Herring Lakes Watershed Mangement Plan

2003

(Rev. no.1 12/05)

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The Herring Lakes Watershed Management Plan represents the work and input of many stakeholders including citizens, businesses, sportsman interests, agriculturalists, governmental representatives, researchers, and resource specialists.

We extend our appreciation to the following partners for their contributions and support of the Project:

Lower Herring Lake Association

Osaha Inc. (Camp Lookout)

Watervale Inn

Evergreen Association (Upper Herring Lake)

Benzie County Equalization Department

Benzie County Planning Department

Benzie County Road Commission

Blaine Township

Joyfield Township

Northwest Michigan Groundwater Stewardship Program

Grand Traverse Regional Land Conservancy

Great Lakes Environmental Center

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Benzie Conservation District

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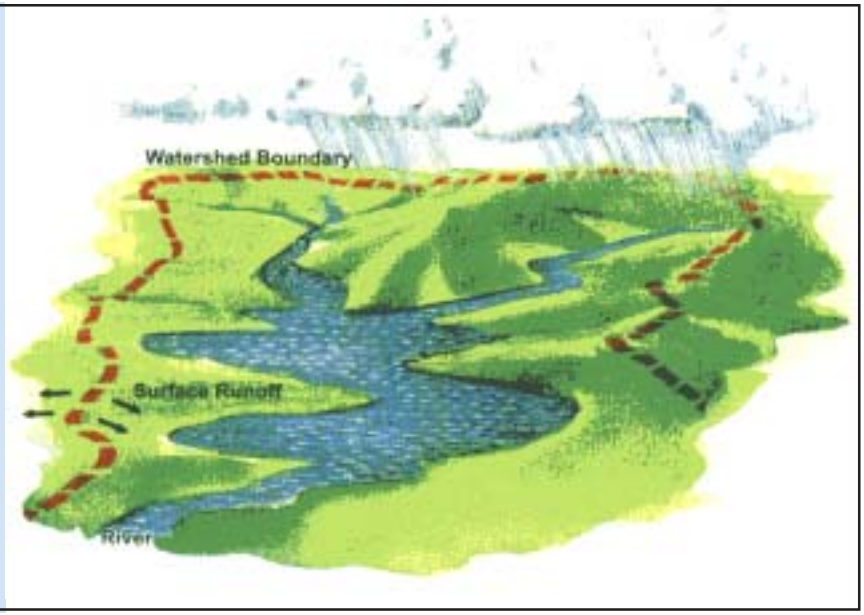
The Herring Lakes Watershed Project Background

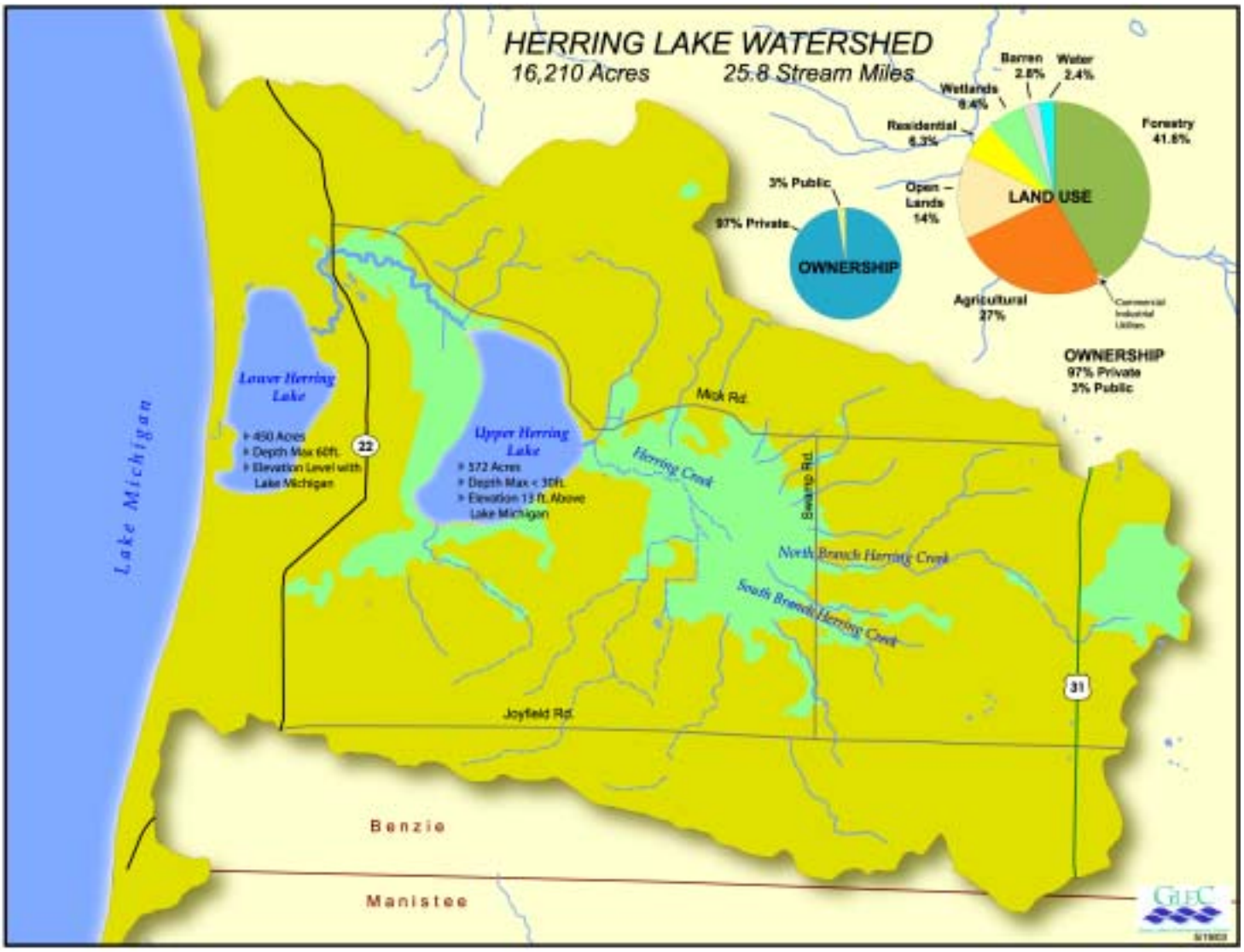
Preserving the character and function of the watershed is the fundamental purpose of watershed management planning .

The Herring Lake Watershed Project began in October 2000 in response to growing local concern over declining water quality in these interconnected lakes. The Michigan Department of Environmental Quality NonPoint Source Pollution Program awarded funding to the Benzie Conservation District to complete a two-year evaluation of factors contributing to surface and ground water degradation in the Herring Lakes Watershed. The aim was to develop a watershed management plan which would define water quality problems and threats so that sensible and timely actions could be implemented to restore and protect water resources.

A **watershed** is the total land area draining to a common body of water such as a river, lake, wetland, or storm sewer. Surface runoff is confined within the boundaries of the watershed formed by surrounding hills and slopes.



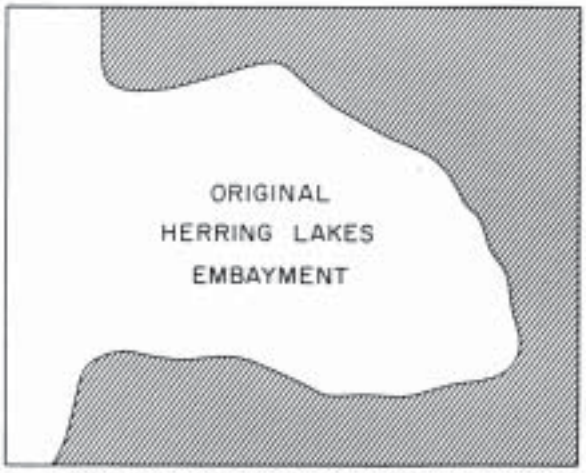
The Herring Lakes Watershed drains a land area of roughly twenty-five square miles in southwestern Benzie County. The primary water bodies are Upper Herring Lake, Lower Herring Lake, Herring Creek and extensive wetlands. Herring Creek and its tributaries drain a large area of the watershed which includes forest land, agricultural crop land, orchards and livestock farmland.



