2.4 JURISDICTIONS

The Good Harbor Bay watershed is comprised of portions of five townships (Centerville, Cleveland, Glen Arbor, Kasson and Leland) within Leelanau County (Table 5). Cleveland township has the most land within the Good Harbor Bay Watershed (89% of the township is in the watershed). Sleeping Bear Dunes National Lakeshore comprises 12.5% of the watershed (Figure 14, Table 6). The majority of the watershed is in private ownership (80%), which includes about 494 acres or 1.7% in private conservation easements.

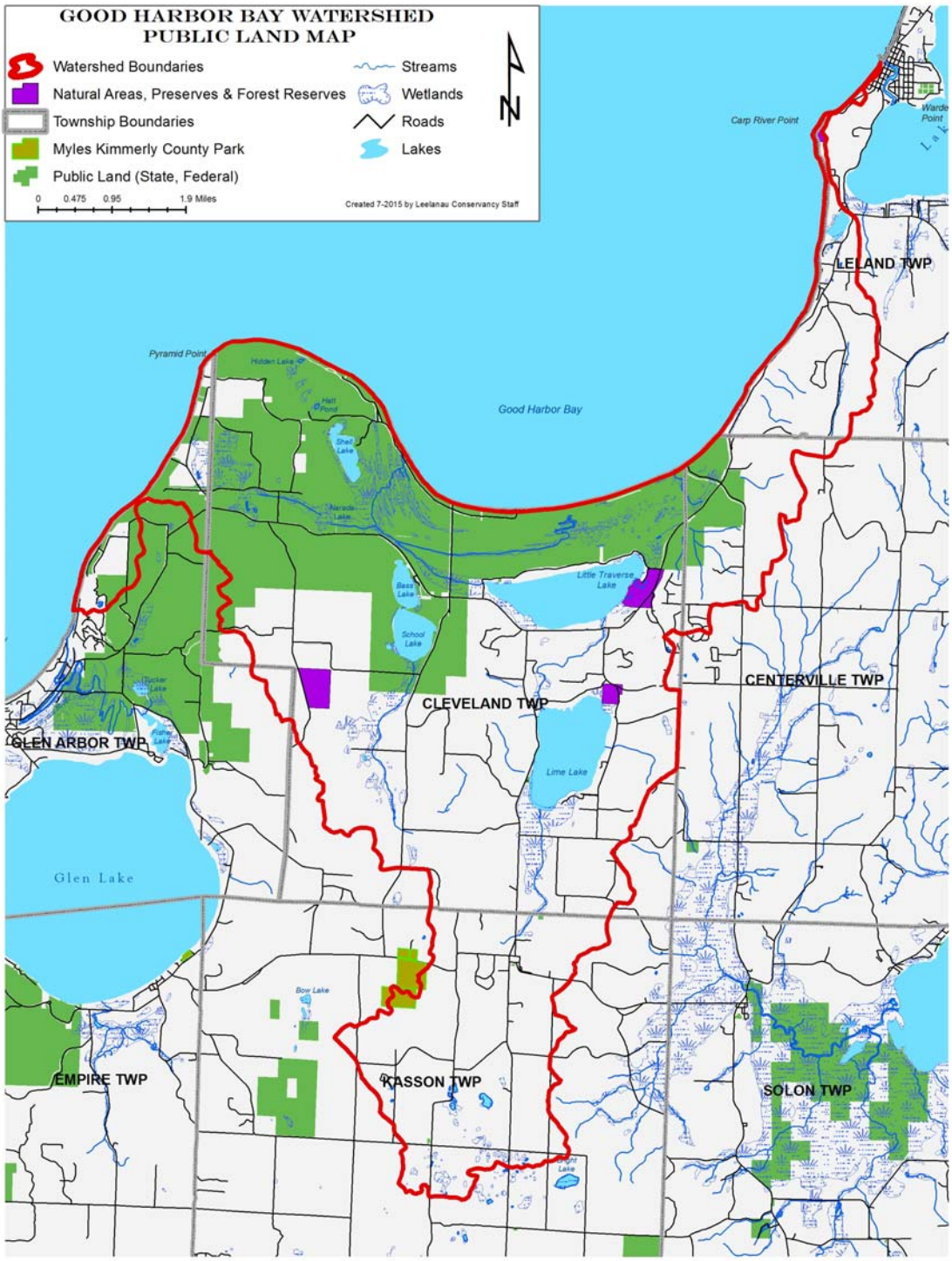
Table 5: Percent of each township within the Good Harbor Bay Watershed

Township	Acres in Watershed	% of Township in Watershed	% of Watershed
Centerville	1,893.1	10	7
Cleveland	19,008.1	89	66
Glen Arbor	1155.4	7	4
Kasson	4,907.1	21	17
Leland	2,055.9	8	7
Total	29,020		100%

Table 6: Public and Private Land in the Good Harbor Bay Watershed

Jurisdiction	Acres	% of Watershed
Privately Protected Land (conservation easements- CE's)	494	1.7
LC Natural Areas/Preserves	169	0.6
Nat'l Lakeshore	3,630	12.5
State Land	26	0.1
County Land	216	0.7
Private Land	22,763	78.4
Water (Lakes and Streams)	1,723	5.9

Figure 14: Public/Protected Lands in the Watershed



2.5 POPULATION

Rich in land and water resources, the Good Harbor Bay Watershed is home to both seasonal and year round residents living in Leelanau County and covering five Townships (Table 7). Since the Good Harbor Bay Watershed does not directly follow census boundaries, it is difficult to evaluate demographic characteristics of the exact population within the watershed boundary. According to the last census Leelanau County is one of the counties that grew at one of the fastest rates in Northwest Michigan. From 2000 to 2010 the area's population rose 10% (Table 7) and future projections indicate a steady growth rate for years to come. Leelanau County showed a percent population change of 2.8% (Table 7)

The greatest individual township population increases between 2000 and 2010 were found in Centerville and Glen Arbor Townships, with 16.3 % and 9% increases respectively. Leelanau County's population doubles during summer months to nearly 26,000 persons. These increases in population and future development have the potential to impact the entire watershed through nonpoint source pollutants, increased stormwater runoff, loss of wetlands, land fragmentation and potential degradation of important groundwater recharge areas.

Table 7: Population and Population Change

Township	1990	2000	2010*	% Change (2000-2010)	
Centerville	836	1,095	1,274	16.3	
Cleveland	783	1,040	1,095	5.3	
Glen Arbor	644	788	859	9.0	
Kasson	1,135	1,577	1,609	2.0	
Leland	1,642	2,033	2,043	0.5	
					Average 6.6
Total	**5,040**	**6,533**	**6,880**	**33.2**	
Leelanau County	16,527	21,119	21,708	2.8	

**Estimate – Population Division, U.S. Census Bureau*

2.6 LAND USE/LAND COVER

The land use within the watershed is dominated by 53.5% forested lands, (44.9% deciduous and 8.6 % coniferous), followed by 18.1 % Open shrub/Grassland and 9.6% agriculture (5.4% cropland, 3% orchards and vineyards, and 1.2 % permanent pasture or other agriculture), 6.7 % water, Urban uses comprising 5.7% and 1.4 % wetlands, (Figure 15, Tables 8 & 9).

