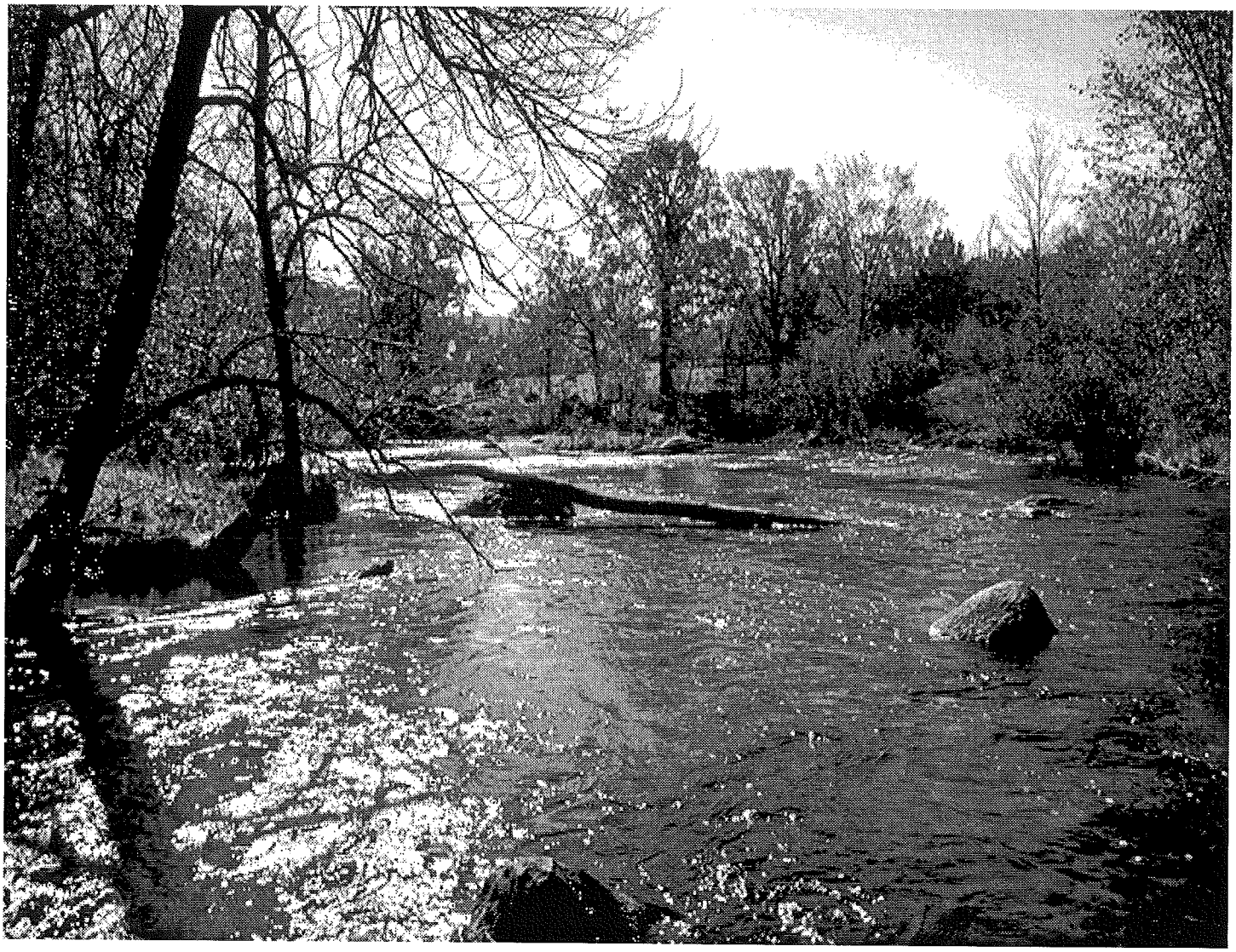
TOMORROW / WAUPACA RIVER PRIORITY WATERSHED

Surface Water Resources

Appraisal Report

April 1995



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Cover Photo

Tomorrow River above Co. Hwy. DD

Portage County

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Tomorrow/Waupaca River Priority Watershed

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I. INTRODUCTION

The function of this appraisal is to summarize the condition of surface water resources in the Tomorrow/Waupaca River Watershed and develop preliminary water resource objectives/goals for each subwatershed.