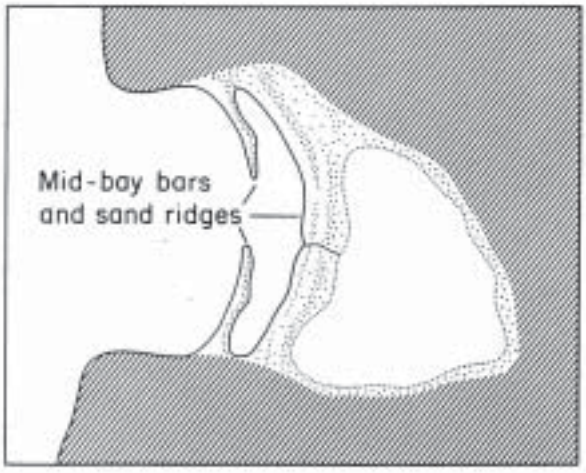
Geologic History

Source: The Geology of Michigan, Door and Eschman 1970.

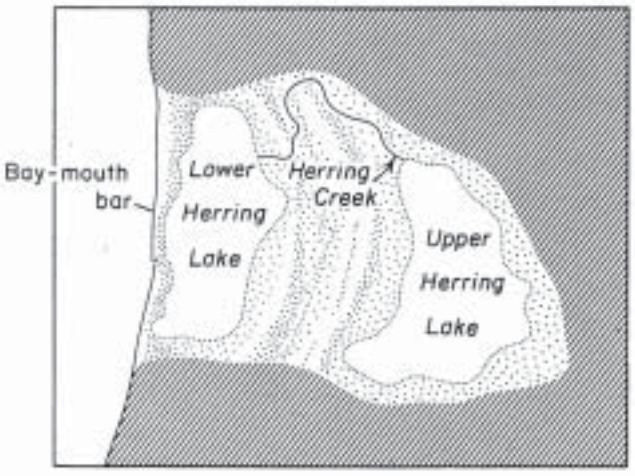
The lake basins were formed around 10,000 years ago as a result of dune and sand bar formation. Both lakes were originally combined as one U-shaped embayment of Lake Algonquin, a stage in the formation of Lake Michigan which persisted for approximately 1.6 million years.



Upper Herring Lake was the first of the two lakes formed as fluctuating lake levels and corresponding sand ridges isolated the waters from Lake Nipissing, the final stage in the formation of present day Lake Michigan. There was also a third depression east of Upper Herring Lake which was eventually filled by vegetation and sediment carried by streams. This area remains today as vast wetlands west of Swamp Road.



Lower Herring Lake, once partially separated from open water by a baymouth bar, was again flooded and remained part of Lake Nipissing. Late in the Lake Nipissing stage, low dunes on the north end of Lower Herring Lake formed and the embayment was later closed by a sandbar that formed during the Lake Michigan period.



The Watershed Today

The geology of the Herring Lake Watershed and the physical aspects of the receiving lakes and streams have changed very little in the past 10,000 years. European settlement gradually transformed other features within the watershed, such as drainage patterns, water chemistry and lake depth .

Photo: View over looking Upper Herring Lake.

Herring Lakes Watershed Statistics

River and tributary length
25.8 miles

Watershed area
16,210 acres

Lakes
1,022 acres

Like all water bodies, Upper and Lower Herring Lakes are aging through a process called ***eutrophication***. This process, typically occurs in hundreds and thousands of years, results from the gradual delivery of sediment and organic matter from the watershed to the receiving waters. Over time, lakes become more sediment-laden and nutrient rich contributing to a biologically productive environment.

Watershed development causes the otherwise slow aging process of lakes to accelerate by increasing the delivery of sediment and nutrients to the lakes. Signs of accelerated aging are present in both lakes and are likely a result of increasing human activity in the watershed .

Maintaining the natural dynamics of the watershed help to limit the aging process once watershed development has begun. Managing growth and development at the watershed level is key to protecting water resources.

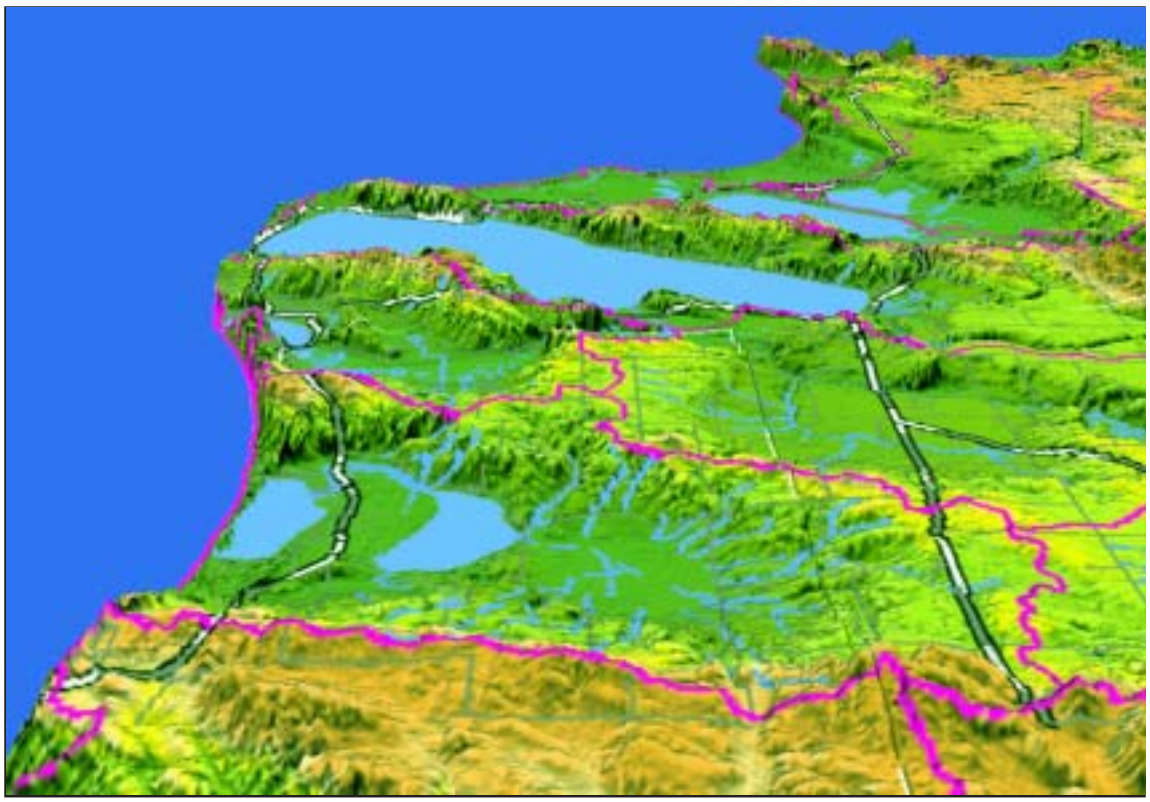
Photo above: Field sample of abundant aquatic plant life on Upper Herring lake.

Photo: Lower Herring lake empties into Lake Michigan.

Watershed Management Approach

Watershed management is a process that works to maintain a healthy balance between human development needs and water resource protection. It is based on the premise that water quality is a direct reflection of the health of the surrounding drainage basin or watershed. The management planning process is used to:

- **Determine the designated and desired uses of the water resources.**
- **Identify known and potential pollution sources and causes.**
- **Determine the natural features and human alterations of the landscape that influence water quantity and quality.**
- **Understand the community factors influencing water quality by identifying all stakeholder interests in the watershed.**
- **Define the tasks needed to ensure short and long term water resource protection.**



Herring Lakes Watershed Relief Map by Meridian Geographics

Designated and Desired Uses

Water resource protection and preservation is best achieved by managing for specific water uses. An approach combining State **designated uses** and locally determined **desired uses** was employed on this project. Desired uses are typically defined at the local level and address water resource management objectives not addressed under the State designation guidelines.

Concerns expressed by the watershed community relate primarily to excessive weeds in both lakes, quality and quantity of drinking water supply and the control of exotic plant and aquatic animal species. Therefore, desired uses are sufficiently accounted for under the following designated uses categories.

Designated uses in the Herring Lakes Watershed , as defined by the Michigan Department of Environmental Quality are:

- **Partial and Full Water body contact-recreational**
- **Public Water Supply**
- **Cold Water Fishery**
- **Warm Water Fishery**
- **Other Indigenous Aquatic Life and Wildlife**

Designated Uses are evaluated in the following three ways:

- **Being Met**
- **Threatened**
- **Impaired**

Partial and Full Water body contact-recreational

This designated use refers to the quality and safety of the resource for recreational uses such as swimming and wading. The lakes are considered high quality recreational waters however, elevated levels of coliform bacteria now being detected in Herring Creek suggest that the Upper Herring Lake may be **threatened**. Concentrated shoreline development and associated septic systems extend the threat to Lower Herring Lake.

