of the watershed is classified as urban (MDNR Wildlife Bureau 1994). The soils are 55% sand, 20% loam, and 34% wet soils (Gooding 1995). The Betsie River watershed receives about 31 inches of precipitation in an average year (Gooding 1995).

The Betsie River has been a state-designated Natural River since 1973. A Natural Rivers Zoning Board oversees development and other projects that are proposed within 400 feet of the riverbank on either side (Michigan Department of Natural Resources, 1973). The Natural Rivers Designation helps to protect the Betsie River ecosystem as development continues to occur at a rapid pace in the northwestern lower peninsula of Michigan.

Fishery Resource

The Betsie River is best known for its potamodromous fisheries, specifically for chinook salmon and steelhead. Some migratory brown trout and coho salmon are also caught. Chinook and coho salmon are not stocked in the Betsie system. These runs are comprised primarily of wild fish, or strays from other rivers. Little Manistee River strain steelhead have been stocked each year since 1990 (Table 1). Summer-run strains of steelhead (Rogue River and Skamania) were stocked in most years from 1984-90. These plantings of hatchery steelhead were made to enhance the fishery and supplement the low levels of steelhead naturally produced in the watershed. However, the plants of summer-run steelhead were then halted due to poor returns. Since 1991, about 540,000 winter-run (Little Manistee strain) steelhead smolts have been reared and released at the Orsini Hatchery by the Manistee County Sportfishing Association (Table 2). Annual stocking rates have ranged from 29,000 yearlings to almost 55,000 yearlings, averaging about 42,000 per year. Chinook salmon spawn extensively in the mainstem of the Betsie River. Steelhead and coho salmon spawning occurs throughout the mainstem and in the tributaries, although most of the wild smolts are produced in the Little Betsie River, Dair Creek, and other small tributaries throughout the watershed. In fact, Newcomb (1998) found that fully 50% of the wild steelhead smolts in the Betsie River came from the tributaries, even though they comprised only 11% of the channel area studied. The estimated number of wild steelhead smolts emigrating per year from the Betsie River system averaged less than 3,000 per year during 1993-96 (Newcomb 1998).

The Betsie River is heavily fished for steelhead and salmon, in the spring and fall. An angler census conducted from 1985-88 (Rakoczy and Rogers 1987, 1988, 1990) during April-October indicated that angler effort estimates on the Betsie River ranged from a high of 65,542 hours in 1986 to a low of 39,853 hours in 1987. Limited information exists on angler catch and harvest from the Betsie River, but during the same creel study, harvest ranged from a high of 2,600 steelhead in 1986 down to a low of 1,129 steelhead in 1988. Angler harvest for chinook salmon during the study ranged from 3,071 in 1986 to a low of 1,267 in 1988. Those creel surveys took place in the stretch from Homestead Dam to Betsie Lake, where most of the fishing effort for migratory salmonids is concentrated. Many anglers perceived a decline in steelhead catch rates during the late 1990's and early 2000's. Anglers also complain that steelhead run sizes have been highly variable between years with no apparent explanation. No angler census has been conducted since 1988 so the reported declines in fishing quality cannot be scientifically documented.

The fishery for resident trout is not nearly as popular or well known as the salmon and steelhead fisheries. Early in the 1900s, the Betsie was supposedly known as an excellent brook trout stream (Wicklund and Dean, 1957), although some experts question whether the Betsie ever could have been a top-notch trout stream due to the temperature problems that must have always existed. Resident trout populations are hampered by critically high summer water temperatures due primarily to modest summer groundwater input. Dams, competing fish species, and sand bedload fueled by erosion and poor road/stream crossings also impact trout populations. The brown trout fishery is maintained in the Betsie River primarily through stocking (Table 1). Throughout most of the 20th century, managers have struggled to improve resident trout fishing in the Betsie River. In 1965, rotenone was used to remove potential competing species such as suckers, chubs, and minnows (Bonham 1975), but these fish recolonized the river very quickly, so additional rotenone reclamations were not conducted. The washout and subsequent removal of Thompsonville Dam increased available trout habitat in the Betsie River system by allowing trout access to thermal refuge in the Little Betsie River and by reducing warming of the mainstem.

Since the early 1980s, MDNR Fisheries Division has stocked roughly 15,000 resident brown trout annually in the Betsie River (Table 1). Brown trout stocking sites in the 1990s included Long Rd., Carmean Rd., Black Bridge (Haze Rd.), Red Bridge (Lindy Rd.), Orsini

(near the M-115 crossing in Manistee County), Kurick Rd., Psutka Rd., County Line Rd., and the M-115 crossing in Benzie County. Dair Creek and the Little Betsie River are not stocked. Michigan DNR Fisheries Division personnel conducted electrofishing surveys at multiple sites in 1957, 1965, 1968, 1974, 1990 (Hay 1990), and 1996 to assess the success of the brown trout plantings. Fish surveys aimed at assessing steelhead stocked by the Orsini Hatchery were conducted at several sites in 1998 and 2003.

Other habitat management actions have included the installation of fish habitat structures, stabilization of eroding streambanks, reducing erosion at poorly designed road/stream crossings, and excavation of sand traps. The Betsie River Watershed Restoration Committee (BRWRC) was formed in 1991 to oversee those activities. The Conservation Resource Alliance (CRA), a non-profit group out of Traverse City, administers the committee. The Partnership Agreement that formed the committee was signed by 34 private, public, and governmental organizations (Fleming and Kook 1997; Kim Balke, CRA, personal communication). Since 1991, the BRWRC has overseen work on 63 eroding streambanks, repaired four road/stream crossings, and assisted with the installation of a timber bridge and access site (Kim Balke, CRA, personal communication). One sand trap is currently being operated by MDNR at Kurick Rd. The BRWRC and the CRA are currently conducting a temperature study on the Betsie River with continuous recording thermometers. Newcomb and Coon (1997) conducted an extensive temperature study of the river, and the ongoing BRWRC/CRA study will build on those data.

Master Angler Data

Since 1995, a total of 45 fish caught in the Betsie River have been entered in the MDNR Fisheries Division Master Angler program. Chinook salmon were the most commonly entered species, with 15 individuals entered. Twelve steelhead, three brown trout, and two coho salmon were also entered. Other species entered included redhorse, white sucker, rock bass, and common carp. Of the 45 entries since 1995, 31 were Catch and Keep, while 14 were Catch and Release.

Recent Fisheries Surveys

The analysis below presents results of 1996, 1998, and 2003 electrofishing surveys and compares the results to those from prior surveys. Sample sites are identified in Figure 3. Data are presented sequentially starting with the most upstream site sampled in 1996 and proceeding downstream. All sampling was done using a tow barge electroshocking unit with three probes, using pulsed DC current up to 250 volts. In 1996, we sampled five sites, with two-pass mark and recapture surveys done at four of the sites. For those sites, the Bailey formula was used to derive population estimates. All sampling in 1996 was done from August 7-14. In 1998, we sampled two sites and in 2003 we sampled just one site.

Site 1- Al Serra property

1996

This site is located upstream of Carmean Rd., and downstream of Long Rd. This was the furthest upstream site sampled in 1996, and sampling had never been done here before. We made a single, 1,000-foot shocking run here to inventory the existing fish community. The crew estimated the river to average 55 ft. wide and one foot deep. Gradient was estimated at 11.3 ft/mile. Water temperature was 71°F at11:00a.m. Mean July temperatures upstream of this site but below Grass Lake ranged from 68.5 ^{0}F in a typical flow year up to 69.3^{o}F in a low flow year (Newcomb and Coon 1997). Woody cover and streamside vegetation are sparse in this area. The property is old pasture, and few trees are growing along the streambank. There is little shading on the river, which is very wide along this stretch. Stream morphology here is very homogenous, mostly riffles and runs, with few logjams or deep holes. The substrate consists mostly of gravel.

Only four brown trout were captured, ranging from 7-9 inches long. A total of sixteen steelhead parr from 1-7 inches long were captured. Four were unclipped and presumably wild, while the other twelve had right pectoral clips and most likely had been released from the Orsini Hatchery, which is located ten miles or so downstream in Manistee County (Figure 1). One chinook salmon parr was also captured. All trout were age-1, except for one 7" rainbow that was age-2. Other species collected here included common shiner, central mudminnow, blacknose dace, hornyhead chub, white sucker, and johnny darter.

