Little Manistee River

Instream Fish Habitat Assessment

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February 2015
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Purpose & Context

Many coldwater streams in Michigan, including the Little Manistee River, lack comprehensive data on instream fish habitat conditions. Research has been done to verify that temperature, catchment size, and 90% exceedance flow have a substantial impact on fish community (Zorn et al. 2009, Zorn and Wiley 2004). However, at this time there is not research available which relates the amount, quality, or spatial distribution of in-stream habitat to fisheries population dynamics (density or size structure). Some work has been done to determine if the addition of woody debris has positive impacts on fisheries populations (Roni and Quinn 2001, Bryant 1983), but has not looked at how much wood is needed or optimal. It is our long-term intent to develop paired habitat and fisheries data sets that can be used to statistically determine the degree to which in-stream habitat, substrate, and bedforms shape fisheries populations in Michigan. The ultimate goal of having that scientific insight, would be to assess a stream and fishery and be able to confidently diagnosis its limiting factors and ensure that actions taken to improve fisheries will result in those benefits being realized.

With that in mind, fisheries habitat data was collected, summarized, and discussed in the context of prioritizing restoration and protection efforts in the Little Manistee River. An emphasis was placed on coldwater fisheries habitat. Habitat mapping was used because it provides a comprehensive habitat inventory for the entire river, or a segment of river, in contrast to a small random subsample that may not accurately depict the variability of habitats that truly represent a river's current conditions. The Little Manistee was surveyed from N. Wide Water Rd. to the Weir (30 miles) and a small section from N. Kings Highway downstream for one mile in 2014. This report summarizes the data collected during this survey.

It is important to note, that currently, rigorous statistical relationships between instream fish habitats and fish populations are not available. This means that we are not able yet, to place these results for the Little Manistee River, in a broader statistical context for identifying and justifying priority improvements to target. At this point in time, we must interpret these results in limited context with the other rivers we have thus surveyed, and using the professional or expert judgments of those intimately familiar with our streams' geomorphology and fish populations, and with experience in the practice of stream enhancement techniques and costs. With that said, this report provides summaries of the results of the survey, and interpretations and recommendations of it that represent TU's professional staff's best professional judgment. This platform will be best put to use, through engagement of other partners and practitioners in its review and interpretation, to the end of us all doing the best we can to ensure the improvement and protection of the Little Manistee River.

If you review this report and would like to provide further comments, discussion, alternate interpretations or recommendations for improvement of future versions of it, we welcome that and are available for contact to facilitate that.

Introduction

The Little Manistee River is a high quality trout stream located in northwest Michigan, supporting trout, salmon and steelhead. The Little Manistee River watershed drains 227 square miles; the mainstem is approximately 55 miles long. It is a "cold stream" from the headwaters to Twin Creek and a cold small river from Twin Creek to the mouth (Table 1).

Table 1. Michigan stream and river temperature classification criteria. Temperature ranges are based on predicted mean July water temperature (°F). These classification are the base for protection limits from large quantity water withdrawals under MI statute (Part 327).

Classification	Temperature Range
Cold	<63.5 °F
Cold-Transitional	63.5-67.1 °F
Cool	67.1-69.8 °F
Warm	>69.8 °F

Prior to this survey there was limited current fish habitat data available for the Little Manistee River. Current road stream crossing and bank erosion inventories are available from Conservation Resource Alliance and the DNR has habitat data for a few select sites. These are great tools; however, they don't allow focus on the status of instream fish habitat conditions in the entire river. The purpose of this survey was to catalog in-stream habitat to determine how it may be limiting the coldwater fishery. It is important to note that fish habitat data is only one of the tools used to identify factors that may be limiting a coldwater fishery, albeit a critical one in which data is typically lacking.

"Habitat mapping" differs from many types of habitat monitoring in that fish habitat is surveyed in the entire river, or an entire sub-section of a watershed. It serves as more of a census than a survey. It included; delineating the river channel into bedform types (run, riffle, or pool), recording the length, location, and width of each bedform unit; and the characterization of the amounts of in-stream fish cover (aquatic vegetation, woody debris, and deep water) and streambed substrate composition in each bedform unit. The full methodology is explained and supported in a separate manual, found at, ***http://www.michigantu.org/index.php/river-stewards-manual/habitat-mapping*.**

Each of these variables is important to the health of a coldwater fish community. A variety of bedform structures are needed for a healthy fishery. Each species of fish, at different stages of their life, have specific needs for survival, growth and feeding, and reproduction, and it takes a variety of habitats to provide for all of those unique needs. For example, riffles with coarse substrate are used for spawning and are critical habitat for numerous species of macroinvertebrates, which provide food for trout. Bottom substrate heterogeneity is also important in providing a variety of food sources. A variety of substrate types (gravel, cobble, silt, wood, leaf packs, etc.) provide habitat for a diverse macroinvertebrate community and thus a variety of food sources for coldwater fish. Areas that can hold and hide fish are also important. Woody debris, deep water, and aquatic vegetation are examples of fish habitats which provide cover. Trout and other fish can seek refuge from predators in these areas.

Limited fish sampling was also completed in the Little Manistee River in 2014. A mark-recapture survey was completed at Old Grade Road Campground and a one pass sampling survey was completed at the “Ghillespy property”. The fisheries data collected may help us determine which identified factors are limiting the fishery; however, it is important to note only two sites were surveyed, one for population. More population estimates located throughout the river are needed to make definitive observations about the fishery as a whole. Fisheries densities and size structure can vary significantly from site to site along a river.

In 2014 approximately 31 miles of the Little Manistee River were mapped (Figure 1). Habitat mapping data collected on the Little Manistee River in 2014 is summarized in this report. Trends in bedform composition, substrate composition, and fish habitat structure were compared in four segments of the Little Manistee River.

Figure 1. Map of the Little Manistee River. The two points at start are Kings Highway (upstream) and N. Wide Water Rd. (downstream). Mapping was completed from N. Wide Water Rd. to the weir (end point). A small 1 mile section from Kings Highway downstream was also completed.

Data Examples

As discussed in the “Purpose & Context” section, we do not currently possess well-developed quantitative relationships between instream fish habitat variables and stream fish populations. However, we do have confidence in several general ecological principles.

1.) Habitat heterogeneity and diversity is desired. It provides for habitats to suit many macroinvertebrate and fish species and their various life stages, generally leading to healthy populations, diverse fish communities, and ecosystem resiliency. In contrast, homogeneity of habitats, while possibly benefiting a few select species, generally leads to less productive and resilient fish communities.

2.) Stream fish such as trout, unless prevented from migrating throughout a river system by impassable barriers, will move considerable distances to reach unique habitats they needed for different purposes. If connectivity between river segments exist, each segment need not offer all habitat elements in ideal levels, rivers can form mosaics of different habitats that taken and functioning as a whole provide all the necessary elements.

3.) Trout, salmon and steelhead are lithophilic spawners, meaning they require gravel substrates of the right size ranges, with specific water velocities to reproduce. We do not well understand the exact amounts of this habitat in a stream that are required to ensure maximum spawning potential and success for a given population, but these habitats are essential.

4.) Wood material is critically important in Michigan streams, for influencing channel form, localized substrates, nutrient cycling, substrates for macroinvertebrates, and cover for fish. We do not yet understand how much wood is optimal. Is more wood always better for trout, or is it only better to a certain point, with no real benefit after that? We do not yet understand fine-tuned wood dynamics, but do know it is a critical component to healthy stream fisheries in the Midwest.

5.) Deep water, defined here as >2.5 ft. deep, provides security and comfort to many species of fish in streams, and for large sizes of trout. Very wide and shallow habitats can be productive habitat for small fish and juvenile trout, but generally, larger sizes of stream trout require presence of deep water and other forms of cover.

6.) Moderate slopes or gradients of streams tend to lead to the formation of more riffle and pool bedforms, interspersed with runs. As slopes decrease, riffle and pools become less frequent, and bedforms are dominated by runs. When run bedforms are dominant, it becomes essential that habitat complexity and diversity is accomplished by other habitat elements such as deep water, wood material, and aquatic vegetation.

7.) We are not yet able to confidently state how much "sand" substrate is deleterious to a trout population. The negative impact of sand to a trout population generally, has been well documented. But exact impacts to a population will be dependent on many other variables, including the abundance and distribution of other forms of critical habitat (which may or may not co-vary with sand).

So, we examine the results of instream fish habitat assessments through these very general principles, looking first for clear and obvious deficiencies or imbalances of critical habitats, and secondarily for potential elements that could be optimized further in specific locations. The following are hypothetical data scenarios to familiarize the reader with these concepts and the data summaries to follow.

A healthy stream will have diverse bedform structure with ample run, riffle, and pool habitat. The river will not be dominated by one bedform type (Figure 2). River A has a good balance of bedform types, whereas River B is dominated by run habitat with little riffle or pool habitat available. The dominance of run habitat in river B may indicate a problem.

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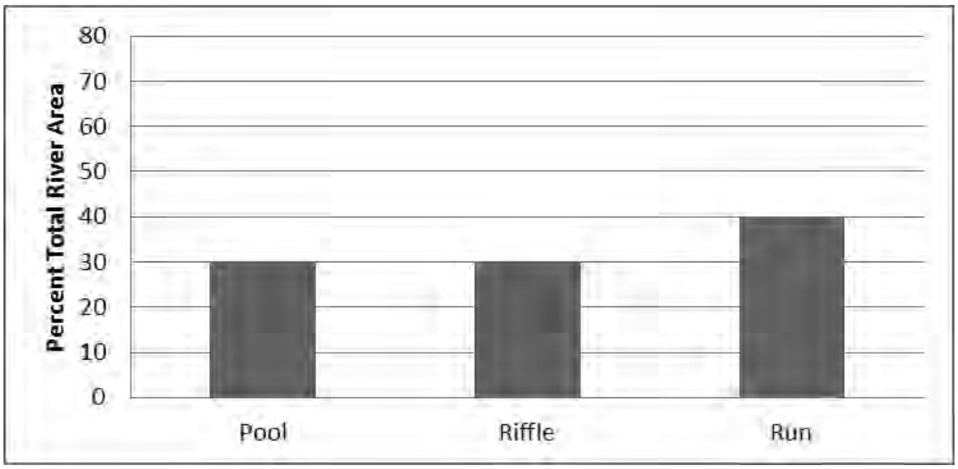

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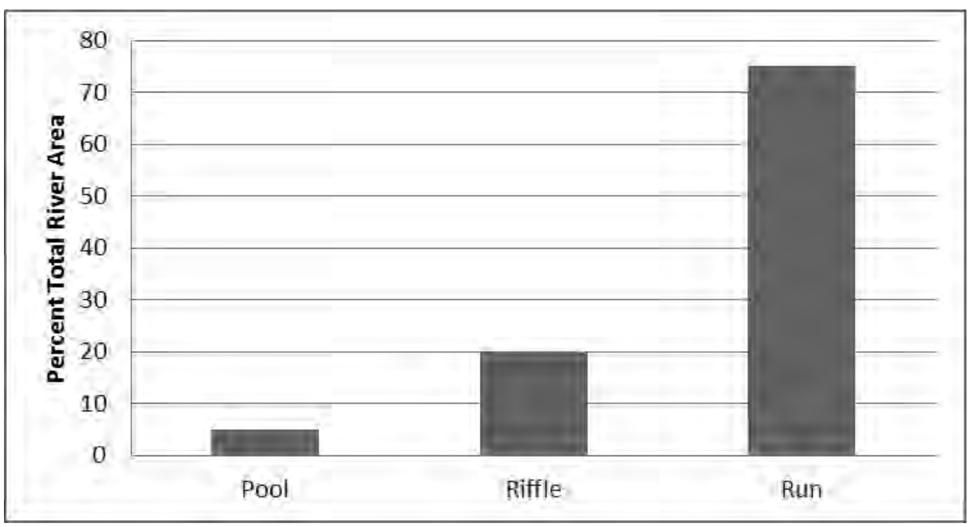
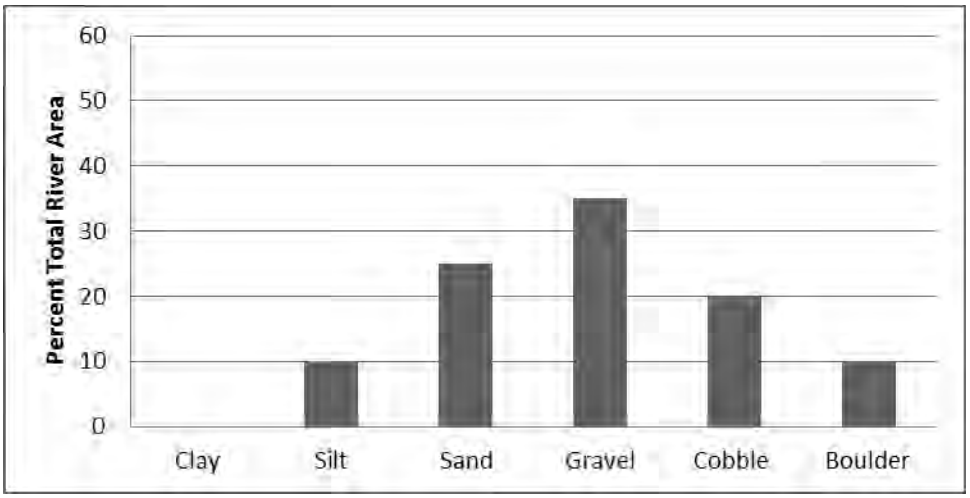


Figure 2. Hypothetical bedform composition data for a healthy balanced river (A) and a river with limited bedform heterogeneity (B).

A variety of substrate types are also present in a healthy river. It is especially important that fine sediments (sand and silt) do not dominate a river bottom. Erosion is a major source of pollution to our waterways, an overabundance of fine sediment may be a sign that there is an erosion problem in the watershed, or a legacy of past sedimentation that has not been "flushed" out of the system. A healthy river will have a balance of substrate types (Figure 3). River A has a good balance of fine and hard substrate; whereas river B is dominated by silt and sand with little hard substrate present.