Public Water Supply

Soils in the watershed are predominantly sandy and provide excellent aquifer recharge capacity. Unfortunately, these porous soils offer little filtration of pesticides, nutrients and other contaminants.

Drinking water in the Herring Lakes drainage area is supplied solely by private wells. Historical agricultural activity in the watershed and the presence of abandoned wells pose a potential risk of groundwater contamination from the leeching or spilling of pesticides and other agricultural chemicals. Improper storage of residentially-used chemicals and fertilizers further contributes to the risk of ground water contamination.

The Benzie-Leelanau District Health Department reports that there are presently no known sites of ground water contamination. However, because contamination risks are significant based on current landuses in the watershed, the public water supply is considered **threatened.**

Cold Water Fishery

While Herring Creek is not a designated trout stream, some reaches within the extensive network of tributaries provide habitat for trout species and other aquatic organisms acclimated to cold water environments. The impairments or threats to this designated use are typically those which can alter the cold-water environment of the stream. Typical pollutants are:

- **Sediment**
- **Nutrients, pesticides, oils and toxic chemicals**
- **Increased peak flow or reduced base flow**
- **Thermal pollution from inadequate vegetative buffers, discharges of heated waste water and dams or ponds which may cause increases in water temperature above 50 ^{0} F.**

Isolated impairments to the cold water fishery have been identified throughout the watershed. Channelized stream flow through road culverts, erosion, livestock in the stream and non-vegetated sections of stream bank collectively contribute to the cold water fishery being **impaired.**

Threatening Invaders

Crustaceans:

Fishhook Waterflea
Rusty Crayfish
Spiny Waterflea

Fish:

Common Carp Goby
Ruffe Sea
Lamprey White
Perch

Plants:

Curley-leaf
Pondweed
Flowering Rush
Purple Loosestrife

Warm Water Fishery

Warm water fishery environments characterize most shallow inland lakes. Upper and Lower Herring Lakes fall into this category by providing warm water habitat to aquatic life that generally does not thrive in the colder waters of Herring Creek.

The quality of warm water lake habitats can be threatened by shoreline development, polluted runoff from the contributing drainage area, recreational use and invasive non-native plant and animal species.

One indicator that this designated use is **impaired** in the Herring Lakes is the abundance of weed growth in both lakes. Weed growth is natural in lakes, but to the extent it is occurring in the Upper and Lower lakes is a sign that nutrient runoff from the watershed and along the developed shoreline is greater than normal background levels.

Other Non-Indigenous Aquatic Life and Wildlife

Photo: DNR Invasive species sign at Upper Herring Lake boat launch.

This designated use classification refers to the health and diversity of the native community. A diverse aquatic animal and plant community supports recreational use goals and provides an important natural defense against increasing pollution runoff from the watershed.

The greatest threat to the indigenous biological community of the Lakes comes from the on-going propagation of non-native species. Invasive, non-native species tend to thrive in the absence of natural controls such as predation and other competition. In time, they begin to replace native plant and animal species and may quickly proliferate to the extent that eradication becomes challenging and costly. Die off and decay of vast colonies of these organisms further adds to the nutrient load of the water body.

Several invasive species have been identified in Lower Herring Lake determining the designated use as **impaired** for this water body. Zebra mussels and Eurasian Water Milfoil are the most prolific species. The two have likely been introduced through public recreational access which increases the likelihood of cross contamination from other affected lakes. Non-native species are so far absent from Upper Herring Lake. This may be due to the fewer number of public access points on the lake and natural differences between the two lakes. However, because they are interconnected, the

Types of Pollution

Point Source Pollution

Map of Herring Lake Point Source Pollution Sites.

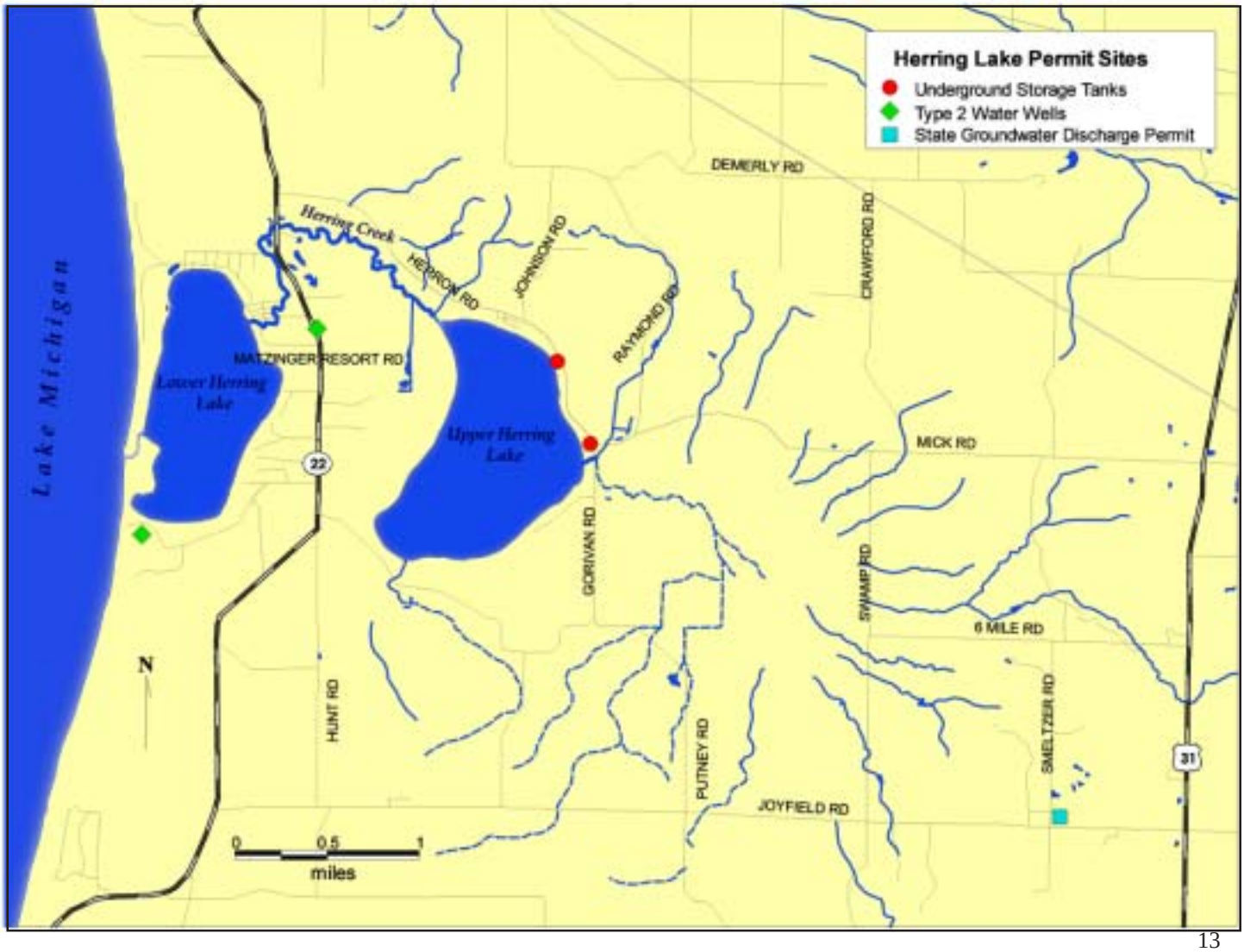
Water pollution occurs either by direct or indirect means. Pollutants discharged from factory or sewage treatment facilities, for example, are called **Point Source Pollution**.

There are currently five known point source pollution sites in the Herring Lakes watershed. All are regulated under the State permitting system and are perceived to be meeting clean discharge standards. They include:

2 - Regulated underground fuel storage tanks

2 - Type 2 water wells (Non community well serving 15 or more households)

1 - State groundwater discharge permit



Non-Point Source Pollution

Nonpoint Source Pollution is derived from numerous sources throughout the watershed. With each rainfall, runoff from roads, parking lots, lawns and farms carry sediment, fertilizers and other pollutants to the lakes via natural and manmade drainage ways. Nonpoint source pollution also includes wind-blown contaminants, atmospheric deposition and ground water contamination from septic waste and chemical spills. Nonpoint source pollution is a serious problem in the Herring Lakes Watershed and elsewhere.

