BOARDMAN RIVER FEASIBILITY STUDY
A Report on the Boardman River Fisheries Existing Data

August 2007

Submitted by:

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ACKNOWLEDGMENTS

We would like to acknowledge the U.S. Department of Interior, Fish and Wildlife Service, for funding this important work through a Tribal Wildlife Grant provided to the Grand Traverse Band of Ottawa and Chippewa Indians.

Finally, the project team would like to thank the following organizations for their assistance and for providing critical data that was used in the preparation of this report:

- Grand Traverse Band of Ottawa and Chippewa Indians (GTB)
- Michigan Department of Natural Resources – Fish Division (MDNR)
- Michigan Department of Environmental Quality – Water Bureau (MDEQ)
- Michigan State University, Department of Fisheries & Wildlife (MSUFW)
- United States Fish and Wildlife Service (USFWS),
- Watershed Center Grand Traverse Bay (WCGTB)

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PURPOSE

As part of the Work Order #2, an ECT effort for the Grand Traverse Band of Ottawa and Chippewa Indians, existing data on Boardman River fisheries was sought out, collected, cataloged, summarized, and discussed in the context of its adequacy in evaluating alternatives for the fates of the Boardman River dams.

EXECUTIVE SUMMARY

The Boardman River is a high quality coldwater trout stream in the North and South Branches. From the confluence of the two branches, the mainstem Boardman downstream to the Brown Bridge Dam impoundment is also a coldwater, high quality trout stream with high densities of brown and brook trout. Brown Bridge Dam impoundment supports a good warmwater fishery, and elevates the water temperature in the Boardman River downstream of the dam. The consequence of the warmer temperature is lower densities of trout. Brown trout are still relatively common downstream to the Boardman Dam impoundment, though at approximately half the density as upstream of Brown Bridge Dam. Trout in this zone, as well as upstream of Brown Bridge Dam impoundment exhibit good reproduction and average growth, but few individuals of older ages and larger sizes are present. Boardman Dam impoundment supports a fair-poor warmwater fishery, and Sabin Dam provides a poor fishery. Below Sabin Dam water temperatures become sub-optimal for coldwater fishes. Brook trout are absent and brown trout are found in very low densities, but exhibit above average growth with large individuals present. Union Street Dam impoundment provides both warm and coolwater fisheries, and is in part a natural lake. Union Street Dam allows selective fish passage for species such as salmon and steelhead. Downstream of Union Street Dam, rigorous fisheries surveys are absent. Sea lamprey are present and controlled by the USFWS, and lake sturgeon have been confirmed to use this river segment. Kids Creek (also known as Hospital Creek), a significant tributary to this section of river, provides habitat for some trout and salmon and optimal conditions for larval sea lamprey.

Currently, sufficient fisheries surveys exist (or are planned for collection) for all pertinent river segments of the Boardman River, with the possible exception of the segment downstream Union Street Dam. Information on water quality parameters of interest to fisheries, principally water temperature data, is also sufficient for purposes of preliminarily informing the Boardman River Dams Committee's decision making process. A possible exception might include water temperature profiles of the reservoirs, to estimate the abundance of cold hypolimnion waters, which would be needed if certain dams with negative temperature impacts to the river were deemed desirable to be maintained. The most essential void in current existing data on the Boardman River, is information on stream morphology. This information is absent for a vast majority of the river, and is crucial to understanding the quality of fisheries habitat present, and for predicting the likely outcomes of various dam management alternatives. Highest priority for future data collection should be afforded to this data need.

Several possible fishery management issues will likely arise as part of the Boardman River Dams decision making process. In order to facilitate a discussion and resolution of these issues, several are identified and discussed; including the value of river versus impoundment fisheries, the interaction between stream trout and Great Lakes salmon and steelhead, and their anglers, lake sturgeon restoration potential, and aquatic invasive species management, including sea lamprey.

Part I. Review of Existing Data on Boardman River Fisheries

Section A. Summary of Data Sources

Fourteen individuals from various state and federal agencies, businesses, non-profit conservation groups, and universities were identified as possible candidates for possessing existing fisheries data for the Boardman River. These potential data sources included the Michigan Department of Natural Resources –

Fish Division (MDNR), MI Department of Environmental Quality – Water Bureau (MDEQ), United States Fish and Wildlife Service (USFWS), MI Natural Features Inventory, Michigan State University Extension, Northwestern Michigan College – Great Lakes Campus, Grand Traverse Band of Ottawa and Chippewa Indians (GTB), Boardman River Project, Conservation Resource Alliance, Watershed Center Grand Traverse Bay (WCGTB), Land Information Access Association, and the Great Lakes Environmental Center. Information on the contact with each potential data source is recorded and contained in the Boardman River Fisheries Database, included electronically with this report. Ultimately, the MDNR, USFWS, GTB, MDEQ, and WCGTB contributed data to aid in the evaluation of Boardman River fisheries conditions. All data files acquired are archived in the Boardman River Dams fisheries database included electronically with this report.

The MDNR was in possession of the majority of fisheries data available, including; fish density estimates, age & growth data for trout sampled at nine locations within the Boardman River and one at Boardman Lake, a list of all fish species distributions sampled in the entire Boardman River watershed from earliest record through present times, a listing of all fish stocking efforts in the river, water temperature information sampled at 10 locations within the Boardman River, and stream morphology, "fish habitat", data from one survey location on the river. This information was partly from historic sampling efforts, and partly from recent sampling efforts aimed at providing information to assist with the Boardman River Dams effort. The USFWS contributed; information on water temperature and the abundance and timing of adult spawning sea lampreys at the Union Street Dam from April – June each year from 1978 – 2006, aquatic species occurrences in the Boardman River Watershed sampled during targeted sea lamprey searches from 1960 – 2006 (only downstream of Union Street Dam during recent years), a survey of fish habitat conditions in the lower Boardman River (downstream of Union Street Dam) and in Hospital Creek, and a list of sea lamprey control treatments conducted in the Boardman River Watershed. The GTB contributed data from a 2000 fisheries survey of Boardman Lake, and 2007 fisheries assessments of Brown Bridge Pond, Boardman (Keystone) Pond, and Sabin Pond. The MDEQ provided; a report of sampling conducted in 1998 on the upper Boardman River (North and South Branches) and selected tributaries to the mainstem of the Boardman River – including macroinvertebrate, water quality, and some 1998 fisheries information, and macroinvertebrate and habitat data colleted from the upper Boardman River and selected tributaries on the mainstem of the Boardman River. The WCGTB did not possess data directly on fish in the Boardman River, but did contribute the following data that may be of use in evaluating the quality of fish habitat in the river; habitat quality rankings from aquatic macroinvertebrate sampling for selected tributaries to the Boardman River, a database of archived water quality information collected on the Boardman River, a Boardman Lake (Union Street Dam impoundment) watershed study which included data from aquatic macroinvertebrate sampling.

In 1999, fish, macroinvertebrates, stream channel morphology, and water quality variables were quantitatively sampled as part of a thesis by Joanna Lessard and Dr. Daniel Hayes, in the Department of Fisheries & Wildlife, at Michigan State University (MSUFW). Surveys were conducted at multiple transects, at three sites downstream of Brown Bridge Dam, and three sites upstream of the Brown Bridge Dam impoundment, in an attempt to document the effects of Brown Bridge Dam on the Boardman River (full thesis is available through Michigan State University library and the Department of Fisheries & Wildlife).

Section B. Description of Boardman River Fisheries

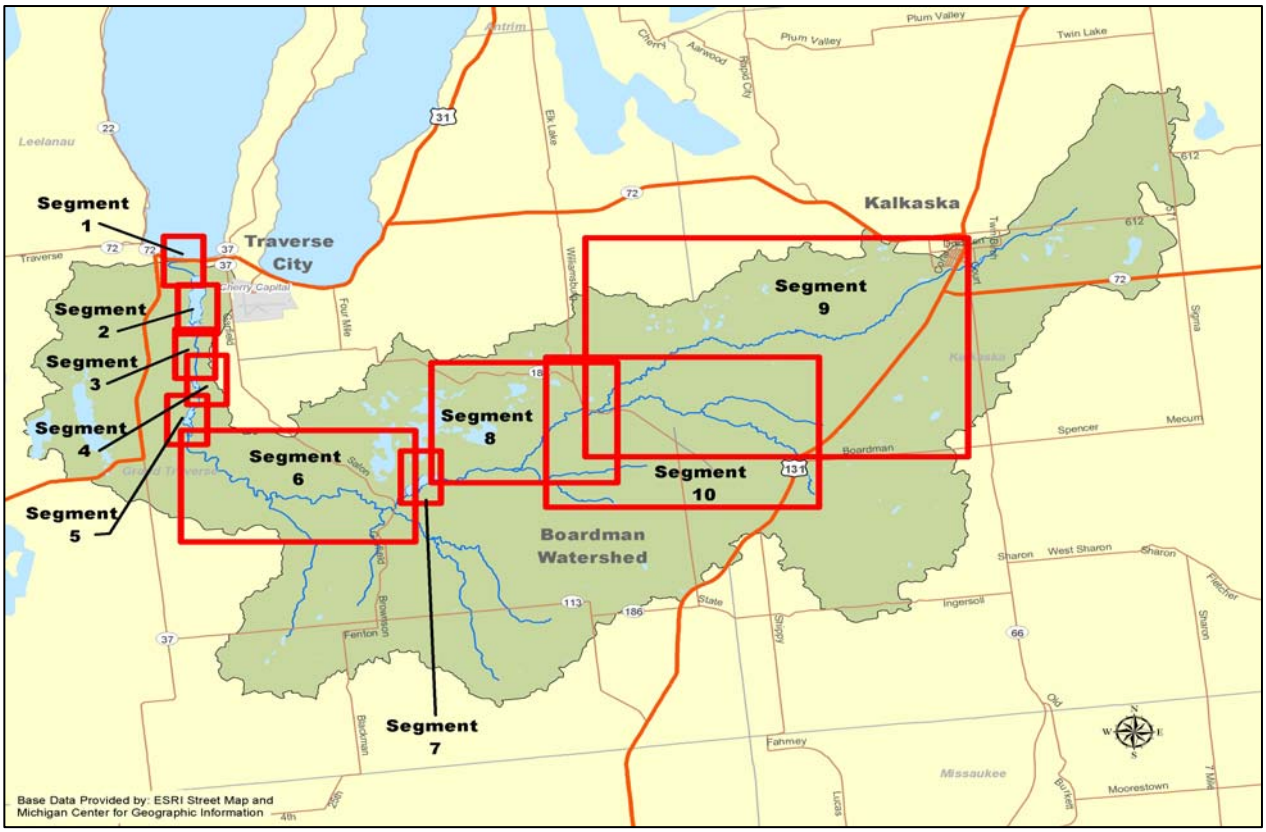
For purposes of disseminating the existing data in a framework useful for identifying gaps in essential data and evaluating alternative fates of the Boardman River Dams, in this report the Boardman River is divided

into 10 segments. These segments are based on the spatial extents of impacts of the dams, and possible spatial extents of impacts from dam management alternatives (Table 1).

Table 1. Descriptions of the 10 spatial segments of the Boardman River, in relation to fisheries and spatial extents of impact from the Boardman River Dams.

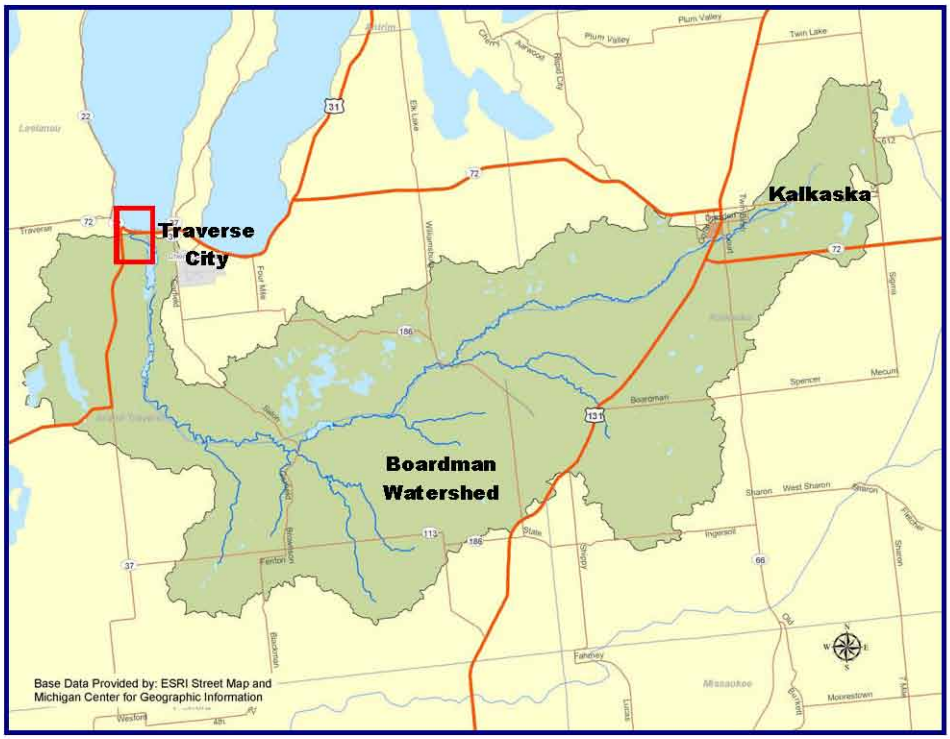
Segment #	Description
1	From Union Street Dam downstream to Lake Michigan, and Hospital (Kids) Creek
2	Union Street Dam impoundment, also known as Boardman Lake
3	From Sabin Dam downstream to Union Street Dam impoundment, or Boardman Lake
4	Sabin Dam impoundment, also known as Sabin Pond, upstream to Boardman Dam
5	Boardman Dam impoundment, also known as Boardman Pond or Keystone Pond
6	From Brown Bridge Dam downstream to Boardman Dam impoundment
7	Brown Bridge Dam impoundment, also known as Brown Bridge Pond
8	From the confluence of the North and South Branches of the Boardman River, also known as the Forks, downstream to the Brown Bridge Dam impoundment
9	North Branch of the Boardman River
10	South Branch of the Boardman River

Figure 1. Location of Segments 1-10 Along the Boardman River
Division of the Boardman into distinct segments is required for modeling and facilitates identification of appropriate input data.