The Good Harbor Bay watershed is blessed with more than 53% of its land in a forested condition (Table 8 & 9). Deciduous forest stands comprise the single largest land use of the watershed and, with sustainable management, provide an economic resource. At the same time, these forests have vital ecological roles. Following behind forests, Open shrub/Grassland (18.1%) and agriculture (9.6%) cover the majority of the remaining portions of the watershed (Table 8).

According to the land use layer, the major human land use of the watershed is agricultural (9.6%) along with residential homes, which comprise nearly 6% of the watershed (Table 8). Agriculture is an important part of the Good Harbor Bay Watershed, especially cherry orchards. The lack of significant industry in the watershed is a legacy of the 1950's resort era that followed the crash of the resource dependent early 1900's economy. The economy of the watershed has become more reliant seasonal tourism and summer residents that are drawn to the natural scenery found few other places. The high percentage of forested land in the watershed provides scenic beauty enjoyed by thousands of tourists while simultaneously protecting wildlife habitat, groundwater recharge and important water quality functions.

Figure 15: Land Use in the Good Harbor Bay Watershed

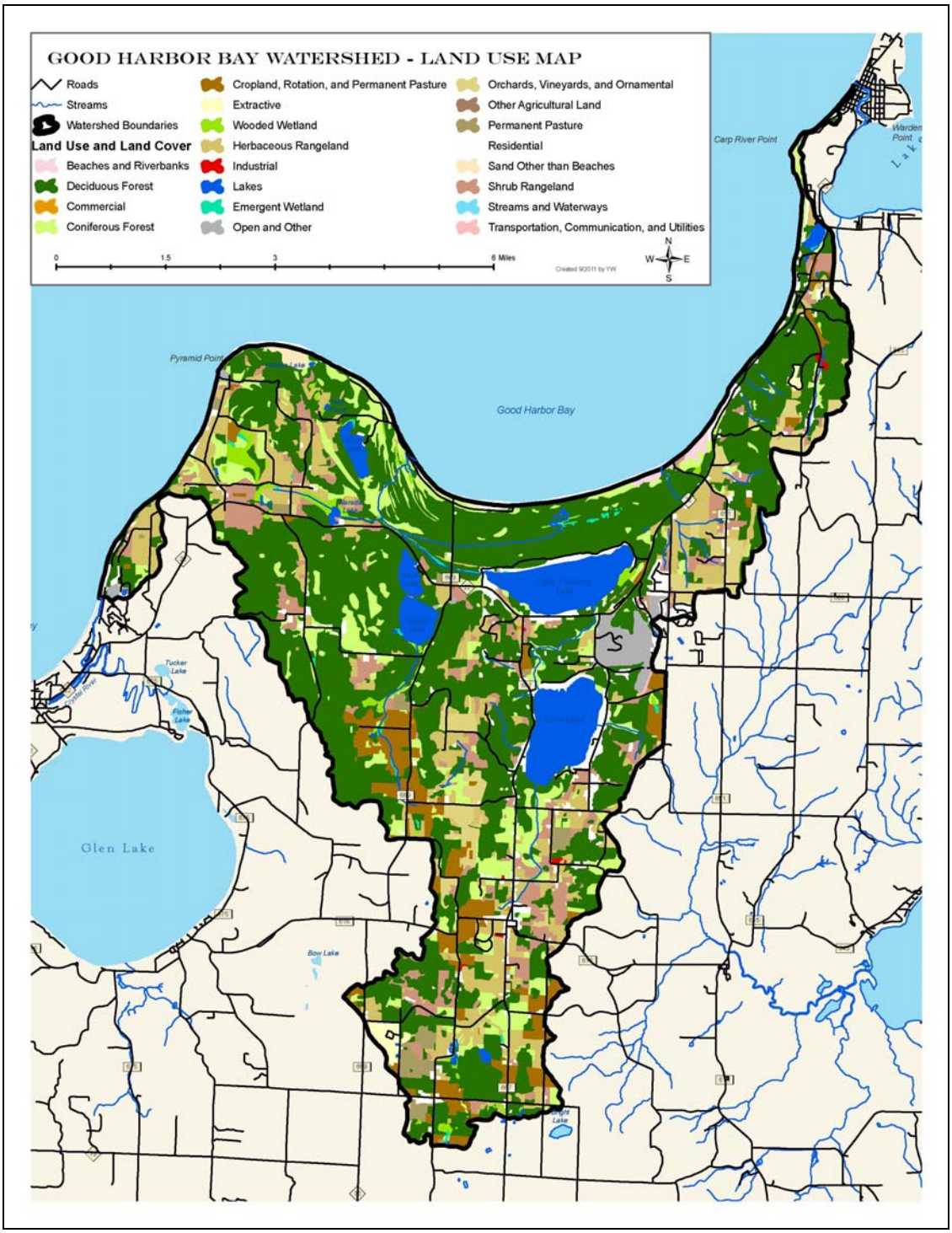


Table 8: Land Use/Cover in the Good Harbor Bay Watershed

Land Use/Cover	Acres	% Total
Commercial	29.5	0.10
Coniferous Forest	2,480.1	8.55
Cropland	1,568.1	5.40
Emergent Wetland	109.7	0.38
Extractive (Sand and gravel)	186.9	0.64
Deciduous Forest	13048.6	44.96
Herbaceous Rangeland	3289.6	11.34
Industrial	40.3	0.14
Lakes	1755.4	6.05
Open/Other	736.9	2.54
Orchards, Vineyards, and Ornamental	881.5	3.04
Other Agricultural Land	26.6	0.09
Permanent Pasture	335.1	1.15
Residential	1386.2	4.78
Scrub-Shrub Wetland	346.1	1.19
Shrub Rangeland	1969.5	6.79
Streams	6.4	0.02
Transportation/Utilities	6.3	0.02
Wooded Wetland	817.7	2.82
Total	29,020.4	100%

Table 9: Grouped Land Use/Cover

Land Use/Cover Category*	Acres	% Total
Forested (non-wetlands)	15,528.7	53.51
Agriculture	2,811.2	9.69
Open Shrub/Grassland	5,259.1	18.12
Urban	1,649.1	5.68
Water	1,761.8	6.07
Wetlands (emergent and forested)	1,273.5	4.39
Barren (beaches, dune, rock)	736.9	2.54
Total	29,020.4	100%

Land Use Groupings:

- *Forested: coniferous, deciduous*
- *Agriculture: confined feeding, cropland, orchards/vineyards, other agriculture, permanent pasture*
- *Open Shrub/Grassland: herbaceous and shrub rangeland*
- *Urban: commercial/services/institutional, extractive, industrial, residential*
- *Water: lake, streams/waterways*
- *Wetlands: emergent, shrub and wooded wetlands*
- *Barren: open/other*

2.7 THREATENED AND ENDANGERED SPECIES

This is a listing of all known occurrences of the Endangered (E), Threatened (T), and Probably Extirpated (X) plant and animal species of Michigan, and high quality natural communities occurring within the Good Harbor Bay watershed (Table 10). The species and community information is derived from the MNFI database. The watersheds are based on the 14 digit Hydraulic Unit Codes (HUC).