A)



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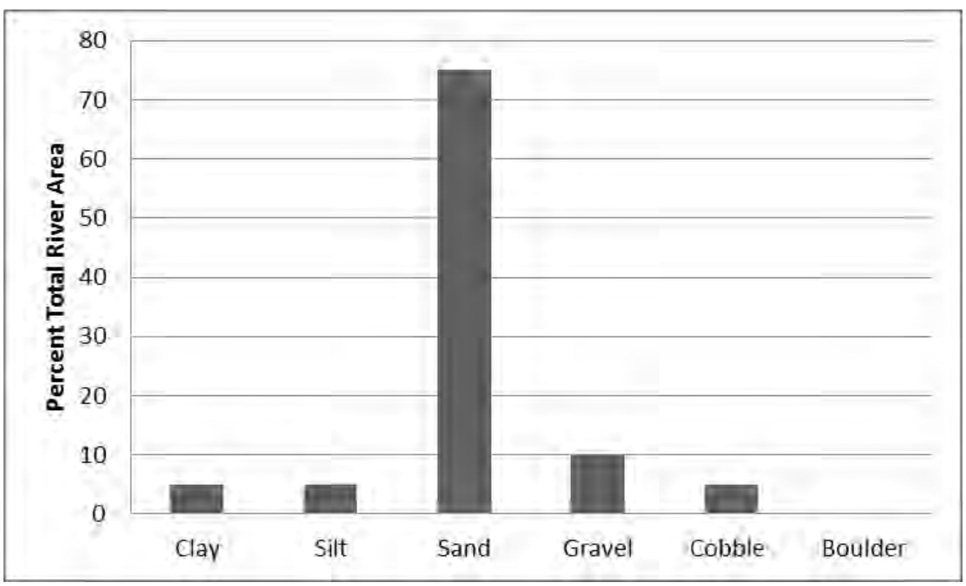

Figure 3. Hypothetical substrate composition data for a healthy river (A), and a river with excess fine sediment (B).

In-stream habitat diversity, or fish “cover” is also an important portion of what makes a stream ideal for coldwater fish. Fish need a variety of places to seek cover from predators including aquatic vegetation, woody debris, and deep water. River A has abundant, diverse in-stream fish habitat (80%); whereas, river B has sparse in-stream habitat available (25%) (Figure 4).

A)

B)

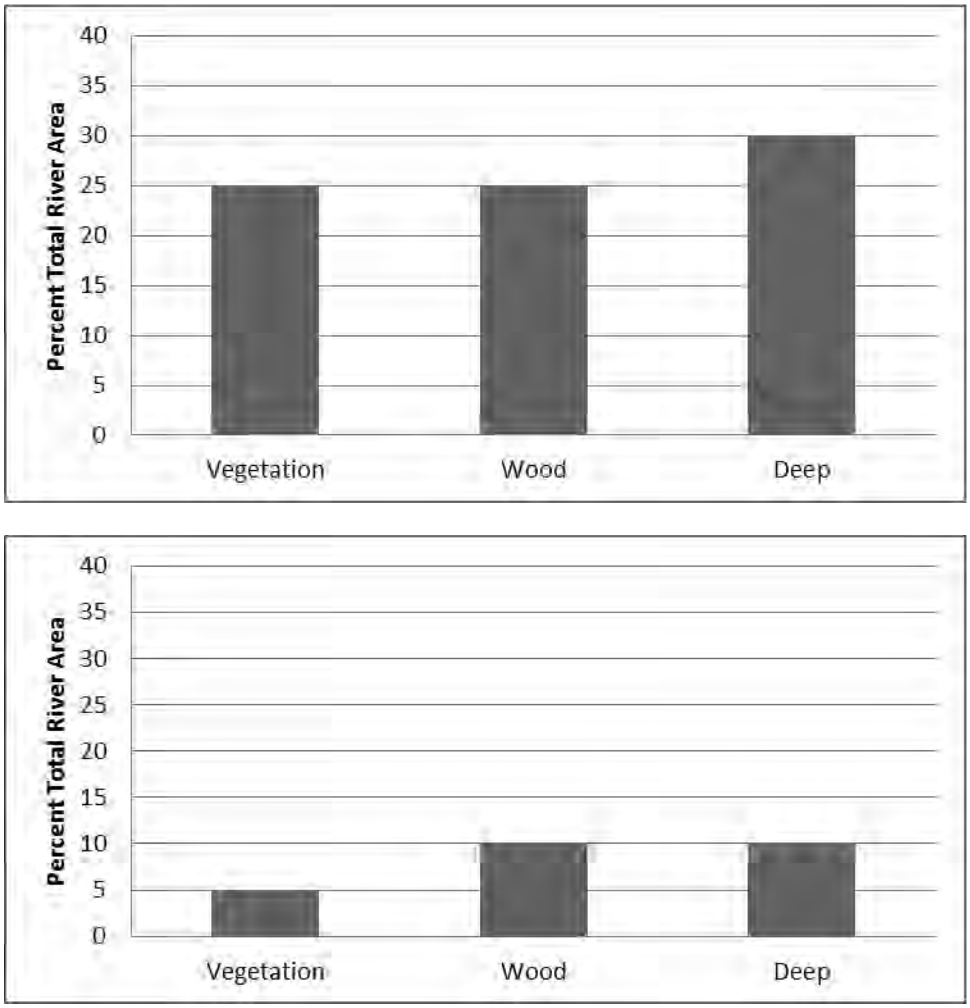

Figure 4. Hypothetical in-stream habitat data for a river with good diverse habitat (A), and a river deficient in-stream habitat (B).

Graph A in Figures 2-4 depict a “healthy” river, ideally each river mapped will have data similar to that *generally* seen in the A graphs. Graph B in Figures 2-4 depict issues which may be indicative of a limitation to the coldwater fishery. When we see data similar to that in the B graphs restoration or enhancement may be needed, and more indepth analysis and discussion is appropriate.

Methods

Methodological details for this instream fish habitat assessment can be found in full detail in report form, at: http://www.michigantu.org/index.php/river-stewards-manual/habitat-mapping.

This survey was conducted by Michigan Trout Unlimited (MITU) interns. Interns were trained in habitat mapping methods by Michigan Trout Unlimited Aquatic Ecologist Kristin Thomas. All mapping was completed during average or low flow conditions. It is important that habitat is not mapped during times of high flow because high flow can make it difficult to distinguish bedform delineations. Mapping was completed in June; therefore the amount of aquatic vegetation present may have been lower than it would have been later in the summer.

Training included instruction on how to determine bedform delineation, substrate classification, and practice visually estimating percent of streambed. Stream diagrams were used to practice estimating the percent of streambed occupied by substrate types and fish cover. Volunteers estimated substrate composition and fish cover for each diagram. A key with a grid and actual percentages were then provided. This exercise was used to help volunteers visually estimate percent of stream bottom.

Bedform delineation and qualitative observations were derived through independent visual observations and evaluations. Bedform delineation involved the categorization of the stream into bedforms (run, riffle, pool, rapid, as defined in Table 2). The length and widths (top and bottom) of each bedform section were measured. Latitude and longitudes were recorded at the top and bottom of each bedform section using a handheld GPS. Measurements of bedform lengths and widths were made with a Nikon Laser Rangefinder (+/- 0.5 yard accuracy) or a tape measure.

Quantitative streambed substrate composition measurements were made through visual estimation. The percent area of each bedform segment occupied by clay, silt, sand, gravel, cobble, or boulder was estimated visually. Substrate classification followed Wolman size classes for sand, gravel (all sizes combined), and cobble (all sizes combined) (Table 3). The percent area of streambed in each bedform section covered by woody debris, aquatic vegetation and deep water (>2.5 ft.) was also visually estimated. The amount of wood, vegetation, and deep water was expressed as a percent of streambed area (5% increments). The maximum depth present in each bedform section was also recorded. In cases were maximum depth could not be measured; maximum depth was listed as greater than 4 feet.

Table 2. Bedform delineation explanation.

Bedform	Description
Run	Fast or slow current, unbroken water, average depth.
Riffle	Swift current, turbulent broken water, shallower than average depth.
Pool	Slow or no current, unbroken water. Generally about 1.5 times deeper than average depth.
Rapid	Swift current, very turbulent, broken water. Large boulders or bedrock often breaking the surface.
Waterfall	The majority of the stream flow over a ledge or cliff.

Table 3. Substrate classes used to denote substrate composition.

Particle	Description
Clay	Very fine sticky texture. Easily forms ribbons when rolled in hand, generally reddish or gray in color.
Silt	Very fine texture. Smooth, silky feel when handled.
Sand	Crumbles readily when handled. Single sand grains are apparent.
Gravel	Rocks 1/16 to 2 ½ inches in diameter
Cobble	Rocks 2 ½ to 10 inches in diameter.
Boulder	Rocks greater than 10 inches in diameter.
Bedrock	Solid rock surface, not the tops of boulders.

The Little Manistee River was originally divided into 8 habitat mapping sites, for the purpose of organizing field data collection (Table 4). In most cases, access points dictated the beginning and end of each site. Habitat data for all of the mapped portions of the river were analyzed and then the 8 sites were grouped into 4 analysis segments. Segments were chosen based on commonalities in habitat conditions, and clear contrasts between them (Table 5). Figures 5 -7 below are provided, to illustrate that the consolidation into 4 segments for analysis was based off similarities in instream habitat elements, and not arbitrary grouping that would obscure significant differences between the segments.

Table 4. Descriptions of the 8 original Little Manistee River mapping sites. Shading indicates transition between 4 segments used in analysis.

Site Name	*Site Description*	*Segment*
Little Man 1	N Kings Hwy to N Wide Water	Segment 1 (only 1 mile mapped)
Little Man 2	N Wide Water to M-37	Segment 1
Little Man 3	M-37 to S. Peacock Trail	Segment 1
Little Man 4	S. Peacock Trail to Irons Rd.	Segment 2
Little Man 5	Irons Rd. to N. Johnson Rd.	Segment 2
Little Man 6	N. Johnson Rd. to N. Bass Lake Rd.	Segment 2
Little Man 7	N. Bass Lake Rd. to Skocelas Rd.	Segment 3
Little Man 8	Skocelas Rd. to Weir	Segment 4

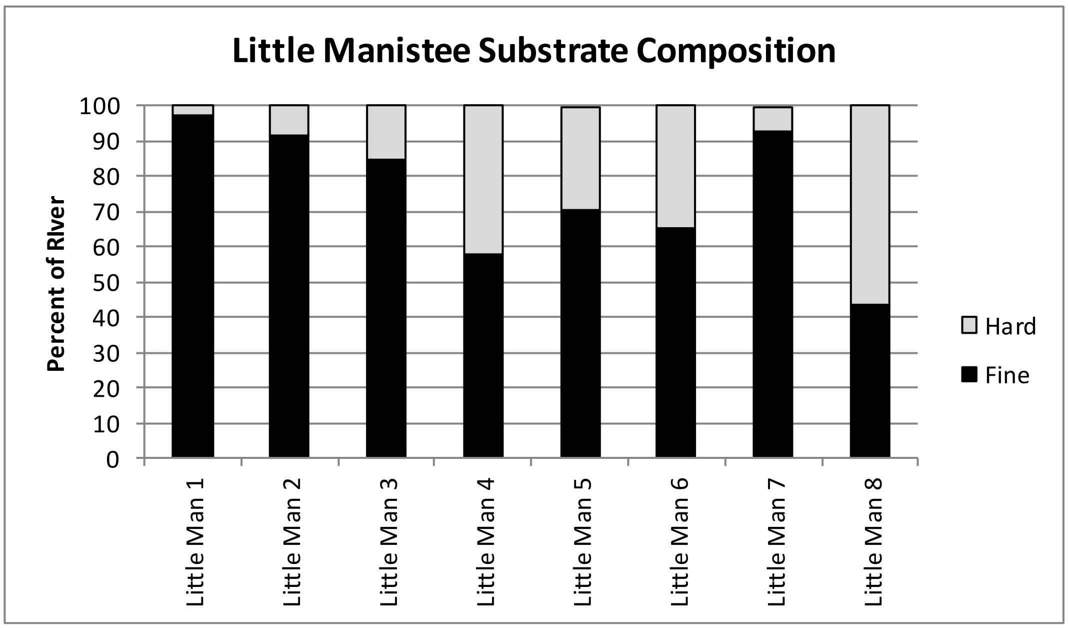

Figure 5. Little Manistee River Substrate Composition. Fine – clay, silt, and sand. Hard – gravel, cobble, and boulder.

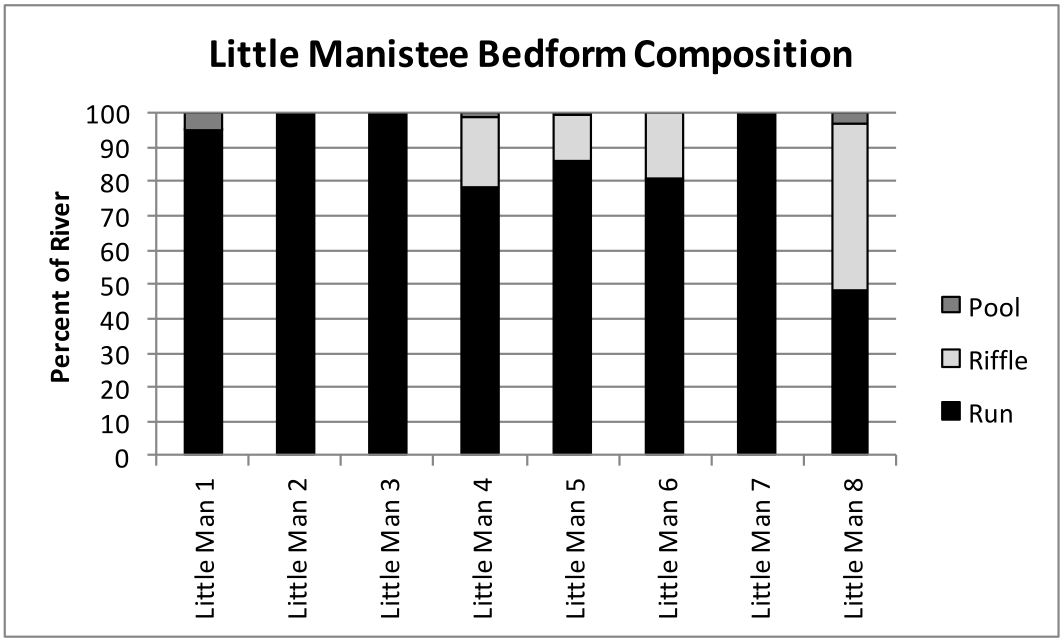

Figure 6. Little Manistee River bedform structure.