Although this site had never been surveyed before, both Long Rd. (upstream) and Carmean Rd. (downstream) had been surveyed in 1957, 1968, and 1974. Catches of brown trout in those previous surveys were generally low. The best catch was at Long Rd. in 1968, when 18 brown trout up to 16" were caught.

Rainbow trout and chinook salmon were not caught in any previous surveys in the area, because Thompsonville Dam blocked migrations. Unlike previous surveys, we captured no warmwater or coolwater gamefish species in 1996. Warmwater and coolwater gamefish captured in previous surveys included smallmouth bass, largemouth bass, northern pike, rock bass, pumpkinseed sunfish, bluegill, and yellow perch. Bullheads were also collected in previous surveys. In the past, these species may have migrated downstream from the Grass Lake impoundment which has since largely filled in with sediment. Some may have also migrated upstream from the Thompsonville impoundment. The most likely explanation for the poor catch of trout at this site is high water temperature.

1998

The 1998 fisheries survey at the Al Serra property site again consisted of one electrofishing pass, done on August 7th. The catch in 1998 at the Al Serra property site was similar to that from 1996, although even fewer trout were observed. Five steelhead parr from 3-7 inches were captured, one of which had a right pectoral fin clip, indicating hatchery origin. The others were presumably wild. Only one 7" brown trout was captured. Other species observed included creek chubs, blacknose dace, rock bass, white suckers, sculpins, largemouth bass, johnny darters, common shiners, black bullhead, and brown bullhead. Water temperature was recorded as 68°.

Site 2-King Road

This site is located several miles north of Thompsonville. It is several miles downstream of the Al Serra property, ½ mile above the confluence with the Little Betsie River. This 1,200 foot long station was previously surveyed in 1957, 1968, 1974, and 1990. In 1990, stream width was estimated to average 37 feet, with a substrate composition of 70% sand and 30% gravel (Hay, 1990). Stream gradient was measured in 1996 at 4.38 ft/mile, and the water temperature was 74 °F at 10:30 am. No major changes in habitat from the 1990 survey were noted. Again, woody cover and large woody streamside vegetation are sparse in this area, and there are no logjams or deep holes. The streambanks at this site are forested, with a pine plantation on one side, and mixed hardwoods on the other side.

In 1996, a total of eight brown trout, from 7-9", were captured in the survey, resulting in an estimated density of 1.93 lbs/acre (Table 3), and a numerical density of 7.92/acre (Table 4). All brown trout were yearlings, except for one age 2 fish. There were 3.94 lbs/acre of rainbow trout at this site. Numerical density of rainbow trout was 55.45/acre. All rainbow trout were yearlings, except for one age 2 fish, and they ranged from 4 to 7 inches long. None of the rainbows had fin clips. One three-inch chinook salmon was captured, as was one two-inch coho parr. Other species captured included sculpin, blacknose dace, creek chub, common shiner, rock bass, white sucker, johnny darter, hornyhead chub, central mudminnow, longnose dace, and bluntnose minnow.

Previous surveys of this site had similar results, with very few holdover brown trout ever captured at this site. The main difference between the 1996 survey and the 1990 survey is that in 1996, more rainbow trout were captured.

Regardless, trout densities here were very low in 1996, as they were in 1990. This is most likely due to the high water temperatures found in this. The lack of instream habitat, pools or LWD may also contribute to the apparent low survival of stocked fish.

Site 3-Lindy Road (Red Bridge)

This site is located several miles west of Thompsonville, and several miles downstream of the old Thompsonville Dam Site. Previous surveys of this area were conducted in 1957, 1971, 1974, and 1990. The river here averages 52 feet wide and gradient was estimated at 7.9 ft/mile. The station is 1250 feet long. No estimate of substrate composition was recorded during the 1996 survey. Mean July water temperature at M-115, located about two miles downstream of this site, ranged from 66 ^{0}F in 1994 , to 67 ^{0}F in 1995 (Newcomb and Coon 1997). However, the mean temperature in August 1995, a low flow year, was 70.7 ^{0}F. The stream temperature during the 1996 survey was recorded as 70^0 at 10:40 am. Instream cover is a little better here, in the form of some old DNR logjam habitat structures. Some deep runs which are very difficult to shock also provide cover.

Only six brown trout, ranging from seven to nine inches, were captured here during the 1996 survey. The estimated density of brown trout was 1.03 lbs/acre (Table 3), and the numerical density was 4.05/acre (Table 4). Rainbow trout density was 4.04 lbs/acre. Total numerical density of rainbow trout was 60.17/acre. Of these, all were yearlings except for one age 2 fish. Only one rainbow captured here had a right pectoral fin clip. Nine chinook salmon parr were captured, and their density was 0.15 lbs/acre. One coho parr was also captured in the survey. Other species collected here included creek chub, white sucker, central mudminnow, sculpin, blacknose dace, common shiner, rock bass, and johnny darter.

The brown trout population at this site declined dramatically from the 14.1 lbs/acre found in 1990. In that survey, 52 brown trout up to 22" were captured (Hay 1990). However, rainbow trout levels in 1996 were higher than in 1990, when the estimated rainbow trout density was only 0.3 lbs/acre. One of the rainbow trout captured here had a right pectoral fin clip, most likely indicating that it was stocked from the Orsini Hatchery. No salmon parr were found at this site in 1990. Although the 1957 survey found no trout in this area, the 1971 and 1974 surveys did find fair levels of brown trout. Populations were not estimated during the 1970's surveys so densities can not be directly compared to those from more recent surveys.

Site 4-Kurick Rd.

1996

This site is located in Manistee County, about four miles northwest of the Village of Copemish. It is roughly four miles downstream of the Lindy road site. Previous surveys of this area were conducted in 1965, 1968, 1971, 1974, and 1990. The river here averages about 54 feet in width, with 80% sand and 20% gravel substrate. There is some cover here, in the form of woody debris and a logjam or two. The stretch consists mostly of riffle habitat, with some pools and pocket water. The gradient is 14.2 ft/mile, which is the highest gradient of any site measured during this survey. During the 1996 survey, water temperature was 67 °F at 1:30 pm. This site is located about 1 stream mile downstream of M-115 where Newcomb and Coon (1997) reported that mean July water temperatures were 66 ^{0}F in a normal flow year and 67 ^{0}F in a low flow year. The Orsini Hatchery is located one mile upstream of the Kurick Road station.

As with the other sites, the brown trout catch here was very poor during the 1996 survey. Only 10 yearling brown trout ranging from 6-8" were captured in the 1,250 foot station, resulting in a density estimate of 1.48 lbs/acre (Table 3) and a numerical density of 9.74/acre (Table 4). The rainbow trout catch was better, as 404 individuals up to 9" were captured, resulting in a density estimate of 53.8 lbs/acre and a numerical density of 166.23/acre. However, about 75% of these fish had right pectoral clips, indicating that they were planted from the Orsini Hatchery. Of the rainbow trout sampled, 113 unclipped (and

presumably naturally reproduced) individuals were captured, resulting in a density estimate of 7.48 lbs/acre. Approximately half of these unclipped rainbows were young of the year (YOY). The rest were yearlings. Five chinook salmon parr were also observed, resulting in a density estimate of .05 lbs/acre. Other species captured here included creek chub, rock bass, white sucker, bluegill, sculpin, blacknose dace, johnny darter, and one pumpkinseed sunfish.

As with the previous site, the brown trout population seems to have declined some since 1990. In 1990, brown trout density was 7.9 lbs/acre. Numerical density was 25.3/acre and the largest individual was over 21 inches long (Hay 1990). Only one brown trout from either the 1990 or 1996 survey was a young of the year. This indicates that although survival of stocked fish may be good at this site in some years, natural reproduction of brown trout here is not significantly contributing to the population. The 1990 density of brown trout age-2 and older was roughly 5.25/acre. Although this density is not great when compared to other rivers statewide, at least some planted fish survive. Earlier surveys also found a few holdover brown trout. Rainbow trout abundance in 1996 was substantially higher than in 1990, but the presence of so many hatchery fish is alarming. It suggests that a large percentage of the yearling steelhead planted in 1996 did not smolt and emigrate to Lake Michigan. Even so, the presence of so many rainbow trout at this site may indicate that there is better temperature and habitat near Kurick Rd. than in other areas of the river.