The pollutants and other factors affecting water quality in the Herring Lake Watershed are:

- **Sediment**
- **Nutrients (fertilizers and organic matter)**
- **Bacteria**
- **Toxic chemicals and oils**
- **Invasive species**

Pollution Sources

Several potential pollution sources have been discovered in the Herring Lakes Watershed. These sources are categorized based on the following criteria:

- Ø **Known**
- Ø **Suspected**
- Ø **Threatened Impairment**

Water quality degradation from Nonpoint Source Pollution results from collective influences rather than specific locations, activities or landuse types. It would therefore be unreasonable to single out any one particular location or activity as the sole source of water quality problems found in Herring Creek and Upper and Lower Herring Lakes. In some cases however, specific problems are readily linked to upstream sources. Streambank erosion and livestock access to the creek are two documented examples. These sources are categorized as **known** pollution sources**.**

In most cases, however, the exact location of pollution sources is not known. Instead, assumptions are made based on universally recognized links between certain landuse practices and activities in the watershed and the corresponding effect on water quality. Septic systems, fertilizer and pesticide applications are common examples of **suspected** pollution sources. Future potential sources such as watershed development, recreational use and abandoned open wells are categorized as **threatened .**

Agricultural Activities

Agricultural operations including row crop and orchard farming have the potential to contaminate surface and ground water through excessive nutrient and pesticide runoff and infiltration. Livestock farming occurring too close, or in one observed case, directly within the drainage way of Herring Creek, is a suspected source of sedimentation, nutrient loading and bacterial contamination. Recent improvements have been made to limit cattle access at this location, however, a more comprehensive approach is needed to eliminate this problem. Old farm dumps and abandoned wells throughout the watershed may also be a source of groundwater contamination.

Forestry Activities

Forested land covers forty-one percent of the Herring Lakes Watershed. Commercial logging and private landowner removal of trees and vegetation has the potential to contaminate surface and ground water. Logging practices such as haphazard road construction and heavy cutting increase soil erosion which funnels sediments into waterways. Outreach and education to landowners is needed to raise awareness of poor practices and steer landowners to operators who do take water quality into consideration.

Shoreline Development

Development in the watershed has been historically low. However, concentrated residential and vacation property development along the lake shoreline may be a source of nutrients, chemicals and bacterial contamination. Runoff of fertilizers, pesticides and other lawn chemicals is a common pollution source. Shoreline erosion and thermal pollution may be increasing from the removal of near-shore and shoreline vegetation. Additional nutrient and bacterial contamination may be occurring from failing, improperly sited or concentrated septic systems near surface water and high groundwater table areas.

Road-Stream Crossings

There are twenty-eight (28) cases in which roads cross streams or wetlands creating potential sites of erosion and sedimentation. Improperly aligned, undersized or deteriorating culverts can impact water resources by causing erosion at the culvert embankment or in the stream channel upstream and downstream of the culvert. Interruptions in the natural flow regime caused by channelizing through culverts can also alter wetland hydrology and disturb aquatic habitat. This problem in the Herring Lakes watershed is minor compared to other watersheds, however, some crossings are severe enough to warrant future restoration efforts.

Watershed Development

Development by itself is not necessarily a source of pollution. However, factors such as location, density and site development standards can be leading causes of nonpoint source pollution at the watershed level. The Herring Lakes Watershed has remained sparsely populated, agricultural and forested drainage basin . Future zoning maps suggests this trend will likely remain. However, the continued viability of farming will likely be the primary determining factor. Should the community shift in its character towards greater residential and commercial development densities, safeguards such as stormwater management, development setbacks and greenbelts will be needed along waterways and within recharge areas to prevent further water resource decline.

Water Quality Summary

Upper and Lower Herring Lakes and the main tributary, Herring Creek, presently exhibit signs of declining water quality.

Excessive weed growth in the lakes is one indicator of polluted runoff occurring within the watershed. Unusually high levels of coliform bacteria have also been detected in Herring Creek at several locations including the inlet to Upper Herring Lake. The presence of bacteria at the levels measured in the study may pose a significant risk to human health. Elevated levels of phosphorus in groundwater have been detected near the lower Herring Lake shoreline indicating that subsurface water quality may also be threatened.

Photo: Overlooking Green Point Dunes. The Lower Herring lake connects to Lake Michigan.

Table 1. SUMMARY OF NONPOINT SOURCE POLLUTION IN THE HERRING LAKES WATERSHED

Known = (K); Suspected = (S); Threatened = (T)

POLLUTANT OF CONCERN	SOURCE	CAUSE
Sediments (K)	Streambank erosion (K)	Unrestricted livestock access to the stream (K)
	Road-stream crossings (K)	Undersized and misaligned road culverts (K)
Nutrients (K)	Agricultural Operations(S)	Livestock Pasture / Feedlot Runoff (K)
		Fertilizer Runoff (S)
		Subsurface leeching (S)
	Septic Systems (S)	High density of systems in high groundwater shoreline areas (S)
		Improperly sited and / or maintained septic systems (S)
	Storm water runoff (S)	Improper application / overuse of lawn fertilizers (S)
		Improper storage of organic wastes (compost, manure, etc.) near surface water (S)
		Inadequate shoreline vegetative buffers
Bacteria (K)	Agricultural Operations (S)	Unrestricted livestock access to the stream (K)
	Storm water Runoff (S)	Livestock Pasture / Feedlot Runoff (K)
	Septic Systems (S)	Failing or inadequately maintained and / or high density in shoreline areas (S)
Toxic chemicals, oils and salts (T)	Agricultural Operations (S)	Improper residential / commercial use and overuse of pesticides and chemicals (S)
	Stormwater Runoff (S)	Unfiltered Road Runoff (S)
	Residential Lawn Care(S)	Runoff and infiltration to groundwater from improper storage and over use (S)
Other non-indigenous aquatic life and wildlife (K)	Public and private water craft access sites (K)	Improper cleaning of private water craft (K)
		Inadequate public education of threatening invasive species (S)

Water Quality Studies

Several studies have been conducted in the past decade that contribute to our current scientific understanding of water quality problems in the Herring Lake Watershed. Following is a brief summary of findings from each study.

1992 South Branch Herring Creek Study

This report provides the first resource management plan for the Watershed although it focuses only on the Upper Herring Lake drainage area. The study addresses concerns based largely on qualitative assessments of geological and land use databases and observed problems rather than actual sampled data . The study however, accurately defines the primary nonpoint source pollution threats to water quality and proposes a implementation strategy to further study and address these concerns.

1992 MDEQ Biological Survey of Herring Creek

This survey covered the section of Herring Creek northeast of Putney Road in the Upper Herring Lake drainage area. Overall, the study rated this stream section as fair to moderately impaired. (Conditions leading to this rating include a lack of bottom substrate suitable for fish and aquatic insects. This was attributed to heavy silt and sand deposits caused by an eroding stream bank upstream of one sample location and stream channel erosion caused by cattle access at another.) Excessive nitrogen and phosphorus was also detected.

While measurable water quality and habitat degradation was revealed in this study, the presence of young trout and other fish species migrating from Upper Herring Lake indicates that some sections of the stream still serve as spawning and nursery habitat.

1996 MDNR FISH Survey Analysis Report

Upper and Lower Herring Lakes have long been valued as a sport fishing resource with Upper Herring Lake having a better reputation than Lower Herring Lake. Since the 1930's, both lakes have been periodically stocked with bluegill, largemouth bass, smallmouth bass and walleye. The lakes are now managed by the Michigan Department of Natural Resources as a two-story cold water-warm water fishery. The unique ecology of these lakes make this strategy possible and supports a healthy and diverse fish community.

According to the 1996 MDNR survey, the continued quality of the sport fishing resource may be threatened without deliberate action to preserve the elements contributing to a healthy lake fishery. Particularly, Herring Creek and the extensive wetland system contiguous to the lakes provide critical spawning habitat and food resources for fish and other wildlife. Wetlands also filter contaminated runoff from

the watershed. Preserving the healthy function of these watershed features is key to preserving lake ecology and ultimately recreational quality of the lakes.

2002 Great Lakes Environmental Center Aquatic Plant Survey of Upper and Lower Herring Lakes

A survey of the rooted aquatic plants in Upper and Lower Herring Lakes was conducted by Great Lakes Environmental Center as part of this current project. The purpose was to map and characterize the vegetation of both lakes as a way to evaluate water quality.