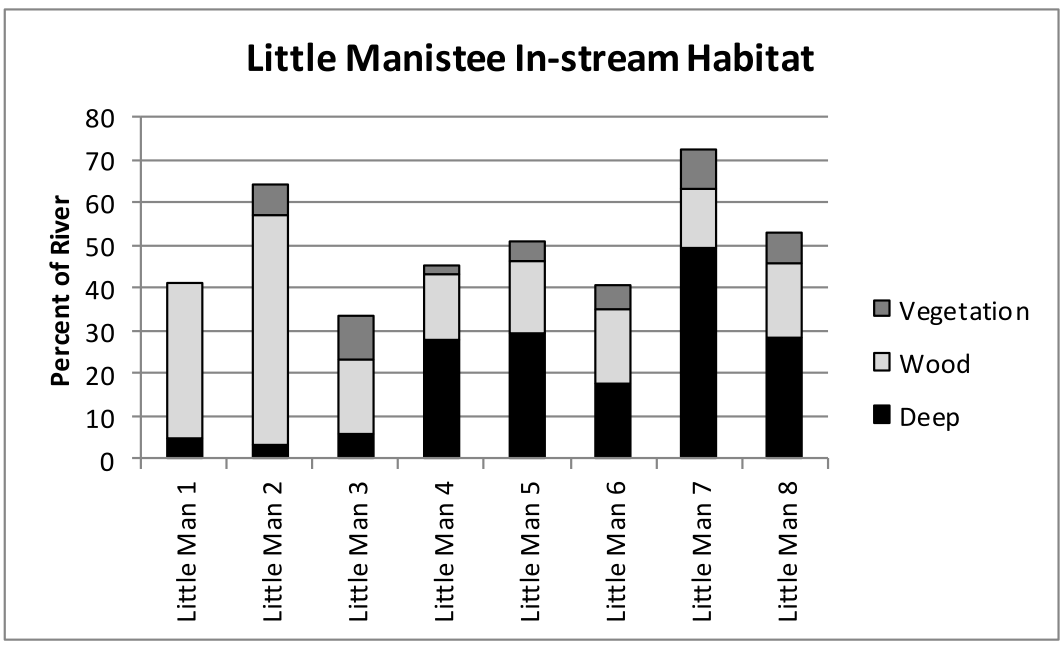

Figure 7. Little Manistee River in-stream habitat structure.

Table 5. Description of the four Little Manistee segments used for analysis.

Segment Name	Segment Description	Segment Length (miles)
Segment 1	N Kings Hwy to S. Peacock Trail	6.8
Segment 2	S. Peacock Trail to N. Bass Lake Rd.	9.6
Segment 3	N. Bass Lake Rd. to Skocelas Rd	7.8
Segment 4	Skocelas Rd. to Weir	6.6

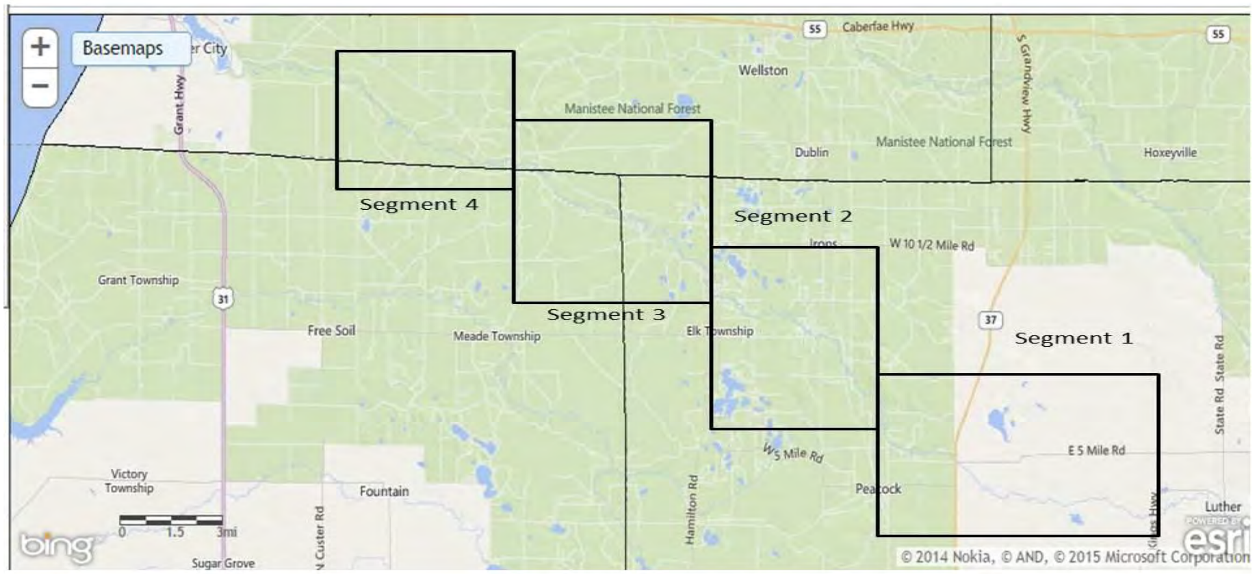

Figure 8. Map of the mainstem of the Little Manistee River, showing the 4 main segments of the river related to distinct differences in instream fish habitat conditions. Boundary descriptions found in Table 5.

Habitat features for each section were summarized (Table 6). For all analyses, percent of total streambed was used. For example, to determine what percent of the Little Manistee River is run, riffle, and pool the total area of run, riffle, and pool was calculated and then expressed as a percent of total streambed area. To calculate the area of each bedform section the mean bedform section width (top width + bottom width/2) was multiplied by bedform section length. Percent substrate and habitat was calculated by expressing the percent substrate or habitat as an area (i.e. (percent gravel/100)*bedform section area). The total area of sand, gravel, cobble etc. was then summed and expressed as a percent of total stream or segment area. Thus, each percent presented on a graph represents the proportion of total stream bed occupied by that in-stream habitat element as estimated for this study.

The deepest point in each bedform section was also recorded. This allowed for the calculation of minimum width to depth ratio. We were unable to calculate width to depth ratio in the traditional format because we do not have a mean depth or bankfull width for each bedform section (width to depth ratio = bankfull width/mean depth). Therefore, we calculated minimum width to depth ratio = wetted width/maximum depth. This calculation results in a smaller number than a traditional width to depth ratio; thus, it is referred to as minimum width to depth ratio. In cases where maximum depth was listed as greater than 4 feet, 4 feet was used to calculate minimum width to depth ratio.

Results and Discussion

Table 6. Instream fish habitat summary data for the Little Manistee River. Percentages and proportions are mean values for all bedform segments in the river as a whole and within each section.

	All Sections Mapped	Segment 1	Segment 2	Segment 3	Segment 4
Total Length (ft.)	162,994	35,858	50,895	41,280	34,962
Width (ft.) *Mean*	37	24	35	45	49
Range	15-96	15-48	24-54	23-87	30-96
Percent Run Bedform	80	98	82	100	48
Percent Riffle Bedform	18	0	17	0	49
Percent Pool Bedform	2	2	1	0	3
% Deep Water (>2.5 ft.)	30	5	25	50	28
% Woody Debris	18	28	17	14	18
% Aquatic Vegetation	7	5	4	9	7
Total Section - % Clay	0	0	0	0	0
Total Section - % Silt	5	11	4	8	2
Total Section - % Sand	65	80	61	85	41
Total Section - % Gravel	26	9	31	7	49
Total Section - % Cobble	3	0	3	0	6
Total Section -% Boulder	1	0	1	0	2

Little Manistee River Analysis: Whole River

The Little Manistee has a fairly high percentage of run habitat (80%) with riffle being the second most common bedform type (18%), sand is the most common substrate (65%) followed by gravel (26%), there is an abundance of deep water (30%), moderate levels of woody debris (18%) and limited aquatic vegetation (7%) (Figure 9). These percentages vary substantially from those presented as hypotheticals in Figures 2, 3, and 4, especially the high proportion of run habitat and sandy substrate. However, most Michigan Rivers that have been analyzed have between 70 and 90% run habitat (Figure 10). In fact, only two analyzed rivers have less than 70% run (Figure 10). In comparison the Little Manistee does still lag in pool habitat; however, there is an abundance of deep water which makes the limited recorded pool habitat less concerning (Figure 10). The Little Manistee River does have a higher percentage of fine substrate (predominantly sand) than many other streams in Michigan (Figure 10). To a large extent the dominance of run habitat and sandy substrate in so many Michigan Rivers can be explained by geology and geomorphology. Most rivers in Michigan's Lower Peninsula are low gradient streams which limits the amount of riffle that will naturally occur in the stream. The Little Manistee does have an abundance of deep water habitat and an average amount of woody debris. However, there are several areas that would benefit from an increase in in-stream habitat, such as woody debris. Data for the Little Manistee as a whole is useful in comparing rivers and identifying clear deficiencies. However, data from analysis of specific segments will be used to identify areas of need and potential projects.

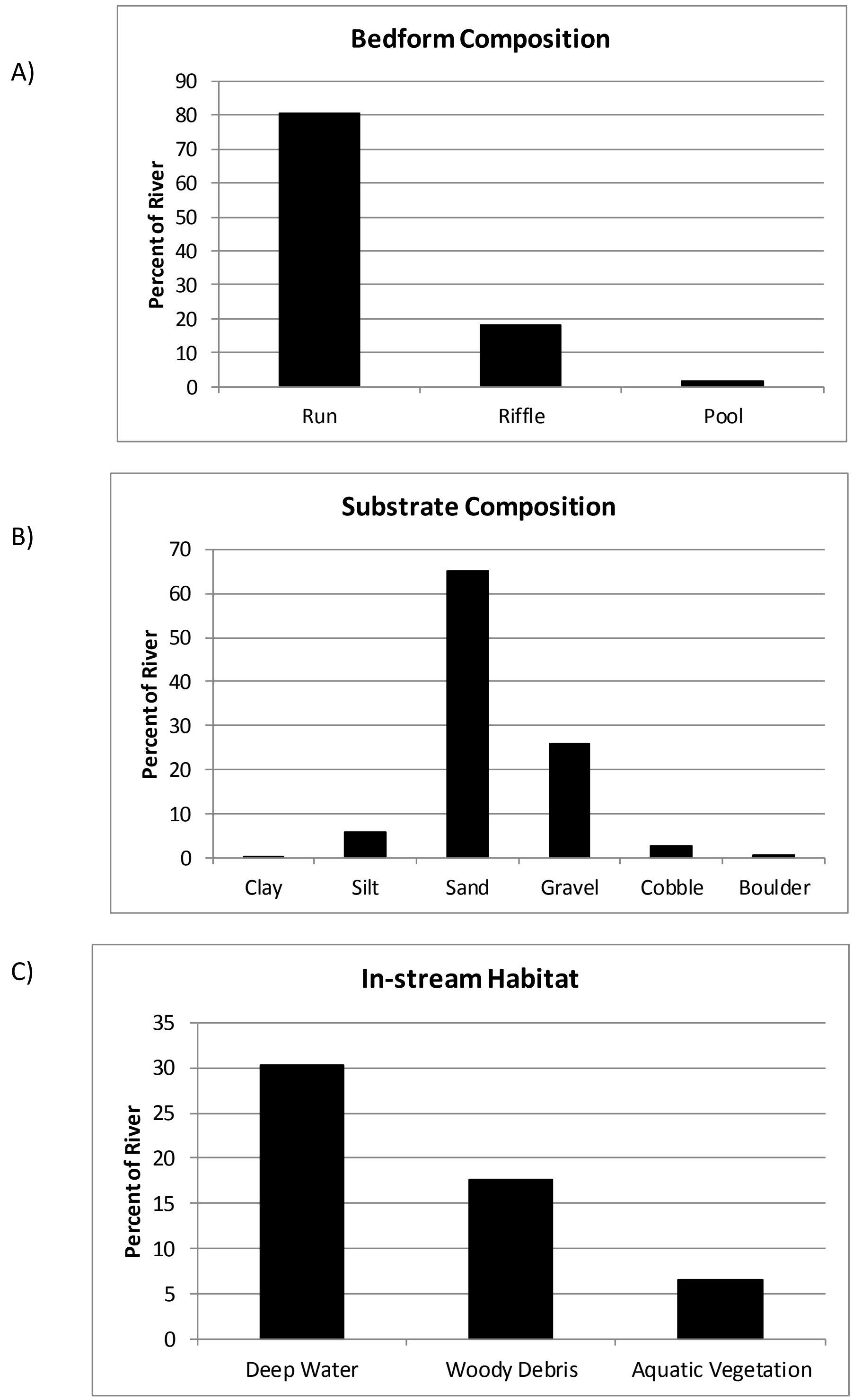

Figure 9. Little Manistee River bedform delineation, bottom substrate, and in-stream fish habitat.