The species on this list are protected under the Endangered Species Act of the State of Michigan (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act). The current list became effective on April 9, 2009, after extensive review by technical advisors to the Michigan Department of Natural Resources and the citizenry of the state. Also included in this list are Natural Communities, plant and animal species of Special Concern. While not afforded legal protection under the Act, many of these species are of concern because of declining or relict populations in the state. Should these species continue to decline, they would be recommended for Threatened or Endangered status. Protection of Special Concern species now, before they reach dangerously low population levels, would prevent the need to list them in the future by maintaining adequate numbers of self-sustaining populations within Michigan. Some other potentially rare species are listed as of Special Concern pending more precise information on their status in the state; when such information becomes available, they could be moved to threatened or endangered status or deleted from the list.

The listing is based on the polygon representation of the occurrences. Consequently any single occurrence may span watershed boundaries and be listed in more than one watershed. This list is based on known and verified sightings of threatened, endangered, and special concern species and represents the most complete data set available. It should not be considered a comprehensive listing of every potential species found within a watershed. Because of the inherent difficulties in surveying for threatened, endangered, and special concern species and inconsistency of

inventory effort across the State species may be present in a watershed and not appear on this list.

This list was produced by the Endangered Species Program of the Michigan Department of Natural Resources and the Michigan Natural Features Inventory. English names in common usage or from published sources have been incorporated, when possible, to promote public understanding of and participation in the Endangered Species Program. To comment on the list or request additional copies, or for information on the Endangered Species Program, contact the Endangered Species Coordinator, Wildlife Division, Michigan Department of Natural Resources, P.O. Box 30028, Lansing, MI 48909 (517-373-1263). To report occurrences of these species, please contact: mnfi@msu.edu.

Source: http://mnfi.anr.msu.edu/

Table 10: Good Harbor Bay Watershed Rare Plant & Animal Species/Natural Communities List:

Scientific Name	Common Name	Federal Status	State Status
Acris crepitans blanchardi	Blanchard's cricket frog		T
Ammodramus savannarum	Grasshopper sparrow		SC
Berula erecta	Cut-leaved water parsnip		T
Botrychium campestre	Prairie Moonwort or Dunewort		T
Bromus pumpellianus	Pumpelly's bromegrass		T
Cirsium pitcheri	Pitcher's thistle	LT	T
Dendroica discolor	Prairie warbler		E
Gavia immer	Common loon		T
Great Lakes Barrens	Barrens, Upper Midwest Type		
Haliaeetus leucocephalus	Bald eagle		SC
Microtus pinetorum	Woodland vole		SC
Open Dunes	Beach/shoredunes, Great Lakes Type		
Orobanche fasciculata	Broomrape		T
Panax quinquefolius	Ginseng		T
Pterospora andromedea	Pine-drops		T
Stagnicola contracta	Deepwater pondsnail		E
Wooded Dune and Swale Complex			

Source: http://mnfi.anr.msu.edu/data/watshd_dat.cfm?id=4060104 28L 3

T= Threatened, E= Endangered, SC= Special Concern, LT= Listed Threatened

2.8 MASTER PLANS AND ZONING ORDINANCES

Master Plans and Zoning Ordinances

How communities manage their land use has a direct impact on the community's water resources. Zoning, master plans, and special regulations are a few of the more commonly used land management tools. Zoning ordinances, if enforced, establish the pattern of development, protect the environment and public health, and determine the character of communities. In 2006, PA 110, The Michigan Zoning Enabling Act was signed into law. This act codified the laws regarding local units of government regulating the development and use of land. It also provides for the adoption of zoning ordinances; to provide for the establishment in counties, townships, cities, and villages of zoning districts; prescribes the powers and duties of certain officials; to provide for the assessment and collection of fees; authorizes the issuance of bonds and notes; and prescribes penalties and provide remedies. In 2008, PA 33, titled Michigan Planning and Enabling Act, was signed into law. This law consolidated previous planning acts under one statute, creating a standard structure for all local planning commissions and one set of requirements that will apply to the preparation of all master plans. Since protecting water quality requires looking at what happens on land, zoning is an important watershed management tool.

Planners should recognize that water quality is directly impacted by adjacent land use with the amount of impervious surfaces being particularly paramount. Land use planning techniques should be applied that preserve sensitive areas, redirect development to those areas that can support it, maintain or reduce impervious surface cover, (such as roads, driveways and parking lots) and reduce or eliminate nonpoint sources of pollution.

Zoning's effectiveness depends on many factors, such as the restrictions in the language, the enforcement, and public support. Many people assume existing laws protect sensitive areas, only to find otherwise when development is proposed. Zoning can be used very effectively for

managing land uses in a way that is compatible with watershed management goals. A wide variety of zoning and planning techniques can be used to manage land use and impervious cover in the watershed. Some of these techniques include: watershed based zoning, overlay zoning, impervious overlay zoning, floating zones, incentive zoning, performance zoning, urban growth boundaries, large lot zoning, infill/community redevelopment, transfer of development rights (TDRs), and limiting infrastructure extensions. Some benefits of zoning include: increased local control/autonomy over land use decision-making; communicating clear expectations with developers based on community needs; and, an opportunity for the residents of the area to design the type of community they want to live in – one that respects their unique cultural, historic, and natural resource values.