Fisheries surveys of the Boardman River reservoirs gathered estimates of relative abundance, not absolute estimates of fish population densities. This is normal protocol given the difficulty involved with conducting absolute fish density estimates on reservoirs. These surveys result in measures of the number of fish caught per amount of effort spent sampling. This is referred to as catch per unit effort (CPUE), and is usually presented as the number of fish of a species captured per hour of electroshock sampling, or per one night of a net being deployed. By using the same unit of effort, CPUE's between different lakes or reservoirs can ideally be used to place relative rankings on the abundance of fish in a given waterbody. However, many variables factor into the efficiency of sampling gears, and influence the comparability of CPUE's between sampling events, sampling gears, and different waterbodies. Additionally, the MDNR has only recently initiated a statistically valid statewide sampling program for Michigan's lakes and reservoirs (Status & Trends Program). This program will eventually allow comparison of fish relative abundances from a particular waterbody, with the distribution of relative abundances from the entire state. However, at this date, that capability is not yet available. Furthermore, research is also not available that links the relative abundance of fish sampled during fishery surveys, with the perceived "quality" of a fishery experienced by anglers. Many variables would also affect this, including the "catchability" of the fish present. For all of these reasons, it remains difficult to assess a ranking of quality to a reservoir fishery given only relative abundances from fishery surveys. In this report, the professional opinions of several experienced fisheries biologists were consulted in order to provide at least a precursory qualitative ranking of the quality of fishery that exists in each Boardman River reservoir.

Figure 2



Segment 1:
From Union Street Dam downstream to Lake Michigan and Hospital (Kids) Creek

Segment 1

Habitat

Stream morphology conditions were surveyed by the USFWS for Segment 1 of the Boardman River and Kids (Hospital) Creek, a significant tributary of the Boardman River in this river segment. Three general types of conditions were described on the basis of their suitability for larval sea lamprey, and the abundance of each type was measured. Type I is indicative of depositional hydraulic environments where stream velocities are generally slow (<0.16 ft/s) and the streambed consists primarily of silt, with sand and detritus as secondary components. Densities of larval sea lamprey are highest in this habitat type. Type II is indicative of transitional environments with intermediate water velocity (0.16 to 0.33 ft/s), and the streambed consists primarily of medium and coarse sand. Amounts of silt and detritus decline, while those of gravel and rubble increase. Type III is indicative of erosional hydraulic environments, such as in riffle areas or in the thalweg of the stream, where velocity (>0.33 ft/s) and bottom characteristics restrict the deposition of fine particles and streambed substrate is primarily hard substrates such as gravel, rubble, hardpan clay, or bedrock. Type III habitat may occasionally harbor larval sea lamprey, but is generally poor habitat because it restricts burrowing of the larvae. The Boardman River downstream of Union Street Dam was found to be 1% Type I habitat, 83% Type II, 16% Type III, and had a mean infested area of approximately 7.5 acres. Hospital Creek, also accessible to sea lamprey, was 21% Type I habitat, 69% Type II, 10% Type III, with a mean infested area of approximately 5.5 acres.

Information on the quality of the macroinvertebrate community and habitat conditions in this river segment were provided by the WCGTB, in 2003, for a location near the Hannah Park, using MDEQ's Procedure 51 methodology. The macroinvertebrate community received a rating of "acceptable, tending toward poor", and the habitat conditions were rated as "good". Similar samples were collected for various locations on Kids Creek, with macroinvertebrates rating "poor" and habitat rating "marginal".

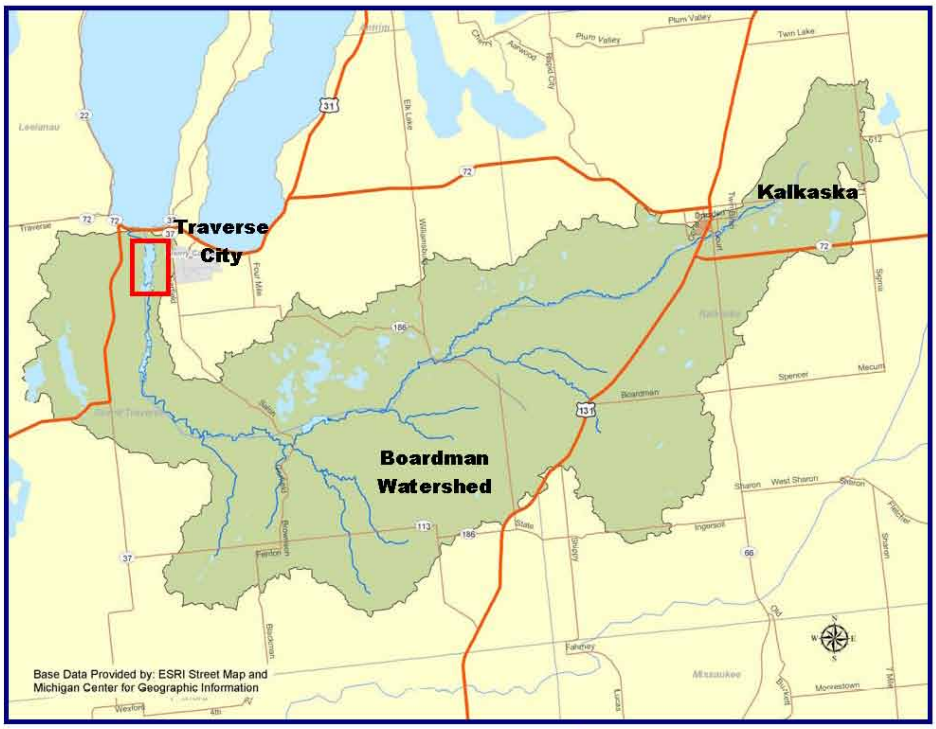
Fisheries

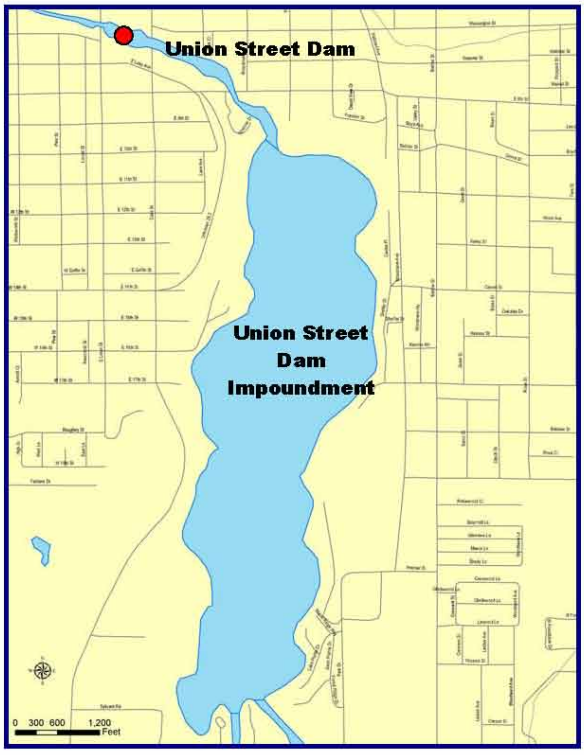
Fish species sampled in this segment of the Boardman River include: American brook lamprey, banded killifish, blacknose dace, bluntnose minnow, brook stickleback, brook trout, brown trout, Chinook salmon, coho salmon, common carp, creek chub, goldfish, Iowa darter, lake sturgeon, rainbow trout, rock bass, round goby, sea lamprey, smallmouth bass and yellow perch.

The MDNR has been annually stocking this segment of the river with approximately 15,000 – 20,000 rainbow trout (steelhead) yearlings, and approximately 70,000 – 100,000 coho salmon yearlings. Additionally, Kids or Hospital Creek receives approximately 150,000 – 300,000 chinook salmon fingerlings.

From 2002 – 2006, between 244 – 506 adult spawning phase sea lamprey were captured annually in traps located downstream of Union Street Dam in April, May and June. Water temperatures measured at the trap site indicated that water temperatures were already approaching marginal levels for coldwater fish (>70° F) by June. Both the Boardman River downstream of Union Street Dam, and Hospital Creek are treated for sea lamprey approximately every five years. Treatments were administered in 1980, 1987, 1991, 1996, 2001, and 2006.

Figure 3





Segment 2:
Union Street Dam impoundment, also known as Boardman Lake

Segment 2

Habitat

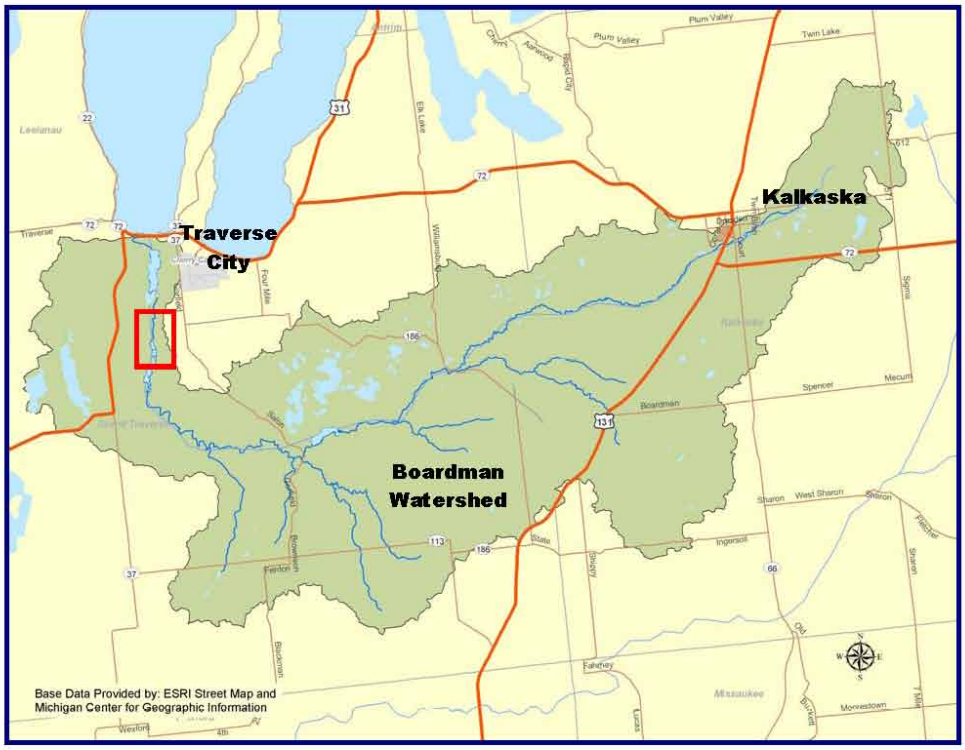
Benthic macroinvertebrate samples collected at various locations in Boardman Lake, were reported in a 2003 report on the Boardman Lake watershed, available through the WCGTB. These samples indicated the macroinvertebrate community was dominated by zebra mussels at a majority of the sample locations.

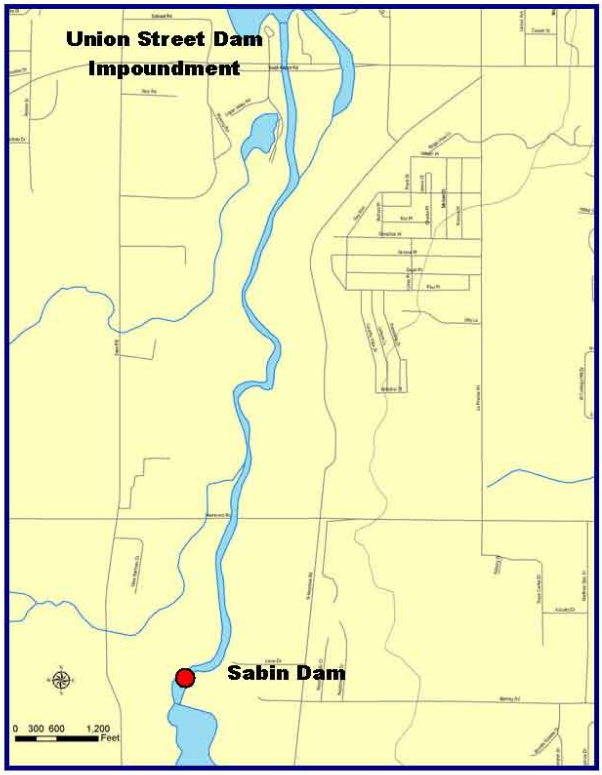
Fisheries

Fish species sampled in this segment of the Boardman River include: black bullhead, black crappie, bluegill, bluntnose minnow, brown bullhead, brown trout, common shiner, grass pickerel, Iowa darter, Johnny darter, largemouth bass, northern pike, pumpkinseed sunfish, rainbow trout, rock bass, sand shiner, sculpins, smallmouth bass, walleye, white sucker, and yellow perch.