Upper Herring Lake hosts the greatest plant diversity. Twenty-three (23) species were identified and mapped. Plant densities are alarmingly high indicating excessive nutrient runoff from the watershed. However, only native plant species are present which supports a diverse fish community and prevents the establishment of non-native invasive species. While this native plant community structure is preferred, the large densities of plants may be contributing to eutrophiation of the lake by adding nutrients to the lake through the annual die back and decay of plants.

Lower Herring Lake, with fourteen (14) plant species, has a less diverse plant community than Upper Herring Lake although it still denotes a healthy lake ecology. The Lower Herring Lake plant community also includes two non-native invasive species: **Eurasian milfoil** (Myriophyllum spicatum) and **giant reed grass** (Phragmities australis). Eurasian milfoil was the second most abundant plant identified in the lake signaling a significant concern and need for appropriate management policies. Both exotic species are problematic because they aggressively out-compete native plants and reduce the overall plant diversity of the lakes.

It is not clear why the non-native plants are limited to Lower Herring Lake although both environmental and human factors are suspected. Differing lake size and depth may be one factor. Environmental factors such as changes in water levels and temperatures are also contributing factors. Eurasian milfoil is typically introduced by boats which carry fragments from other affected lakes. Lower Herring Lake has three public boat launches, while Upper Herring has only one which may further explain the difference in non-native plant introduction.

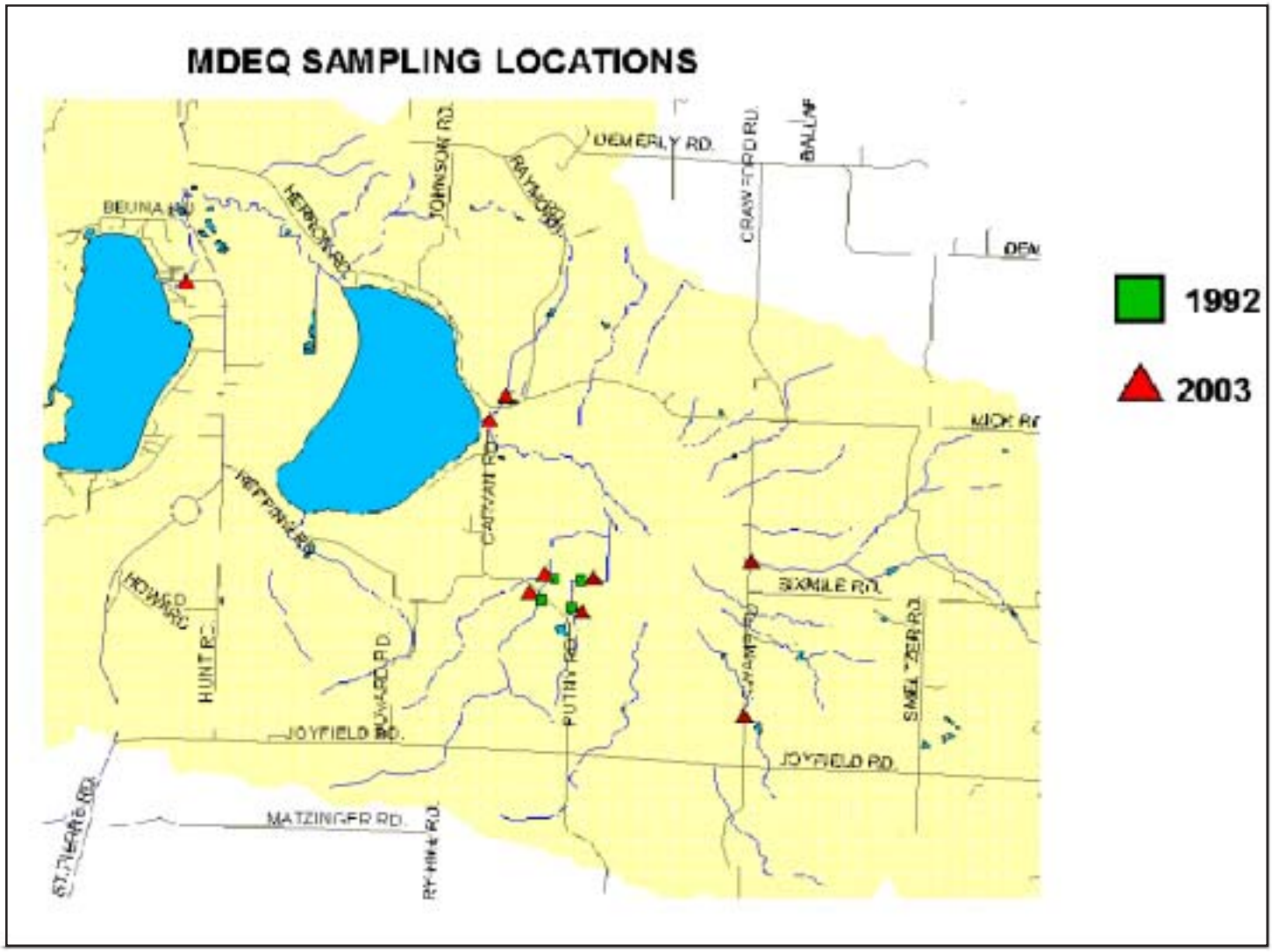
Other human factors which may contribute to the expansion of invasive plant species include bottom disturbance from boat motors and the removal of competitive native species in shallower shoreline areas. The introduction of Zebra mussels is also likely influencing the proliferation of exotic plant species.

MDEQ 1992 and 2003 habitat assessment sampling locations.

2003 MDEQ Habitat Assessment (Draft)

An update of the 1992 study by MDEQ was completed in August 2003. This survey revisited survey sites from the 1992 study and added locations at the inlet to Upper Herring Lake and Lower Herring Lakes and off Swamp Road in the upper-most portion of the Watershed.

Sampling sites near Putney Road revealed a continuation of habitat degradation first detected in 1952. The cause remains from livestock access and an eroding stream bank downstream of the culvert at Putney Road. Young Brown trout and



sculpin were observed, however, indicating that this reach of stream continues to support some level of the fishery. The researcher also notes the addition of some cattle fencing along the stream which, while not completely excluding cattle access to the stream, was an improvement over previous conditions. Regardless, this reach of stream received a poor rating for aquatic insects due to an overburden of silt and sand.

The added survey sites along Swamp Road revealed good to excellent habitat conditions. This is attributed to the largely undeveloped stream corridor and surrounding forested wetlands. Erosion caused by road culverts was noted although gravel stream beds continue to dominate this section. Survey results at M-22 and Elberta Resort Road rated conditions good to excellent for habitat and insect diversity.

Water samples reveal high phosphorous and nitrogen at the sampling locations between Putney Road and the inlet to Upper Herring Lake. Levels dip slightly below Upper Herring Lake. Nutrients in the stream sections along Swamp Road approximate normal background conditions.

1992 Lower Herring Lake Water Quality report

Water quality samples were taken on Lower Herring Lake on October 6, 1992. The study completed by Dr. Wally Fusilier reported the lake as having excellent water quality.

2003 Great Lakes Environmental Center Water Quality Report

A comprehensive monitoring program was conducted including lake and tributary sampling, aquatic weed survey (cited above), fecal bacteria sampling and a hydrogeologic investigation including soil classification, hydrogeology, land cover analysis and a determination of the chemicals of concern.

Lake Water Quality

Monitoring data for 2003 shows phosphorus and nitrogen levels to be overall consistent with other northern Michigan lakes having good water quality. Another water quality indicator, **chlorophyll *a*** was detected at levels high enough to suggest that lake nutrients levels may be increasing. **Sediment phosphorus** was measured at acceptable levels throughout the two lakes except near the inlet of Herring Creek on Upper Herring Lake and the southern edge of the lake. This condition is likely contributing to high weed growth occurring in these areas of the lake.

Tributary Monitoring

Stream sampling was conducted after rainfall events to monitor runoff from agricultural areas. Phosphorus and nitrogen (nitrate) were measured at levels ranging from 30 parts per billion to over 100 parts per billion. For comparison, the 5-year average for nutrients in surface waters of a watershed with similar characteristics and land use in Leelanau County was 10 to 20 parts per billion which indicates that significant nutrient loading is occurring in Herring Creek. Dry weather sampling revealed nutrient levels comparable with the 5-year average for dry weather sampling in Leeleanu County.