Local officials face hard choices when deciding which land use planning techniques are the most appropriate to modify current zoning. Table 10, adapted from the Center for Watershed Protection's Rapid Watershed Planning Handbook, provides further details on land use planning techniques and their utility for watershed protection (CWP 1998). While most of these techniques are for watersheds much bigger than the Good Harbor Bay watershed, it still presents a good picture of available land use planning techniques. In addition, the DEQ has published a book titled *Filling the Gaps: Environmental Protection Options for Local Governments* that equips local officials with important information to consider when making local land use plans, adopting new environmentally focused regulations, or reviewing proposed development (Ardizone, Wyckoff, and MCMP 2003). An overview of Federal, State, and local roles in environmental protection is provided, as well as information regarding current environmental laws and regulations including wetlands, soil erosion, inland lakes and streams, natural rivers, floodplains, and more. The book also outlines regulatory options for better natural resources and environmental protection at the local level. *(A copy of this guidebook is available via the DEQ website: WWW.MICHIGAN.GOV/DEQ → Water → Surface Water → Nonpoint Source Pollution (look under Information/Education heading).*

Local governance can be a complicated issue. Generally, local governments may enact zoning laws that are more stringent than the next highest ranking form of government, but not less. In any case, all applicable State laws must be followed. Most of the townships located in the Good Harbor Bay watershed have both a Master Plan and Zoning Ordinance (Tables 12 & 13). Assisting local governments in updating and enacting strong zoning ordinances to protect water quality and secure natural areas is extremely important in the Good Harbor Bay watershed and is a high priority for implementation efforts (Chapter 8). Master plans and zoning ordinances have great potential to affect water quality. Zoning ordinances have a direct role in determining the type and density of land use allowed. They regulate permitted uses of the land, for example, setting minimum/maximum lot sizes and setback requirements (from neighbors, roads, water bodies). Overall, zoning ordinances are enacted to ensure that the use of private property does not negatively affect the public's safety, health, and welfare. Since protecting water quality requires looking at what happens on land, zoning can be an extremely important watershed management tool.

Examples of zoning to protect water quality include requiring vegetative buffer zones along bodies of water (see earlier section on Lack of Riparian Buffer), requiring greenbelt areas, protecting the integrity of soil by having filtered views along stream corridors (protects banks from erosion), or protecting wetlands.

Table 10: Land Use Planning Techniques

Land Use Planning Technique	Description	Utility as a Watershed Protection Tool
Watershed-Based Zoning	Watershed and subwatershed boundaries are the foundation for land use planning.	Can be used to protect receiving water quality on the subwatershed scale by locating development out of particular subwatersheds.
Overlay Zoning	Superimposes additional regulations for specific development criteria within specific mapped	Can require development restrictions or allow alternative site design techniques in specific areas.
Impervious Overlay Zoning	Specific overlay zoning that limits total impervious cover within mapped districts.	Can be used to protect receiving water quality at both the subwatershed and site level.
Floating Zones	Applies a special zoning district without identifying the exact location until land owner specifically requests the	May be used to obtain proffers or other watershed protective measures that accompany specific land uses within the district.
Incentive Zoning	Applies bonuses or incentives to encourage creation of amenities or environmental	Can be used to encourage development within a particular subwatershed or to obtain open space in exchange for a density bonus at the site level.
Performance Zoning	Specifies a performance requirement that accompanies a zoning district.	Can be used to require additional levels of performance within a subwatershed or at the site level.

Table 10: Land Use Planning Techniques (Cont'd)

Land Use Planning Technique	Description	Utility as a Watershed Protection Tool
Urban Growth Boundaries	Establishes a dividing line that defines where a growth limit is to occur & where agricultural or rural land is to be preserved.	Can be used in conjunction with natural watershed or subwatershed boundaries to protect specific water bodies.
Large Lot Zoning	Zones land at very low densities.	May be used to decrease impervious cover at the site or subwatershed level, but may have an adverse impact on regional or watershed imperviousness.
Infill/ Community Redevelopment	Encourage new development and redevelopment within existing developed areas.	May be used in conjunction with watershed based zoning or other zoning tools to restrict development in sensitive areas and foster development in areas with existing infrastructure.
Transfer of Development Rights (TDRs)	Transfers potential development from a designated "sending area" to a designated "receiving area".	May be used in conjunction with watershed based zoning to restrict development in sensitive areas and encourage development in areas capable of accommodating increased densities.
Limiting Infrastructure Extensions	A conscious decision made to limit or deny extending infrastructure (e.g. public sewer, water, roads) to designated areas to avoid increased development.	May be used as a temporary method to control growth in a targeted watershed or subwatershed. Usually delays development until the economic or political climate changes.

Table adapted from Center for Watershed Protection's Rapid Watershed Planning Handbook – page 2.4-5 (CWP 2001)

During the process of drafting the GHBWPP a review and summary of master plans and zoning ordinances was conducted (Tables 12 and 13). For the most part, community master plans usually have good intentions when it comes to protecting natural resources. The natural resources of this area are why most people choose to live in the Good Harbor Bay region. In general however, townships and communities often lack the knowledge on how to draft and enact effective, yet enforceable, zoning requirements. The validity of a zoning ordinance, particularly those that are more restrictive is often challenged by developers, among others. Local governments may have trouble obtaining information to back up their ordinances that will stand up in court. Additionally, it is often an argument of property rights vs. the public good, with local governments trying to show and prove that a certain ordinance is important to protect water quality.

Soil Erosion and Stormwater Ordinances

It is important to note that, in addition to township zoning ordinances, Leelanau County has a separate "Soil Erosion, Sedimentation and Stormwater Runoff Control Ordinance (SESSRC). This ordinance incorporates Part 91 of Act 451, Michigan's Soil Erosion and Sedimentation Control Law, which regulates and requires a permit for earthwork within 500 feet of a lake or stream or for any soil disturbance of 1 acre or more regardless of the location of that land to water. The county ordinance goes beyond those State requirements by requiring permits for all commercial projects that disturb soil, for any project within 100 feet of a regulated wetland, for construction of a driveway with a slope of 10% or greater and for any site determined to be in an environmentally sensitive area. This ordinance is an extremely valuable tool in protecting water quality.

In Leelanau County the Leelanau Conservation District has been authorized by the County to administer the SESSRC Ordinance. Upon receiving a permit application the Soil Erosion Control Officer completes a site visit to insure that all necessary soil erosion control measures and sediment control measures are properly planned and installed prior to the start of a project. It is necessary to obtain a soil erosion permit before any soil

disturbance takes place. Further information and details can be obtained by contacting Leelanau Conservation District.

Drain Commissioner

The Drain Commissioner provides assistance in the following areas: The County Drainage Plan, The Soil Erosion, Sedimentation and Stormwater Runoff Control Ordinance (SESSRC), the management and control of County Drainage Districts and County Dam inspections.