In March and April 2000, the GTB conducted three electrofishing surveys of Boardman Lake. The fish species sampled were walleye, northern pike, smallmouth and largemouth bass, yellow perch and rainbow trout. Only walleye and northern pike were captured in significant numbers, and their average relative abundance (number caught per hour of boat electrofishing) was; walleye = 7/hr, and northern pike = 4.8/hr. In 2003, the MDNR conducted fishery surveys on Boardman Lake using multiple net types and electrofishing gear. The most abundant species sampled were rock bass, juvenile white suckers, smallmouth bass, northern pike, walleye, and yellow perch. The yellow perch and northern pike both exhibited good growth rates, but few large individuals of either species were sampled. Eighteen of the 78 smallmouth bass sampled were of legal length (14") or greater, and 8 out of 70 walleye sampled were 15" or greater in length. Boardman Lake provides a sportfishery for 4 species of popular gamefish, produces low to moderate relative abundances of those species, and relatively low proportions of those species of legal size or greater. It therefore appears to be provide a fair – average coolwater fishery.

Figure 4





Segment 3:
From Sabin Dam downstream to Union Street Dam impoundment, or Boardman Lake

Segment 3

Habitat

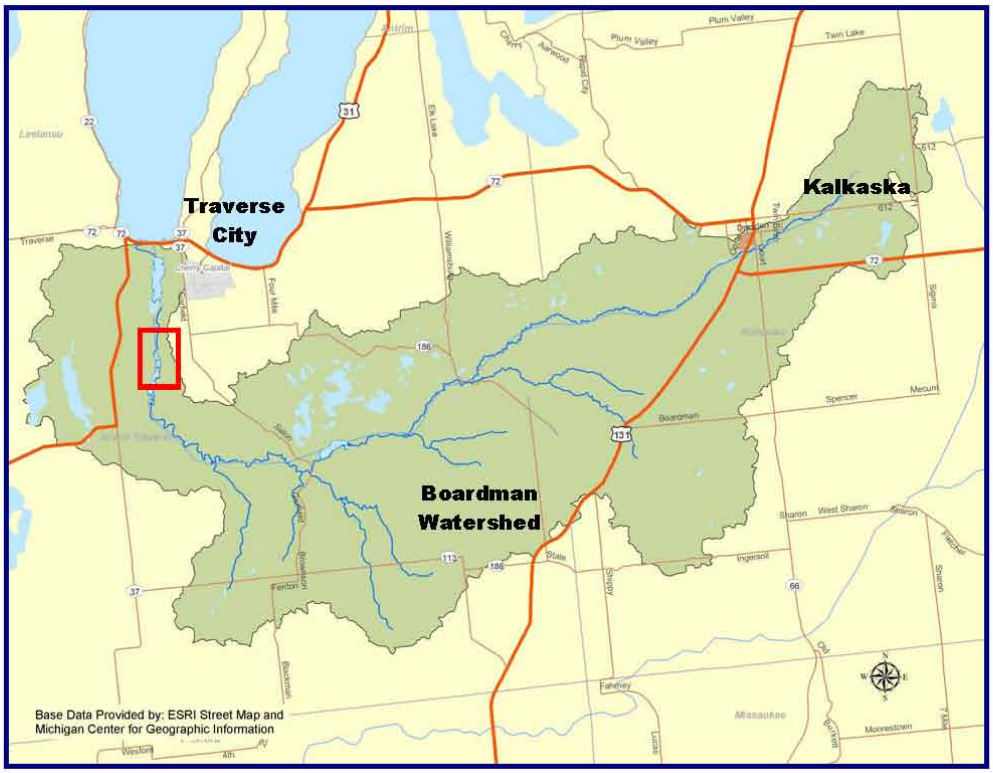
Information on the quality of the macroinvertebrate community and habitat conditions in this river segment were provided by the WCGTB, in 2003, for a location near the Keystone Rd dump site, using MDEQ's Procedure 51 methodology. The macroinvertebrate community received a rating of "acceptable, neutral", and the habitat conditions were rated as "good". Maximum water temperatures recorded during July and August (~75 - 77° F), in this river segment were at levels potentially lethal to coldwater fishes.

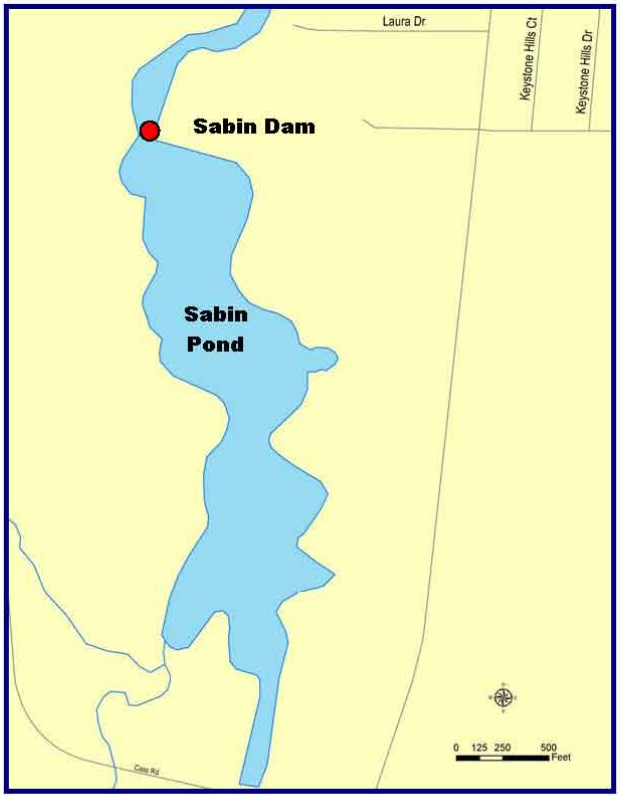
Fisheries

Fish species sampled in this segment of the Boardman River include: American brook lamprey, bluntnose minnow, brown trout, central mudminnow, chinook salmon, coho salmon, Iowa darter, Johnny darter, largemouth bass, northern pike, rainbow trout, rock bass, sculpins, smallmouth bass, white sucker, and yellow perch.

The most recent fisheries survey of this river segment was conducted by the MDNR during August of 2006. This survey showed that the most abundant species present were brown trout, smallmouth bass, white sucker, rainbow trout and chinook salmon. Coho salmon, Johnny darters, northern pike, rock bass, sculpins and yellow perch were also present in lower abundances. Brown trout density was low (33 fish/acre), but brown trout growth in this river segment was quite high relative to state averages. Brown trout of age classes 0-6 were present, and 37% of the brown trout were greater than 12" in length.

Figure 5





Segment 4:
Sabin Dam impoundment, also known as Boardman Pond or Keystone Pond

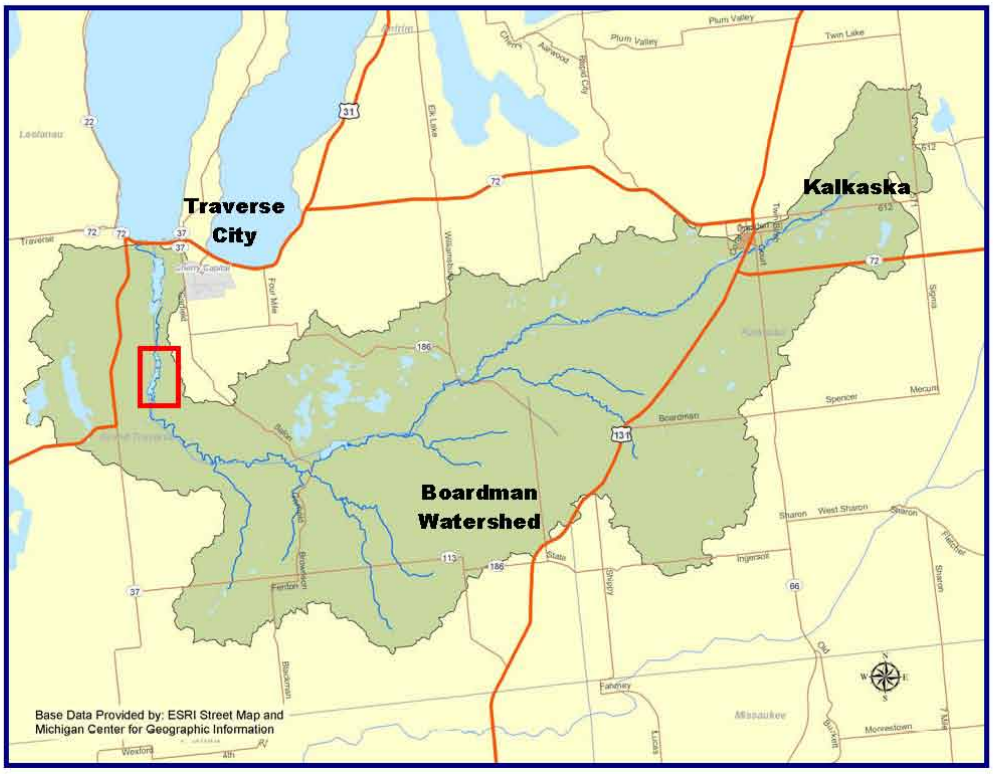
Segment 4

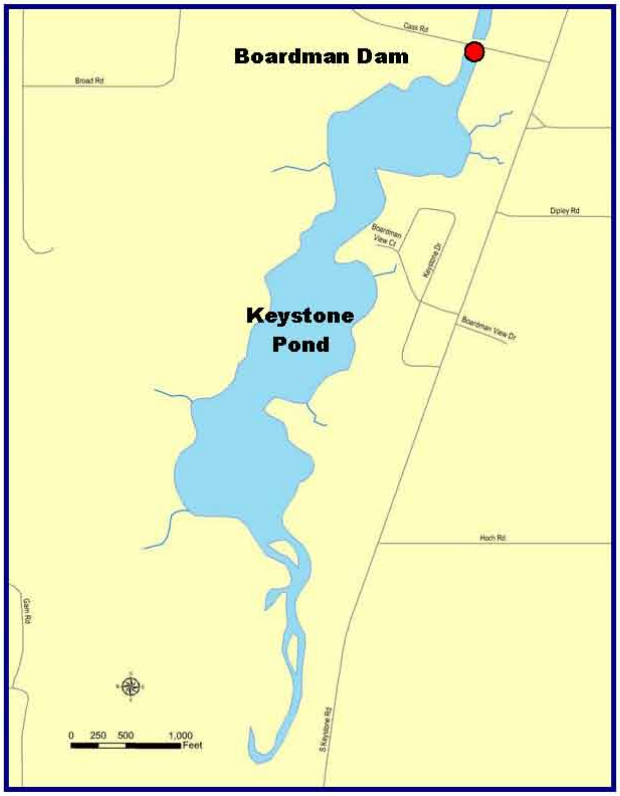
Habitat – none acquired

Fisheries
Fish species sampled in this segment of the Boardman River include: American brook lamprey, black bullhead, bluegill, bluntnose minnow, brook trout, brown trout, coho salmon, golden shiner, mimic shiner, northern pike, pumpkinseed sunfish, rockbass, sculpins, smallmouth bass, white sucker, and yellow perch.

The GTB conducted a fisheries assessment of Sabin Dam impoundment during June 2007. The survey utilized various nets and boat electrofishing. Bluegill, rock bass, smallmouth bass, northern pike, yellow perch, white sucker, and brown trout were sampled. However, only northern pike and white sucker were abundant. Northern pike CPUE was 2.77/net night and 61/hour of electroshock time, but were generally small, with an average length of 9 inches. White sucker CPUE was 2.59/net night and 57/hour of electroshock time, and had an average length of 19 inches. Due to the low relative abundances of most sportfish, and the small average size of northern pike, Sabin Dam reservoir appears to provide a poor fishery.