A) B) C)

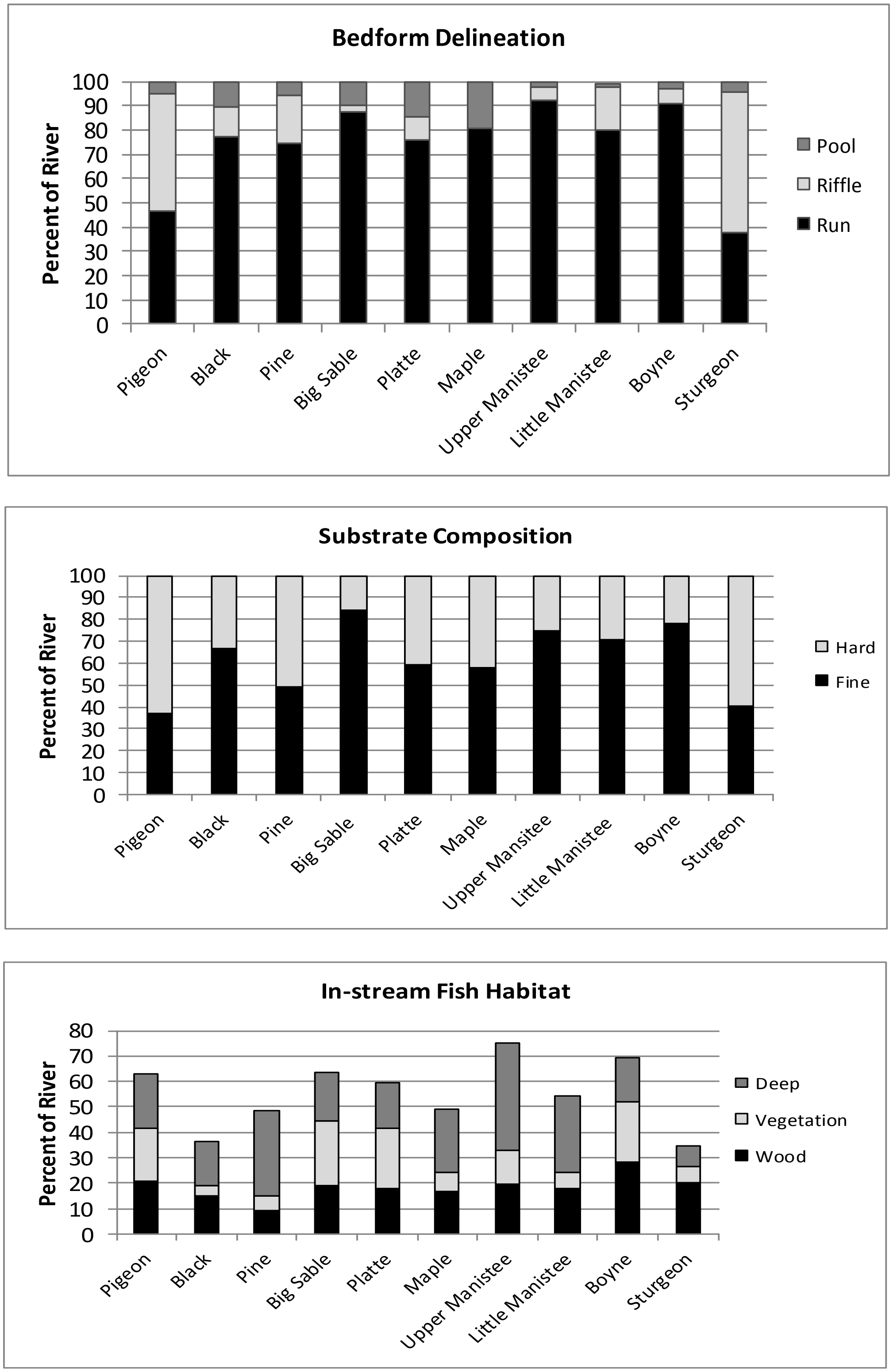

Figure 10. Bedform composition (A), substrate composition (B), and in-stream habitat (C) data for Michigan coldwater streams including the Pigeon, Black, Pine, Big Sable, Platte, lower Maple, Upper Manistee, Little Manistee, Boyne, and Sturgeon Rivers.

Little Manistee River Analysis: By Segment

Segment 1 consists of sites 1-3. These sites were grouped because their relative abundance of run habitat and fine substrate. Sites 4-6 were grouped into segment 2 because of the increased abundance of riffle habitat and hard substrate relative to segments 1-3. Segment 3 is site 7 and was offset from segment 2 and 4 because of the dominance of run habitat and abundance of fine substrate. Segment 4 is site 8 and was not grouped with segment 3 due to the increased abundance of riffle and hard substrate (Figures 5, 6, and 7).

Bedform Structure

In the Little Manistee River as a whole there is limited riffle and pool habitat; however, when the river is looked at in smaller segments better bedform diversity become apparent (Figure 11). While segments 1 and 3 are almost completely dominated by run habitat, segments 2 and 4 offer larger proportions of riffle habitats. These should be assumed to be the key critical spawning habitats for trout and salmon, and treated as key reproduction areas by ensuring sedimentation does not impact these segments in the future. Increasing juvenile trout habitat in these segments may also be of interest to pursue.

Although bedform diversity is good in segments 2 and 4, there is still limited identified pool habitat. The limited presence of formal pool habitat would be more alarming if the river did not offer as much deep water habitat as it does in segments 2,3, and 4.

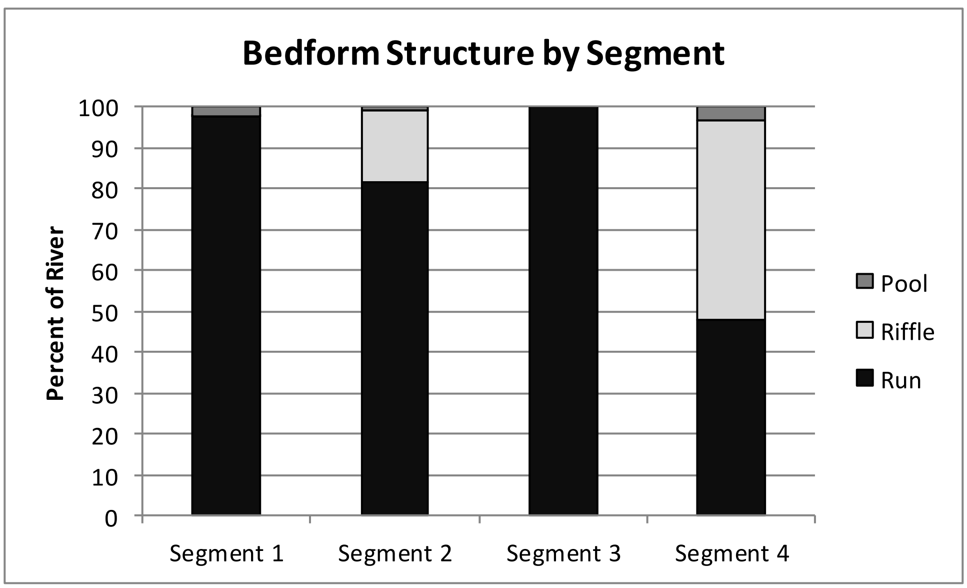

Figure11. Bedform structure of segments in the Little Manistee River.

In-stream Habitat Availability

The Little Manistee River has a fairly good quantity and diversity of in-stream habitat, although there are some areas that would benefit from an increase. All segments had more than 30% cumulative fish habitat (Figure 12). Deep water is the most abundant habitat type followed by woody debris and aquatic vegetation. The amount of aquatic vegetation throughout the river is very limited, although sampling was completed in July therefore the vegetation may have been limited due to seasonal variation. Had sampling occurred in August or September there may have been significantly more aquatic vegetation present.

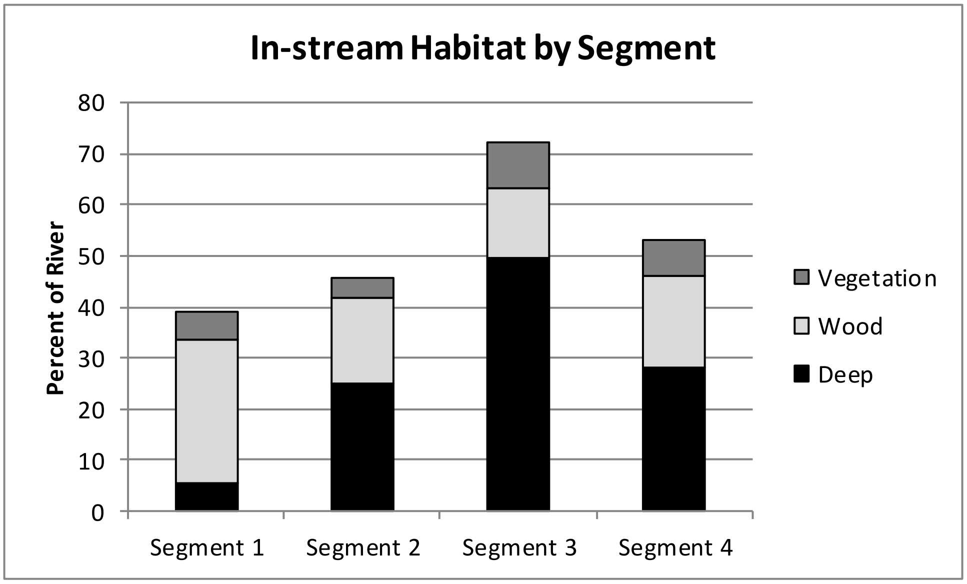

Figure12. In-stream habitat structure in the Little Manistee River.

Segment 1 contained the least amount of fish cover, with only about 5% deep water and aquatic vegetation, and also was nearly all run habitat. It did however, have a relatively large amount of wood material (28%). Segments 2 and 4 both had similarly higher amounts of deep water habitat, and average amounts of wood material. These habitat elements in combination with the higher percentages of riffle habitat make these segments appear reasonably well-balanced in their habitats provided. Segment 3 had a large amount of deep water habitat, nearly 50%, but also had the lowest amount of wood of the 4 segments. The abundance of deep water habitat in segments 3 seems to indicate a large amount of deep run habitat. Segment 3 did not have much noted pool habitat. This is most likely partially a result of the river geomorphology and the methods used to map bedform structure. As mentioned before much of the Little Manistee River is low gradient, which means there is very little riffle and pool habitat based on geomorphology alone. In addition, the protocol used to classify run, riffle, and pool habitat may miss some “pool like” habitat in that slow moving, deep run may be classified as run, rather than pool because the water is flowing and there may not have been a change in average depth. The definition of pool used states a pool occurs where there is “slow or no current, unbroken water; generally about 1.5 times deeper than average depth.” If there is no change in depth, or current stays consistent deep water is often characterized as run habitat, which adheres to this definition.

Substrate Composition

Sand is the most common substrate in segments 1, 2, and 3; gravel is most common in segment 4 (Figure 13). Segments 1 and 3 have over 80% fine substrate, while segments 2 and 4 have a greater proportion of hard substrate, between 35 and 60% (Figure 14). We know this abundance of sand is due both to the geology and slope of the river and to historic logging and land use practices which contributed large amounts of sand. Although there is clearly an overabundance of fine sediment in most segments of the river (Figure 14), there are also some sizeable areas of gravel in segments 2 and 4 (Figure 13). It is difficult to determine if the gravel present in these segments is sufficient for the coldwater fishery. The amount of hard substrates and riffles present, primarily in segments 2 and 4, currently provide for significant natural reproduction of trout and salmon this river is well-known for. While additional hard substrates and riffle habitats may increase the spawning and reproduction capacity of the river, commensurate increases in juvenile rearing habitat would also need to be provided in order to realize an overall increase in fish abundance.

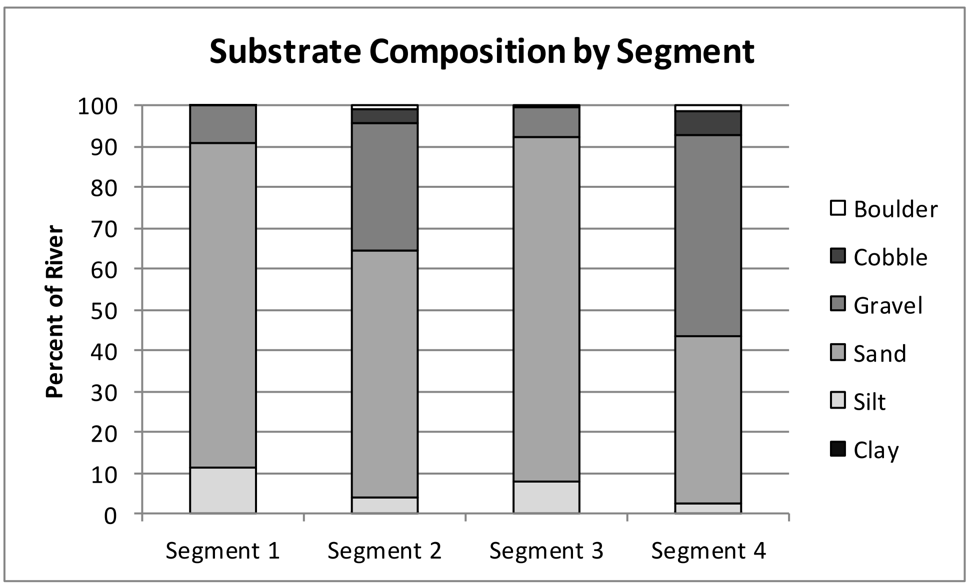

Figure 13. Little Manistee River substrate composition by segment.