1998

On August 7, 1998, a one-pass electrofishing survey was conducted to investigate whether or not significant numbers of the stocked steelhead had remained in the river (Table 7). No population estimates were obtained. Four brown trout from 7-8" were caught, along with three chinook salmon parr and a few coho parr. A total of 298 steelhead parr from 1-9" were caught, along with one 24" adult steelhead. Of the 298 steelhead parr captured, 134 from 4-9" had right pectoral fin clips, indicating Orsini Hatchery origin. The majority of the steelhead parr larger than 6" had fin clips. The adult steelhead also had a right pectoral fin clip. Other species noted in the survey included sculpin, blacknose dace, white sucker, rock bass, green sunfish, pumpkinseed sunfish, and yellow perch. Water temperature was recorded as 63°.

2003

On August 12, 2003, another one-pass electrofishing survey was conducted, again to investigate whether or not significant numbers of the stocked steelhead had remained in the river (Table 7). Water temperature was recorded as 65° at 1:30 pm. As in 1998, no population estimates were obtained. A total of 22 brown trout were caught, ranging from 3-16" in length, along with one 6" brook trout, 68 chinook salmon parr from 2-4" in length, and 29 coho salmon parr, from 3-4" in length. One adult chinook salmon was also observed, but not captured. A total of 389 steelhead parr from 1-7" were collected, along with one 23" adult steelhead. Of the 389 steelhead parr captured, 141 bore right pectoral fin clips, indicating Orsini Hatchery origin. A total of 248 unclipped steelhead parr were caught, with many of those being YOY in the 1-3" range. The adult steelhead had dorsal-left ventral fin clips, indicating that it was a stray skamania (summer run) steelhead, from the 2001 Manistee River plant. The summer of 2003 was a cool, dry summer, which is likely the reason for the high number of naturally reproduced YOY steelhead seen in this survey.

Site 5-Psutka Rd.

This site was the most downstream site sampled in the 1996 survey. It is located about six miles west of the Village of Copemish, and is several miles downstream of Kurick Rd. Previous surveys of the area were conducted in 1957, 1965, 1968, 1971, 1974, and 1990. At this site, river width averages 46.5 feet, with 90% sand, 5% clay, and 5% gravel substrate in this 1,250 foot long station. During the 1996 survey, water temperature was 66° at 10:20 am. Habitat at this site was poor. The field notes indicate there is much less woody material and gravel here than at Kurick Rd. Gradient at this site was the lowest of any the five measured sites, at 2.6 ft/mile. There are no riffles in this station. This

site was planted with 1,921 yearling brown trout in the spring of 1996.

As with the other sites, the brown trout catch here was very poor. Only 12 brown trout up to 9" were captured, resulting in an estimated density of 1.92 lbs/acre (Table 3) and a numerical density of 11.28/acre (Table 4). Eleven of the twelve brown trout were yearlings, while one was two years of age. The rainbow trout catch was poor here as well. Thirty-three individuals up to 9" were captured, resulting in an estimated density of 6.46 lbs/acre. Of those, 23 individuals had right pectoral fin clips, so only ten of the rainbow trout encountered here were wild, with an estimated density of 0.49 lbs/acre. Four of those wild rainbow trout were in the two-inch class, indicating that they were young of the year. No salmon were observed here. Other species captured included creek chub, blacknose dace, sculpin, rock bass, white sucker, common shiners, johnny darter, and pumpkinseed sunfish.

The brown trout population at this site in 1990 was also very poor, with six individuals up to 8 inches captured (Hay, 1990). The rainbow trout catch improved slightly in 1996, as only 11 individuals were seen in 1990. A few coho and chinook smolts were also observed in 1990. Very few trout and even fewer holdover brown trout have ever been captured at this site during past surveys.

Age and Growth

Age and growth analysis was conducted on 43 brown trout and 82 rainbow trout caught during the 1996 survey (Table 5). Growth for age-1 rainbow and brown trout appears to be exceptional, but the majority of those fish were most likely recently stocked fish. Trout that are reared in hatcheries typically show excellent growth in their first year, while they are in the hatchery. However, the age-2 rainbow and brown trout captured in this survey grew slowly. Age-2 brown trout and rainbow trout were 1.4 inches and 0.8 inches below the state of Michigan average, respectively. This is not an unexpected result, as studies have shown that trout growth can be inhibited at high water temperatures. We hypothesize that the extremely hot summer of 1995 and the resulting high water temperatures inhibited growth of Betsie River brown and rainbow trout.

Analysis

The brown trout catch in the 1996 survey was poor and very few "holdover" (fish that have survived at least one full year since being planted) brown trout were captured. Although the brown trout catch from the 1990 survey was not good, more were captured than in 1996. This may have been due to the extremely hot and dry weather during the summer of 1995. Newcomb and Coon (1997) found that the mean summer water temperatures in the Betsie River were warmer in 1995 than in 1993-94 or in 1996. They reported that mean June, July, and August 1995 exceeded 20.7 ^{0}C (69.3 ^{0}F) throughout the river reach from Green Lake to below the former Thompsonville dam. Thus, plantings of brown trout upstream of the old Thompsonville Dam site have low prospects for significant survival (A. Nuhfer, MDNR, Hunt Creek Research Station, personal communication). Similarly, Newcomb and Coon (1997) found significant negative correlations between the summer densities of age-0 and age-1 steelhead parr and the mean and maximum summer temperature. For the 1990 and 1996 surveys, the Betsie River was at 4-11 brown trout/acre, while other Michigan trout streams (Jordan River, Boardman River, Au Sable River, etc.) often have densities greater than 500/acre (A. Nuhfer, MDNR, Hunt Creek Research Station, personal communication). Very few yearling brown trout stocked in the spring of 1995 survived to the summer of 1996. No yearling trout stocked in 1994 were captured in 1996 (Table 6). Percent survival from one year to the next for both the 1990 and 1996 sampling efforts is shown in Table 6. Unfortunately, in very hot summers like 1995, we may expect significant mortality on stocked brown trout, with few surviving to the next year. In years with normal weather, we should be able to provide a respectable fishery with some holdover and some trophy potential. By altering the stocking locations, densities, and the strain of brown trout stocked we may be able to improve the fishery. For example, the stretch of river between the confluence of Dair Creek and Homestead Dam has some of the coldest temperatures on the mainstem of the Betsie, and

may allow for better survival of stocked brown trout.

The catch of large numbers of juvenile Orsini Hatchery steelhead in the Betsie River in 1996, 1998, and 2003 (Table 7) indicates that the Orsini steelhead are not "smolting out" as they should. Typically, hatchery steelhead perform best when they smolt out within the first several months after stocking. According to Newcomb (1998), steelhead in the Betsie River typically smolt between early May and mid to late June. Therefore, any juvenile steelhead that have not left the river by late June will spend another full year in the river. In the Betsie River, this means that they will likely be subjected to temperature extremes and probably not survive. Therefore, strategies should be employed at the Orsini Hatchery to ensure that as many of the released juvenile steelhead successfully smolt out to Lake Michigan shortly after they are released from the hatchery.

Management Direction

Currently, Fisheries Division manages the 48 miles of the Betsie River below Grass Lake Dam for migratory Great Lakes trout and salmon and resident brown trout. Below the Grass Lake Dam, the Betsie River and its tributaries are Designated Trout Streams. Below Kurick Road in Manistee County, the Betsie River is currently regulated by Fisheries Division as a Type 4 stream, and is open to fishing all year. Minimum size limits for angler harvest are 8 inches for brook trout, 10 inches for all other trout and salmon species, except for Atlantic salmon, which must be 15 inches. Brook and brown trout or Atlantic salmon may not be harvested between September 30 and the last Saturday in April. Five fish may be kept per day, but only three of those may be 15 inches or larger. Rice Creek, Dair Creek, the Little Betsie River, and the Betsie River above Kurick Road are all regulated as Type 1 streams. Seasons for these waters follow the traditional trout season (last Saturday in April- September 30), and again, five fish may be harvested per day, but only three of those may be 15 inches or larger. Minimum size limits in Type 1 waters are 8 inches for brown and brook trout, and 10 inches for rainbow trout and other Pacific salmon species. In 2000, we moved the Type 4 boundary upstream to Wolf Rd., hoping to create more year-round fishing opportunity for steelhead anglers. However, due to public opposition, the boundary was moved back to Kurick Rd. in 2001.