Figure 6





Segment 5:
Boardman Dam impoundment, also known as Boardman Pond or Keystone Pond

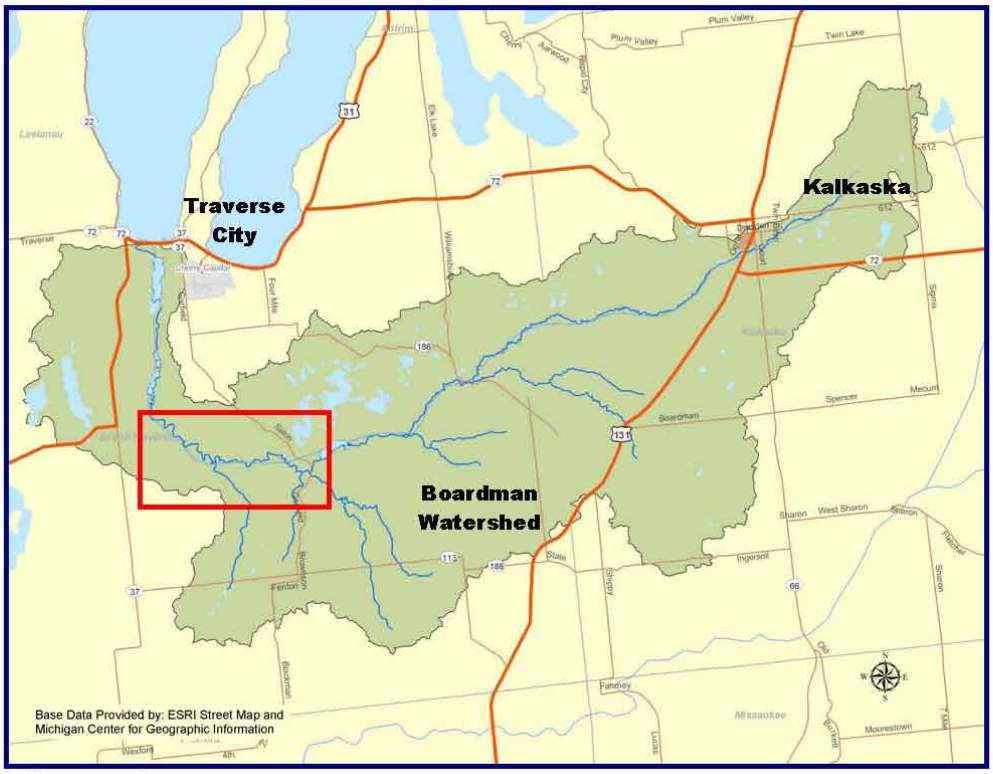
Segment 5

Habitat – none acquired

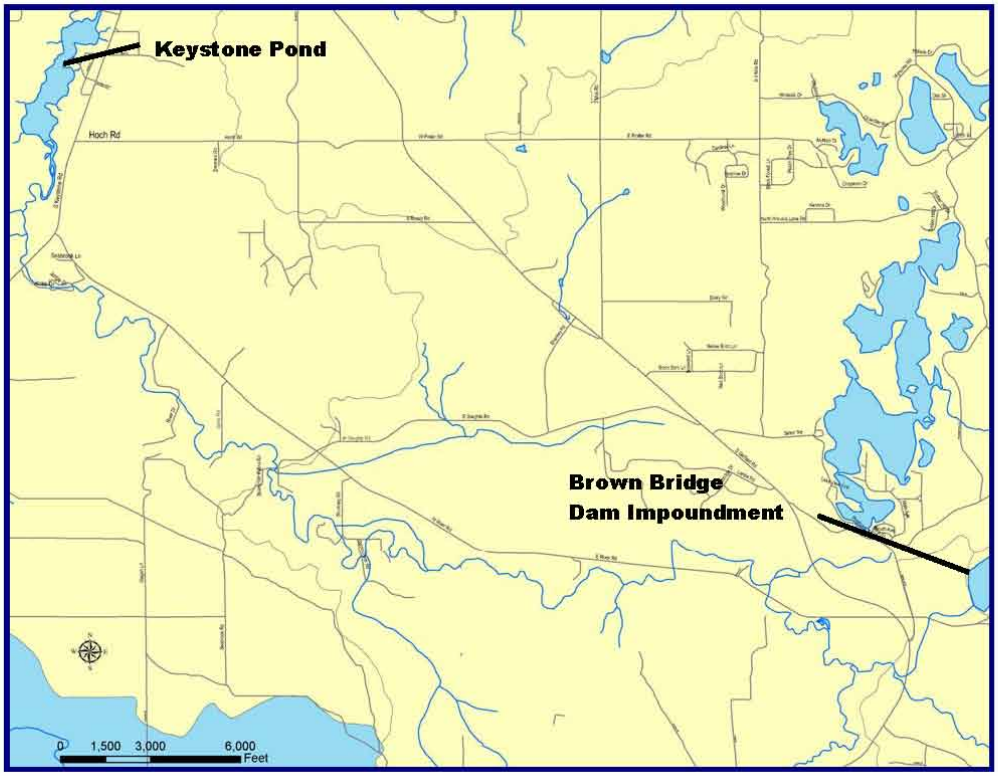
Fisheries
Fish species sampled in this segment of the Boardman River include: black bullhead, bluegill, brown bullhead, brown trout, common shiner, hornyhead chub, largemouth bass, northern pike, pumpkinseed sunfish, rock bass, sand shiner, white sucker, yellow bullhead, and yellow perch.

In June of 2007, the GTB, in cooperation with the MDNR, conducted a fisheries survey of the Boardman Dam impoundment. The survey utilized various nets and boat electrofishing. Rock bass and white sucker were the most abundant species present. Smallmouth bass and northern pike were common and bluegill, yellow perch, largemouth bass, and pumpkinseed sunfish were also present in low relative abundance. Smallmouth bass CPUE was 0.77/net night and 21.29/hour of electroshock time, and had an average length of 11 inches. Northern pike CPUE was 0.33/net night and 9.03/hour of electroshock time, and had an average length of 16 inches. Boardman Dam reservoir appears to provide a fair smallmouth bass fishery and poor fisheries for other gamefish.

Figure 7



Segment 6:
From Brown Bridge Dam downstream to Boardman Dam impoundment



Segment 6

Habitat

Information on the quality of the macroinvertebrate community and habitat conditions were collected by the WCGTB in 2004, using the MDEQ's Procedure 51 methodology. This information was collected upstream of Brown Bridge Rd., and indicated "good" and "excellent" quality ratings.

MSUFW surveys of this river segment were conducted at multiple transects, at each of three sites downstream of Brown Bridge Dam. This research documented a mean summer temperature for this river segment of 65.7° F, a mean width of 60.7 ft and a mean depth of 1.5 ft. The study found that Brown Bridge Dam was raising the mean summer water temperature of this river segment by 8.2°F, a high level of impact.

Water temperatures recorded by the MDNR, at the three fish sampling sites in this river segment (Brown Bridge Rd., Shumsky's, and Beitner Rd.) revealed monthly maximum temperatures for June – August in the suboptimal range for coldwater species such as trout (>70° F).

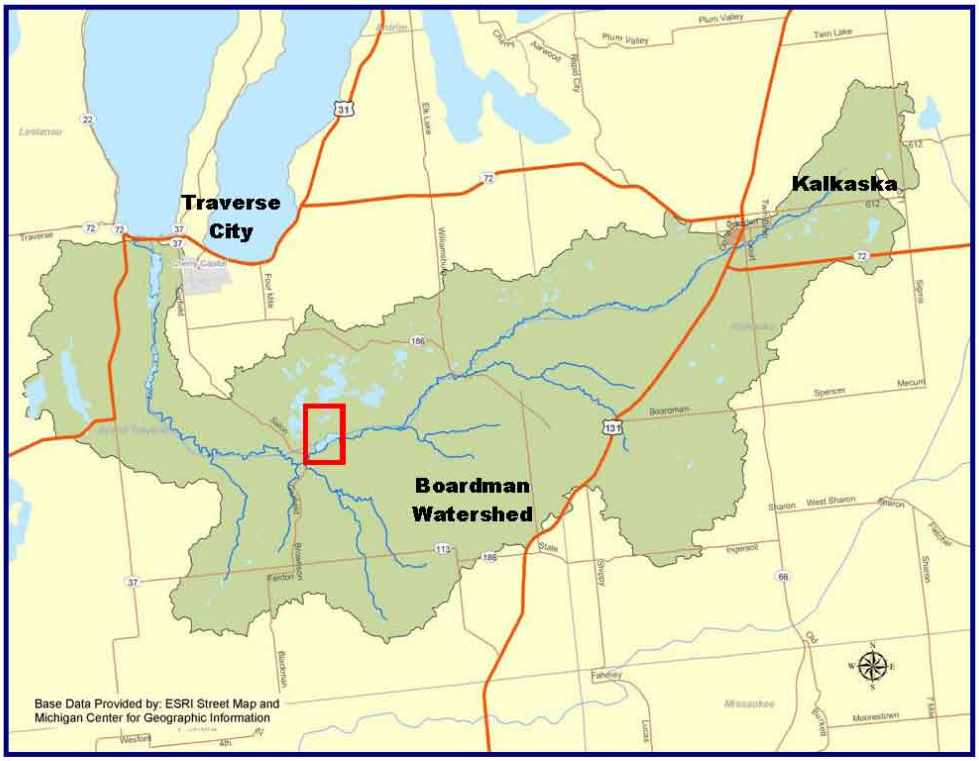
Fisheries

Fish species sampled in this segment of the Boardman River include: American brook lamprey, blacknose dace, bluntnose minnow, brook trout, brown trout, central mudminnow, coho salmon, common shiner, creek chub, golden shiner, green sunfish, largemouth bass, longnose dace, northern pike, pumpkinseed sunfish, rock bass, sculpins, smallmouth bass, white sucker, and yellow perch.

The MDNR conducted fisheries surveys of this segment of river during August 2005, at three locations: "Brown Bridge Rd", "Shumsky's", and "Beitner Rd". The "Brown Bridge Rd" location was located a short distance downstream from Brown Bridge Dam, where Brown Bridge Rd crosses the Boardman River. The most abundant fish species present at this site were brown trout, blacknose dace, white sucker, sculpins and creek chubs. The density of brown trout has historically ranged from 71 – 259 fish/acre and was 246 fish/acre in 2005, with 7% of them 12" or greater in length. Brook trout densities have ranged from 6 – 14 fish/acre, and were at 12 fish/acre in 2005. The "Shumsky's" survey site is located near River Rd and Sleight Rd, approximately half way between Brown Bridge Dam and the upstream extent of Boardman Dam impoundment. At this site, blacknose dace, brown trout, and white sucker were most abundant. Brown trout density has ranged from 80 – 208 fish/acre, and was 128 fish/acre in 2005, with approximately 5% being 12" or greater in length. Brook trout were and have always been scarce at this site during sampling. The "Beitner Rd" survey location was at the Beitner Rd river crossing, just upstream from the Boardman Dam impoundment (Keystone/Boardman Pond). Brook trout, brown trout, and white sucker were the most abundant fish species at this site. Brown trout density was 379 fish/acre, with only about 1% of the fish 12" or greater in length. Brook trout density was 328 fish/acre. In general, all three sampling sites within this river segment appear to have moderate densities of brown trout, low densities of brook trout (except the Beitner Rd site), and both species exhibit average – above average growth rates compared to statewide averages. The trout populations, however, are lacking fish of older mature age classes (i.e., brown trout 3-6 years of age, brook trout 2-3 years of age). Since it appears that spawning and growth are sufficient, conditions must be unfavorable for adult trout. This could be due to large age-specific mortalities (natural or angling harvest) or a lack of suitable adult habitat in this river segment (e.g., sufficient deep water habitat, wood cover, water temperature refuges, etc.).

The MSU thesis research by Lessard and Hayes, in 1998, found there were significantly lower densities of trout and sculpins in this river segment, as compared to river segment 8, upstream from the Brown Bridge Dam impoundment, but trout growth and fish species richness were higher than upstream.

Figure 8



Segment 7:
Brown Bridge Dam impoundment, also known as Brown Bridge Pond

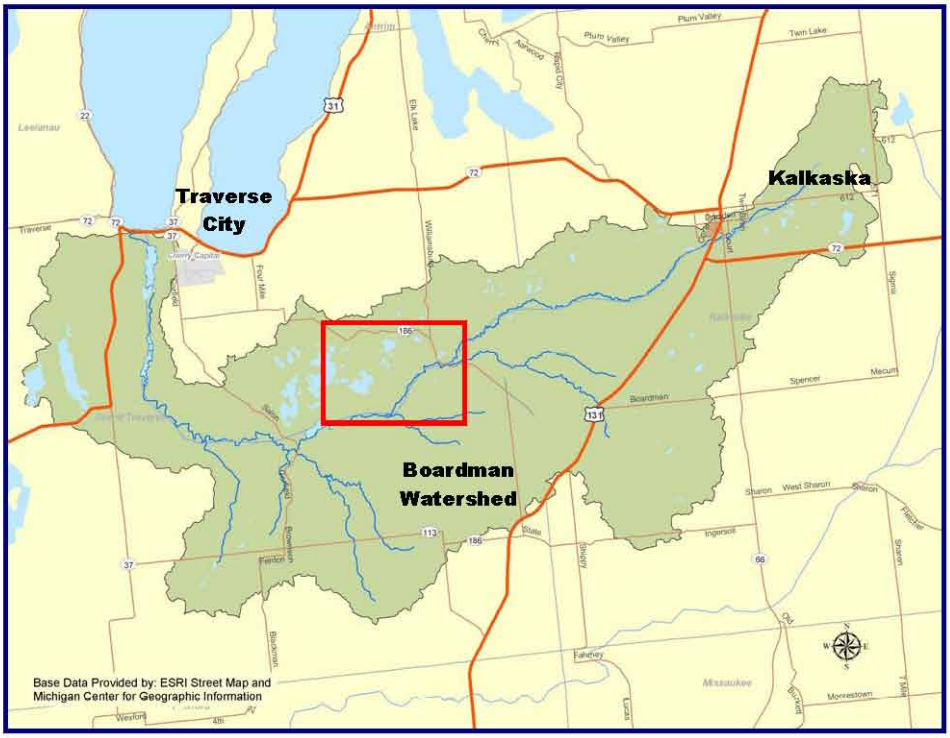
Segment 7

Habitat – none acquired

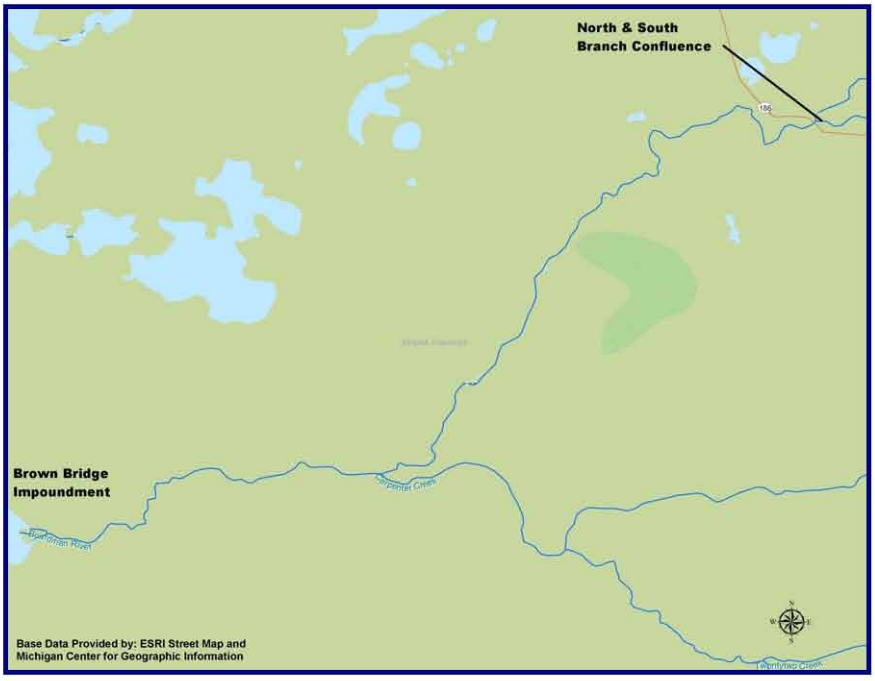
Fisheries
Fish species sampled in this segment of the Boardman River include: black bullhead, bluegill, brown trout, golden shiner, largemouth bass, northern pike, pumpkinseed sunfish, rock bass, smallmouth bass, white sucker, and yellow perch.