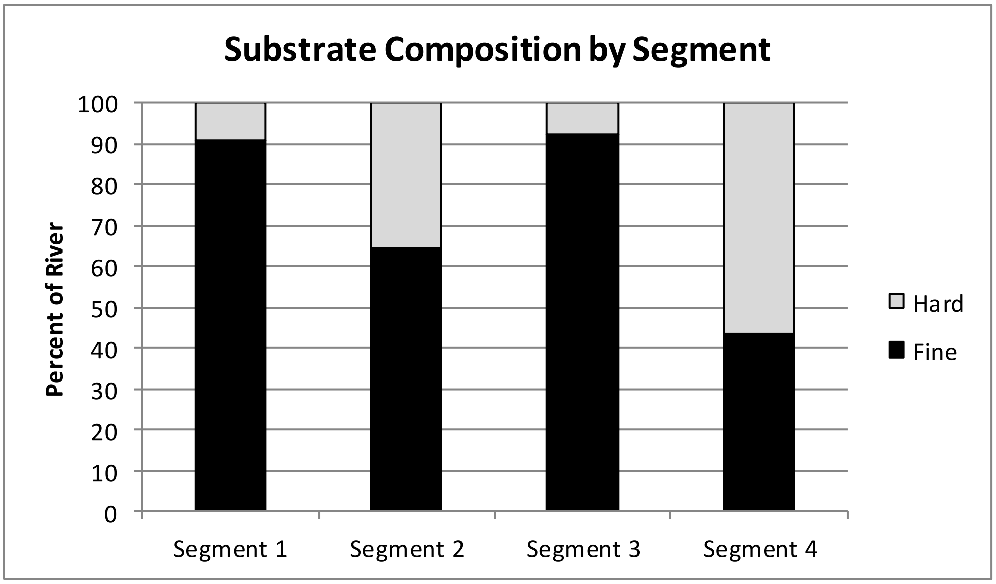

Figure 14. Little Manistee River fine (clay, silt, and sand) and hard (gravel, cobble, and boulder) substrate composition by segment.

Recommendations and Management Actions

<u>Segment 1</u>,

Segment 1, from Kings Highway downstream past M37 to South Peacock Trail, is almost exclusively run habitat (98%); with about 11% silt, 80% sand and 9% gravel, offers very little deep water habitat (5%), and little aquatic vegetation (5%). Taken together, these elements suggest that this section of the river is fairly poor habitat overall. The greatest habitat element of this section is that it does have a relatively large proportion of wood debris (28%). Still, we speculate that this section of the river is probably providing limited spawning, and very little habitat for older/larger classes of trout. The fisheries survey results from the Old Grade Campground survey (Appendix 2), appear to substantiate this. That survey showed the presence of juvenile trout (brown and rainbows) in relatively robust numbers, but also show a marked drop in brown trout after their first year of life. The drop from year 1 brown trout to year 2 brown trout is far greater than the average annual mortality of brown trout in Michigan, indicating a largescale emigration of year 2 and older brown trout from this section. Steelhead juveniles do appear to be using this section for both of their first two years of life in the stream before emigrating out to Lake Michigan. But taken together, the paucity of deeper water and habitat complexity in segment 1 seems to render it relatively unsuitable for older / larger stream trout.

If worked is pursued in segment 1, it would be well-served to focus on increasing the complexity of fish habitat. Possible actions that could be taken:

- Increase instream wood debris material, to increase juvenile fish habitat/cover

- Use of “brush bundles” and smaller wood material placed on the shallow stream margins to foster deposition of fine sediments within them, a promote narrower/deeper stream channels.

- Add larger instream wood debris structures with designs that would promote localized bed scouring, adding cover but also unique deep water habitats and localized gravel substrates may result. Many possible designs exist for these purposes. The key elements would be stable installation with the objective of addressing the wide/shallow stream shape with localized areas that are narrower/deeper and sustainable (increased water velocities to prevent sand deposition in them).

- Investigate the feasibility of transplanting and/or promoting increased areas of aquatic vegetation. Aquatic vegetation serves as high quality juvenile fish cover, and may be possible to promote in portions of wide/shallow stream channels otherwise lacking suitable fish habitat. While this may not increase suitability to larger trout, it could help ensure that segment 1 at least provides optimal juvenile rearing habitat within the river.

If enhancement efforts are desired to be undertaken in segment 1, it is advisable that either formal or informal assessment of instream fish habitat conditions upstream of the segment be evaluated. From a fish population perspective, each segment is not independent of the ones upstream and downstream of it. Segment 2, downstream provides better deep water and riffle habitat than segment 1. Understanding what kind of habitat lies immediately upstream of segment 1 would help complete the context for needed enhancements in segment 1.

<u>Segment 2</u>.

Segment 2, from Peacock Trail to Bass Lake Rd, contained a reasonably good mix of instream fish habitat conditions, including 17% riffle habitat, 31% gravel, 25% deep water habitat, and a moderate 17% wood debris. Aquatic vegetation was low (4%), run habitat was still the most dominate (82%) and sand was the most dominate substrate (61%). Segment 2 appears to be, along with segment 4, an important area of the river for trout and salmon reproduction, given its relative abundance of riffles and gravel, in combination with reasonable amounts of deeper water habitats. We encourage segment 2, along with segment 4, to be thought of as high quality critical habitat within the Little Manistee River, to be monitored and protected from degradation. Sedimentation would be a primary concern to prevent here. Possible actions that could be taken:

- Ensure that sand from either upstream, severe bank erosion sites, roads, or other sources are prevented from delivering sand to this section of stream.

- Establish several long-term monitoring sites within this segment, where substrate conditions would be periodically monitored to detect any sedimentation that might occur. This could be done through monumented cross-sections at several riffles, where the pebble count method would be used, analyzed, and repeated annually or semi-annually.

- Wood material augmentation could be undertaken to increase fish cover beyond, the 17% current average. One particular portion of this segment was identified that had less wood material than the rest, and could be targeted (Appendix 1). However, the entire reach may benefit from an overall increase in wood material for fish cover. Care should be taken in design of these efforts if pursued however. Priority should be given to small to medium sized relatively mobile wood material. This would ensure the river can move and adjust the materials location. Large and/or fixed wood structures, if not carefully designed, could disrupt the riffle-run-pool sequencing that exists with unintended negative consequences.

- Investigate the feasibility of transplanting and/or promoting increased areas of aquatic vegetation. Aquatic vegetation serves as high quality juvenile fish cover, and may be possible to promote in portions of this segment otherwise lacking suitable fish habitat. Boosting juvenile rearing habitat is often the key to translating successful spawning into increased abundance of mature stream trout or increased outputs of steelhead and salmon smolts.

<u>Segment 3</u>.

Segment 3, from Bass Lake Rd. to Skocelas Rd., is quite unique in habitat from the other segments. It is 100% run habitat and had 93% fine substrates. However, unlike segment 1, segment 3 offers 50% deep water habitat, a large percentage. But, while this amount of deep water offers attractive fish habitat, there was only an average of 14% wood material, the lowest of any segment in the Little Manistee (although not outside the normal ranges seen river-wide elsewhere in Michigan (Figure 10 C.)). This segment had slightly more area of aquatic vegetation than other segments (9%), but still far less than seen on many other rivers.

It is clear that segment 3 is not currently, nor is it likely to be a key spawning area in this river like, like segments 2 and 4 which bookend it . Despite this, the high percentage of deep water habitat can lend this segment to providing key habitats not offered in abundance by other segments. If its abundant deep water habitats were enhanced with additional wood debris, this section could be ideal habitat for larger sizes of brown trout, and offer more temporary holding cover for adult salmon and steelhead during their migrations. In order to improve the complexity of habitat here, and improve its suitability to certain life stages of key fisheries, it is advisable that this section of river be targeted for enhancement work. Actions to be considered:

- Addition of wood material, moderate sized, with mobility. This would boost the overall abundance of this material for fish cover, and allow it to be distributed throughout the segment through time. As it initially moves, it would create unique microhabitats and localized scour through the channel through the section, including both deep and shallow water areas. Eventually, a large portion of these would be suspected to come to rest in more permanent locations and still continue to provide enhanced cover for fish.

- Addition of wood material, large and significant in size, with restricted mobility. This type of wood enhancement is more intensive and expensive, and requires appropriate access for installation. However, if properly designed, these could create significant fish cover habitats, through creation of large logjams complexes; and/or can be designed to promote significant localized scouring or flow constrictions to create high quality deep pool habitat with high complexity and cover attributes.

At the time of writing of this report, we are aware of the project targeted for construction in the summer of 2015, to add wood material to a portion of segment 3. This multi-partner project, led by the Conservation Resource Alliance, has a design report produced by Interfluve, Inc.. We have reviewed this design report and found it to be highly inline with the findings and recommendations of this habitat assessment report. The area in which it will be done is identified as being low in wood material (Appendix 1), and the design objectives of the wood installation planned fall into both of the two categories of possible actions to be considered explained above. This plan will help address this habitat enhancement priority for segment 3. Upon completion of it, partners will need to re-evaluate the need, feasibility, and relative priority of repeating this type of enhancement effort in remaining portions of segment 3.

Segment 4.

Segment 4, from Skocelas Rd downstream to the Little Manistee Fish Weir, represents the segment of this river with the highest abundance of key spawning habitat for salmonids, and the highest diversity of instream fish habitats. It has nearly equal proportions of run (48%) and riffle (49%) habitats, and also the largest proportion of pool (3%) habitats observed among the segments of the river. The dominant substrate is gravel (49%) followed by sand (41%). It offers significant deep water habitats (28%), and had a moderate level of wood material (18%). Aquatic vegetation was moderate (7%) for the river as a whole, but still relatively low as compared for other Michigan rivers. This diversity of habitats is the best seen within the river. The spawning habitat it provides are a hallmark of the segment, and perhaps has long been suspected by anglers of the river fishing during the salmon and steelhead spawning migrations.

Segment 4 should be considered primarily as high quality critical habitat that needs to be protected. The large amount of federal land ownership along this segment is an asset for ensuring human disturbances do not degrade this habitat. However, at this time, the Little Manistee River is not under the State's Natural Rivers program, so attention needs to be given to development activities on private lands in this segment that could lead to degradation of instream habitats. Conservation easements could be pursued with willing property owners to help prevent land use activities in the future that may threaten this segment of river.

Other actions to be considered for this segment:

- Ensure that sand from either upstream, severe bank erosion sites, roads, or other sources are prevented from delivering sand to this section of stream.

- Establish several longterm monitoring sites within this segment, where substrate conditions would be periodically monitored to detect any sedimentation that might occur. This could be done through monumented cross-sections at several riffles, where the pebble count method would be used, analyzed, and repeated annually or semi-annually.

- Wood material augmentation could be undertaken to increase fish cover beyond, the 18% current average. Intense scrutiny should be given to design of any such efforts if pursued. Any such efforts if pursued, should focus on small sized relatively mobile wood material. This would ensure the river can move and adjust the materials' location, without interruption to the riffle, run , pool sequencing naturally occurring here.

- Investigate the feasibility of transplanting and/or promoting increased areas of aquatic vegetation. Aquatic vegetation serves as high quality juvenile fish cover, and may be possible to promote in portions of this segment otherwise lacking suitable fish habitat. Boosting juvenile rearing habitat is often the key to translating successful spawning into increased abundance of mature stream trout or increased outputs of steelhead and salmon smolts. However, site selection for any such effort should focus on shallow sand bottom run areas and avoid covering up any gravel bottom riffle habitat used as spawning habitat.

Overall Prioritization

Prioritizing protection and enhancement efforts is often a difficult process, which by necessity needs to explicitly consider: 1.) current status of the river and its fisheries, 2.) certainty of benefits to be derived by the activities, 3.) risk of creating unintended negative consequences, 4.) feasibility of the projects contemplated including coordination & management, funding, permitting and regulations, and access, 4.) the array of stakeholder values and motivations for undertaking such efforts. This habitat assessment report is intended to help contribute to elements 1,2, and 3. Elements 4 and 5, along with the others, will be up to all those engaged in stewardship of the Little Manistee River to consider.

With that said, from the results of this instream fish habitat assessment, the following general priorities are offered as a starting place for further discussions that follow.

<u>Tier 1 Priorities</u>

- Complete the large wood debris addition project planned in a portion segment 3 in 2015.

- Institute the long-term sedimentation monitoring strategies described for segments 2 and 4. MITU will be glad to work with others to set this up and provide analysis of results. It would involve a dedicated volunteer to do the monitoring, or several riparian landowners able to monitor one site in front of their properties annually or semi-annually. Equipment is limited to a metal ruler and a data sheet that could be mailed to MITU.

- Segment 1 enhancement efforts. This segment currently has the poorest habitat conditions of any segment assessed.

- Evaluate the need to address any current sources of excessive sedimentation into the river, e.g., bank erosion sites, poorly designed road crossings.

Tier 2 Priorities

- Upon completion of the 2015 wood debris addition project in a portion of segment 3, evaluate the need and feasibility of repeating it in remaining portions of segment 3.

- Consider possible enhancement efforts mentioned for segment 2, targeted in specific locations.

- Consider expanding the instream fish habitat assessment to portions of the Little Manistee River upstream from Kings Highway, and/or in tributaries of significance. Understanding the status and contributions of tributaries to the Little Manistee River watershed should not be understated. The conditions observed in segments 1-4 are a direct result of the underlying geology of those segments, legacies of land use in the watershed, and the conditions of all the waters flowing into them. In many coldwater fishery watersheds in Michigan, tributaries can be significant or even dominant critical habitat. MITU will be glad to assist in identifying all the tributaries, and developing a practical and feasible strategy towards their assessment, if desired. Mark Tonello, DNR fish biologist, produced a valuable report in 2003 with fisheries surveys of this watersheds' tributaries, that is of use in this regard.

Notes

Graphs of the longitudinal distribution of percent woody debris in each of these segments can be used to identify the exact areas most in need of woody debris additions (Appendix 1). Target areas for the addition of woody debris for fish habitat are identified in Appendix 1, and detailed location data can be generated for this use upon request.

Literature Cited

Our purpose was not to summarize all pertinent information and data for this river, so these references are limited and should not reflect all the applicable information available on this topic or for this river.

Bryant, M.D. 1983. The Role of Management of Woody Debris in West Coast Salmonid Nursery Streams. North American Journal of Fisheries Management 3:322-330.

Roni, P and T.P. Quinn. 2001. Density and size of juvenile salmonids in response to placement of large woody debris in western Oregon and Washington streams. Canadian Journal of Fisheries and Aquatic Science 58:282-292.

Tonello, M. 2005. Little Manistee. Status of the Fishery Resource Report. MI DNR. 2005-08. Found at https://www.michigan.gov/documents/2005-8_Little-Manistee_River_144067_7.pdf .