Levels of the bacterium, ***E. coli***, measured at the inlet to Upper Herring Lake were generally much higher (2-10 times higher) than levels measured upstream in the Herring Creek tributary. However, all samples of *E. coli* were at levels which would likely exceed the State of Michigan standard for *E. coli* in surface water, based on a single sample event. This contamination may originate from various sources such as septic system failures or wildlife, farm animals, pets or waterfowl waste. The presence of *E. coli* is not necessarily indicative of septic failures, but is an indicator of fecal contamination. Unrestricted access of cattle to the Herring Creek tributary is a likely contributor although further sampling is needed to confirm this suspicion.

Hydrogeologic Investigation

This portion of the monitoring effort was conducted to collect data to evaluate suspected groundwater contributions to water quality problems in the Herring Lakes. Potential groundwater contamination sites were also assessed.

This investigation first determined the best location of permanent and temporary groundwater monitoring wells needed to define subsurface characteristics including depth, flow direction, gradient, etc. Land use and land cover assessments, including a review of local, State and Federal databases were also used to determine the location of potential environmental contamination and areas of concern.

Findings from this work performed by Ball and Associates, Inc. include:

- A property near one tributary of Herring Creek, above Upper Herring Lake, demonstrated potential nutrient deposition from uncontrolled livestock access in the creek and surrounding drainage way.
- A property in the north-east corner of the watershed could be a contributor of elevated levels of arsenic, lead, DDD, DDE and DDT from agricultural operations.

- Specific residential properties located on Lower herring lake may be sources of nutrient and septic waste contamination to the lake.

- Temporary groundwater monitoring wells installed at sites along the Lower Herring lakeshore revealed levels of total phosphorus roughly 30 times higher than the natural level expected for 90% of Michigan groundwater. Nitrate and nitrite levels at the same locations were measured at levels expected for groundwater in Michigan.

- A shallow groundwater well near a State boat launch on Lower Herring Lake detected total phosphorous at levels 200 times greater than normal levels for groundwater. Nitrate nitrogen was measured at 6.5 times greater than normal background levels. Conclusions by the investigator are that further sampling is needed to determine the exact source of these contaminants.

Future Water Quality Studies

Watershed dynamics and lake ecology are highly complex and require a scope of study beyond what has been completed so far. To better assess contamination sources and track future remedial actions, continued monitoring is recommended including the following parameters:

- **Wet-weather tributary and lake sampling**
- **Annual lake water quality and lake sediment analysis**
- **Groundwater testing**
- **Watershed modeling**

Public Partcipation

Community involvement is key to successful watershed management planning. Accurately determining water resources protection goals and prioritizing implementation tasks require participation from the watershed community.

The Herring Lakes Watershed Project sought public input in several ways. Presentations were given early on at public and lake association meetings to inform citizens, elected officials and decision makers on the nature of watershed management planning and our expectations for the two-year planning project.

Direct involvement from the stakeholders was provided through an advisory council consisting of lake association members, farming and business representatives and resource specialists. The group was instrumental early in the project in helping to identify specific resource concerns. Copies of the completed management plan were submitted to several advisory council members for review and comment prior to submitting the final plan for approval.

Increasing awareness and involvement of the watershed community is an on-going effort that began early in the project. News releases were used to announce the start of the project and to begin educating the community on the concepts of watershed management. At the end of the first year, a direct mailing was sent to watershed property owners to provide an update of project findings and to solicit participation.

The successful completion of management plan tasks will require continued involvement by watershed stakeholders. A diverse and involved advisory council is needed for project success. Also key is the immediate and continued implementation of the outreach and education plan (Table 7).

Management Plan Goals

Tables 2,3,4,5 and 6 summarize the Watershed Management Plan objectives for reducing current pollution, restoring affected areas and preserving clean water resources. Goals are categorized by each pollutant of concern. Specific Best Management Practices, cost estimates and time lines are given where known. Additional task lists are provided for outreach and education and land protection goals.

Table 2. Sediment Reduction

Goal: Reduce sediment loading to all water bodies.

DESIGNATED/ DESIRED USE ADDRESSED	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
Cold Water Fishery Warm Water Fishery	Replace culverts and repair crossing approaches at Buena Road and Elberta Resort Road .	Benzie Co. Road Commission/ Benzie Conservation District	$250,000	2005-2006
	Calculate sediment loading estimates	Benzie Conservation District	Undetermined	2005
	Install approved cattle exclusion measures at impacted locations on Herring Creek.	Land Owner/ Herring Lakes Watershed Project	Undetermined	Fall 2005
	Restore eroded stream banks and establish filter strips along impacted reaches of Herring Creek.	Land Owner/ Herring Lakes Watershed Project	Undetermined	Fall 2005

Table 3. Nutrient Reduction

Goal: Reduce nutrient loading to all water bodies.

DESIGNATED/ DESIRED USE ADDRESSED	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
Cold Water Fishery Warm Water Fishery	Continue investigation and monitoring of potential sources of nutrients.	Benzie Conservation District	$2000 / year	Ongoing
	Calculate nutrient loading estimates	Benzie Conservation District	Undetermined	2005
	Establish filter strips along Herring Creek at livestock farms.	Property Owner / Benzie Conservation District	$2500	2004
	Install cattle watering ramps and exclusion fencing along waterways.	Property Owner / Benzie Conservation District	$12,000	2004
	Promote the use of manure composting facilities at farms along waterways and areas of high groundwater.	Benzie Conservation District / Ground Water Stewardship Program	Undetermined	2004
	Continue investigation of potential septic system contributions near lake shore development. Promote system upgrades and maintenance.	Benzie Conservation District	$2500-$3000 / year	2004-2005
	Increase nutrient management education and awareness through targeted outreach to farmers, businesses and resort owners and residents.	Benzie Conservation District	Included in Outreach budget	Ongoing

Table 4. Harmful Bacteria Reduction

Goal: Reduce and control harmful bacteria to safe levels.

DESIGNATED/ DESIRED USE ADDRESSED	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
Full and Partial Water Body Contact - Recreational	Continue investigation and monitoring of potential sources and causes of elevated fecal coliform bacteria in Herring Creek.	Benzie Conservation District	$1500/Year	Ongoing
	Continue Upper and Lower Herring Lake near-shore sampling at the Upper Herring Lake inlet.	Benzie Conservation District	$2500/year	On Going
	Install livestock controls as prescribed under Nutrient and Sediment goals.	Property Owner/ Benzie Conservation District	Included in Nutrient budget	2004
	Promote septic system upgrades and maintenance.	Benzie Conservation District	Included in Outreach budget	On Going

Table 5. Toxic Chemical and Oil Reduction

Goal: Reduce, eliminate and prevent chemical and petroleum product contamination of surface and ground water.

DESIGNATED/ DESIRED USE ADDRESSED	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
Cold Water Fishery Warm Water Fishery Public Water Supply	Conduct farm assessments to determine potential threats.	Benzie Conservation District/Ground water Stewardship Program	$0	2004
	Promote the use of agri-chemical containment facilities where needed.	Property Owner/Benzie Conservation District/Ground water Stewardship Program	$3500/ facility	2006
	Conduct targeted outreach to increase awareness and education of proper residential use and storage of household chemicals.	Benzie Conservation District/Ground Water Stewardship Program	Included in Outreach Budget	On going

Table 6. Invasive Species Eradication and Control

Goal: Halt the introduction of aquatic non-native species and control the expansion of existing populations.

DESIGNATED/ DESIRED USE ADDRESSED	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
All	Coordinate and implement outreach and educational activities to increase awareness of invasive species.	Benzie Conservation District	Included in Outreach Budget	Ongoing
	Expand the use of signs and informative brochures and materials, presentations, workshops and other activities to increase awareness.	Benzie Conservation District	$2500	2004
	Develop local consensus on a preferred invasive species program and begin a long-term implementation strategy.	Benzie Conservation District/ Project Partners	$2500/year	2005

Outreach and Education

Many water resource impairments and threats can be solved through structural improvements and sensible land use practices. Lasting protection of surface and groundwater resources, however, can only be achieved if sufficient work is done to inform and educate the watershed community of its role in preventing and controlling non-point source pollution. Table 7 reveals outreach and education goals beyond those included in the pollution reduction goals.