Table 11: Master Plan and Zoning Ordinance Status Summary for Local Governments in Watershed (For a map of Jurisdictions see Figure 2)

County	Township	Master Plan	Zoning
Leelanau County		Y, with updates in 2000 and 2005	N (Rely on individual
	Centerville	Y, (2005)	Y, 1971 with amendments 2007
	Cleveland	Y, 2009	Y, 1973 with 2009 amendments
	Glen Arbor	Y, (2013)	Y, 2008
	Kasson	Y (2004)	Y, 1997, updates 2011
	Leland	Y, 2009	Y, 1996 with 2014 amendments

Table 12: Good Harbor Bay Watershed 2014 Master Plan Assessments

	MASTER PLAN ASSESSMENT								
Unit of government	***Plan Reviewed ("NA" indicates no plan) and "NP" indicates plan not provided by project deadline)***	***Master Plan Goals/ Narrative Address:***							
		Maintaining /Promoting Community Character	**Land use limitations for environ-mental constraints**	**Protecting Shoreline/ Lake Michigan/Inland lakes**	**Protecting Wetlands**	**Preserving and protecting Streams/ Surface Water/ Groundwater**	**Soil erosion/ Stormwater Measures**	**Protecting Dunes/ Hills/ Slopes**	**Protecting Forests/ Agriculture/ Open Space**
Leelanau County	X	X	X	X	X	X	X	X	X
Centerville	X	X		X		X		X (Soils)	X
Cleveland	X	X	X?	X	X	X	X	X	X
Glen Arbor	X		X	X	X	X	X	X	X
Kasson	X	X	X	NA		X	X		X
Leland	X	X	X	X		X	X	X	X

Table 13: Good Harbor Bay Watershed 2014 Zoning Ordinance Assessments

ZONING ORDINANCE ASSESSMENT									
Unit of government	***Ordinance Reviewed ("NA" indicates no plan and "NP" indicates plan not provided by project deadline)***	***Ordinance Regulations Include:***							
		Special Districts for Environ-mentally Sensitive Areas	**Approval or Permits for Environ-mentally Sensitive Areas or Uses**	**Requirements for Shoreline/ Riparian Areas**	**Requirements for Wetland Areas (such as for areas not regulated by DEQ or US Army Corp. of Engineers)**	**Provisions to Protect Streams/ Surface Water/ Groundwater**	**Soil Erosion/ Stormwater Provisions**	**Sewer/ Water Provisions**	**Open Space Requirements**
Leelanau Co	No Zoning	---	---	---	---	---	---	---	---
Centerville	X			X				X	X
Cleveland	X		X			X			
Glen Arbor	X			X	X	X	X	X	
Kasson	X								X
Leland	X	X?	X	X	X	X	X	X?	X

2.9 FISHERIES

The two fisheries reports for the two major lakes (Lime and Little Traverse) in the watershed written by the Michigan Department of Natural Resources are summarized below. The full reports can be found in Appendix A.

Lime Lake Fisheries (adapted from Seites/Hettinger report 2010)

Lime Lake is fed by several hillside seeps, springs, and small creeks, with the largest being Lime Creek which flows in at the southern end of the lake. Shetland Creek flows out of the north end of Lime Lake and into Little Traverse Lake, and from there Shalda Creek flows out of Little Traverse Lake and into Good Harbor Bay on Lake Michigan (Seites 2011). In years of high water migratory fish from Lake Michigan have access to Lime Lake through Shalda Creek, which flows from Little Traverse Lake to Lake Michigan. Shalda Creek is a Type 4 designated trout stream. (Seites 2011). Type 4 trout streams **are** open for the entire year. The **Possession season f**or brook trout, brown trout and Atlantic salmon is the last Saturday in April through September 30. For all other species of trout and salmon the season is open for the entire year. Artificial lures and all types of natural bait may be used. The **Daily Possession Limit is** five (5) trout and salmon in any combination, except that the daily possession limit shall not include more than three (3) trout 15 inches or greater. The size limit is 7 inches for Brook Trout and 10 inches for Brown Trout. (FO-200.15. Statewide Trout, Salmon, Whitefish, Lake Herring, and Smelt Regulations)

Lime Lake is a Type C designated trout lake that is open to trout fishing for the entire year (Seites 2011). Type C Lakes have a fishing and possession season open for the entire year. All types of natural bait and artificial lures may be used and the daily possession limit is five trout and the minimum size is 8 inches for Brook Trout, Brown Trout, Rainbow Trout, Lake Trout and Splake (FO-200.15. Statewide Trout, Salmon, Whitefish, Lake Herring, and Smelt Regulations). The lake is accessible via a Michigan Department of Natural Resources (MDNR) public boat launch. This launch is located on the southwestern shore of the lake and has one dock, two slips to launch and retrieve boats, vault toilet facilities, and approximately six gravel parking spaces. The Lime Lake Association is the only riparian association that is currently active on Lime Lake. The Cedar Rod and Gun

Club in nearby Cedar, MI is a local sportsman's group that has historically been interested in the management of Lime Lake. MDNR Fisheries Division often receives fishing reports from both local and out-of-town anglers.

According to Fisheries Division records, Lime Lake was first stocked with walleye fry in 1910. A mixture of cold and cool water species such as lake trout, walleye, bluegill, smallmouth bass, largemouth bass, yellow perch, and northern pike were stocked from 1920 until 1949. At this time the Michigan Department of Conservation (MDOC, precursor to today's MDNR) switched the focus of Lime Lake to the management of trout and began stocking rainbow trout. During the 1960's the trout fishery declined and the MDOC stocked a mix of brown trout and rainbow trout in order to determine which species would create a better fishery. In 1968 the MDOC decided to stock brown trout exclusively. With the exception of 1987 when both brown trout and rainbow trout were stocked, and 1969 and 1991 when no fish were stocked, Lime Lake has been stocked with brown trout annually from 1968 to 2011 (Fisheries Division files, Cadillac).

Lime Creek was also stocked by the MDOC for a number of years. Brook trout were first stocked in 1933, annually from 1935 to 1944, and for one final year in 1949 before this stocking was discontinued.

Current Status

The most recent Lime Lake fisheries survey was conducted in 2010 using Status and Trends protocols (Wehrly et al. 2009), and was intended to evaluate the success of brown trout stocking. During the 2010 survey a total of 1,912 fish representing 19 species were caught. Rock bass, yellow perch, and spottail shiners comprised the largest portion of the catch. A total of 1,203 rock bass made up 63% of the catch by number, ranging from 2 to 11 inches in length. Additionally rock bass represented 38% of the total catch by weight with 194 total pounds. Yellow perch represented 28% of the total catch by weight with 186 individuals collected.

Game fish caught in the 2010 fisheries survey included brown trout, smallmouth bass, largemouth bass, yellow perch, longear sunfish, bluegill, and northern pike. Although smallmouth bass only represented 3.7% of the catch by number, they

represented 85.4% of the catch by weight with 71 individuals ranging in size from 3 to 20 inches. Twenty-eight brown trout ranging in size from 6 to 14 inches represented 6.9% of the total catch by number. Most species caught in May had growth rates slightly below the State average length at age. Bluegill and rock bass were the only two species with growth rates above State average. Yellow perch growth rates were significantly below State average. Not enough largemouth bass or northern pike from any one age class were collected to make statistical inferences regarding age and growth; however as individuals the northern pike were growing above State average and the largemouth were growing below State average.