Zorn, T.G., P.W. Seelbach, and M.J. Wiley. 2009. Relationships between habitat and fish density in Michigan streams. Michigan Department of Natural Resources, Fisheries Report 2091, Ann Arbor.

Zorn T.G. and M.J. Wiley. 2004. Untangling relationships between river habitat and fishes in Michigan's Lower Peninsula with covariance structure analysis. Michigan Department of Natural Resources, Fisheries Research Report 2073, Ann Arbor.

Appendix 1.

Focus areas for woody debris work segment 3 (10 Mile to Skocelas Rd.). Red boxes indicate priority areas for work, based on low percent woody debris or high percent fine substrate. Shaded boxes indicate areas of overlap between woody debris priorities and sediment priorities. GPS for each box are listed below.

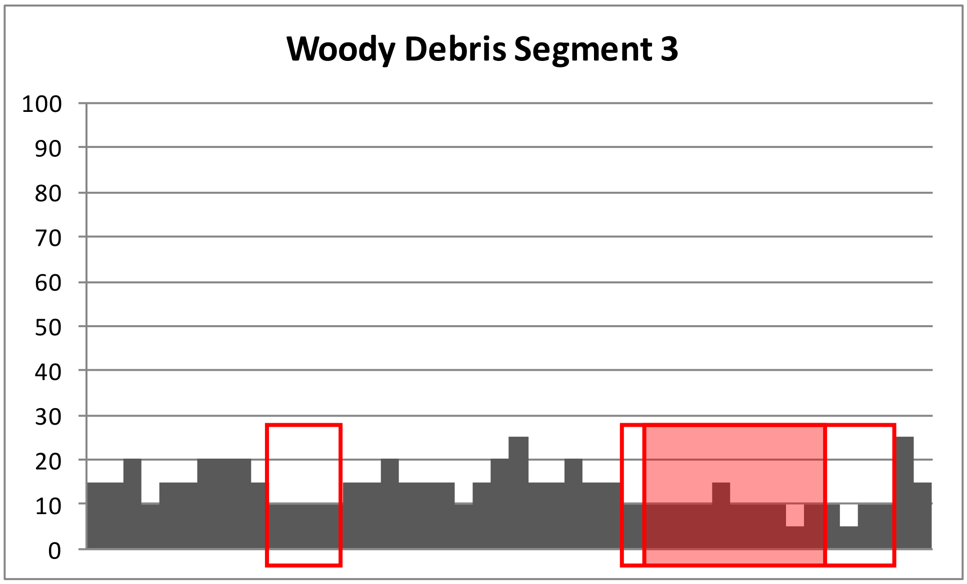

Figure A1. Woody debris in segment 3. Boxes indicate focus areas for increaseing woody habitat.

Table A1. GPS locations of areas highlighted for woody debris work in segment 3.

Box	Upstream Lat.	Upstream Long.	Downstream Lat.	Downstream Long.
Wood One	N 44.14351	W -86.01538	N 44.14721	W -86.02505
Wood Two	N 44.15234	W -86.06547	N 44.15462	W -86.06427
Wood Shaded Box	N 44.15544	W -86.06763	N 44.17059	W -86.0642

Segment 1 (N. Kings Highway to S. Peacock Trail) has an overabundance of run habitat. There are only a couple small sections of riffle or pool present. Increasing pool or riffle habitat would be beneficial at any point in this section of river; or at least focusing on wood additions to add complexity in the most homogenous section of segment 1. In designing wood structures aimed at creating some bedform diversity, It would be ideal to look more closely at gradient within this segment to determine which specific areas may be most suitable for pool or riffle habitat augmentation. This analysis can be generated upon request if work to increase bedform diversity is pursued.

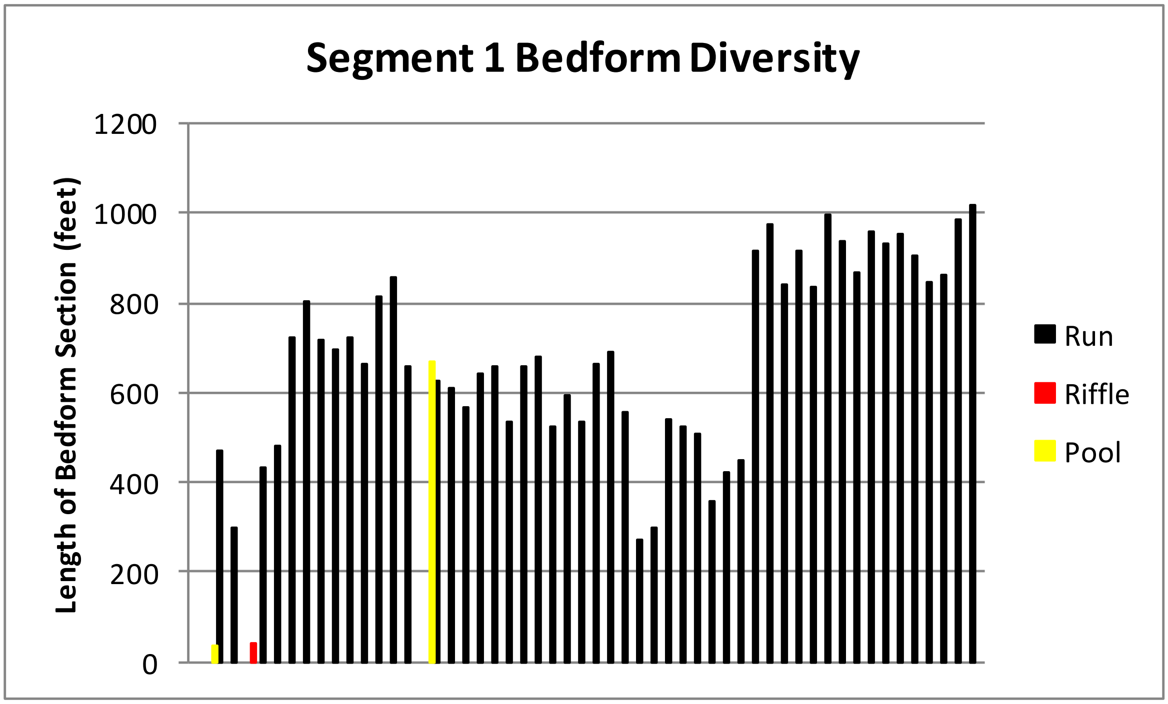

Figure A2. Bedform diversity of segment 1 of the Little Manistee River.

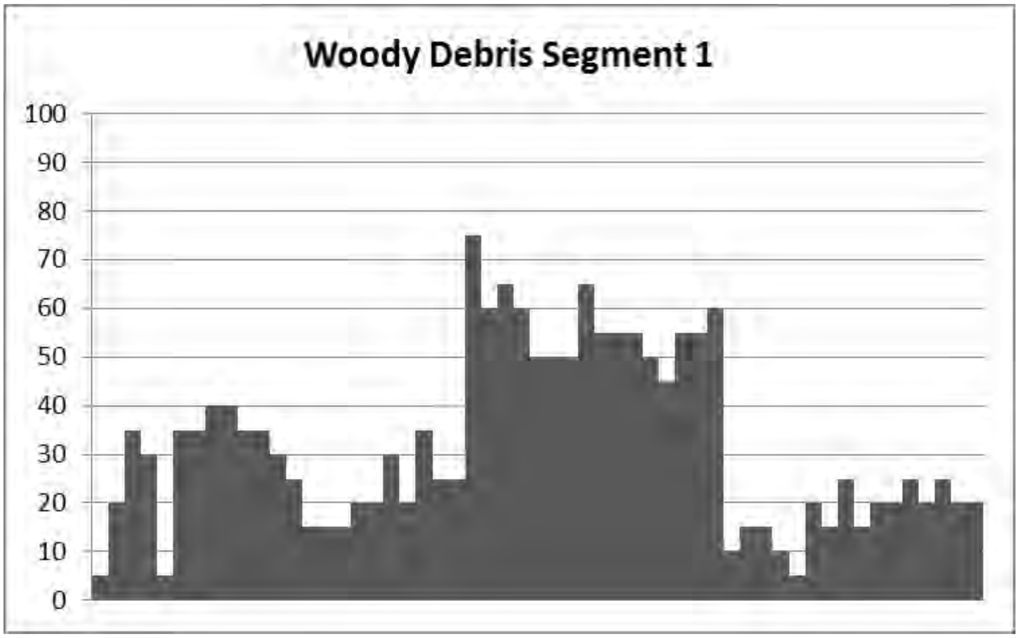

Figure A4. Woody debris abundance in segment 1 of the Little Manistee River.

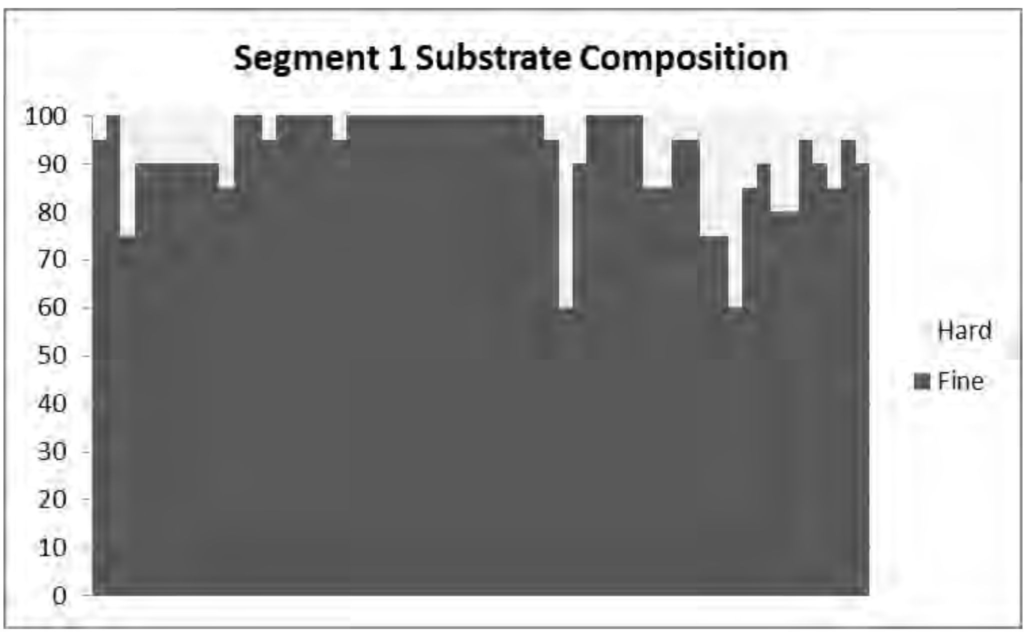

Figure A5. Hard and fine substrates in segment 1 of the Little Manistee River.

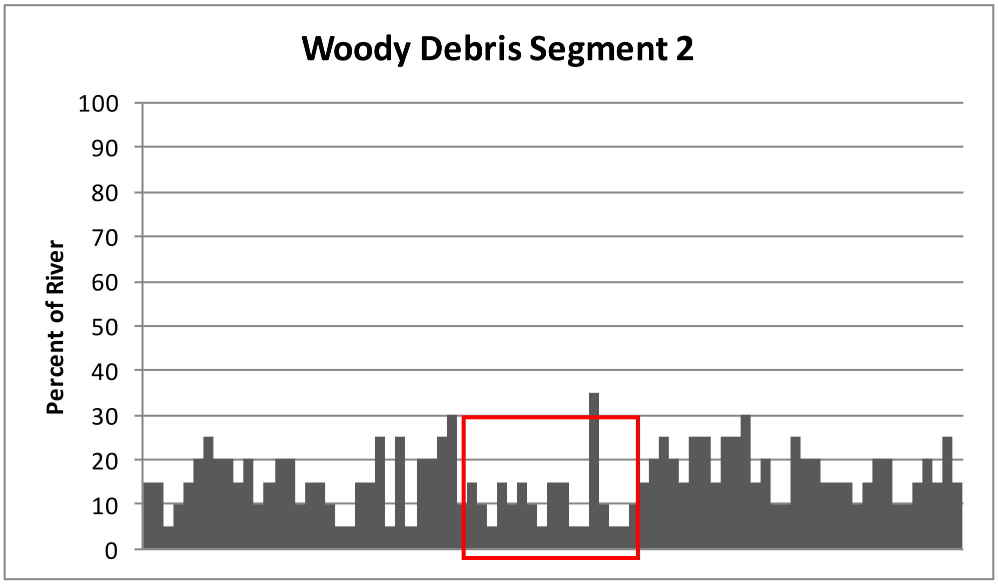

Figure A6. Woody debris in segment 2 of the Little Manistee River. Red box indicates possible priority work area.

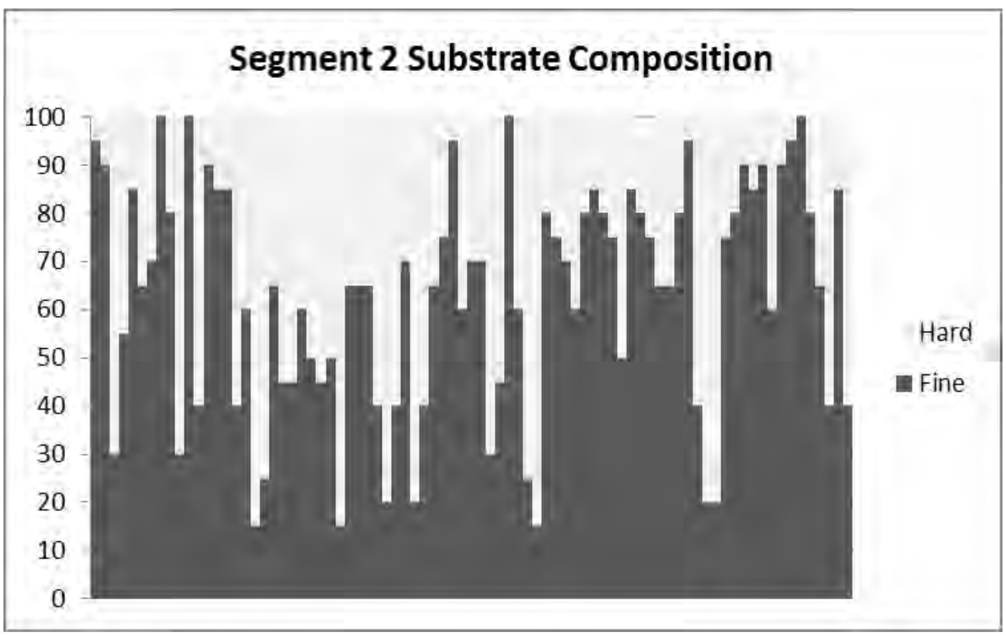

Figure A7. Hard & fine substrates in segment 2 of the Little Manistee River.