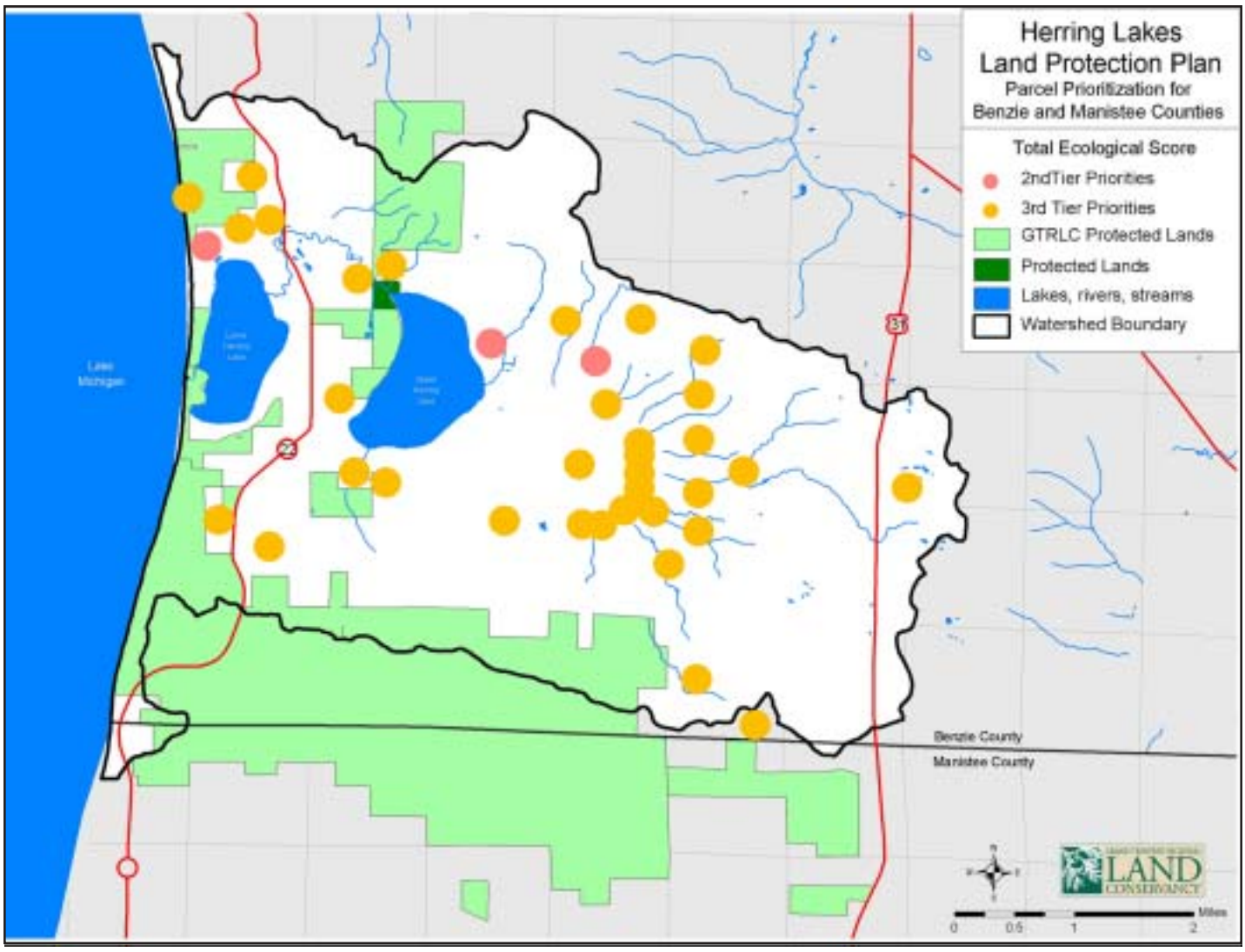
Table 7. Outreach and Education

Goal: Increase awareness within the watershed community and educate about Nonpoint Source Pollution issues and concerns. Evalutate effectiveness of outreach activities.

OBJECTIVE	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
Increase individual and community knowledge of water resource issues.	Develop a project logo. Conduct campaigns using multi-media. Complete and maintain project website.	Benzie Conservation District	$3000	2005
Support lake associations and watershed groups and efforts of existing associations.	Provide technical assistance and customized outreach materials.	Benzie Conservation District	$1000 / year	Ongoing
Expand involvement in schools and groups.	Provide programming and curriculum assistance for teachers.	Benzie Conservation District	$3000 / year	Ongoing
Increase invasive species education and awareness.	Provide hands-on activities and distribute materials.	Benzie Conservation District	$1500 / year	Ongoing
Increase nutrient management awareness through targeted outreach to farmers, businesses, resort owners, and residents.	Conduct greenbelt waterfront landscaping and sustainable forestry workshops.	Benzie Conservation District	$3000 / year	2006
Promote livestock controls and streambank restoration.	Provide technical assistance and customized resources.	Benzie Conservation District	$1500 / year	2005
Promote near lake shore septic system upgrades and maintenance.	Provide informational brochures to landowners and realitors.	Benzie Health Department / Benzie Conservation District	$2000 / year	2006
Promote proper use and storage of household chemicals.	Conduct targeted outreach to residents on household chemicals.	GroundWater Stewardship Program / Benzie Conservation District	$1500 / year	Ongoing
Preserve existing forested lands and prevent erosion and sedimentation.	Provide forestry management services to the private landowner.	Benzie Conservation District	Undetermined	Ongoing

Land Protection

A necessary component of watershed management is the protection of undeveloped lands which may be critical to maintaining water quality and watershed function. In the Herring Lakes Watershed, over 1800 acres have been protected through various programs offered by the project partner, Grand Traverse Regional Land Conservancy.



Fruithaven Preserve

The first parcel to be protected in the Watershed was the 551-acre Fruithaven Orchard. This property is presently being managed as a sustainable forestry preserve. Low-impact public recreation including hiking, hunting and fishing is also part of the long-term management and stewardship plan.

Watervale Forest Conservation Easement (Completed 2002)

This 75-acre conservation easement includes forested and critical dunes south of the historic Watervale Resort. This conservation easement adjoins and earlier donated easement by the Watervale resort.

Rudy and Nancy Ranke Memorial Conservation Easement

The Ranke Family donated a conservation easement on 1,765 feet of lake Michigan shoreline. This 37 acre parcel is part of the 258 acre Green Point Natural Area and includes habitat for the Federal protected Pitcher's Thistle and the State designated critical dunes.

Green Point Dunes Natural Area

The Conservancy purchased this 221 acre property from the Ranke Family under land contact. Final acquisition is dependent upon successful fund-raising. The land is currently open for public access and includes walking access to Lake Michigan, making it the first public beach access in Blaine Township. The land is further being managed for passive recreation including hunting.

CMS/Arcadia Conservation Project

The Conservancy is under a purchase option for this 6,000 acre property which includes 1,300 acres in the Herring Lakes Watershed and two miles of Lake Michigan Shoreline. A great deal of planning and fund-raising is needed to complete this acquisition.

Areas noted as "First" through " Third Tier Priorities" on the previous map are the parcels identified by the Conservancy as candidates for future donation or other land protection options by private property owners.

Private Forest Land Protection

With over forty-percent of drainage area as forested land cover, the watershed is relatively protected from soil erosion All forested areas not already preserved are in held in private ownership so the potential for degradation is significant as land is cleared for private development or as forests are logged for profit. An important land protection task will be to provide sensible forestry management options for the private landowner.

Local Planning and Zoning

Other recommended land protection work is specific to properties in the watershed deemed buildable by local zoning standards but which also include critical lands. Critical lands in the Herring Lakes Watershed are described as:

- Ø Sites adjacent to water bodies with slopes greater than 10 percent
- Ø Sites with high soil erosion and sedimentation potential
- Ø Sites within 25-feet of wetlands
- Ø Flood plains
- Ø Riverbanks
- Ø Inland Lakes and Rivers
- Ø Lake Michigan bluffs and shoreline

Adequate setback requirements and isolation distances from water bodies for all future residential and commercial development are recommended to prevent the continuation of pollution now threatening water resources.

Table 8. Land Protection

Goal: Insure future protection and preservation of water resources and manage current preserved lands to meet water quality protection goals.

DESIGNATED/ DESIRED USE	TASK	RESPONSIBLE ORGANIZATION	ESTIMATED COST	TARGETED COMPLETION DATE
All	Promote the adoption of Township and County planning and zoning measures to buffer future development from waterways.	Benzie Conservation District/Benzie County Planning Department/ Blaine and Joyfield Townships	$0	2004
	Provide land protection options to private landowners holding priority parcels.	Benzie Conservation District/Grand Traverse Regional Land Conservancy	$2500/year	Ongoing
	Implement stewardship plans for Fruithaven Preserve, Greenpoint Dunes and CMS property.	Benzie Conservation District/ Grand Traverse Regional Land Conservancy	Undetermined	2006
	Promote farmland preservation.	Benzie Conservation District/ Grand Traverse Regional Land Conservancy	Undetermined	2005
	Provide forestry management services to private landowners.	Benzie Conservation District Forester	Undetermined	Ongoing

Project Evaluation

Implementation of the management plan will require tasks that have varying degrees of measurability of the success. Table 9 summarizes the process that will be used to evaluate the effectiveness of each of the proposed tasks.