The resident trout populations of the Betsie River will never rival those of other nearby rivers such as the Platte or Little Manistee. Salmonid survival and growth in the Betsie will continue to be limited by high summer temperatures, particularly in low-flow years. However, modifications to present stocking practices may improve the resident brown trout fishery and produce more trophy-sized individuals. We recommend that stockings be concentrated in thermally suitable areas identified by previous researchers (Newcomb, 1998; Newcomb and Coon 1997), and where holdover brown trout have been found in the past. Therefore, starting in 2001, stockings at Long Rd., Carmean Rd., and Psutka Rd. were discontinued. Plants at the five remaining sites (Black Bridge, Red Bridge, Orsini, Kurick Rd., and County Line Rd., Figure 4) were increased to 3,000 Seeforellen strain yearling brown trout per site. Also, one new stocking site was added.

Starting in 2002, 3,000 yearling brown trout were stocked at the M-115 crossing just downstream of the confluence with Dair Creek. This results in an overall stocking rate of 120 brown trout/acre in the Betsie River. In the past, Wild Rose strain brown trout were stocked in the Betsie River. According to Jim Dexter (MDNR, Plainwell, personal communication), Seeforellen strain brown trout have survived much better in southern Michigan trout streams that are limited by warm temperatures. Gilchrist Creek strain brown trout are unlikely to be adapted to survive well in warmer streams because their natal stream is cold (mean July 1995 water temperature was 62 ^{0}F). Moreover, their smaller size at planting requires that they survive about a year longer than the Seeforellen and Wild Rose strains before they grow to catchable size (Andy Nuhfer, MDNR Hunt Creek Research Station, personal communication). Therefore, when available, Seeforellen strain brown trout should be stocked

into the Betsie River. The results of changes to the stocking program will be monitored by conversing with anglers and by repeating the population estimate surveys of 1990 and 1996.

Possible causes for the perceived decline in steelhead fishing are unknown. The washout of Thompsonville Dam in 1989 gave steelhead access to the entire river, including the Little Betsie, thus spreading the run over a larger area. Reduced densities per unit of stream area presumably could reduce angler catch rates. Small steelhead released from the Orsini hatchery in some years in the early to mid 1990's may not have been large enough to smolt the year they were planted. Studies have shown that survival for stocked steelhead smolts is much higher when they are larger than 200 mm or 7.9 inches (Seelbach et al. 1994). In recent years however, the average size of the yearling steelhead planted by the Orsini hatchery has increased. Since 1998, steelhead smolts planted in the Betsie River have averaged over 7.0 inches long. The Orsini Hatchery should have a target size of 8.0 inches for steelhead smolts, even if it requires a reduction in the numbers of steelhead smolts raised and stocked. In an attempt to increase the average size of the stocked steelhead, the number of fish supplied to the Orsini Hatchery for the 2004 plant was reduced from 40,000 to 35,000. Hopefully, decreasing the density of steelhead in the raceways will allow them to grow to a larger size.

Another potential problem in the past with the Orsini Hatchery operation has been date of release. In many previous years, the Orsini steelhead were not released from the hatchery until mid-June. This may have been too late, dooming the juvenile steelhead to spend another entire year in the Betsie River, and thus possibly subjecting them to lethal temperatures. In 2003, the Orsini steelhead were released in mid-May, hopefully early enough so that at least those big enough successfully smolted out. In 2004, the Orsini steelhead will be released from the hatchery in early April. Interestingly enough, no hatchery steelhead larger than 7" were captured in the 2003 survey of the Kurick Road site (Table 7.). In the previous two surveys in 1996 and 1998, there were larger, 8 and 9 inch hatchery steelhead caught. Hopefully, the lack of larger hatchery steelhead in the 2003 survey indicated that they were released early enough, and that they successfully smolted out to Lake Michigan. Another management action that will help to assess the Orsini Hatchery program is fin clipping. Starting in 2005, the Orsini steelhead will be marked with their own individual fin clip, instead of the generic right pectoral fin clip used to mark all winter-run steelhead stocked into Michigan tributaries. This will help us assess the survival and return of the Orsini steelhead to the Betsie River.

Although the Orsini Hatchery operation has not been without problems, it should still be viewed as a successful cooperative venture with the Manistee County Sportfishing Association. In the early 1980s, the Betsie River was being planted with an average of about 20,000 steelhead fingerlings, and they were often very small, even as small as 3.2" in 1982. These stocked fish could not have provided much benefit to the Betsie River steelhead fishery. Also, recent research (Jory Jonas, MDNR, Charlevoix Research Station, unpublished data) has shown that steelhead imprint and return to several Michigan rivers much better when they are planted at upstream sites. In the Jonas study, fish planted at harbor sites had much higher straying rates. Michigan DNR hatchery personnel have monitored the condition of the Orsini steelhead in recent years (Martha Wolgamood, MDNR Wolf Lake Hatchery, personal communication) and the condition of the Orsini fish has been as good as from hatcheries operated by MDNR. In summary, the Orsini hatchery operation has allowed the Betsie River to be stocked with higher numbers of steelhead at an upstream site, which should provide better imprinting and homing to the river. Therefore, MDNR Fisheries Division will continue to supply the Orsini Hatchery with 35,000 fall fingerling steelhead annually. Fisheries Division will also fund up to $3,000 per cycle of the hatchery power needs as well as providing staff to inspect and review the Orsini hatchery capacity and operating conditions.

The perceived decline in steelhead fishing on the Betsie River may be just that, perception. It is entirely possible that steelhead fishing on the

Betsie has actually not declined, or was never really as good as some say. The available data seem to support this conclusion. According to Rakoczy and Rogers (1987, 1988, and 1990), total catch per hour for steelhead on the Betsie River below Homestead Dam was .0397 in 1986 (April-November), .0303 in 1987 (April-October), and .0270 in 1988 (April-October). While these catch rates are respectable, they are not exceptional. For example, in 1986, catch rates were higher in the Grand River (.0553), the Muskegon River (.0484), and the Bear River (.0428). In recent years, total catch per hour for steelhead on the Manistee River below Tippy Dam was .0419 in 1999 and .0418 in 2000 (Rakoczy, unpublished data). While fishing may have been good on the Betsie in those years, it does not appear to have been better than that on many other Michigan rivers, then or now. Michigan west coast steelhead runs and angler catch rates can be extremely variable from year to year. The run size and timing is dependent on many different factors, including weather, water temperature, rainfall, Lake Michigan conditions, and so on.

Fisheries Division personnel will continue to work with the BRWRC and the Conservation Resource Alliance to halt sand inputs from eroding streambanks and poorly constructed road/stream crossings. As sand inputs are eliminated, the focus of the BRWRC should turn to the installation of various types of habitat, including large woody material, lunker structures, boulders, and shading (tree planting). We should continue to maintain the sand trap at Kurick Rd. and should make sure it is emptied in a timely manner. The combined effects of reducing sand erosion, removing excess sand already in the channel, and tree plantings are management actions that will help reduce temperatures in the Betsie River. Streams with heavy sand bedloads tend to widen and become shallower, allowing them to warm at a faster rate. Fisheries Division personnel should also work with the BRWRC and CRA to interpret the results of the temperature study currently being conducted by those groups. Although the upper Betsie River is not presently suitable for year-round brown trout survival, habitat improvement work should still continue there. The upper Betsie River is much wider than it should be, most likely due to turn-of-the-century logging practices. Therefore, we should continue to work to narrow and deepen the channel as much as possible. This may help to moderate stream temperatures somewhat. Even as it is now, the upper Betsie River is moderate-gradient water with abundant gravel, which allows for outstanding natural reproduction of chinook salmon.