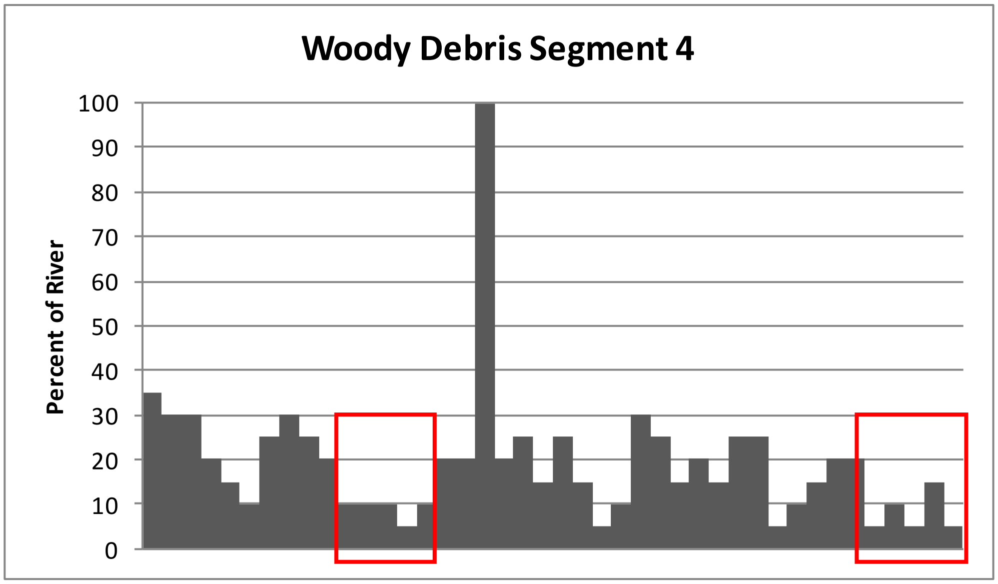

Figure A8. Woody debris in segment 4 of the Little Manistee River. Red boxes indicate possible priority work areas.

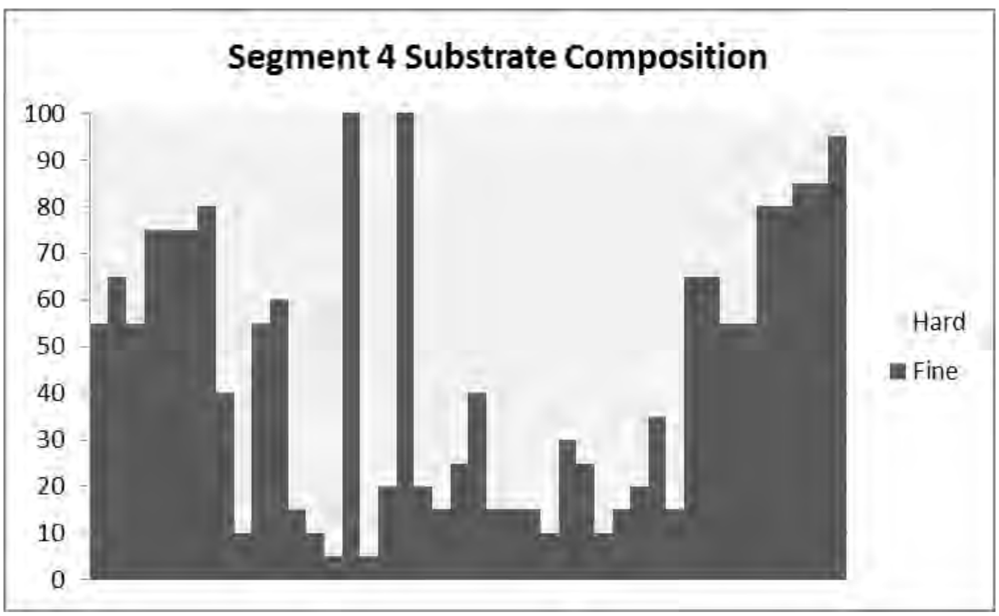

Figure A9. Hard and fine substrates in segment 4 of the Little Manistee River. Red boxes indicate possible priority work areas.

Appendix 2. Fish Sampling Data

Fish sampling was completed at two sites on the Little Manistee River in 2014. Mark-recapture population estimate surveys were planned at each site; however, equipment failure did not allow for all of the planned work to be completed. A mark-recapture population estimate was completed at Old Grade Campground (located in analysis segment 1). A one-pass survey was completed at the Ghillespy property (located in analysis segment 3). An additional one-pass survey was completed on Seyers Creek a tributary to the Little Manistee located near the Old Grade Road site. A summary of the fish sampling data can be found below.

Old Grade Road

Mark recapture sampling was completed for a 500 foot long stretch of river within the Old Grade Road campground area. A marking run was completed on 8/11/14 and a recapture run was completed on 8/12/14. All salmonids were marked including brown trout, rainbow trout, and coho salmon. MI DNR methods were utilized to complete population estimates. Brown trout captured were 2 - 21 inches, rainbow trout captured were 1 - 7 inches, and coho salmon captured were 3 - 4 inches. Population estimates were calculated for brown and rainbow trout as >50 of each species were marked. Length frequency graphs for brown and rainbow trout captured during the marking run are provided (Figure A10, Figure A11).

At Old Grade Rd. the majority of trout captured were in the 1 - 4.9 inch range. While it is normal to have the number of individuals decrease with size, there is a sharper than expected decrease at this site (Table A2). This marked decrease in larger brown trout exceeds typical annual mortality levels seen elsewhere in MI, and thus probably reflects emigration of larger brown trout from this site after their first year of life. Based on the data collected during the habitat mapping process it is known that there is minimal pool and deep water habitat in this stretch of river, but there is ample wood available. The limited number of fish over 5 inches captured at Old Grade Road may be due to the limited habitat available for larger fish (i.e. pool and deep water habitat combined with woody structure). An increase in these habitat types may allow more fish over 5 inches to remain in this section of river. This does not necessarily indicate a shortage of brown trout over 5 inches in the Little Manistee River as a whole, just a limited number at this site. The fishery data presented here agrees with the management suggestion that an increase in pool/deep water habitat and fish cover would be beneficial to the fishery in this section of the Little Manistee River.

Of note however, is that the density estimates for brown trout and rainbow at Old Grade Rd were nearly double in 2014 than those reported there from a 1979 DNR survey (Tonello 2005).

Table A2. Old Grade Road trout population estimates. *indicates uncertain estimates due to a very small sample size.

Species/Size	Trout per Acre	Pounds per Acre	Trout per Mile
Brown Trout	930	61.48	2,456
Brown Trout 1-4.9 inches	820		
Brown Trout 5-7.9 inches*	76		
Brown Trout 8+ inches*	34		
Rainbow Trout	1,100	32.08	2,903
Rainbow Trout 1-4.9 inches	869		
Rainbow Trout 5-7.9*	219		

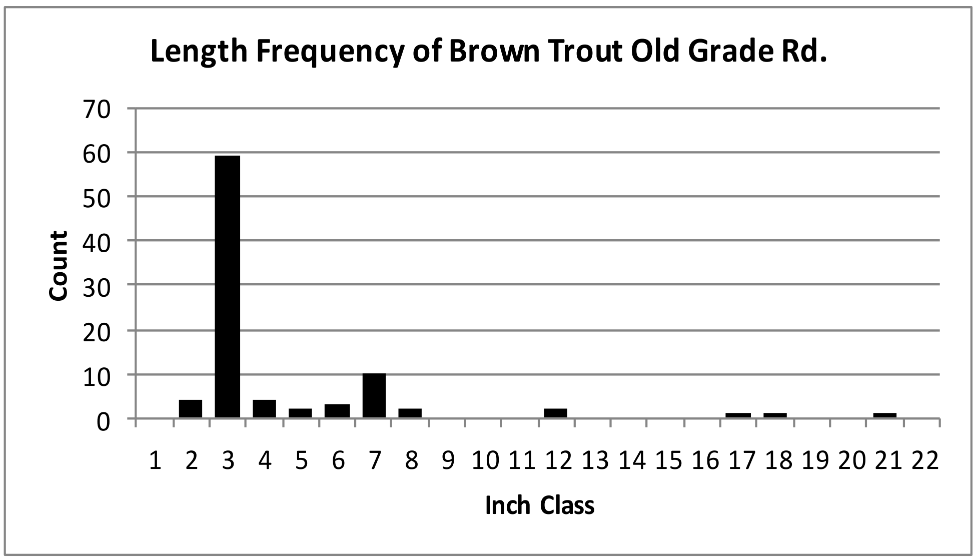

Figure A10. Brown trout length frequency caught during marking run at Old Grade Rd.

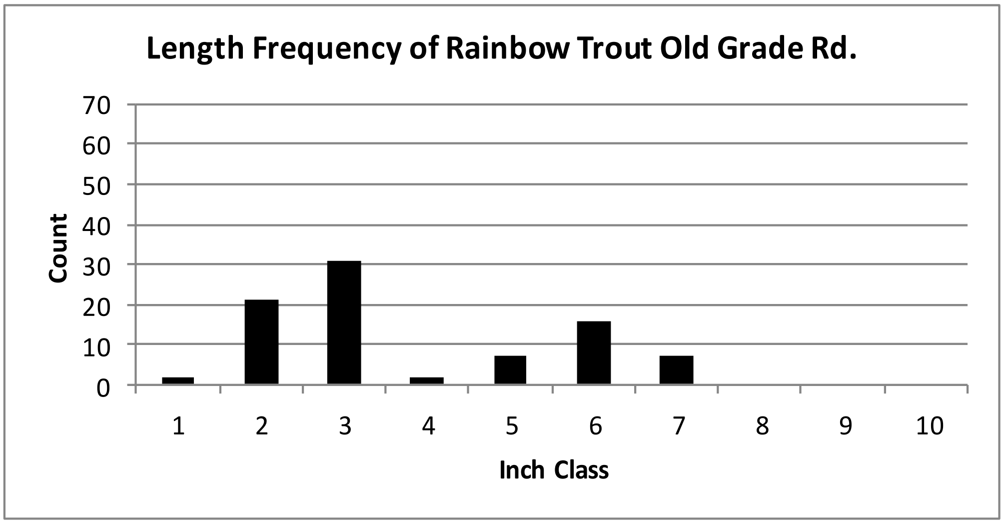

Figure A11. Rainbow trout length frequency caught during marking run at Old Grade Rd.

Other species captured are listed in Table A3, Figure A12. In addition to brown trout, rainbow trout, and coho salmon, white sucker, blacknose dace, sculpin, creek chub, and yellow perch were captured.

Table A3. Species composition Old Grade Rd.

Species Composition Old Grade Rd.			
Species	**Min. Length**	**Max Length**	**Count**
Brown Trout	2	21	89
Rainbow Trout	1	8	86
Coho Salmon	3	4	8
White Sucker	1	17	15
Blacknose Dace	2	5	68
Sculpin	1	3	33
Creek Chub	2	2	1
Yellow Perch	1	2	24

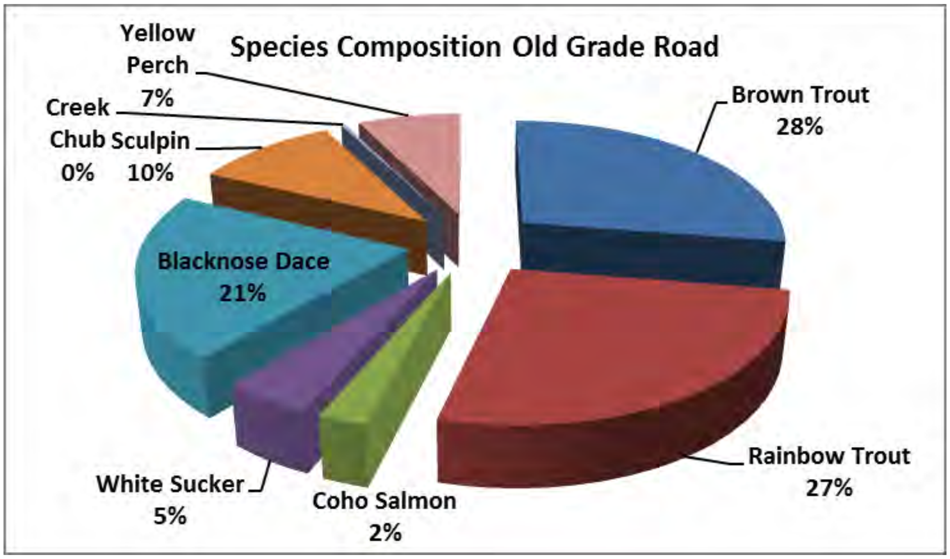

Figure A12. Old Grade Road fish species composition. Percent of total species captured is depicted.

Ghillespy Property

A 1000 foot long stretch of stream was sampled at the Ghillespy property, located within segment 3. All salmonids were marked during this sampling run. However, a recapture run could not be completed due to equipment failure. Therefore, population estimates could not be completed. Summary data is provided. It is worth noting that it is recommended at least 50 individuals of a given fish species be captured during a marking run in order for an accurate mark-recapture population estimate to be completed. At the Ghillespy site 53 rainbow trout were marked, however, only 34 brown trout were marked.