Table 9. Project Evaluation

TASK CATEGORY	EVALUATION PROCESS	MEASURE OF SUCCESS
Pollutant Reduction	Quantitative assessments of applied pollution reduction controls via annual lake and tributary monitoring.	Reduction in pollutants of concern.
	Qualitative assessments of filter strip plantings, bank restoration, road stream crossings, and other approved Best Management Practices.	Long-term stabilization of restored areas.
Information and Education	Public interest and involvement.	Attendance at meetings and workshops.
	Public awareness surveys (MDEQ approved).	Shifts in public awareness of water resource issues before and after plan implementation.
		Number of calls and inquiries for water resource-based concerns and assistance.
		Increased participation by local groups and schools.
Land Protection	Adoption and enforcement of local zoning measures targeted to reduce water pollution.	Periodic review of permits and assessment of enforcement success including numbers of variances and violations.
	Continued preservation of private riparian areas.	Number of acres protected under conservation easements or other land protection options.

Conclusion

Water resource degradation and threats including nutrient , sediment, bacterial contamination, and invasive species have been identified within the Upper and Lower Herring Lake and it's tributary streams. **The Herring Lakes Watershed Management Plan** compiles the known and suspected water pollution problems. Goals have been established to **restore water quality and protect water resources** in the Herring Lakes Watershed.

The Management Plan provides an excellent framework to begin this work, however, it is not a singular solution to the complex problems affecting the threatened surface water and ground water resources. Water protection goals and tasks outlined in the document should remain open to additions and modifications to accommodate growing community interest, involvement, new findings and innovative technologies.

The Benzie Conservation District is committed to carrying out the main objectives of this Plan. Our organization will continue to seek funding and other support needed to implement the Plan's objectives and will continue to serve as a clearing house of resources and services to the Herring Lakes Watershed Community.

Appendix A

Pollution Causes and Sources

Pages 15 through 17 of the management plan describe pollution source categories. The Agricultural Activities category is further subdivided to define farming operations requiring specific pollution control practices.

The Critical Area Map (Appendix A.1) shows the location of livestock operations in the Upper Herring Lake drainage basin. Sites B, C and D are individual farms totaling approximately 368 acres and supporting roughly 960 cattle. The land area is characterized by high ground water and is drained by Herring Creek and several smaller first and second order tributaries. Approximately 10,100 feet of stream is potentially affected by this landuse.

Sites C and D, while within the critical hydrologic area have benefited from some voluntary measures in recent years to control pollution sources. Measures include cattle exclusion fencing, chemical and fertilizer containment buildings and other BMPs measures. Fewer polltantion controlefforts have been made at Site B. Approximately 4500 feet of stream is affected. This area remains a likely source of excessive nutrient, sediment, bacterial and possible chemical pollution.

Appendix B

Pollutant Loading

Nutrient pollution entering Herring Creek and the two lakes was calculated from tributary and lake profile sampling and from weed density analysis.

The following nutrient loading estimates provide a baseline for quantifying current watershed pollutant loadings and for determining pollution reduction goals.

PHOPHORUS

	INLET	OUTlET	LOAD
		(Lbs / Yr)	
Upper Herring Lake	435.5	299.83	135.7
Lower Herring Lake	533.72	375.46 *	158.3

NITROGEN

	INLET	OUTlET	LOAD
		(Lbs / Yr)	
Upper Herring Lake	115.56	42.39	73.17
Lower Herring Lake	38.51	10.76*	27.75

* Nutrient load ing to Lake Michigan

LAKE MACROPHYTE LOADING

Phosphorus loading from the decay of aquatic weeds in both lakes were was estimated from plan t biomass calculaltions. Data for Upper Herring Lake illustrates the likely occurence of excess nutrient loading from the upper watershed as presented in the 2002 *Aquatic Plant Survey of Upper and Lower Herring Lakes.*

	Total Plant Biomass	Phosphorus Loads	
Upper Herring Lake	55.12 acres	49,073.2 lbs	0.16 lbs / day
Lower Herrign Lake	16.59 acres	14,770.8 lbs	0.048 lbs / day

Appendix C

Pollutant Loading Reduction Estimates

Background

Pollution reduction priorities include reducing and controlling sediment, nutrient and chemical pollution at critical area sites B, C and D. (Site A is a septic system problem that requires additional monitoring to determine the extent of pollutant loading).

Recent sampling data suggests that significant phosphorus and nitrogen loading is occurring in Herring Creek and the two lakes. High phosphorus readings are a chief concern since this nutrient plays the biggest role in lake productivity, or the increase in aquatic weeds. Sedimentation from pasture and feedlot runoff and severe stream bank erosion at Site B is also a problem. Earlier sampling for E.coli shows a bacterial loading problem in Upper Herring Lake, possibly emanating from the feedlots and pastures.

Pollution Reduction Goals

Determining precise pollutant reduction goals for the Herring Lakes Watershed is difficult since there is no TMDL (Total Maximum Daily Load) mandated for the water bodies. The challenge then is to determine what load reduction will result in lower nutrient concentrations and thus a shift toward lower lake productivity.

Accurately estimating pollutant reduction from proposed Best Management Practices is also difficult since the nutrient contributions from groundwater is yet unknown. The majority of the Critical Area (B, C and D) land is characterized by high ground water. The USGS topographical map identifies much of this area as wetland. After many decades of livestock and crop farming, it is reasonable to expect that soils are now saturated with phosphorus, which is presumably leaching to shallow subsurface waters. Future monitoring efforts should include soil moisture sampling at these locations to determine phosphorus concentrations. Soil sampling for nitrogen should also be conducted to determine possible threats to local drinking water.

Further complicating accurate loading reduction estimation are recent findings from several local mass balance studies suggesting that atmospheric phosphorus deposition is a significant fraction of the annual load.

Recent findings on nearby Crystal Lake offer a reasonable direction for determining pollutant reduction goals for Upper and Lower Herring Lakes.

Crystal Lake is classified as an oligotrophic lake meaning, in part, that plant productivity is moderate or low and water clarity is typically high. The Cold Creek drainage area is similar, although not exact, in several aspects to Herring Creek. Much of the land area had historically been farmed although it is not clear if livestock farming occurred.

Water quality sampling data at the inlet of Crystal Lake on Cold Creek depicts an annual phosphorus load of **290** pounds per year (Source: Great Lakes Environmental Center) .

Annual phosphorus loading to Upper Herring Lake at the inlet is **435.5** pounds per year and **533.72** pounds per year at the Lower Herring Lake inlet. With this information, we have set phosphorus load reduction goals for the two lakes at the difference between current loading estimates and the Crystal Lake calculated annual load.

	Phosphorus Reduction Goal (lbs/yr)
Upper Herring Lake Inlet:	**145.5**
Lower Herring Lake Inlet:	**243.7**

Appendix D

Some agricultural pollution reduction activities are underway or are planned in the Watershed that meet the goals stated on pages 27 through 32 of the management plan. These activities affect seven farms in the watershed, two of which are located at critical areas C & D. This work, in conjunction with comparisons to future tributary and lake sampling data will improve program evaluation.

Farm Site #	Farming Type	Activity	Anticpated Completeion Date
1	Orchard	Farm*A*Syst assesment	Fall 2005/Spring 2006
		Pesticide Application Controller	
		Well closure (3)	
2	Orchard	Farm*A*Syst assesment	Spring 2006
		Integrated Pest Management	
		Offset Hydrant	
		Pesticide storage shed	
		Dripless sprayer nozzles	
		Impervious storage surface	
		Pesticide fuel spill kit	
3	Orchard	Farm*A*Syst assesment	Fall 2005
		Well closure	
4	Orchard	Farm A*Syst assesment	Spring 2006
		Pesticide application controller	
		Dripless sprayer nozzle and calibration	
		Well closure	
5	Livestock/ Row crop	Farm*A*Syst assesment	Spring 2006
		Liquid nitrogen containment facility	
6	Livestock	Chemical storage facility	Summer 2005
		Integrated Pest Management	
		Livestock exclusion fencing	
7	Orchard/Row crop	Well closures (3)	Summer-Fall 2005