Scale samples were collected in the July electro fishing survey from rock bass, yellow perch, and smallmouth bass to be aged and compared to the State average length at age. Not enough smallmouth bass or yellow perch from any one age class were collected to make statistical inferences regarding age and growth; however rock bass were growing just slightly below State average. As individuals, both the smallmouth bass and yellow perch were growing either just below or right at the State average.

Analysis and Discussion

The 2010 MDNR fisheries survey showed Lime Lake hosts a healthy fish community with abundant species diversity. Game fish species collected include brown trout, largemouth bass, northern pike, and smallmouth bass. Brown trout were represented by two year classes (ages 1 and 3), indicating that some holdover of stocked trout is occurring. Smallmouth bass were represented by 10 year classes and are growing at a fairly good (-0.1 inches) pace compared to the State average. Very few largemouth bass or northern pike were collected. It is important to note that in the time that Lime Lake has been a managed fishery, northern pike have only occurred in low densities. In Lime Lake where maintaining a trout fishery is one of the management goals it is critical to keep northern pike densities low to reduce predation on stocked trout.

Panfish species collected in the survey include bluegill, yellow perch, longear sunfish, and rock bass. Yellow perch were represented by five year classes and exhibited very slow growth rates compared to the State average (-1.2 inches),

supporting angler comments reporting catching low numbers of very large perch, mostly in the winter months or early spring. Rock bass were represented by eight year classes and were growing above State average (+0.5 inches).

There are notable differences between the fish communities collected in the 2010 fisheries survey and the fish communities collected in the prior surveys. A sharp decline occurred in alewife numbers from the 1999 survey. This could partially be attributed to gear bias, as more fyke nets were used in the 1999 survey. Fyke nets could be more effective at collecting alewife than the trap nets used in the 2010 survey. It could also be due to the fact that connectivity between Lime Lake and Lake Michigan has declined over the years. Both Shalda Creek and Sheltland Creek have experienced low water, beaver activity, and other blockages which may be preventing migratory species from reaching Lime Lake as they have in the past. Species absent from the 2010 catch included pumpkinseed sunfish, green sunfish, and fathead minnows. New species collected in the 2010 survey included longear sunfish, creek chub, bowfin, Johnny darter, mimic shiner, and sand shiner. Based on the three species of sunfish that have shown up in the catch through the years, there is potential that hybridization of panfish is making identification difficult.

Management Direction

Any remaining riparian wetlands adjacent to Lime Lake and its tributaries should be protected as they are critical to the continued health of the watershed. Appropriate watershed management is necessary to sustain healthy biological communities, including fish, invertebrates, amphibians, reptiles, birds and aquatic mammals. Generally for lakes this includes maintenance of good water quality, keeping nutrients balanced, preservation of natural shorelines; especially shore contours and vegetation, and preservation of bottom contours, vegetation, and woody structure within the lake.

Additionally, dredging of the littoral zone should be avoided if possible on Lime Lake, particularly where gravel and cobble substrates are located. Most of the near shore properties that are developed on Lime Lake have gravel and cobble substrates present which is critical for a number of important Lime Lake fish species. MDNR Fisheries Division should work collaboratively with the Lime Lake

Association, MDEQ, National Park Service, and various non-profit environmental agencies to identify aquatic connectivity barriers and sustain or enhance aquatic connectivity among all the basins within the Lime Lake watershed, specifically Lime Creek, Shetland Creek, Shalda Creek, and Little Traverse Lake. Enhanced aquatic connectivity will help sustain healthy fish populations into the future.

Native species like smallmouth bass, rock bass, and yellow perch should continue to thrive in Lime Lake. The smallmouth bass population in Lime Lake is exceptional, and Lime Lake has an excellent reputation among anglers for its smallmouth bass fishery. The brown trout stocking program for Lime Lake should continue. Although the current Lime Lake northern pike densities appear low, this lake should be a candidate for a no minimum size limit classification and 5 fish per day limit for northern pike. It is recommended to have the MDNR Fisheries Division survey Lime Lake again within the next five to ten years in order to continually assess the fish community and evaluate brown trout stocking efforts (Seites 2011). Fisheries Division should also survey the major tributaries to Lime Lake to better understand their contributions to this watershed. Many of these streams have never been surveyed or have not been surveyed in many years.

Little Traverse Lake Fisheries-(adapted from Seites/Hettinger report 2014)

Little Traverse Lake is classified as a mesotrophic, slightly eutrophic lake. A combination of sand and marl dominates the bottom substrate. Much of the lake is less than 20 feet in depth, with good vegetative growth and areas of heavily wooded natural shoreline. Water clarity is impacted by tannic acid contribution from the watershed, as well as the marl bottom substrates. The surrounding topography of the 640 acre Little Traverse Lake is wooded, with adjacent sand dunes, rolling hillsides, and lowland cedar swamps (Hettinger 2014). While Little Traverse Lake is moderately developed with homes and cottages, much of the surrounding shoreline has been left unarmored. Numerous small seeps and creeks drain the surrounding hillsides and feed Little Traverse Lake (Hettinger 2014). Much of the shoreline is wooded or wetland area, with some areas of shore being sandy beaches or lightly armored with rock rip rap. Shallow near shore areas are predominately sand and marl, with water depths of 1-5 feet (Hettinger 2014). The remaining deep water areas are marl or a pulpy peat and

marl combination. The lake has an average depth of 5-10 feet and reaches a maximum depth of about 50 feet (Hettinger 2014).

There are two public access sites that provide boat launching facilities on Little Traverse Lake. The most accessible is a Cleveland Township Park located in the northwest corner of the lake. The second site is a Leelanau County parcel on the north east corner of the lake. There is one lake association on Little Traverse Lake, the Little Traverse Lake Property Owners Association. This association was founded originally as the Little Traverse Lake Association, and throughout the years has very active in the watershed. There is one nature preserve managed by the Leelanau Conservancy that is found along the shore of Little Traverse Lake; the Swanson Preserve (Hettinger 2014).

History

The earliest recorded fish stocking in Little Traverse Lake was in 1933. Fish were stocked annually by the Michigan Department of Conservation (MDOC, pre-cursor to the present Michigan Department of Natural Resources) from 1933 to 1944. A variety of species such as yellow perch, bluegill, largemouth bass, walleye, and northern pike were stocked during this time frame (Hettinger 2014). Once the Department of Conservation stopped raising cool water species in the hatchery system, Little Traverse Lake was no longer stocked with fish. Adult panfish were transferred to the lake on three occasions in 1991, 1992, and 1993, when fish were available. These fish came from nearby Turtle Lake in Benzie County. No fish have been stocked in Little Traverse Lake since the last panfish transfer in 1993. The first known work completed by the MDOC on Little Traverse Lake, aside from stocking, started in 1949 (Hettinger 2014).