The surface water quality appraisal group, which was formed at the start of the planning process, analyzed existing water quality problems, determined waterbody potential uses, and developed preliminary goals/objectives. These preliminary water resource goals/objectives will be combined with results of land use inventories (identify critical fields/sub-basins, barnyards, land uses and streambanks) to produce final water resource goals/objectives and pollutant loading reduction goals for the project. This appraisal provides important information for use in writing the Tomorrow/Waupaca River Watershed plan and implementing the plan. An appraisal is not meant to be an all inclusive comprehensive document. Further baseline information such as lake and stream biological and chemical data could help better assess the attainment of surface water goals and objectives of the project.

II. SUMMARY OF WATERSHED CONDITIONS

The Tomorrow/Waupaca River watershed is approximately 291 square miles in surface area with 189 square miles (65%) in Portage County, 93 square miles (32%) in Waupaca County and 9.5 square miles (3%) located in Waushara County. (Fig. 1)

Originating as a trickle from Mudhole Lake in Portage County, the Tomorrow/Waupaca River flows southeasterly for approximately 69 miles through primarily agricultural and woodland settings with scattered rural urban areas, gathering clear, hard water from springs and tributaries to become one of the best trout streams in the area. That portion of river which flows in Portage County is named the Tomorrow, and the portion located in Waupaca County is called the Waupaca River. The river eventually drains into the Wolf River, east of Weyauwega. Much of the stream supports food and habitat for trout, including brook, brown and rainbows. Areas of riffles and rapids, coupled with deep pools, make this stream an aesthetically pleasing river as well as a productive one.

From the headwaters to the Waupaca County border (approximately 37 miles), the river is classified as Class I and II trout waters. The remainder of the river is classified as a warmwater sport fishery. The upper portion of the river is managed as Class I trout waters. The river above the city of Waupaca is classified as Class II trout while below the city the river contains warm water and forage fish species. The Tomorrow River

portion is one of the best trout streams in the area and is listed in NR 102 as an Outstanding Resource Water for the Class I trout portions.

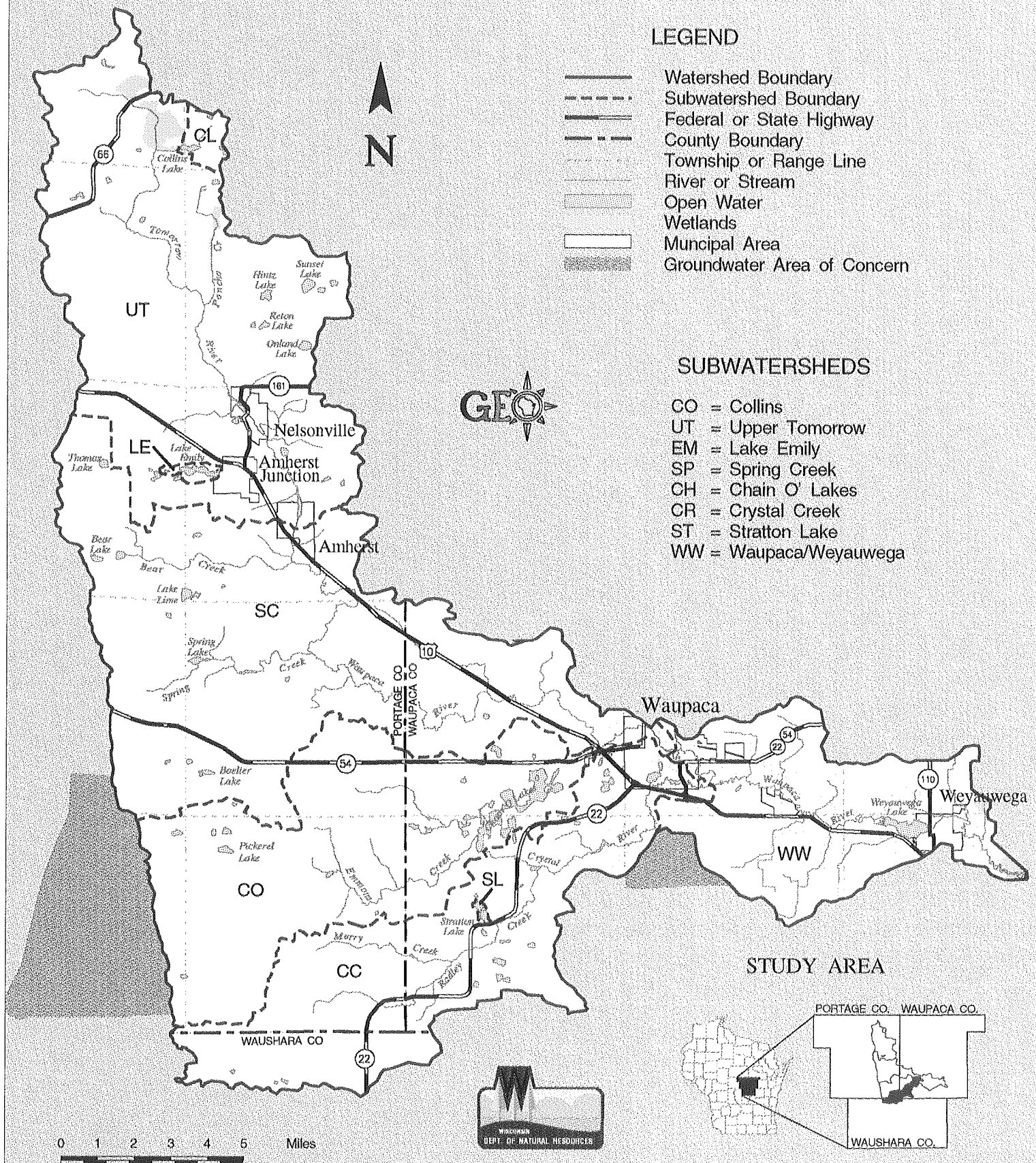
The Tomorrow/Waupaca watershed ranked a medium priority for streams and high priority for groundwater under the Nonpoint Source (NPS) Priority Watershed selection process. There was insufficient data on the majority of lakes within the watershed to include them in the above ranking.