MDNR Wildlife Division is currently in the process of evaluating the function of the Grass Lake Flooding (Rich Earle, MDNR Wildlife Division, Traverse City, personal communication). If it is determined that the Grass Lake Flooding is not providing the appropriate benefits to wildlife populations, then we should work with Wildlife Division to remove the dam. While this will likely not drastically affect the watershed, it may moderate water temperatures somewhat in the upper Betsie River and allow for better survival of stocked trout and possibly some natural reproduction as well.

One other situation that needs to be addressed is the old Dair Mill site on Dair Creek. Sometime around 1900, a mill and dam were constructed on Dair Creek. The mill is long since gone, but half of the flow of Dair Creek continues to flow into the Betsie River through an artificial channel. This diminishes the flow in the natural channel of lower Dair Creek. The result is that steelhead may have difficulty accessing the upper portions of Dair Creek. Newcomb (1998) identified Dair Creek as critical spawning and rearing habitat for wild steelhead in the Betsie River. To remedy the situation, the artificial channel should be filled in and all the flow returned to the natural channel of Dair Creek. This will ensure that steelhead and other migratory salmonids will be able to access the upstream portions of Dair Creek.

Since a large portion of the Betsie River, Little Betsie River, and Dair Creek watersheds are within the Pere Marquette State Forest, Best Management Practices and Natural Rivers buffers need be followed by DNR Forest Management personnel when they propose timber harvests. Fisheries Division personnel should analyze and comment if necessary on

Forest Compartment Reviews that pertain to the Betsie River watershed. Forested areas along important tributary streams like Dair Creek, the Little Betsie River, and others should not be managed for young successional aspen. Instead, coniferous species should be encouraged, and Old-Growth designations pursued. Young aspen is a prime food source for beaver, and beavers have the potential to severely degrade and even completely block small streams like the Little Betsie River and Dair Creek. Newcomb (1997) identified these tributary streams as important contributors of cold water to the Betsie River, as well as critical producers of wild steelhead smolts. Therefore, every possible effort should be made to discourage beavers from colonizing and blocking these tributary streams. Beaver dams degrade small trout streams by blocking upstream fish migrations, warming the water, blocking woody debris and organic material downstream movements, and interfere with insect drift.

Fisheries Division personnel should also work with the Michigan Department of Environmental Quality to protect the Betsie River watershed from unwise land use and improper development. Improper development and poor land-use practices have the potential to further degrade the Betsie River (through increased runoff, less shade, more erosion at crossings, etc.). Newcomb (1997) found a negative relationship between spring flow and the number of age-0 steelhead present. Therefore, stormwater runoff from any new developments should not be allowed to enter the river. The larger tributaries, particularly the Little Betsie River and Dair Creek, are critical for wild steelhead reproduction. Newcomb (1998) also found that small tributaries and springs also provided good thermal refuge and habitat for juvenile steelhead. Therefore, all tributaries should be protected with extra diligence from improper land use and poor logging practices. Natural Rivers designation should also continue to help with this management goal.

References

Bonham, M. 1975. An assessment of the Betsie River trout population since rehabilitation in 1965. Michigan Department of Natural Resources, Fisheries Division, Lansing, Michigan.

Bonham, M. 1976. Betsie River water temperature study; Grass Lake wildlife flooding. Technical Report No. 76-2. Michigan Department of Natural Resources, Fisheries Division, Lansing, Michigan.

Fleming, K., and K. Kook. 1997. Evaluating streambank stabilization measures on the Betsie River. Conservation Resource Alliance, Traverse City, MI.

Gooding, M. P. 1995. A watershed classification scheme for lower Michigan. A Practicum Paper. University of Michigan. Ann Arbor. 36 pp.

Hay, R. L. 1990. Stream surveys: Betsie River, 1990. Michigan Department of Natural Resources, Fisheries Division. Cadillac, MI.

MDNR Wildlife Bureau. 1994. Gap Northern Lower Peninsula Landcover. MDNR Spatial Information Resources Center. Roscommon, MI.

Newcomb, T. J., and T. G. Coon. 1997. Assessment of management alternatives for altering the thermal regime of the Betsie River, Michigan. Fisheries Research Report 2047, Michigan Department of Natural Resources. Ann Arbor.

Newcomb, T. J. 1998. Productive capacity of the Betsie River watershed for steelhead smolts. Ph D. Dissertation, Michigan State University. East Lansing. 166 p.

Rakoczy, G. P., and R. D. Rogers. 1987. Sportfishing catch and effort from the Michigan waters of Lakes Michigan, Huron, and Erie, and their important tributary streams, April 1, 1986-March 31, 1987 (Appendices). Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report No. 87-6 a and b, Ann Arbor.

Rakoczy, G. P., and R. D. Rogers. 1988. Sportfishing catch and effort from the Michigan waters of Lakes Michigan, Huron, and Erie, and their important tributary streams, April 1, 1987-March 31, 1988 (Appendices). Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report No. 88-9 a and b, Ann Arbor.

Rakoczy, G. P., and R. D. Rogers. 1990. Sportfishing catch and effort from the Michigan waters of Lakes Michigan, Huron, and Erie, and their important tributary streams, April 1, 1988-March 31, 1989 (Appendices). Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report No. 90-2 a and b, Ann Arbor.

Seelbach, P. W., J. L. Dexter, and N. D. Ledet. 1994. Performance of steelhead smolts stocked in southern Michigan warmwater rivers. Fisheries Research Report 2003, Michigan Department of Natural Resources. Ann Arbor, MI.

Wicklund, R. G., and B. C. Dean. 1958. Betsie River Watershed: Survey and plans report. Michigan Department of Conservation, Fish Division, Lake and Stream Improvement Section. Lansing, MI.

Table 1.-Michigan DNR fish plantings into the Betsie River from 1980-2003.

Year	Species and Strain	Long Rd.	Carmean Rd.	King Rd.	Black Bridge	Red Bridge	Orsini	Kurick Rd.	Psutka Rd.	County Line Rd.	M-115	River Rd.	Frankfort
1980	Brown Trout	1,000	1,000		1,000			1,000	1,000	1,000	500		
	Rainbow Trout (MI steelhead)												20,000
1981	Brown Trout	1,000	1,000		1,000	1,000		1,000	1,000	1,000	500		8,400
	Rainbow Trout (MI steelhead)												20,004
1982	Brown Trout	1,400	1,400		1,400	1,400		1,500		1,500	750		
	BNT fall fingerlings												20,000
	Rainbow Trout (MI steelhead)												15,000
1983	Brown Trout	2,000	2,000		2,000	2,000		2,000		2,000	1,000		10,000
	BNT fall fingerlings												20,000
	Rainbow Trout (MI steelhead)												23,359
1984	Brown Trout	2,000	2,000		2,000	2,000		2,000	2,000	2,000	1,000		15,000
	BNT fall fingerlings												17,000
	Rainbow Trout (MI steelhead)												15,000
	RBT (Rogue R. steelhead)												8,000
1985	Brown Trout	1,910	1,910			1,910		1,810	1,810	1,810	810		11,300
	BNT fall fingerlings												20,000
	Rainbow Trout (MI steelhead)												13,000
1986	Brown Trout	1,930	1,930		1,930	1,930		1,850	1,850	1,850	850		15,000
	BNT fall fingerlings												20,000
	Rainbow Trout (Skamania)												20,001
1987	Brown Trout	1,940	1,940		1,940	1,940		1,880	1,880	1,880	880		14,900
	BNT fall fingerlings												11,500
	Rainbow Trout (Shasta, fall fingerlings)												4,560
	Rainbow Trout (Skamania)												17,500
1988	Brown Trout	2,000	2,000		2,000	2,000		2,000	2,000	2,000	1,000		15,000
	BNT fall fingerlings			10,000		10,000					10,000		
	Rainbow Trout (Skamania)												15,000