Limnology surveys were also conducted throughout the years, with the first being in August of 1949. Subsequent limnology samples were taken in 1970, 1978, 1989, and 2013. The first fisheries survey on Little Traverse Lake took place in 1965 (Hettinger 2014). At this time the fishing was described as good, with the catches being predominately bluegill. Nets were set again in August of 1970, when a combination of experimental gill nets, trap nets, fyke nets, and electroshocking was used to assess the fish community (Hettinger 2014). This

was the only survey where cisco were ever collected in Little Traverse Lake. These fish may have had free movement out to Good Harbor Bay in many years of high water, but once water levels declined and fish passage began to become obstructed via undersized culverts, the movement of cisco most likely was inhibited, thus preventing new stocks from migrating into the lake (Hettinger 2014).

A request was made by the Little Traverse Lake Association in 1989 for a lake survey to be conducted after angling success reportedly declined (Hay 1989). Therefore, in June of that year the Michigan Department of Natural Resource Fisheries Division surveyed the lake using a combination of experimental gill nets and large mesh fyke nets set for three net nights (Hettinger 2014). In the summer of 1990 Fisheries Division worked with the Little Traverse Lake Association to place bundles of 12 Christmas trees at three locations in the lake to improve fish habitat (Hettinger 2014). Little Traverse Lake was surveyed again in June of 1995, using experimental gill nets, large mesh fyke nets, and small mesh fyke nets set for three net nights. The purpose of this survey was to evaluate the stocking of panfish that occurred in the early 1990's.

Current Status

In 2013, Fisheries Division conducted a Discretionary Survey in Little Traverse Lake which followed Status & Trends protocol (Wehrly et al 2009). This protocol uses the same types of collection gear and protocols in lakes of similar sizes, and allows the data collected in Little Traverse Lake to be compared with data collected from similar lakes across the state (Hettinger 2014). . Three sections of shoreline were electrofished using a boom electroshocking boat, and four beach locations were sampled with a seine net on July 23, 2013. During this survey a total of 861 fish representing 17 species and 18 turtles representing two species were collected (Hettinger 2014).

Rock bass were the most abundant species by number, with 261 individuals collected (Table 3). Rock bass also had the highest percent by number making up 30.3 % of the catch, followed by pumpkinseed which comprised 13.1% of the catch by number with 113 individuals. The biomass of the catch was

predominated with 68.2 lbs. of smallmouth bass and 43.6 lbs. of northern pike. Smallmouth bass represented 23.3 % of the catch by weight, while northern pike accounted for 14.9 % of the catch by weight. Growth rates for all species aged were above the state of Michigan average length at age, with the exception of northern pike which were growing 2.2 inches below average, and yellow perch which were growing 0.1 inches below average (Table 4). While most species were only slightly above average, smallmouth bass were growing well above average with growth at 1.7 inches above the state of Michigan average length at age. Not enough largemouth bass were collected from any one year class to make statistical inferences about growth (Hettinger 2014). .

Analysis and Discussion

Overall the growth of most fish species found in the most recent survey of Little Traverse Lake is comparable to the State average, and is in the acceptable ranges for a lake with a slightly mesotrophic/eutrophic classification (Hettinger 2014). Good numbers of smaller forage fish such as shiners and minnows produce higher growth rates in species such as the smallmouth bass; however the low numbers of smaller panfish and a relatively short growing seasons result in below average growth for northern pike (Hettinger 2014).

Throughout its management history, Little Traverse Lake has been plagued with reports of a poor panfish fishery. Despite having adult panfish transferred into the lake in the early 1990's, this issue has persisted until recent times (Hettinger 2014). While numbers of bluegill still appear to be low, the numbers of longear sunfish and pumpkinseed sunfish are on the rise. One phenomenon that could be attributing to the increasing success of these panfish species is in fact the troublesome culvert located on Traverse Lake Road. Since the culvert's replacement in the late 1990's, water levels in Little Traverse Lake in the spring and the fall have been much higher than when the old culvert was in place, so high in fact that riparian owners have expressed major concerns over the flooding of their properties. However, in the spring when panfish are spawning these higher water levels and thus the increased nearshore vegetated areas may be aiding the spawning success of panfish by increasing available spawning areas and providing additional protection for newly hatched fry (Hettinger 2014).

Management Direction

Little Traverse Lake has a well preserved natural shoreline across many areas of the lake. Efforts should be made to protect remaining riparian wetlands from development in order to maintain the healthy aquatic ecosystem that currently exists (Hettinger 2014). Future unwise riparian development and wetland loss may result in deterioration of the water quality and aquatic habitat. Healthy biological communities on inland lakes and streams require suitable natural habitat (Hettinger 2014). Appropriate watershed management is necessary to sustain healthy biological communities, including fish, invertebrates, amphibians, reptiles, birds and aquatic mammals (Hettinger 2014).

Additionally, dredging of the littoral zone should be avoided on Little Traverse Lake, particularly where woody debris and cobble substrates are located (Hettinger 2014). Most of the nearshore properties that are developed on Little Traverse Lake have sand and cobble substrates present, and many have high quality woody debris. This nearshore habitat is critical for a number of important Little Traverse Lake fish species, as cobble substrates and woody debris provide spawning habitat and also host many important aquatic invertebrates that help to sustain healthy fish populations (Hettinger 2014). Currently Little Traverse Lake has excellent fisheries for multiple species, such as smallmouth bass and pumpkinseed sunfish. These are well maintained by natural reproduction, and thus no fish stocking is required at this time (Hettinger 2014). However, another Discretionary or Status & Trends fisheries netting survey should be conducted on Little Traverse Lake within the next ten years in order to continually assess the fish community (Hettinger 2014).

Fisheries Division should continue to work with the Little Traverse Lake Property Owners Association, the National Park Service, the Leelanau Conservancy, and the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) to help develop and implement the Good Harbor Bay Watershed Protection Plan, as well as to help develop a solution for the poor road stream crossing at Traverse Lake Road (Hettinger 2014). These collaborations should also work to address additional aquatic connectivity barriers and sustain or enhance aquatic connectivity among

all the basins within the Good Harbor Bay watershed, specifically Lime Creek, Shetland Creek, and Shalda Creek. Enhanced aquatic connectivity will help sustain healthy fish populations into the future (Hettinger 2014).

2.10 HUMAN HISTORY

Written by Dean Manikas

Humans have inhabited the Good Harbor Watershed since before recorded time. Different bands of Native Americans trapped, hunted, fished, farmed and traded in the region before a written record was made. European settlers would later appropriate their trails as the first network of roads. Initial contact between Europeans and Native Americans was along the shore of Lake Michigan trading for goods from the natural bounty of the region. A treaty in 1836 between the United States of America and local tribes opened the region to settlement by European immigrant groups.