The Winnebago Comprehensive Management Plan (1989) rated this watershed a medium priority due to critical local surface water problems from animal waste. Because of the infertile and porous nature of the sandy soils predominant in the watershed, the greatest overall water quality concern is that of groundwater contamination due to excess application of nutrients and other agricultural chemicals. This concern is addressed through a separate groundwater study (Tomorrow/Waupaca River Priority Watershed Groundwater Appraisal Report, Weister, 1995). Measurements of nitrates and pesticides in baseflow (groundwater contribution to a stream) were taken in order to estimate loadings to surfacewaters from groundwater. Baseflow comprises 70% of the streamflow in the Tomorrow/Waupaca River and it's tributaries, accounting for the majority of streamflow during periods of low flow conditions such as winter. Monitoring was performed during the winters of 1994 and 1995 to take advantage of the winter baseflow conditions.

Nitrates ranging from 0.60 ppm to 7.4 ppm nitrate-N were detected in the Tomorrow River or it's tributaries during the 1994 sampling event and 0.22 ppm to 9.29 ppm nitrate-N in 1995 (Weister, 1995). Although nitrate levels are elevated in surface waters, personal conversation with Greg Searle (WDNR Environmental Toxicologist) and Bob Masnado (WDNR Water Quality Effluent Limits Unit Supervisor) did not reveal cause for concern regarding the toxicity of nitrates to freshwater organisms. The maximum safe criterion of nitrate ion (NO_3-) for domestic water supply established at 10 ppm might be considered protective for fish and invertebrates in freshwater ecosystems (Camargo and Ward, 1992). However, the presence of nitrates and pesticides in baseflow indicates these and potentially other agricultural chemicals are entering surface waters through inflow of groundwater.

The degree and extent to which the agricultural chemicals are impacting streams, lakes and wetlands in the watershed is unknown. The groundwater appraisal report identifies the activities which were conducted in 1994 and 1995 to evaluate existing groundwater conditions and land use practices impacting groundwater quality.

Tomorrow / Waupaca River Priority Watershed



(Fig. 1)

Overall, the watershed appears to be in good condition. The majority of the river and its tributaries are well buffered by natural vegetation. However, there are specific problem areas of streambank erosion, terrestrial and aquatic habitat loss, sedimentation and organic loading from animal waste. Also, there are impoundments located on the mainstem of the river at the cities of Amherst, Weyauwega, and two dams in the city of Waupaca. There are two small impoundments located on the tributaries, Spring Creek and the Crystal River. These impoundments eliminated instream habitat, and cause elevated summer water temperature variations detrimental to trout below the impoundments. Prior to the 1970's, carp and other rough fish inhabited impounded areas and extensive stretches of the Tomorrow River. These rough fish populations negatively impacted trout carrying capacity. In 1971, the river was chemically treated by the DNR to drastically reduce abundance of rough fish. Resident trout salvaged prior to chemical treatment were reintroduced and stocking with hatchery reared trout was also done for several years to reestablish the trout fishery.