Table 1.-Continued

Year	Species and Strain	Long Rd.	Carmean Rd.	King Rd.	Black Bridge	Red Bridge	Orsini	Kurick Rd.	Psutka Rd.	County Line Rd.	M-115	River Rd.	Frankfort
1989	Brown Trout	2,000	2,000		2,000	2,000		2,000	2,000	2,000		1,000	15,000
	BNT fall fingerlings	14,000	14,000		14,000	14,000						14,000	57,000
	Rainbow Trout (MI steelhead fry)				110,875								
	Rainbow Trout (Skamania)				15,000							15,000	
1990	Brown Trout	2,000	2,000		2,000	2,000		2,000	2,000	1,999	1,000		14,998
	BNT fall fingerlings										10,000		
	Rainbow Trout (MI steelhead)											10,000	
	Rainbow Trout (Skamania)											10,360	
1991	Brown Trout	2,000	2,000		1,999	2,000		1,990	1,990	1,990	998		15,738
	Rainbow Trout (MI steelhead)						29,171						
	Rainbow Trout (Skamania)											10,000	
1992	Brown Trout (Wild Rose)	1,990	1,990		1,990	1,990		1,990	1,990	1,990	990		14,700
	Rainbow Trout (MI steelhead)						32,141						
1993	Brown Trout (Wild Rose)	2,000	2,000		2,000	2,000		2,000	2,000	2,000	1,000		14,900
	Rainbow Trout (MI steelhead)						44,125						
1994	Brown Trout (Wild Rose)	1,999	1,999		2,000	1,999		2,000	1,996	1,999	998		15,000
	Rainbow Trout (MI steelhead)						48,560						
1995	Brown Trout (Wild Rose)	1,970	1,970		1,970	1,970		1,940	1,940	1,940	940		14,900
	Rainbow Trout (MI steelhead)						49,206						
1996	Brown Trout (Wild Rose)	1,980	1,980		1,980	1,980		1,921	1,921	1,921	970		13,500
	Rainbow Trout (MI steelhead)						54,916						
1997	Brown Trout (Wild Rose)	2,057	2,058		2,058	2,060	1,058	2,059	2,059	2,058			14,170
	Rainbow Trout (MI steelhead)						49,279						
1998	Brown Trout (Wild Rose)	1,990	1,990		1,975	1,990	980	1,980	1,980	1,980			14,500
	Rainbow Trout (MI steelhead)						38,700						
1999	Brown Trout (Wild Rose)						1,000	2,000	2,000	2,000			
	Brown Trout (Gilchrist Creek)	2,000	2,000		2,000	2,000							
	Brown Trout (Seeforellen)												15,000
	Rainbow Trout (MI steelhead)						38,700						

Table 1.-Continued

Year	Species and Strain	Long Rd.	Carmean Rd.	King Rd.	Black Bridge	Red Bridge	Orsini	Kurick Rd.	Psutka Rd.	County Line Rd.	M-115	River Rd.	Frankfort
2000	Brown Trout (Wild Rose)	2,100	2,100		2,100	2,100	1,100	2,100	2,100	2,100			20,000
	Rainbow Trout (MI steelhead)						39,991						
2001	Brown Trout (Wild Rose)												15,800
	Brown Trout (Seeforellen)				3,070	3,070	3,070	3,070		3,070			
	Rainbow Trout (MI steelhead)						39,400						
2002	Brown Trout (Wild Rose)												15,800
	Brown Trout (Gilchrist Creek)				3,040	3,040	3,040	3,040		3,040	3,040		
	Rainbow Trout (MI steelhead)						38,560						
2003	Brown Trout (Wild Rose)				3,050	3,050	3,050	3,050		3,050	3,050		15,500
	Rainbow Trout (MI steelhead)						38,725						

Table 2.-Orsini Hatchery Steelhead Production, 1991-2003

Year	# Stocked	Size (cm)	Size (inches)
1991	29,171	17.4	6.9
1992	32,141	20.4	8.0
1993	44,125	15.2	6.0
1994	48,560	13.7	5.4
1995	49,206	17.6	6.9
1996	54,916	15.5	6.1
1997	49,279	16.8	6.6
1998	38,700	17.8	7.0
1999	40,400	18.3	7.2
2000	39,991	18.2	7.2
2001	39,400	17.4	6.9
2002	38,560	18.5	7.3
2003	38,725	16.7	6.6

Table 3.-1990 and 1996 Betsie River salmonid population estimates, in lbs/acre.

	Brown trout	Rainbow trout	Coho salmon	Chinook salmon
King Rd.				
1990	1.7	0.23	None obs.	**
1996	1.93	3.94	0.01	0.01
Lindy Rd.				
1990	14.1	0.3	None obs.	None obs.
1996	1.03	4.04	0.01	0.15
Kurick Rd.				
1990	7.9	4.6	2.8	None obs.
1996	1.48	53.8*	None obs.	0.05
Psutka Rd.				
1990	0.8	1.5	0.4	**
1996	1.92	6.46	None obs.	None obs.
Homestead Dam				
1990	0.9	0.7	**	**
1996				

* Many of the rainbow trout captured at this station had right pectoral fin clips and were most likely stocked from the Orsini Hatchery.

** Indicates that although a few individuals were observed at the station, not enough were captured for a reliable estimate.

Table 4.-1990 and 1996 Betsie River salmonid population estimates, in number/acre.

	Brown trout	Rainbow trout	Coho salmon	Chinook salmon
King Rd.				
1990	11.9	4.0	None obs.	0.5
1996	7.92	55.45	0.99	0.99
Lindy Rd.				
1990	64.9	9.5	None obs.	None obs.
1996	4.05	60.17	0.68	10.14
Kurick Rd.				
1990	25.3	236.4	149.3	None obs.
1996	9.74	624.68*	None obs.	3.25
Psutka Rd.				
1990	6.8	9.8	97.7	2.3
1996	11.28	41.6	None obs.	None obs.
Homestead Dam				
1990	2.2	49.3	1.8	**
1996				

* Many of the rainbow trout captured at this station had right pectoral fin clips and were most likely stocked from the Orsini Hatchery.

** Indicates that although a few individuals were observed at the station, not enough were captured for a reliable estimate.

Table 5.-Average total length (inches) at age, and growth relative to the state average, for fish sampled from the Betsie River during August, 1996.

Species	Age Group	Number of fish	Length range in inches	Mean length in inches	State average length	Growth index* (by age group)
Brown trout	I	38	6.4-10.1	8.1	6.2	1.8
	II	5	7.1-9.1	7.8	9.2	-1.4
Rainbow trout	I	75	4.3-9.1	6.5	5.7	0.8
	II	7	7.0-9.1	7.9	8.7	-0.8
Rock bass	I	9	2.7-4.2	3.3	3.5	-0.2
	II	1	5.8	5.8	4.8	
	V	1	8.8	8.8	10	

* Growth index is the deviation from the state average length.

Table 6.-Betsie River brown trout numbers by age, percent by age, and annual survival. Data were combined for 4 stations where populations were estimated in 1990 and 1996.

Betsie River brown trout numbers by age group for 4 stations where populations were estimated in 1990 and 1996.								
	Number by age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6+**	Total number
1990	3.0	172.6	10.6	1.5	1.0	0.0	4.0	192.7
1996	0.0	45.7	7.0	0.0	0.0	0.0	0.0	52.7
Betsie River brown trout percent of population by age group for 4 stations where populations were estimated in 1990 and 1996.								
	Percent by age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6+**	Total Percent
1990	1.6	89.6	5.5	0.8	0.5	0.0	2.1	100
1996	0.0	86.7	13.3	0.0	0.0	0.0	0.0	100
Percent survival to the next age (assumming uniform recruitment)								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6+**	
1990		6.2	14.1	66.7	0.0			
1996		15.3	0.0					