Steam shipping around the Great Lakes required fueling stops for wood to feed the boilers. The earliest settlements (approximately 1860) in the watershed were at New Harmony and Good Harbor (Schomberg). Both were based on the cutting and selling of wood to the hundreds of steamboats navigating the lakes. The work force, all arriving by water, were German, Czech, and Polish immigrants. Carving out a living in this harsh environment required reliance on neighbors to survive in the region, especially during rough winters. All supplies came by water, often leading to shortages of essential goods in the winter months. A story from New Harmony claims how the settlement survived the first winter thanks to the migration and easy hunting of the now extinct passenger pigeon. The continuous removal of timber began to open areas for agriculture. Potatoes, cabbage, beans, a little wheat, and game from the lakes and forests became the foodstuff of the settlers. Sawmills operated in both villages. Families would work the land during growing season and shift their labor to culling wood from the forests and working the sawmills in the winter.

Sawmills and lumbering were the primary sources of income in the region. Lumbering peaked in the early 1890's and faded quickly at the start of the 20th century. Sawmills dotted streams and lakes. Remnants of the sawmill and fueling industry can be seen at the bottom of Lime Lake and the pilings stretching into Lake Michigan at a couple of locations along the shore of Good Harbor. Gradually,

as the woods were cleared, settlers moved inland, away from the lakeshore. The villages of New Harmony and Good Harbor were abandoned in the early 1900s.

Maple City was founded in 1866. Initially its name was Peg town in recognition of the primary business, the manufacture of wood pegs for shoe making. The factory burnt down in 1880 but the newly named Maple City persisted even being home to a hotel.

Cedar, founded in 1892, was the last community to develop within the interior of Leelanau County. The Railroad passed through and provided easy distribution for the cedar shingle and barrel products from the local factory. 1916 saw the demise of the wood product factory but Cedar persevered.

Agriculture has been rooted in the watershed, on small plots in the earliest of times to multiple acre orchards into the modern era. Potatoes were the first cash crop in the late 1800s. Apple and cherry orchards have been prevalent since the early 1900s and remain viable in the present. But agriculture only makes up a small portion of taxable property in the modern era. Residential property dominates the taxable rolls distantly followed by commercial property. The majority of residents make their living outside the watershed.

Within the heart of Good Harbor Watershed sits Sugar Loaf Mountain. The earliest settlers, harkening memories of the hills in their native lands, admired Sugar Loaf. During Sugar Loaf's 35 years of operation as a resort, it was the largest employer in Leelanau County. Presently, the golf courses of Sugar Loaf, the National Lake Shore, and the inland lakes and streams, attract thousands of visitors every year to the region.

2.11 ECONOMY, TOURISM, AND RECREATION

(written by Dean Manikas)

The Good Harbor Watershed is naturally beautiful; forests, wetlands and lakes compose the majority of the surface area. Township reports show that greater than 50% of local residents are employed outside Leelanau County. The population is educated (95% with a high school diploma and 32% holding a college degree) with over 30% working in professional and managerial roles, 22% in sales/office work, 17% in services, 13% construction trades, 5% agriculture and forestry occupations. The fastest growing employment sector is in the service industry. Major employers include the Grand Traverse Band, school districts, the park service, Triple D Orchards, Leelanau Fruit, and Leelanau Redi-Mix.Poverty rates hover around 16%. Taxable property value is derived from 92% residential, 3% agriculture, and 5% commercial. Residential property value had been greatly increasing for the past 20 years, just slowed by the recent recession.

The Sleeping Bear Dunes National Lakeshore, Sugar Loaf golf courses, and abundant lakes are the major recreational attractions. Seasonal and day visitors can swell the area's populations by 400%. Until its closure, Sugar Loaf Resort was the largest employer in the county. Sugar Loaf is in the heart of the Good Harbor Watershed. Townships within the watershed state the following economic goals: embrace year round employment opportunities, preserve tourist friendly qualities, and protecting farmland and agricultural enterprises.

(Sources include Cleveland and Centerville Township Plans)

SWIMMER'S ITCH SUMMARY

Ron Reimink, Lime Lake Association (LLA Biologist), wrote a summary on swimmer's itch for the LLA and will be involved in a study of Swimmer's Itch in Northern Michigan. He will work with the LLA and steering committee to help with some of the tasks identified in Chapter 8, Table 34) and will keep the lake associations and steering committee for this watershed informed on what is learned and what programs might be implemented in this watershed.

Below is an overview of Swimmer's Itch adapted from the website:

Swimmer's Itch is an infliction generated by a parasite in the water which is part of cycle involving Merganser ducks, other water fowl, and snails. The parasite burrows into one's skin and generates a 'mosquito bite' type irritation which swells into a node on the skin. Swimmer's Itch is of high concern in the inlands lakes in this watershed, particularly Lime and Little Traverse Lakes which have an increase in visitors during the swimming or summer months.

Prevention & Treatment

Until a viable, environmentally safe solution is found, here are few suggestions that many have found helpful. Obviously they are not guaranteed therapies.

- Shower and towel off with vigor and thoroughness after swimming.
- Avoid swimming at midday and in areas exposed to shore winds
- Swim in deeper water where the infecting snails are less likely to occur.
- Avoid feeding waterfowl in your swimming areas
- In case of exposure, application of topical antihistamines (such a Benadryl) or a topical hydrocortisone can help reduce inflammation and relive itching
- Some have reported success using Swimmer's Itch Guard before entering the water as a preventative.

Tracking Program

The Lime Lake Association Swimmer's Itch Program tracks where and when anyone contracts swimmer's itch. The LLA Board has a keen interest in keeping abreast of the latest progress in methods to alleviate swimmer's itch. Ron has been actively involved in swimmer's itch education, research, and control for the past 30 years in Michigan, Wisconsin, Indiana, and Maine and has volunteered to spearhead the efforts to keep Lime Lake on the front edge of any new control developments. Due to roadblocks at the state and national level, most control efforts involving waterfowl are limited. Anyone who decides to take control efforts into their own hands by illegally killing the ducks on Lime Lake is strongly discouraged by the LLA board. In fact, past experience has shown that such efforts actually increase the incidence of swimmer's itch. Please work within the law to maximize efforts.

To begin the assessment process, Ron is taking information from watershed users. Please contact him at his email address with any and all swimmer's itch cases from Lime Lake. Please include all of the following information for EACH PERSON INFECTED (also include repeat infections):

1. Date of contact
2. Approximate age of person infected
3. Approximate number of spots and where located
4. Approximate time of swimming (morning, afternoon, evening)
5. Approximate wind direction and speed
6. Address or location on lake most likely contacted
7. Photo of the swimmer's itch bumps (optional)

Please note: this reported data will help the LLA address this lake issue. Although he may not be able to respond to your email, please rest assured that each contact will be recorded, compiled, and shared with the LLA board and general

membership. Thanks for helping in our quest to alleviate problems with swimmer's itch! Ron Reimink, Lime Lake Association (LLA Biologist), email: reiminkron@gmail.com