Urbanized areas within the watershed include: Amherst, Amherst Junction, Nelsonville, Waupaca and Weyauwega. There are three wastewater treatment plants which discharge to the Tomorrow/Waupaca River, one at Amherst, Waupaca, and the village of Weyauwega. Although these urban areas cover only a small part of the land in the watershed, they could cause significant water quality problems (including toxic pollution), flooding, and habitat destruction. Localized nonpoint sources of pollution that originate from unincorporated communities and developed areas have been modeled to estimate polluted loadings for certain heavy metals and sediment. The draft Watershed Plan contains this information.

At this time, there are a number of ongoing monitoring efforts taking place within the watershed through the DNR Lake Planning Grant program, Lake Michigan District (LMD). These activities on the Waupaca Chain O' Lakes, Lake Weyauwega and Cary Millpond are scheduled for completion in 1995. Information on the details of these activities can be obtained from the LMD office in Green Bay.

Following is a summary of appraisal monitoring activities conducted in the watershed area. This monitoring will help identify factors affecting the surface water quality of the Tomorrow/Waupaca River Watershed.

III. METHODS

Monitoring activities to appraise the surface water resources were initiated in the watershed in May 1994 and completed in November 1994. Following is a summary of methods used to collect information for the appraisal.

A. Dissolved Oxygen and Temperature Monitoring

LMD Water Resource Management staff conducted continuous dissolved oxygen, pH and temperature monitoring above and below the Amherst Millpond for a two week period during mid-summer low flow conditions using a Hydrolab Datasonde 3 logger. (Fig. 3)

B. Fish Surveys

Due to budget constraints in the DNR fisheries program, planned fish surveys during 1994 were not conducted as proposed in the appraisal monitoring plan.

C. Macroinvertebrates

Aquatic macroinvertebrates were collected at 18 sites (Table 1, Figs. 2, 4-7) in the watershed using a D-frame net and methods outlined in Hilsenhoff (1977 and 1982). The samples were preserved in 70% ethanol and sorted by DNR Water Resources staff in Green Bay and Rhinelander. Sample results were evaluated using the Hilsenhoff (HBI) and Family Biotic Indices (FBI) which provide a relative measure of organic loading to streams in the stream segment above the collection site.

D. Stream Habitat Evaluations

Stream habitat evaluations were conducted at 40 locations (Table 1, Figs. 2, 4-7) using the stream habitat evaluation guidelines developed by Ball (1982). These evaluations were used to assess physical factors that may limit the quantity and quality of aquatic life.

E. Surface Water Quality Monitoring

1) Stream Monitoring

A) In 1993, a gage station was established on the Tomorrow River, in Portage County at Clementson Road by the U.S. Geological Survey as part of the National Water-Quality Assessment Program (NAWQA). Samples were collected at approximately monthly intervals and during storm events from March through September in 1993 and 1994. Parameters include monthly samples for nutrients, major ions, and suspended sediments.

2) Lake Monitoring

Water chemistry monitoring was conducted on Collins, Emily, Spring and Stratton Lakes in order to establish the trophic state index of the lakes.

Sampling was conducted monthly from ice-out through fall turn-over at the deepest spot of each lake.

Ice-out, before spring turnover:

Parameters collected include calcium, magnesium, potassium, sodium, pH, tot. alkalinity, color, conductivity, turbidity, total solids, total phosphorus,

dissolved phosphorus, total Kjeldahl nitrogen, ammonia nitrogen, NO_2+NO_3,chloride, sulfate, chlorophyll a, Fe, Mn, water clarity, temperature and dissolved oxygen. One sample was collected from each lake at one meter below the surface.

April through fall turn-over:(monthly)

Parameters for the remainder of the sampling season included: chlorophyll a, total phosphorous, water clarity, temperature and dissolved oxygen. One sample was collected from each lake at one meter below the surface and one meter from the bottom.

F. Wildlife Monitoring -- Frog and Toad Surveys

Frog and toad species and their populations were assessed using calling surveys. These surveys will be used to help identify existing and changing water quality and land uses. Ideally, the surveys will continue through the implementation phase of the project.