Brown trout, rainbow trout, and coho salmon were captured. Brown trout captured were 2 - 21 inches, rainbow trout captured were 1 - 8 inches, and coho salmon captured were 3 - 4 inches. Rainbow trout were the most frequently captured salmonid species (Table A4). Brown trout length frequency (Figure A14) shows that while densities are not high, that older age classes of brown trout are present and using this section of stream, as would be expected given its high percent of deep water habitat.

More species were present at Ghillespy than Old Grade (Figure A13). Salmonids also made up a lower percentage of total individuals captured at this site. This limited amount of fisheries data does seem to indicate that this section of river (segment 3) would benefit from an increase in habitat diversity as suggested in this report.

Table A4. Species composition at Ghillespy property.

Species Composition			
Species	**Min. Length**	**Max Length**	**Count**
Brown Trout	2	21	34
Rainbow Trout	1	8	53
Coho Salmon	3	4	17
Sculpin	1	3	34
Blacknose Dace	1	4	159
Creek Chub	1	6	23
Bluntnose Minnow	2	2	2
Common Shiner	4	4	1
Bluegill	3	3	2
White Sucker	1	10	6
Johnny Darter	1	3	10
Rock Bass	3	7	2
Central Mudminnow	2	3	7
Brook Stickelback	1	1	5
Pearl Dace	2	4	19

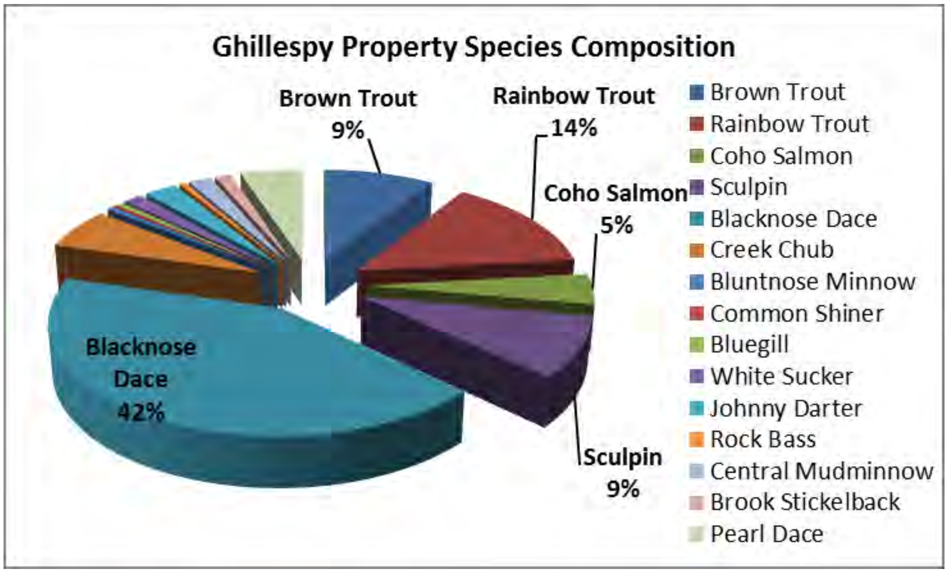

Figure A13. Species composition at Ghillespy property, Little Manistee River.

Worth note from this fish survey, was the presence and relative abundance of pearl dace. These fish are of management concern in many portions of the U.S. They are typically found in slow moving, meandrous sections of rivers offering deep water and aquatic vegetation, and apparently cold groundwater seepage. These descriptions of their critical habitat match well with descriptions of segment 3 as a whole, and their abundance should cause speculation to the degree which segment 3 may provide an important groundwater seepage zone in the lower portions of the Little Manistee. While not endangered, some recognition that this section of the river is providing key habitat for this unique and somewhat threatened fish species is deserved.

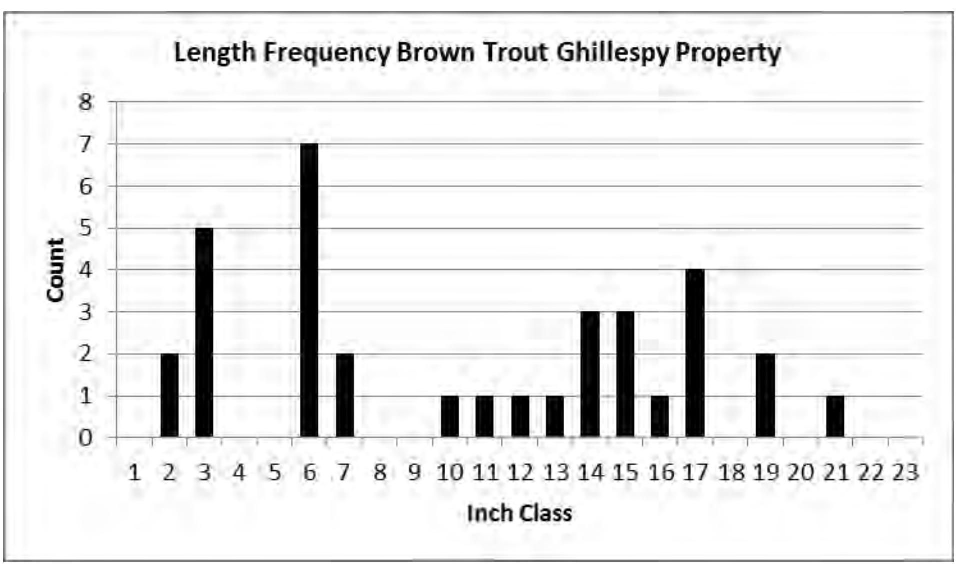

Figure A14. Length Frequency of brown trout captured at Ghillespy Property, Little Manistee River.

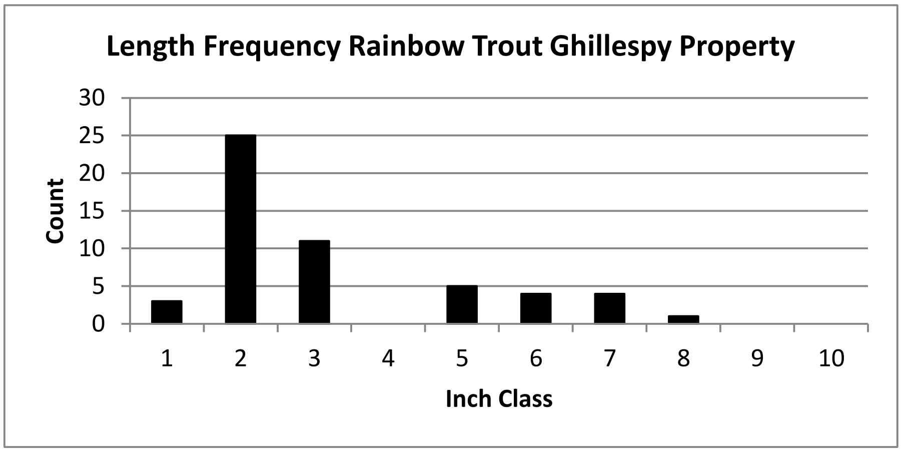

Figure A15. Length frequency of rainbow trout captured at the Ghillespy property, Little Manistee River.

Seyers Creek

Approximately 500 feet of Seyers Creek from the Little Manistee River upstream to the M-37 culvert was sampled with a backpack electrofisher. Rainbow trout, brown trout, and brook trout were captured in Seyers Creek. Rainbow trout were the most common species (Table A5, Figure A15). Length frequency graphs were completed for brown and rainbow trout (Figure A16, Figure A17). Sampling was conducted here in part to determine if "lake" species were present. We did capture yellow perch, brown bullhead, and largemouth bass. A lake exists on Seyers Creek a relative short distance upstream from this lower reach of Seyers Creek.

Table A5. Species composition at Seyers Creek.

Species Composition Seyers Creek			
Species	**Min. Length**	**Max Length**	**Count**
Brown Trout	3	16	18
Rainbow Trout	1	6	30
Brook Trout	5	10	3
Sculpin	1	3	21
Blacknose Dace	2	3	2
Yellow Perch	2	2	4
Brown Bullhead	2	2	2
Chestnut Lamprey	3	6	6
Central Mudminnow	3	3	1
Largemouth Bass	2	2	1

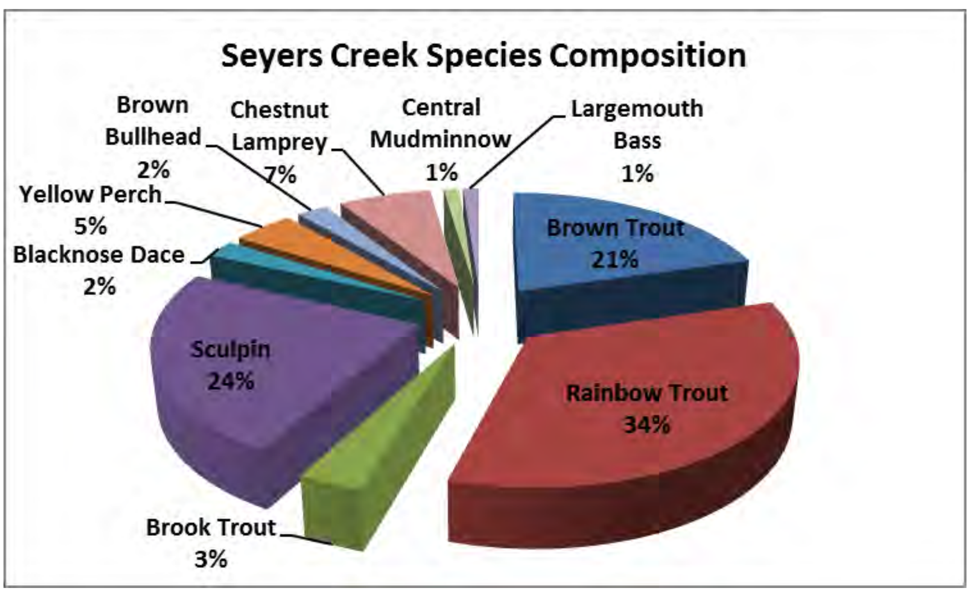

Figure A15. Species composition of fish captured in Seyers Creek.

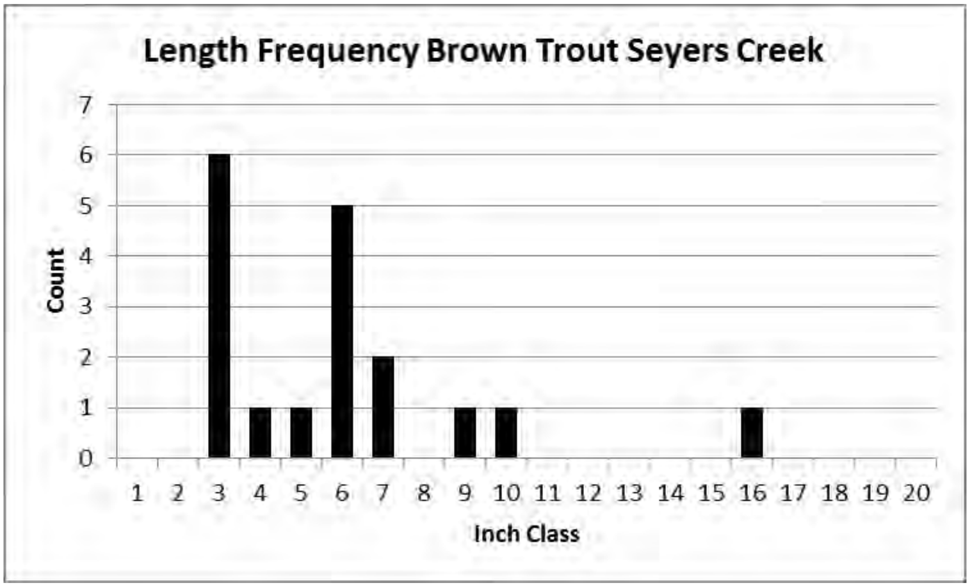

Figure A16. Length frequency distribution of brown trout captured in Seyers Creek.

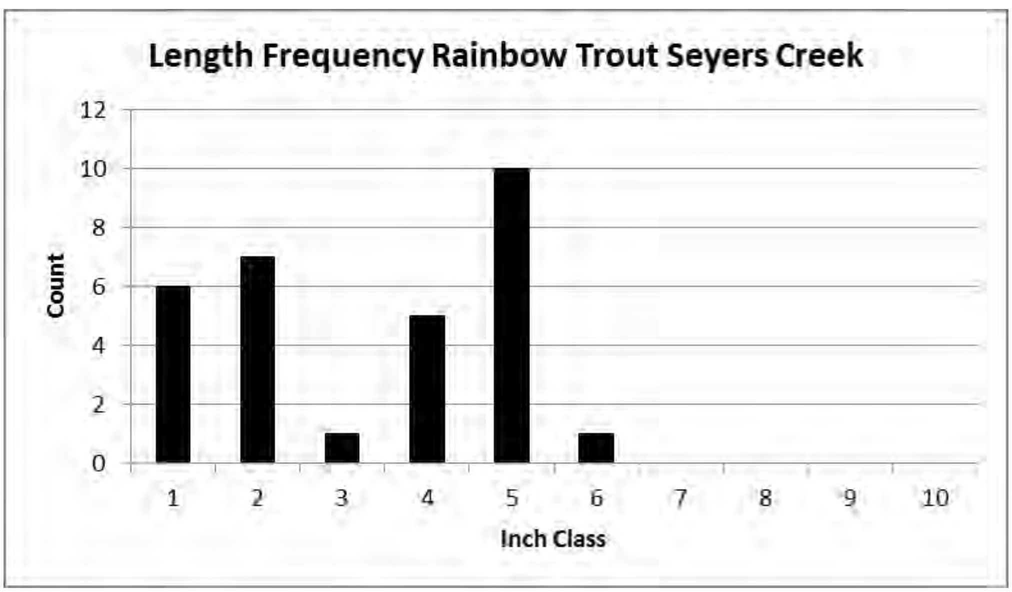

Figure A17. Length frequency distribution of rainbow trout captured in Seyers Creek.