In May of 2007, the GTB, in cooperation with the MDNR and Little Traverse Bay Band, conducted a fisheries survey of the Brown Bridge Dam impoundment. The survey utilized fyke nets, gill nets, and boat electrofishing. Rock bass were the most abundant species, and bluegill, pumpkinseed sunfish, white sucker, yellow perch and largemouth bass, smallmouth bass, and northern pike were also common. Relative abundances (CPUE) and average lengths from electroshock sampling were: smallmouth bass (26.45/hour, 14.5"), northern pike (15.48/hour, 19"), largemouth bass (28.39/hour, 13"), bluegill (67/hour, 4"), and yellow perch (40/hour, 5.5"). Each of these gamefish populations provided reasonable to high proportions of fish of "preferred" length by anglers (preferred length refers to a length at which a fish because desirable to anglers, either for sport or harvest, e.g., the minimum length to "keep"). Brown Bridge Dam reservoir provides relatively good fisheries for several species of gamefish and to provide a good warmwater/coolwater fishery overall.

Figure 9



Segment 8:
From the confluence of the North and South Branches of the Boardman River, also known as the Forks, downstream to the Brown Bridge Dam impoundment



Segment 8

Habitat

Information on the quality of the macroinvertebrate community and habitat conditions was collected by the WCGTB in 2004, using the MDEQ's Procedure 51 methodology. This information was collected downstream of Ranch Rudolph, and indicated "good" and "excellent" quality ratings respectively.

In 2004 and 2005, the MDNR conducted surveys of fish habitat conditions in this segment of river, near the Ranch Rudolph location, following the protocol of the Inland Stream, Status and Trends survey program. In this area, the river ranged from 25 – 59 feet in width, and was 60 – 85% run habitat and 15 – 40% riffle habitat. Bank vegetation was mostly small deciduous trees and tag alders, with "good" or high bank stability ratings (<25% of streambank is bare soil). Streambed substrate consisted mostly of gravel (<2.5"), secondarily small cobble (2.5" – 5"), and sand comprised from 7.5 -16.6% of the substrate. Percent of stream containing wood debris averaged 6%, and rooted plants ranged from 4 – 27%. Average water velocity measured at one transect was 1.13 – 1.75 ft/sec., and the discharge measured during the surveys in July and August ranged from 74.37 – 127.51 cfs.

MSUFW surveys in this river segment were conducted at multiple transects, at each of three sites upstream of Brown Bridge Dam impoundment. This research documented a mean summer temperature for this river segment of 58.5° F, a mean width of 49.9 ft and a mean depth of 1.3 ft.

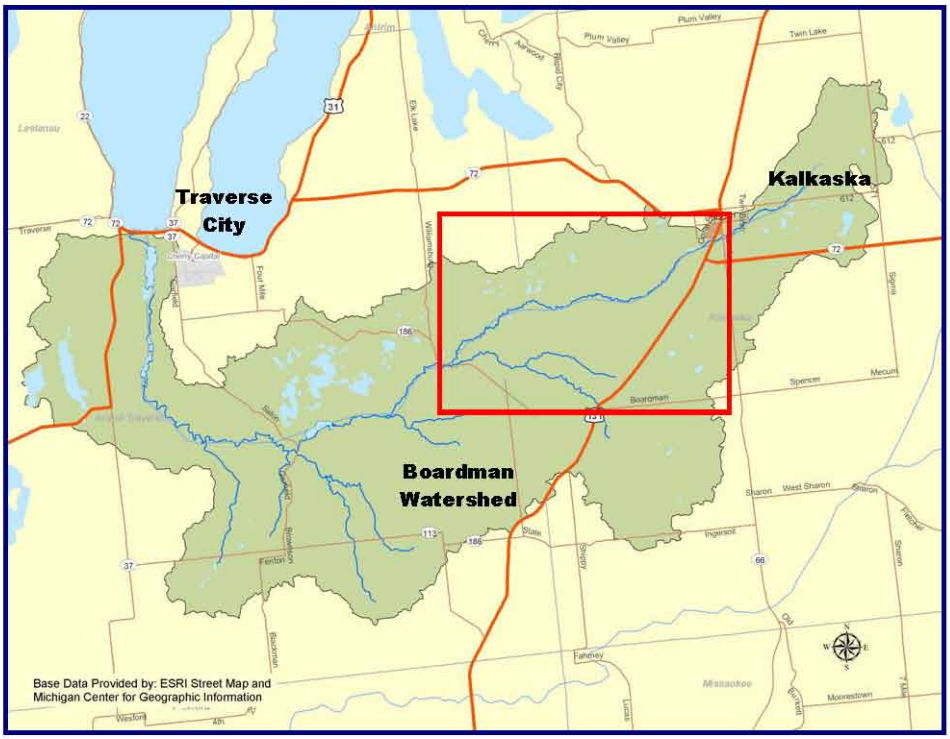
Water temperatures recorded by the MDNR at Ranch Rudolph, Forks campground and Sheck's campground indicated ideal water temperatures for coldwater fish. Maximum monthly temperatures from June – August remained below 70° F.

Fisheries

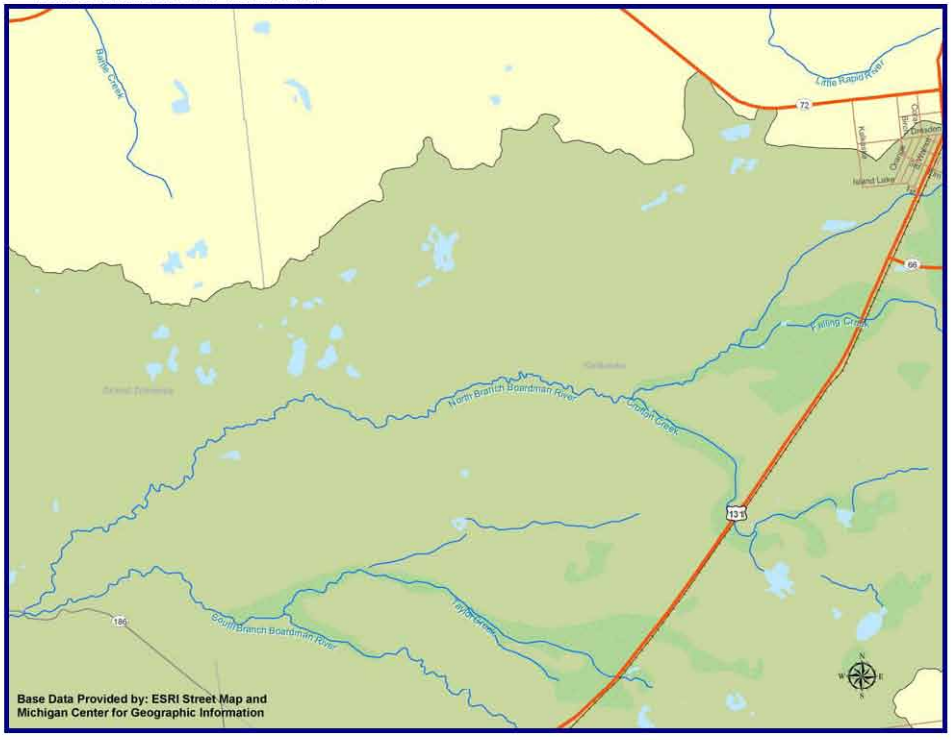
Fish species sampled in this segment of the Boardman River include: American brook lamprey, blacknose dace, blacknose shiner, bluegill, brook trout, brown trout, central mudminnow, coho salmon, common shiner, creek chub, finescale dace, grass pickerel, largemouth bass, mimic shiner, northern brook lamprey, northern pike, northern redbelly dace, rainbow trout, rock bass, sculpins, smallmouth bass, spottail shiner, white sucker, and yellow perch.

The MDNR has conducted fisheries surveys of this river segment, at Sheck's Campground (approximately halfway between the confluence of the North and South branches of the river (i.e., the Forks) and the upstream extent of the Brown Bridge Dam impoundment), at the Forks campground, and at Ranch Rudolph. At Scheck's campground the most abundant species were brown trout, brook trout and sculpins. Brown trout abundance has historically ranged from 510 – 639 fish/acre, and was 510 fish/acre in 2005, with approximately 4% of them 12" or greater in length. Brook trout density has ranged from 35 – 810 fish/acre, and was 271 fish/acre in 2005, with no fish greater than 10" in length. At the Forks campground brown trout density has ranged from 437 – 831 fish/acre and brook trout density from 5 – 97 fish/acre. At Ranch Rudolph, brown trout density has ranged from 200 – 540 fish/acre, but was steady at 200 fish/acre from 2002 – 2004. Brook trout density at Ranch Rudolph has ranged from 21 – 501 fish/acre, and was 435 fish/acre at least survey in 2004. Reproduction in this segment was good and trout growth rates average, but mortality appears high and adult age classes were scarce.

Figure 10



Segment 9:
North Branch of Boardman River



Segment 9

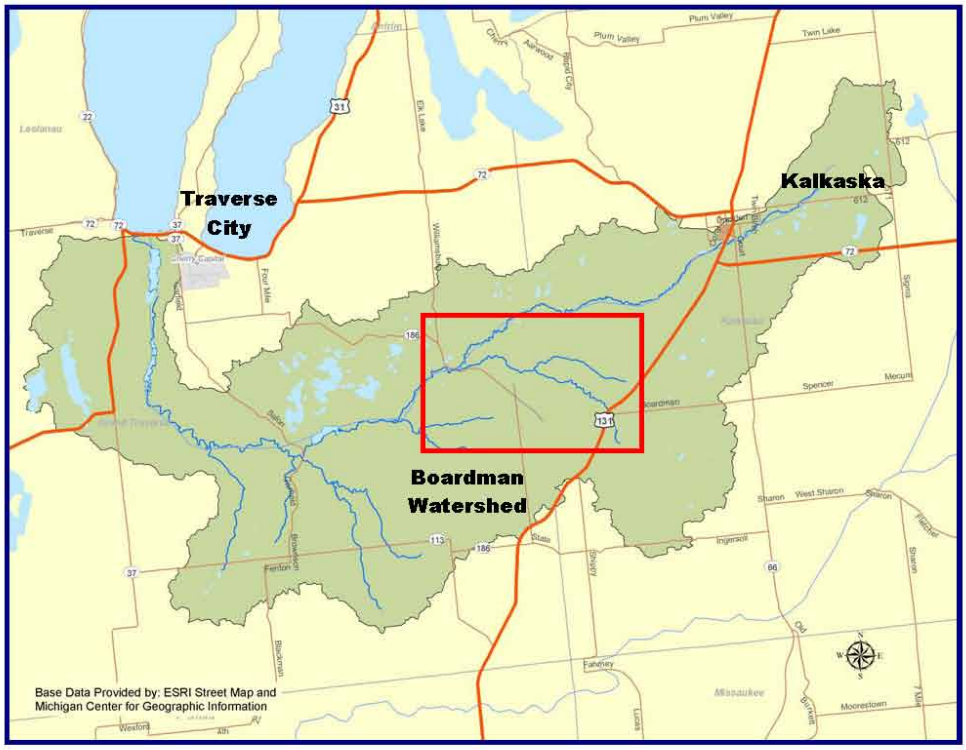
Habitat

Information on the macroinvertebrate community and habitat quality of the North Branch of the Boardman River was collected using the MDEQ's Procedure 51 methodology, by the MDEQ in 1998 and 2003, and by the WCTGTB in 2004, for selected sites in the North Branch. The quality ratings produced with this procedure indicated that across years and sample sites, the North Branch consistently ranks from "acceptable – tending towards excellent" to "excellent" for macroinvertebrates. Habitat quality ratings fall within the range of "good – with slight impairment" to "excellent".