Monitoring was conducted by volunteers with the assistance of the Wildlife Management program from NCD-Wisconsin Rapids office. Calling surveys were conducted when water temperatures reached 50°, 60° and 70° F. These thresholds usually occur from April 08-30, May 20 to June 05 and July 1-15 respectively.

IV. RESULTS AND DISCUSSION

Following is a discussion of appraisal monitoring results for each subwatershed in the Tomorrow/Waupaca Priority Watershed. The subwatershed descriptions provide a summary of available information on each stream evaluated, including a discussion of water resource conditions, problems affecting the resource and preliminary water resource management goals and objectives. Water resource goals and objectives are only identified for major, perennial streams in each subwatershed.

A summary of perennial streams in each subwatershed, including monitoring results, is presented in Table 1. Stream classifications, limiting factors and surface water resource goals for the each subwatershed are presented in Table 2. For explanation of FBI and HBI scores see Appendix A. The Macroinvertebrate Field and Bench Sheet is presented in Appendix B. The Stream System Habitat Rating form is presented in Appendix C. Results of frog and toad surveys are presented in Appendix D.

Table 2: Surface Water Resources Conditions, Goals, Objectives for Subwatersheds in the Tomorrow/Waupaca River Watershed

SUBWATERSHED	STREAM NAME	LENGTH (MILES)	BIOLOGICAL* USE (MILES)	NR 102 OR/ERW	LIMITING FACTORS	OBSERVED OR POTENTIAL SOURCES	SURFACE WATER RESOURCE GOALS	SURFACE WATER RESOURCE OBJECTIVES
	Tomorrow/ Waupaca R.	0 - 32.6 32.6 - 45.8 45.8 - 49.3 49.3 - 56.0 56.0 - 69.3	WWSF / 32.6 COLD / 13.2 CLASS II COLD / 3.5 CLASS I COLD / 6.7 CLASS II COLD / 13.3 CLASS I	 ORW ERW ORW	SED, NUT HAB	CL, SB, BY PSB	-Maintain and improve wildlife habitat -Maintain and improve aquatic life habitat and water quality	-Preserve wetland and woodland corridors -Keep livestock out of streams -Preserve wetland and woodland buffer strips -Control runoff
Chain O' Lakes	Allen Creek	4	COLD / 4 CLASS I	 ERW	SED, NUT, HAB	SL,	-Maintain and improve wildlife habitat -Maintain and improve aquatic habitat and water quality -Reduce nutrient and sediment loading from shoreline development -Preserve migrating strain of brown trout in Emmons Cr. and Chain O' Lakes	-Stabilize eroding shorelines -Educate shoreline property owners on proper riparian ownership -Preserve wetland and woodland corridors -Preserve wetland and woodland buffer strips
	Carden Feeder	1	COLD / 1 CLASS I	 ERW				
	Emmons Creek	9	COLD / 9 CLASS I	 ORW				
	Hartman Creek	2	WWSF / 2					
Crystal River	Crystal River	0 - 2 2 -13	WWSF / 2 COLD / 11 CLASS II	 	SED, NUT HAB	CL, NPS	-Maintain and improve wildlife habitat -Maintain and improve aquatic habitat and water quality	-Preserve wetland and woodland corridors -Preserve wetland and woodland buffers -Control runoff
	Murry Creek	4	COLD / 4 CLASS I	 ERW				
	Naylor Creek	1	COLD / 1 CLASS I	 ERW				
	Radley Creek	13	COLD / 13 CLASS I	 ORW				

Table 2: Surface Water Resources Conditions, Goals, Objectives for Subwatersheds in the Tomorrow/Waupaca River Watershed