***Note: Brown trout scales from South Branch Au Sable used for inch groups that had no readable scales.**

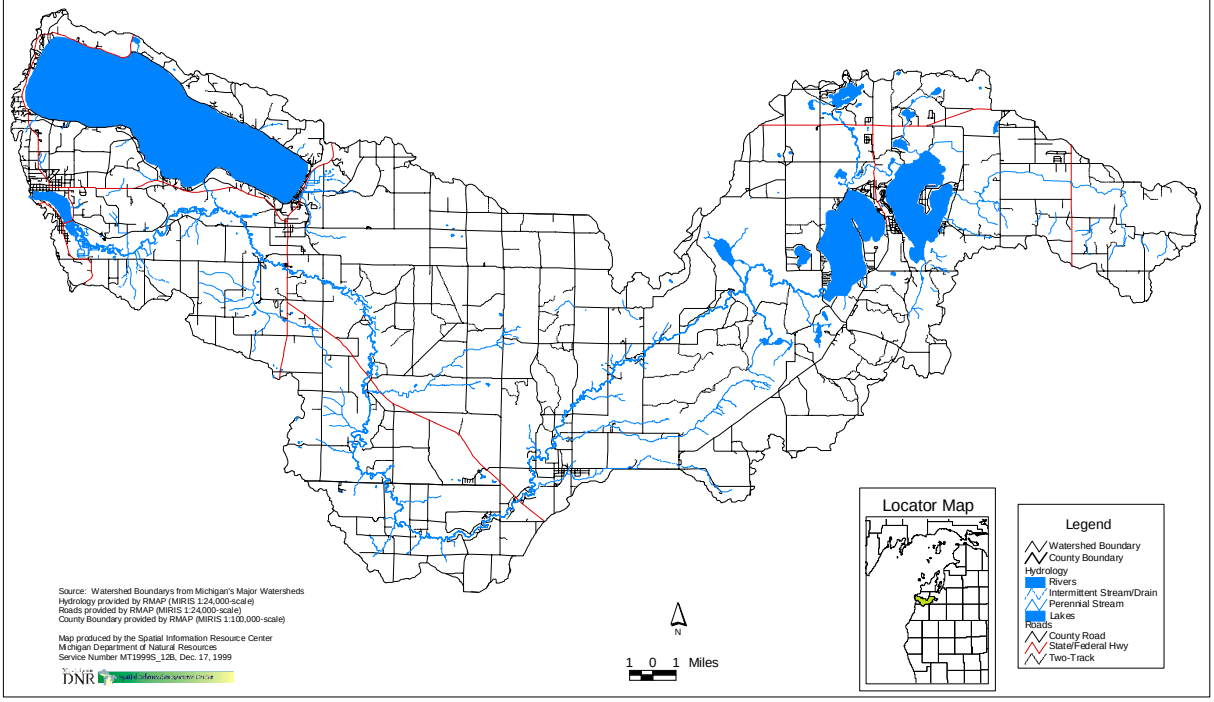
Table 7.-Catch of brown trout and juvenile steelhead from sampling at the Kurick Road station.

1996 Marking run only	Inch Class	# Brown trout	# Steelhead (RP)	# Steelhead (no clip)	# Brook trout
	1"			6	
	2"			21	
	3"			8	
	4"		9	5	
	5"		51	16	
	6"	3	81	6	
	7"	6	52		
	8"	1	12		
	9"		1		
Total		10	206	62	0

1998	Inch Class	# Brown trout	# Steelhead (RP)	# Steelhead (no clip)	# Brook trout
	1"			8	
	2"			69	
	3"			46	
	4"		1	6	
	5"		12	17	
	6"		35	16	
	7"	1	60	2	
	8"	3	22		
	9"		4		
Total		4	134	164	0

2003	Inch Class	# Brown trout	# Steelhead (RP)	# Steelhead (no clip)	# Brook trout
	1"			30	
	2"			125	
	3"	4		48	
	4"		12	4	
	5"		57	30	
	6"		52	8	1
	7"	5	20	3	
	8"	8			
	9"	4			
	16"	1			
Total		22	141	163	1

Figure 1. Betsie River Watershed



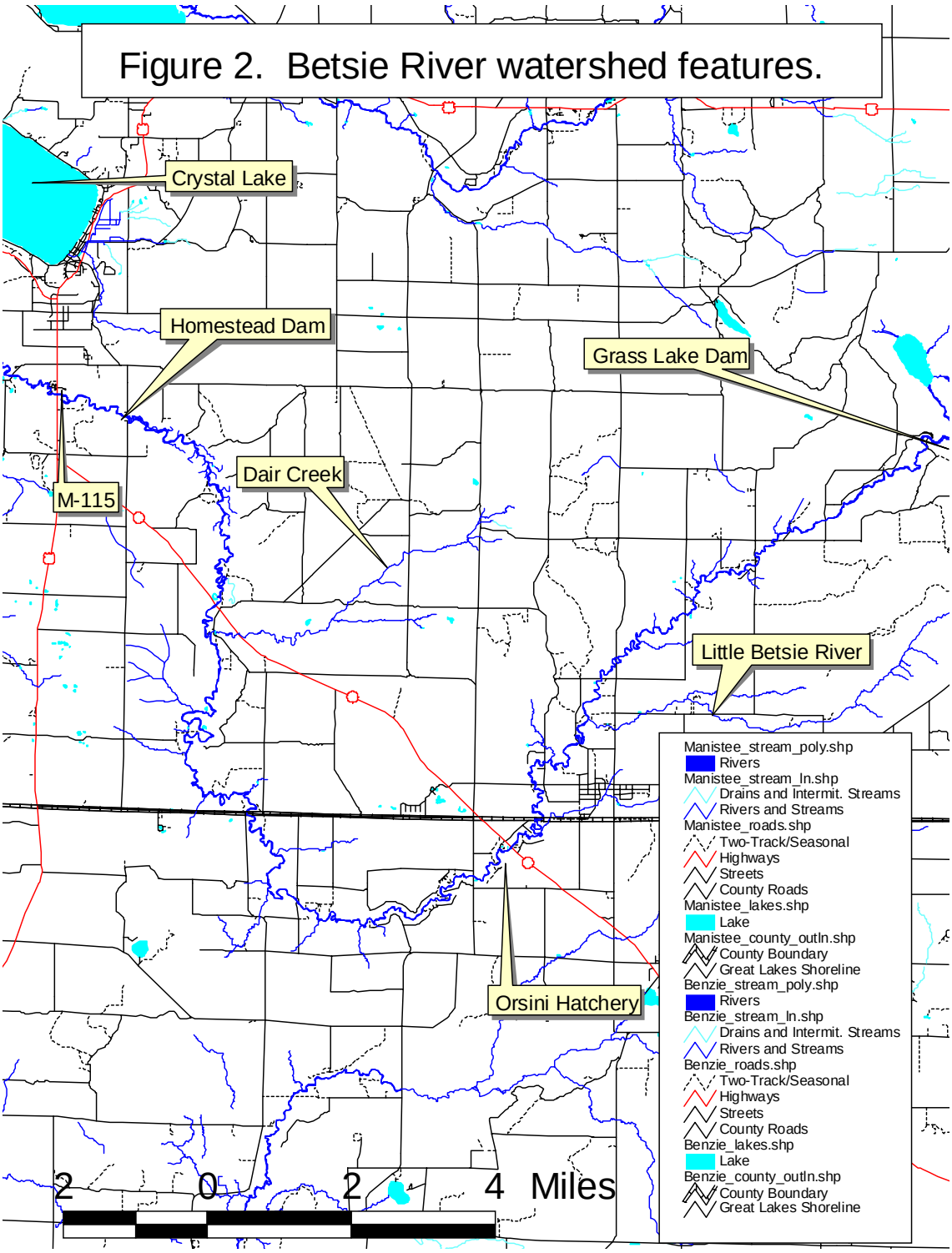
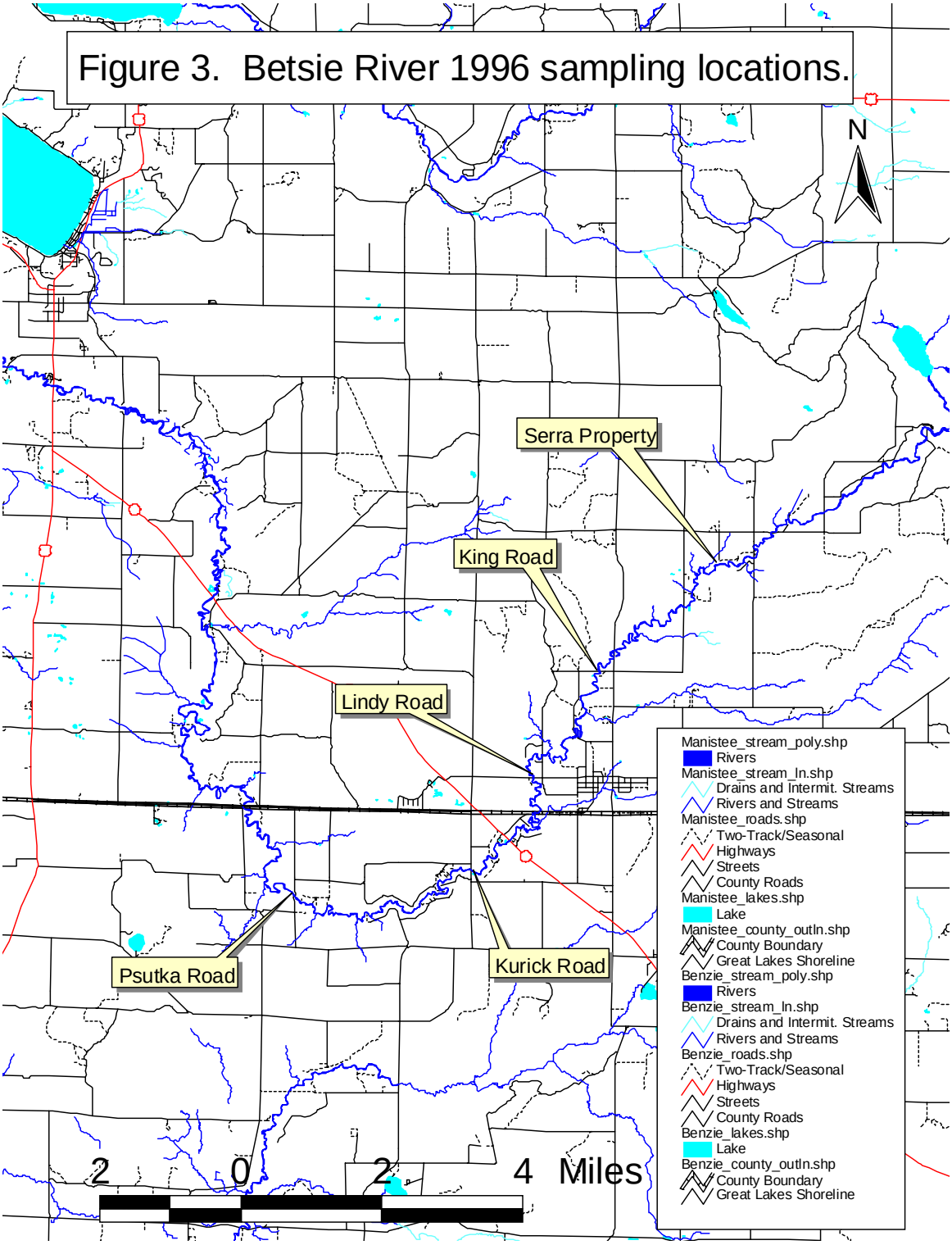