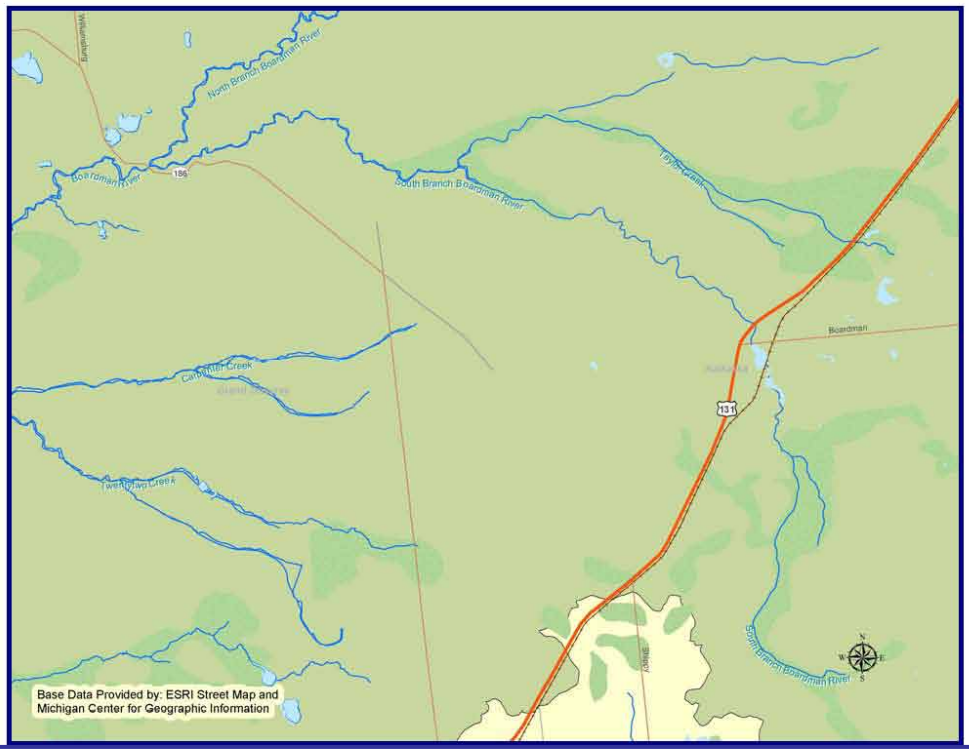
Fisheries

Fish species sampled in the North Branch of the Boardman River include: American brook lamprey, black bullhead, blacknose dace, blacknose shiner, bluegill, bluntnose minnow, brook stickleback, brook trout, brown bullhead, brown trout, central mudminnow, common shiner, creek chub, green sunfish, hornyhead chub, northern pearl dace, northern pike, northern redbelly dace, rockbass, sculpins, white sucker, and yellow perch. Past MDNR fisheries surveys conducted at the Broomhead Rd. crossing have documented brown trout densities from 98 – 1,348 fish/acre (191 fish/acre in 2002), and brook trout densities from 14 – 593 fish/acre (385 fish/acre in 2002).

Figure 11



Segment 10: South Branch of Boardman River



Segment 10

Habitat

Information on the macroinvertebrate community and habitat quality of the South Branch of the Boardman River was collected using the MDEQ's Procedure 51 methodology, by the MDEQ in 1998 and 2003, for selected sites in the South Branch. The quality ratings produced with this procedure indicated that across years and sample sites, the South Branch consistently ranks from "acceptable – tending towards excellent" to "excellent" for macroinvertebrates and habitat conditions.

Fisheries

Fish species sampled in the South Branch of the Boardman River include: American brook lamprey, blacknose dace, brook stickleback, brook trout, brown trout, central mudminnow, Johnny darter, rainbow trout, sculpins, smallmouth bass, tiger trout, and white sucker. Past MDNR fisheries surveys conducted at the Broomhead Rd. crossing have documented brown trout densities from 554 – 1,741 fish/acre (554 fish/acre in 2002), and brook trout densities from 30 – 357 fish/acre (146 fish/acre in 2002).

SUMMARY OF CONDITIONS

The North and South Branches of the Boardman River, located upstream from the zones of influence for the Boardman River dams, are generally high-quality, healthy coldwater fisheries, supporting healthy trout populations along with other coldwater fishes such as sculpins. River segment 8, from the confluence of the North and South Branches, downstream to the Brown Bridge Dam impoundment serves as the best available reference for what conditions in the Boardman River would be like, if not for the impacts of the four dams. Habitat quality is good to excellent in this reach, with stable banks, abundant gravel, and cold water temperatures. Relatively high densities of brown and brook trout exist, with average growth rates. Perhaps the only noticeable problem with fisheries in this reach is the relative scarcity of trout of older mature age groups. Brown Bridge Dam impoundment provides a good warmwater fishery for bass and pike. It raises the water temperature of the Boardman River downstream from it significantly. From Brown Bridge Dam downstream to the Boardman Dam impoundment, trout are still the dominant fish species, but many other coolwater fish species are also present. Trout growth rates are slightly higher in this reach than river segment 8, but the density of trout is significantly lower. Trout of older mature age classes are also scarce in this reach. Habitat data for this section of river is severely limited. Boardman Dam impoundment supports a fair - poor warmwater fishery, and Sabin Dam provides a poor fishery. The segment of river from Sabin Dam downstream to Union Street Dam impoundment (Boardman Lake) appears to provide a somewhat unique trout fishery for the Boardman River. Habitat data is scarce, but suggests it is generally "good" to "acceptable with some impairment", and water temperatures are elevated past preferred conditions for coldwater fishes. However, while brown trout density is quite low in this reach, brown trout growth is quite high, all age classes of brown trout are present (0 -6 years of age), and more than a third of the brown trout are greater than the legal minimum length (in contrast to 0-7% for river segments 6 and 8). The little available habitat data for Boardman Lake suggests that aquatic macrophytes are common and zebra mussels are prevalent. This waterbody does provide an average fishery for preferred sportfish such as walleye, smallmouth bass, and northern pike. From Union Street Dam downstream to Lake Michigan, habitat quality, is generally good, with slight impairment and warmer water temperatures. This section of stream is accessible to fish from Lake Michigan, and thus receives runs of fish including salmon, steelhead, sea lamprey, and lake sturgeon have also been confirmed to use this reach of stream as well. The USFWS treats this river segment every five years to control the production of sea lamprey. The MDNR annually stocks steelhead, coho salmon and Chinook salmon in this river segment. Lastly, Kids or Hospital Creek is a significant tributary that enters the Boardman River in this last segment. This tributary provides some coldwater fisheries, but has also suffered from impairment. It provides nursery areas for both Great Lakes salmon and sea lamprey (for which the river is treated every five years).

Part II. Limitations and Gaps in Existing Data

Section A. Identification of Important Limitations or Gaps in Existing Data

In order to evaluate any limitations or gaps in existing information on the Boardman River fisheries, the intended use of the information must be clearly defined. The intended use of the information, in this case, is to provide guidance to the Boardman River Dams Committee on evaluating various management alternatives for the four lower Boardman River Dams. This information is not at this point defined as being needed for environmental impact statements, for post-management monitoring and scientifically rigorous documentation of effects of any management actions to be taken. Discussion on data limitations is here

based upon the adequacy of existing information for informing the decision process on the fate of the Boardman Dams.

Habitat

Available water temperature data is sufficient to characterize the average water temperatures of the free flowing segments of the Boardman River. Water temperature data is not spatially detailed to the point where specific locations of significant ground water input areas are well-known, but average temperatures for the riverine segments are adequate. The MDNR has collected information on the minimum, maximum and mean monthly water temperatures at ten sites in the Boardman River, from 2004 – 2006. Water temperature data does not exist for the impoundments. Since some of the impoundments appear to significantly elevate water temperatures for riverine segments downstream of the dams, it could be desirable to collect water temperature information for the impoundments, if certain dam management alternatives were to be pursued. As an example, Brown Bridge Dam impoundment significantly elevates the water temperature for the river downstream, and has caused documented impacts to the ecology of that river segment (MSUFW). If this dam is left in place, it could be either mandated or at least desirable to alleviate those negative temperature impacts through various water release strategies. If this dam management alternative was pursued, information on the presence and quantity of cold hypolimnion waters would need to be gathered in order to assess its feasibility.

Information on stream morphology, also referred to as "habitat" in reference to fish or aquatic organism requirements, is generally lacking. This information is critical to evaluating the current conditions in the river (e.g., which segments are quality and unique, which are degraded) and the potential resulting conditions from different dam management alternatives. In other words, this information is essential to the BRDC's mission. Sufficient data on this aspect of the river is only available for segment 8, from the confluence of the North and South Branches, downstream to the Brown Bridge Dam impoundment (collected by the MDNR and MSUFW). Some useful information also exists for segment 1, downstream of Union Street Dam downstream to Lake Michigan (collected by USFWS). However, this data is minimal, and was collected specifically in reference to the availability of larval sea lamprey habitat requirements. Some Procedure 51 data exists for selected sites on selected river segment. However, this data is intended to provide only a qualitative rating indicating the likely quality of the habitat, and will be of limited use to the BRDC's in this process.

Fisheries

With the recent collection of additional fisheries data, provided by MDNR and GTB for the purpose of informing the BRDC's decision process, some fisheries data does exist for each segment of the Boardman River of interest to this project. While all of this data may not be adequate for more rigorous purposes, it is sufficient for providing an indication of the existing fisheries conditions in each segment of the Boardman River. The only exception is that no survey of the relative abundance of fish species (other than for sea lamprey) was conducted for river segment 1, but fish species presence does exist for this river segment. Since this river segment would have both resident and migratory fish present, multiple fisheries surveys of this segment, done during different seasons, would provide an indication of the fish present in the river year round, and the fish utilizing this segment seasonally, as well as providing information on the quantity of migratory fish using this segment that might be impacted by various dam management alternatives.

Section B. Recommendations & Priorities for Additional Data Collection

Additional stream morphology, or habitat, data should be considered essential to collect, and afforded the highest priority. For the purposes at hand, this data need not involve the rigorous survey and mapping of latitudinal and longitudinal transects that may likely be mandatory after dam management alternatives are decided upon. However, mapping bedform distributions, river widths, streambed substrate compositions, and other basic habitat attributes along the entire Boardman River and its impoundments (segments 1-8), should be readily feasible, reasonably economical, and provide a sound foundation for understanding current conditions in the Boardman River and making predictions on the outcomes from various dam management alternatives.

Secondary priority may be given to conducting surveys of fish abundances and run timing in segment 1, downstream of the Union Street Dam. Great Lakes salmonids, (e.g., Chinook and coho salmon, steelhead, brown trout, and lake trout), native sucker species, lake sturgeon, sea lamprey and other fish species could be expected to use the Boardman River for essential life stages. Knowledge of their use of the river, and their relative abundances should be used in evaluating dam management alternatives. The MDNR operates a weir approximately 0.5 miles downstream of the Union Street Dam, and may have information on the timing and relative abundance of fish species using this weir, however, that data may only document those fish that successfully use the weir, likely excluding many fish species. Collection of sufficient data to satisfy this need would likely require several surveys during the spring, one during the summer, several during the fall, and one during winter. This survey would at best only indicate the relative abundances of the fish species using the lower river, during one year, and fish species abundances are highly variable from year to year. This data would also require one year's time to collect and may significantly slow the BRDC's decision process. Decision to collect this information should carefully weigh all of these factors.

Information on the water temperature conditions of the impoundments may not be essential to collect. This information may be reasonably predicted using detailed bathymetric surveys of the impoundments, and may only be needed if particular dam management alternatives are deemed of interest.

Part III. Discussion of Possible Fisheries Management Considerations

Section A. Spatial Scope of Impacts

The presence of dams has been documented to have negative impacts on stream morphology and water quality in rivers for many miles downstream of dams, and for many miles upstream of dams, in both reservoirs and the riverine areas immediately upstream of reservoirs. Given the relatively close proximity of the four lower Boardman River dams, river segments 1-8 are all likely impacted from the presence of the dams, in various ways. In addition to these fish habitat impacts from dams, the loss of connectivity to stream biota is even broader. Aquatic organisms including macroinvertebrates and fish need access to a variety of habitats for different requirements of their life cycles (e.g., feeding, reproduction and survival). In undammed river systems, the organisms are free to move throughout the entire river system in order to fulfill all habitat requirements. When this ability is prevented by dams, those organisms are forced to fill all habitat needs in smaller segments of the river system. Rarely, some species are able to achieve this, but more often the limited habitat available to them is deficient in some critical aspect, and the population is negatively impacted. At the fish community level, overall productivity and diversity declines. In the case of the Boardman River, impacts from the presence of all four dams likely impact the entire Boardman River watershed, including its tributaries. In the consideration of the fate of the Boardman River Dams, various dam management alternatives, including the no-action alternative, should all be considered to have impacts on habitat conditions in river segments 1-8, and on stream biota in the entire watershed.

More specific predictions on the spatial extent of habitat changes that could be expected under various dam management alternatives, at each specific dam, will be possible with the collection of the recommended habitat data (Part II.).

Section B. Types of possible changes to fisheries habitat

No-Action. If no action is taken on any of the Boardman River dams, current conditions will be maintained or slowly degrade through time. Boardman Lake is believed to be partially natural, and partially elevated due to Union Street Dam. The Sabin Dam, Boardman Dam and Brown Bridge Dam however, convert stream habitat (lotic) into lake habitat (lentic). This conversion of habitat types makes the impounded river segments almost entirely unsuitable to riverine organisms. These three impoundments currently support standard warmwater fisheries. Reservoirs "age" due to sedimentation, and these reservoirs can be expected to continually fill with sediment over decades, becoming shallower and warmer, with less desirable fisheries resulting. The riverine segments of the Boardman, 8, 6, 3, and 1 would be expected to also maintain current conditions. These segments are impacted in other more subtle ways by the presence of the dams. Water temperatures are elevated, many habitat attributes can be assumed to be currently impacted, and connectivity is limited. Elevated water temperatures appear to significantly contribute to the very low density of trout in segment 3 and the lower density of trout in segment 6 compared to segment 8. Segments 6 and 8 both appear to have good - excellent trout reproduction and growth, but suffer from a lack of suitable habitat for adult trout.

Coldwater Release (water temperature enhancement). The feasibility of this dam management alternative for each of the Boardman River Dams will depend on the acquisition of additional data (mentioned in Part II). Where feasible, this could alleviate the negative impacts of elevated water temperature that the dams create. The ability of a river system to provide coldwater conditions is unique and valuable, and is vulnerable to degradation caused by dams, and many types of land use. The Boardman River is capable of providing these unique conditions. The presence of the Boardman River Dams currently impact this. Retro-fitting these dams to release coldwater would depend on the presence of coldwater in the reservoirs. In the absence of water temperature data for these impoundments, the warmwater fisheries present in Brown Bridge Dam, Boardman Dam, and Sabin Dam impoundments suggests this coldwater supply may be absent, making this alternative unfeasible. The coolwater fish community in Boardman Lake, suggests this may be a feasible option for that dam. However, costs for this alternative may be prohibitive. The value of lowering water temperatures below Union Street Dam may not be high considering the relatively short segment of stream before reaching Lake Michigan.

Additionally, while this option may potentially alleviate the impact of the dams on water temperature, it would not alleviate impacts of the dams on stream morphology. Dams prevent the natural flow of sediment down rivers. This leads to many impacts to natural riverine habitat. Releasing cold water from dams would not alleviate these types of impacts from the dams.

Fish Passage. Another possible dam management option would be maintaining the dams, but allowing fish passage, or installing fish "ladders". In theory, installing fish passageways at any of the dams would allow connectivity between river segments above and below the dams. However, in reality most fish passage technology is only of limited efficiency. Often fish passage technology is more efficient at allowing fish to move upstream than in a downstream direction. Most fish passage technologies are also limited in their efficiency for many species (i.e., some species use them with success, while others refuse to use them). Also, the presence of the lake habitat, or impoundment can remain a deterrent for many species to travel between segments of river upstream and downstream of dams. For these reasons, this dam

management alternative only partially restores connectivity. It would benefit the fish community more than no-action, but not as much as fully restoring connectivity. Costs for this management alternative would vary greatly with the wide range of fish passage technology employed.

Rock Ramps. Rock ramps are a specialized form of fish passage. They are constructed when a dam is left in place, and fill or rubble is used to create a ramp or wedge of fill from the downstream face of the dam, downstream for some distance. This dam management alternative may be favorable in situations where it is favorable to improve riverine conditions but impoundment sediments are heavily contaminated and can not be allowed to mobilize downstream. This option creates a higher gradient, more riverine looking downstream river segment for a short distance, and also some desirable level of fish passage. However, since the impoundment is left in place, water temperature effects remain, and sediment transport is still restricted, maintaining the negative impacts on habitat conditions. This option therefore improves connectivity partially, but does not alleviate the impact of dams on riverine habitat. Additionally, the cost of creating the rock ramp structure is uncertain, and may be significant.

Dam Removal. This management alternative has proven to alleviate water temperature impacts, habitat impacts, and fully restore connectivity. Removing a dam will cause sediment incision (erosion) in impoundments where sediment was deposited. This incision will also occur for some distance upstream of the easily identifiable reservoir area. Ultimately this process will increase the gradient of the stream, which in turn results in restoration of other habitat attributes including narrower river width, reformation of riffles and pools, increased water velocity and coarser substrate. Downstream of the dam removal, sediment from the impoundment can be transported and deposited or prevented through sediment collection techniques. If sediment transport is allowed, it will raise the streambed, increasing gradient downstream of the dam. Habitat conditions will be negatively impacted for several years as the river adjusts to the sediment, but eventually the river will regain habitat characteristics similar to upstream non-impacted reaches. The raising of the streambed can also potentially lead to closer flood plain connection with riparian wetlands and possibly lead to more frequent wetland recharge. In the case of the Boardman River, dam removal would likely result in the reformation of unique high gradient coldwater stream habitat, upstream and downstream of the dams.

In considering each level of dam management, consider that alleviating the impacts of a dam on riverine habitat conditions can lead to improvements in the abundance and growth of riverine fish species. Improving or restoring connectivity can lead to improvements in abundance and growth of riverine species, and increase the overall diversity and productivity of the fish community.

Section C. Potential Fisheries Management Issues

In the decision-making process for deciding the fate of any dam, established scientific research on the effects of dams and the effects of dam management alternatives, and existing data on the river system under consideration, can help by providing information on current conditions and enabling predictions of likely outcomes of various decisions. However, underlying human values placed on different states of the river system will lead to fundamental differences in preferences for the state of the river system, and fate of a dam. Many commonly held values and preferences may be at odds with each other. The purpose of this section of the report is to identify some of those fundamental management issues that are likely to arise, and to provide information to aid the BRDC's decision-making process regarding them.

Reservoir vs. River, Coldwater vs. Coolwater vs. Warmater Fisheries.
A fundamental decision that will be necessary to make, will be whether stakeholders in the fate of the Boardman River prefer and/or benefit more from the maintenance of reservoirs or from free-flowing river conditions, and at what economic cost. Sabin Dam, Boardman Dam and Brown Bridge Dam impoundments create "lake-like" conditions which support poor to good warmwater fisheries (e.g., bass, panfish, perch, catfish, small northern pike). Maintenance of these fisheries will require the costs of maintaining the dams in conditions which ensure public safety. The regional uniqueness of these warmwater reservoir fisheries can be evaluated by examining the number of similar warmwater fisheries within a reasonable driving distance of the Boardman Reservoirs (as a surrogate for the availability of suitable replacement fisheries for users of the Boardman reservoirs, and as a measure of the attractiveness of these fisheries resources to users outside the area). There are 111 lakes in Grand Traverse County larger than five acres in size. All of the lakes in Grand Traverse County are within a 20 mile radius of Boardman Pond. There are 21 developed access sites in the County according to the State Center for Geographic Information System (http://www.mcgi.state.mi.us/MRBIS/). However, this is not a complete list because there are a variety of boat launch sites that are not included such as road endings, canoe launches, and walk-in access sites. Virtually every lake (five acres or greater) in Grand Traverse County contains the warmwater fish species mentioned. For these reasons, the Sabin Dam, Boardman Dam and Brown Bridge Dam impoundments should not be viewed as regionally unique fisheries. The Union Street Dam impoundment, or Boardman Lake, provides a coolwater (e.g., walleye and northern pike) and warmwater fishery (i.e., in addition to the warmwater fish species previously mentioned it also provides a walleye fishery).

While providing these warm and coolwater fisheries, these dams also have the influence of negatively impacting the adjacent coldwater fisheries (e.g., brown trout, brook trout, rainbow trout, sculpins) through habitat alteration and by fragmentation (loss of connectivity). The various dam management alternatives mentioned in Part III Section B, provide means of partially alleviating some of these negative impacts on the adjacent coldwater fisheries while maintaining the reservoir warm and coolwater fisheries. The dam removal alternative would replace the reservoir fisheries with coldwater river fisheries. Some stakeholders may prefer this alternative, valuing the restoration of free-flowing riverine conditions originally present before human construction of the dams. In the absence of more detailed stream morphology data (recommended in Part II), historic information suggests that the restored river habitat where the impoundments are, could be high-gradient and unique for the lower peninsula of Michigan. This could create high quality, coldwater river habitat that could benefit fish species such as trout, salmon, steelhead, and possibly lake sturgeon. Fisheries of this type and high quality are rare due to their vulnerability to degradation. The closest fisheries of similar type might be the Pine River in Manistee County, or the Jordan River, in Antrim/Charlevoix Counties. Given the existing coldwater fisheries on the Boardman River, the river could potentially be of higher quality than either of those alternatives, providing a unique fishery for the region and for the state of Michigan.

Frequently Asked Questions on this Subject: *What will happen to the fish in the reservoirs if a dam is removed?*

In the short-term, the resident fish of the reservoirs will most likely move upstream or downstream out of the reservoir area. Some fish located in shallow areas of the reservoir, far from the newly forming river channel could become stranded if the water level is lowered very quickly. Most fish however will respond to the changing conditions by relocating either upstream or downstream of the former reservoir, in riverine sections of the stream. Most of the reservoir fishes are capable of surviving in the free-flowing sections of

stream (and are currently found there already, in low abundances). This habitat will not however be optimal, and they will eventually make there way to slow, low gradient sections of stream, including downstream reservoirs or Lake Michigan. In the longterm, they will be displaced from the reservoir areas as the river fishes were when the dams were created and river habitat was converted to reservoir habitat. Some individuals of these warm and coolwater fish species will continue to reside in the river though, and many will continue to use and benefit from the river habitat for various life stages (e.g., spawning).

Frequently Asked Questions on this Subject: *Will the dewatered reservoir bottomlands become unsightly mudflats if dam removal occurs?*

Observations from many other dam removals indicate that the reservoir bottomlands will remain unvegetated for only a very short period of time. The sediment accumulated at the bottom of reservoirs contains a wealth of seeds from many years of plants adjacent to the reservoir and from upstream. These seeds survive in dormancy for long periods of time, and when the sediment is uncovered, sprout and begin growing quickly. You could expect the revegetation process to begin almost immediately during the first growing season following the dam removal. This revegetation process will initially begin with grass-like plants, proceed with shrubs and trees such as willows, and decades later be followed by other tree species. The grasses that revegetate the reservoir bottom lands quickly following dam removal have a high root density, and begin to stabilize the bottomlands immediately.

Effects of restoring fish passage and connectivity

If connectivity is restored through adequate fish passage technology or dam removal, overall fish community productivity and diversity can be expected to increase. However, the specifics of which species will benefit, and if any undesirable effects will occur is often harder to predict.

Resident stream fish such as brown and brook trout will benefit from restored connectivity in several ways. These fish often travel large distances within river systems to best fulfill their needs for feeding, spawning, and survival (e.g., thermal refuge, cover – deeper water, log jams, undercut banks, overwinter refuge). If none of the Boardman Dams were present, you could expect some stream trout to remain in specific areas, while some individual stream trout could move anywhere from Traverse City to Kalkaska depending on the time of year.

Many other fish species that do not live their entire lives in the Boardman River, will also benefit from restored connectivity and fish passage. Sucker fishes, of which many species are native to the Great Lakes, are a major component of the fish community. Some species live their entire lives in rivers, while others live in lakes and make spawning migrations into rivers. These spawning migrations are important to the productivity of the river and lake systems, as they often feed on small food items not significant to the diet of other stream fishes. Allowing suckers access to river habitat can boost productivity of the river system by allowing additional utilization of food resources and spawning habitat, and by yielding juveniles which can serve as food to other fish-eating (piscivorous) fish species, improving the growth of the predatory fish.

Great Lakes salmon and steelhead, also need access to high-gradient river habitat for spawning. These fish provide extremely valuable sport fisheries and contribute significantly to the economy of Michigan. They are also used to help keep alewife abundances in balance in the Great Lakes. These species are currently allowed limited access to the Boardman River for spawning (allowed passage past Union Street Dam, but restricted upstream of Sabin Dam). Due to the restricted amount of spawning area they have

access to, their natural production in the Boardman River is limited, and the MDNR annually stocks Chinook and coho salmon, and steelhead juveniles into the Boardman River system to augment the natural reproduction and maintain optimal fishery management goals in Lake Michigan. The number of these fish stocked annually into the Boardman River downstream of Union Street Dam, and in Kids Creek (both river segment 1) varies from year to year, but averages approximately 17,000 steelhead yearlings, 85,000 coho yearlings, and 225,000 chinook fingerlings. Given the approximate average number of these fish stocked, the average amount of money spent by the MDNR on this supplementation effort is roughly $100,000 (based on $0.73 per yearling, $0.12 per fingerling, MDNR hatchery production costs estimates). Allowing fish passage for these species to utilize additional spawning habitat in the Boardman River could allow for increased natural reproduction, decreased need to supplement with hatchery fish, and provide a new and valuable sport fishery for Great Lakes salmon and steelhead in the Boardman River.

While both of these fisheries types may benefit from restored fish passage and connectivity, the interaction is not without the possibility for undesirable outcomes, social or ecological. It is currently hypothesized that the presence of Great Lakes salmon and steelhead may have negative effects on populations of stream trout utilizing the same stream habitat. Conclusive evidence in support of this hypothesis occurring in nature is currently not available. The suspected mechanisms include competition between juvenile salmon/steelhead and stream trout (steelhead remain in the river for two years before migrating to the Great Lakes, coho one year, and chinook migrate to the Great Lakes the first spring after being hatched). Also suspect, are interactions between the adult spawning salmon and adult stream trout. These possible negative interactions are not well understood or documented at this time, but are possible. Perhaps the only evidence currently available on this issue, is that competition between juvenile steelhead and stream trout is possible only if the densities of these fish are extremely high. However, habitat quality limitations are more often likely to limit the number of stream trout than possible competition with steelhead.