Figure 2. Betsie River watershed features.
Crystal Lake
Homestead Dam
Grass Lake Dam
Dair Creek
M-115
Little Betsie River
Orsini Hatchery
Manistee_stream_poly.shp
Rivers
Manistee_stream_ln.shp
Drains and Intermit. Streams
Rivers and Streams
Manistee_roads.shp
Two-Track/Seasonal
Highways
Streets
County Roads
Manistee_lakes.shp
Lake
Manistee_county_outln.shp
County Boundary
Great Lakes Shoreline
Benzie_stream_poly.shp
Rivers
Benzie_stream_ln.shp
Drains and Intermit. Streams
Rivers and Streams
Benzie_roads.shp
Two-Track/Seasonal
Highways
Streets
County Roads
Benzie_lakes.shp
Lake
Benzie_county_outln.shp
County Boundary
Great Lakes Shoreline
2 0 2 4 Miles

Figure 3. Betsie River 1996 sampling locations.



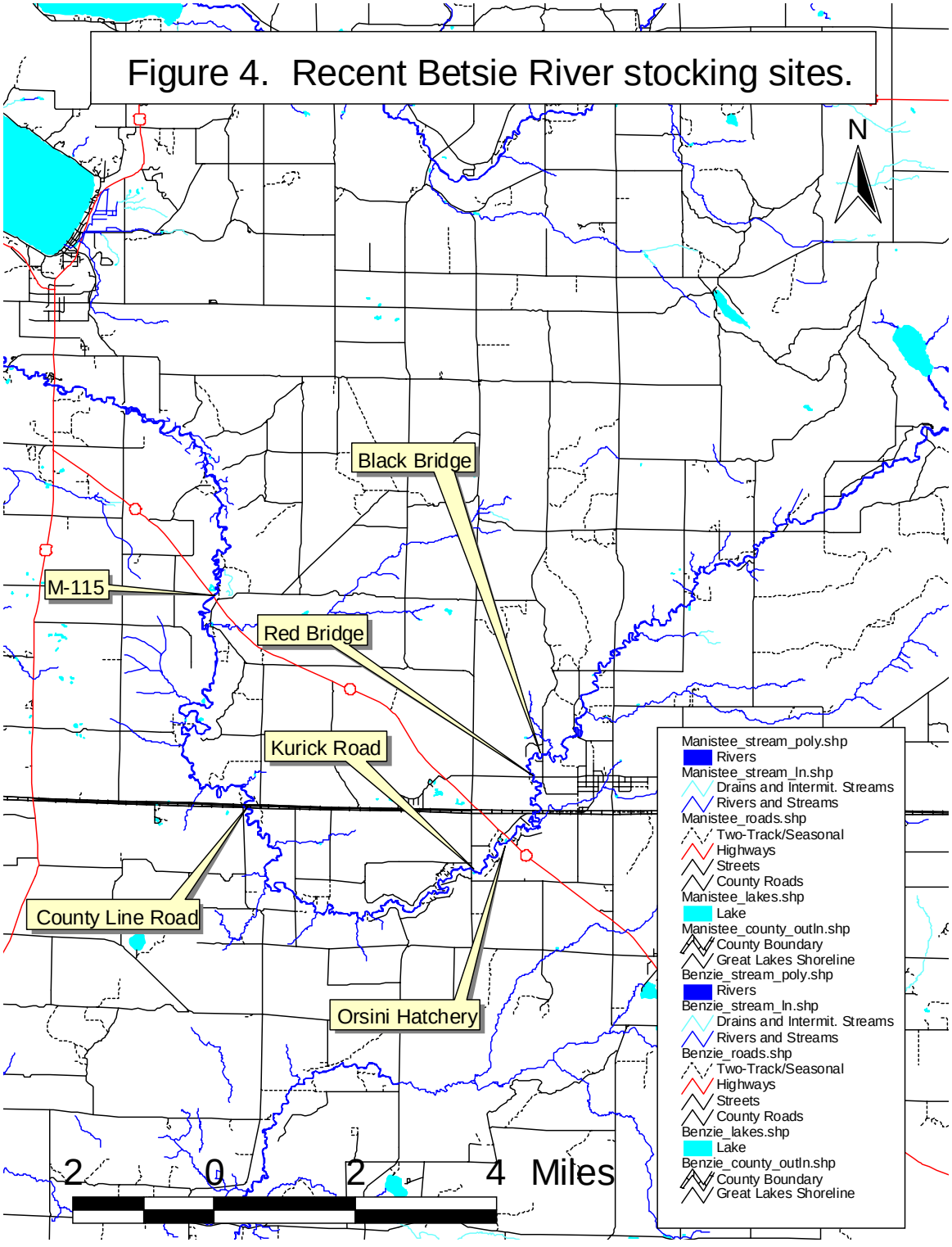


Figure 4. Recent Betsie River stocking sites.
N
Black Bridge
M-115
Red Bridge
Kurick Road
County Line Road
Orsini Hatchery
Manistee_stream_poly.shp
Rivers
Manistee_stream_ln.shp
Drains and Intermit. Streams
Rivers and Streams
Manistee_roads.shp
Two-Track/Seasonal
Highways
Streets
County Roads
Manistee_lakes.shp
Lake
Manistee_county_outln.shp
County Boundary
Great Lakes Shoreline
Benzie_stream_poly.shp
Rivers
Benzie_stream_ln.shp
Drains and Intermit. Streams
Rivers and Streams
Benzie_roads.shp
Two-Track/Seasonal
Highways
Streets
County Roads
Benzie_lakes.shp
Lake
Benzie_county_outln.shp
County Boundary
Great Lakes Shoreline
2 0 2 4 Miles