Social issues can arise from the interaction between salmon and steelhead anglers and resident stream trout anglers. The popularity or attraction of salmon and steelhead fisheries often bring large numbers of anglers to fish a river. This increased use of the river can lead to visible signs of human use including noise, crowds, deviant behavior, well trodden foot paths and litter. Also, a common generalization or stereotype of salmon fishing crowds, is a lower level of stewardship for the river. For these reasons of aesthetics and hypothesized negative ecological interactions, stream trout anglers often prefer separation of stream trout fisheries from salmon and steelhead fisheries. The Boardman River currently supports a stream trout fishery, warm-water reservoir fisheries, and a limited salmon and steelhead fishery. Maintenance of all of the Boardman River Dams would maintain all three of these fisheries types in their currently "average" conditions. On the other end of the dam management spectrum, if several of the dams were removed, the stream trout fishery would likely become well above average in quality, and the potential salmon and steelhead fishery could also expand greatly. Both of these fisheries types would likely lead to increased tourism revenue for the area. Currently there is not evidence that these high value fisheries types are mutually exclusive ecologically, but the socially based issues and compatibility of angler group preferences will need to be evaluated.

Lake Sturgeon

Lake Sturgeon are a unique native fish species to the Great Lakes. They are currently a "Threatened" species in the Great Lakes. This species is highly valuable for its uniqueness of life history and form, for culturally significant reasons, and as a recreational fishery. The restoration of this species is currently strongly supported by the USFWS, MDNR, and the Tribes. There have been several sightings of lake sturgeon, confirmed by MDNR biologists, in the Boardman River, downstream of Union Street Dam.

Currently, very little information is available on the abundance of this species returning to the Boardman River, or in Grand Traverse Bay. However, if several of the Boardman River Dams were removed, it is hypothesized that high gradient rapids areas would be restored. These habitats are unique in the lower peninsula of Michigan, and are needed by lake sturgeon for spawning. Given several of the dam management alternatives which are possible for the Boardman River Dams, restoration of lake sturgeon to the Boardman River could potentially become possible. The potential to restore this unique and important fish species to the Boardman River is dependent on the fate of the Boardman River Dams. The greatest potential for lake sturgeon restoration would be provided by removal of Boardman and Sabin Dams, and efficient lake sturgeon passage installation or dam removal at Union Street Dam.

Aquatic Invasive Species. The restoration of fish passage and river connectivity brings with it the possibility that aquatic invasive species will also be allowed access upstream into the Boardman River. This outcome is possible and must be weighed against the suspected benefits from restoring river connectivity. Some limited guidance can be given for a few of the invasive species already present in the Great Lakes. Zebra mussels have already been transported and are well-established in Boardman Lake, in Brown Bridge Dam Reservoir, and in the Boardman River downstream of Brown Bridge Dam. These mussels have been spread upstream further into the Boardman River despite the presence of the dams. Round Gobies are similar in that they could gain access to the Boardman River from Lake Michigan, but there preferred habitat is not in rivers, so their impact may be minimal. Sea lamprey are well established in the Great Lakes, and the USFWS administers a control program to keep there abundance minimized, to prevent harm to the Great Lakes salmonids fisheries. Currently, sea lamprey are restricted from most of the Boardman River by Union Street Dam. The juveniles of this species prefer slow water habitats with fine sediment substrates. This habitat is present downstream of Union Street Dam, and is abundant in Kids Creek. The USFWS currently treats these river segments every five years with lampricide. Prior to 2006, the USFWS treated the lower Boardman River and Kids Creek with a lampricide called TFM, at a cost of approximately $200,000. In 2006, they continued to treat Kids Creek with TFM, but treated the lower Boardman River in selected locations with granular Bayluscide, at a combined cost of $72,000. If this species was provided access to larger portions of the Boardman River production of sea lamprey larvae would increase. Much of the Boardman river could be expected to be of low suitability for larval sea lamprey since it is relatively high gradient and coarse substrate. However, due to the length of the river and its discharge, costs to treat the river would increase significantly. The USFWS sea lamprey control program would not likely receive additional budget appropriations to deal with this new lamprey habitat, so the overall efficiency of sea lamprey control in the Great Lakes could possibly decrease.

In considering the potential impacts from invasive species, it is important to note that most invasive species will come from Lake Michigan waters. Maintaining some type of barrier somewhere on the river may impede them from accessing the entire Boardman River, but as with the zebra mussels, does not necessarily prevent their spread. Many possibilities exist for invasive species barriers, including maintaining the lower most dam on a river system, lowhead barriers (allow jumping fish like salmon and steelhead to pass), electric barriers (can be selective at preventing only sea lamprey from passing), and seasonal weirs or barriers (only in place seasonally to prevent specific fish migrations such as sea lamprey in the spring-summer). However, the full spectrum of benefits and impacts of fish passage need to be considered, as no barriers are 100% selective to invasive species.

Appendix A . Common and Scientific names of fishes and mussels cited in Boardman River Fisheries Report.

Common Name	Scientific Name (Genus species)
American brook lamprey	*Lampetra lamottei*
banded killifish	*Fundulus diaphanus*
black bullhead	*Ictalurus melas*
black crappie	*Pomoxis nirgomaculatus*
blacknose dace	*Rhinichthys atratulus*
blacknose shiner	*Notropis heterolepis*
bluegill	*Lepomis macrochirus*
bluntnose minnow	*Pimephales notatus*
brook stickleback	*Culaea inconstans*
brook trout	*Salvelinus fontinalis*
brown bullhead	*Ictalurus nebulosus*
brown trout	*Salmo trutta*
central mudminnow	*Umbra limi*
chinook salmon	*Oncorhynchus tshawytscha*
coho salmon	*Oncorhynchus kisutch*
common carp	*Cyprinus carpio*
common shiner	*Notropis cornutus*
creek chub	*Semotilus atromaculatus*
finescale dace	*Phoxinus neogaeus*
golden shiner	*Notemigonus crysolueucas*
goldfish	*Carassius auratus*
grass pickerel	*Esox americanus vermiculatus*
green sunfish	*Lepomis cyanellus*
hornyhead chub	*Nocomis biguttatus*
Iowa darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
lake sturgeon	*Acipenser fulvescens*
largemouth bass	*Micropterus salmoides*
longnose dace	*Rhinichthys cataractae*
mimic shiner	*Notropis volucellus*
mottled sculpin	*Cottus bairdi*
northern brook lamprey	*Ichthyomyzon fossor*
northern pike	*Esox lucius*
northern redbelly dace	*Phoxinus eos*
pumpkinseed	*Lepomis gibbosus*
rock bass	*Ambloplites rupestris*
round goby	*Neogobius melanostomus*
sand shiner	*Notropis stramineus*
sea lamprey	*Petromyzon marinus*
slimy sculpin	*Cottus cognatus*
smallmouth bass	*Micropterus dolomieui*
spottail shiner	*Notropis hudsonius*
steelhead / rainbow trout	*Oncorhynchus mykiss*
tiger trout	*Hybrid cross of brown & brook trout*
walleye	*Stizodstedion vitreum vitreum*
white sucker	*Catostomus commersoni*
yellow bullhead	*Ictalurus natalis*
yellow perch	*Perce flavescens*
zebra mussel	*Dreissena polymorpha*

APPENDIX B

Organization	Primary Data Type	Data Catalog #	Secondary Data Type	River Location	Year Collected	Notes
MDNR	Fish	1	Fish Abundance	BrownBridge Rd, Shecks Campground, Shumskys, Beitner Rd, and Below Sabin Dam	2005 & 2006	Abundance estimates for Brown and Brook trout, relative abundance and length for other species
MDNR	Fish	2	Fish Species Presence/Abscence	Entire Boardman Watershed	Historic - Present	All species observed in all waters of the Boardman watershed inculding lakes
MDNR	Fish	3	Fish Growth	BrownBridge Rd, Shecks Campground, Shumskys, Beitner Rd, and Below Sabin Dam, and Ranch Rudolph	1985 - 2005	A summary of brown trout growth at various sampling sites from 1985 - 2005
MDNR	Fish	4	Fish Abundance	BrownBridge Rd, Shecks Campground, Shumskys, Beitner Rd, Below Sabin Dam, Ranch Rudolph, Forks, and North and South Branch Locations	oldest(~1960) - 2006	A summary of trout population estimates for various sites, for each year in DNR records
MDNR	Fish	5	Fish Abundance	Entire Boardman Watershed	oldest to present	A record of all species and numbers of fish stocked in the entire watershed, with dates and locations stocked
MDNR	Fish Habitat	6	Water Temperature	Forks, Ranch Rudolph. Schecks, below Brown Bridge Dam, Garfield Rd, River Rd by Trestle, Shumskys, Beitner Rd, Below Boardman Dam, below Sabin Dam	2004 - 2006	Minimum, mean, and maximum water temperatures for each month of the year, at various sites in the maninstem Boardman River
USFWS	Other	7	Insects	3.5km upstream of Brown Bridge Dam	2003	Macroinvertebrate riffle community sampled as a "control" for a study on TFM lamprey treatment effects
USFWS	Fish	8	Fish Species Presence/Abscence	Downstream of Union St. Dam, and Hospital Creek	2006	Map of sea lamprey occurrence in Boardman, showing presence only in Hospital creek and downstream of Union St. Dam
USFWS	Fish	9	Fish Abundance	Downstream of Union St Dam	1978-2006	Frequency and timing of adult spawning sea lamprey, and water temperatures, downstream of Union Dam, April - June
USFWS	Fish Habitat	10	River Morphology	Downstream of Union Dam and Hospital Creek	1995&1999 of Boardman River, 1994,1995, 1999, and 2004 for Hospital Creek	Describes proportions and amounts of habitat types (primarily substrates), type 1=silt depositional, 2=sand, 3=gravel erosional
USFWS	Fish	11	Fish Species Presence/Abscence	Various, 1960-2000, entire watershed, 2000 -present, lake michigan delta, hospital creek watershed, downstream of Union Dam, and one site just upstream of union dam	1960 - 2006	Fish species found while sampling targeting sea lamprey, historic species occurrences
USFWS	Other	12			1963 - 2006	Table of sea lamprey treatment dates for Boardman River
MDEQ	Insects, Habitat, Fish	13		North and South Branches, and Creeks: Parker, East, Bancroft, Beitner, Kids.	1998	Final written report from 2002, on 1998 data summarizing quality of selected waters
MDEQ	Other	14		N&S Branches, Jacks Creek, Kids Creek, Swainston Creek	2003	Proc 51 insect sampling and quality rating
MDEQ	Fish Habitat	15	River Morphology	N&S Branches, Jacks Creek, Kids Creek, Swainston Creek	2003	Proc 51 habitat sampling and rating
WCGTB	Other	16	Water Quality	Entire Boardman Watershed	2006	Map of locations within watershed where some form of water quality sampling has occurred
WCGTB	Other	17	WaterQuality and Insects	Boardman Lake Watershed, from Sabin outflow to Lake Michigan	2003	Overview of health of lower Dam watershed, and proc 51 insect and habitat in Boardman Lake - poor to neutral
WCGTB	Fish Habitat	18		Boardman watershed	2005	Background info for the watershed
WCGTB	Fish Habitat	19	River Morphology	N.Br,, some mainstem Boardman, and Kids Creek	2004	Volunteer Proc 51 insect and habitat ratings
WCGTB	Fish Habitat	20	Insects	Jacks and Kids Creek	2005 - 2006	Volunteer insect ratings
GTB Indians	Fish	21	Fish Abundance	Boardman Lake	2000	Fish survey
MDNR	Fish Habitat	22	River Morphology	Ranch Rudolph	2004 & 2005	Paper copy, DNR database housed, Full River channel morphology survey - status and trends protocol

MDNR	Fish	23	Fish Species Presence/Abscence	Watershed	2007	GIS Analusis of the number of other warmwater/colwater fisheries in the Grand Traverse County, similar to the reservoirs.
MDNR	Fish	24	Fish Abundance	Boardman Lake	2003	Results from a MDNR 2003 fisheries assessment of Boardman Lake.
MDNR	Other	25		Entire Boardman River	2004	Preliminary restoration plan of the Boardman River Dams
MDNR	Fish	26	Angler Use/ Creel Survey	Lower Boardman River and reservoirs	2005	Survey of angler effort and harvest on the Boardman River, from Brown Bridge Dam to Lake Michigan, including the reservoirs.
GTB	Fish	27	Fish Abundance	Brown Bridge Dam Impoundment	2007	Raw data from a fisheries assessment of the reservoir (paper copy), available thru GTB
GTB	Fish	28	Fish Abundance	Boardman Dam impoundment	2007	Raw data from a fisheries assessment of the reservoir (paper copy), available thru GTB
GTB	Fish	29	Fish Abundance	Sabin Dam impoundment fisheries data	2007	Raw data from fisheries assessment, paper copy
GTB	Fish	30	Fish Abundance	Reservoir fish abundance summaries	2007	Excel file with summary analysis of fish relative abundances at the three Boardman river reservoirs, Boardman Dam, Sabin Dam, and Brown Bridge Dam