SUBWATERSHED	STREAM NAME	LENGTH (MILES)	BIOLOGICAL* USE (MILES)	NR 102 OR/ERW	LIMITING FACTORS	OBSERVED OR POTENTIAL SOURCES	SURFACE WATER RESOURCE GOALS	SURFACE WATER RESOURCE OBJECTIVES
Spring Creek	Bear Creek	0 - 1.4	COLD / 1.4 CLASS II		SED, NUT HAB	CL, SB, BY PSB	-Protect Calcareous Fen community -Maintain and improve wildlife habitat -Maintain and improve aquatic habitat and improve water quality -Protect Stedman Creek's valuable spawning habitat -Reduce sediment, phosphorus and nitrogen loading to Spring Lake	-Install Conservation Easements and/or through education -Preserve wetland and woodland corridors -Preserve wetland and woodland buffer strips -Limit livestock access to Bear and Mack Creeks and associated headwater wetlands -Control runoff
		1.4 - 8	COLD / 6.6 CLASS I	ERW				
	Mack Creek	2	COLD / 2 CLASS I	ERW				
	Spring Creek	0 - 3.5	WWSF / 1.5					
		3.5 - 5	COLD / 3.5 CLASS I	ERW				
	Stedman Creek	2	COLD / 2 CLASS I	ERW				
	Upper Spring Cr.	1	COLD / 1 CLASS I	ERW				
Upper Tomorrow	Eske Creek	1	UNK.		SED, NUT HAB	CL, SB, BY PSB	-Maintain and improve wildlife habitat -Maintain and improve aquatic life habitat and water quality	-Preserve wetland and woodland corridors -Keep livestock out of Tomorrow River -Control runoff
	Poncho Creek	5	COLD / 5 CLASS I	ERW				
	Stoltenburg Cr.	3	COLD / 3 CLASS I	ERW				
Waupaca / Weyauwega	Unn. Tributary (T22N - R12E - S35, SE SE)	1	UNK.		SED, NUT HAB	CL, SB, PSB, SL	-Maintain wildlife habitat -Maintain and improve aquatic habitat and water quality -Reduce nutrient and sediment loading from shoreline development	-Preserve wetland and woodland corridors -Control runoff -Stabilize eroding lake shoreline banks

See following page for heading descriptions

Table 2: Surface Water Resources Conditions, Goals, Objectives for Subwatersheds in the Tomorrow/Waupaca River Watershed

***Biological Use**

COLD - cold water trout stream
Class I - populations are sustained entirely by natural reproduction
Class II - some natural reproduction, but may need stocking to maintain a desirable fishery
WWSF - Warm water sport fishery

Limiting Factors

HAB - Habitat (lack of cover, sedimentation, scouring, etc.)
SED - Sedimentation (filling of pools)
NUT - Nutrient enrichment

NR 102 Overview

ORW Outstanding resource waters as defined by NR 102
ERW - Exceptional resource waters as defined by NR 102

Observed Potential Factors

NPS - Unspecified nonpoint source
CL - Cropland erosion
SL - Shoreline erosion
SB - Streambank erosion
PSB - Streambank pasturing
BY - Barnyard or exercise lot runoff
SEP - Septic systems

Length

River miles are measured from the mouth of the stream to the headwaters

Upper Tomorrow River Subwatershed

The Upper Tomorrow River Subwatershed is 73.9 square miles in area and is located in the upper end of the watershed in Portage County (Fig.1). Perennial rivers and streams in the subwatershed include Eske Creek, Poncho Creek, Stoltenburg Creek and the upper reaches of the mainstem of the Tomorrow River.

Land composition is approximately 42% agricultural, 46% forested, 9% wetlands and 3% developed lands.

Surface Water Resource Conditions

Tomorrow River

The section of the Tomorrow River from its headwaters to approximately one mile below Nelsonville (upper section of the Tomorrow River), is managed as a Class I brook and brown trout fishery and is designated as an Outstanding Resource Water. Historically, a millpond located at Nelsonville greatly degraded the river's habitat and fish composition. In 1988, the dam was removed, and the trout fishery has improved dramatically according to Jack Zimmermann, WDNR Fish Manager for Portage County. From this point south to one quarter mile below the Amherst Millpond (mid section of the Tomorrow River, and downstream border of the subwatershed), the river is managed as a Class I and II brook and brown trout fishery and is designated as an Exceptional Resource Water.

The river flows mainly through wetlands, forested areas, buffered corridors and agricultural practices.

USGS water chemistry monitoring conducted in 1993 and 1994 at a gage station on Clementson Road did not reveal any state standard violations.

Habitat ratings at five locations on this stretch of the river range from "fair" to "good". Macroinvertebrate results above and below a barnyard on CTH I in the upper reach of the river indicate excellent water quality with organic pollution unlikely, though the downstream site did receive a higher biotic index score, indicating more organic pollution. (Table 1)(Fig 2)

Surface water resource problems include streambank erosion, organic loading, sedimentation and loss of habitat due to livestock activities at the stream site. Impoundments generally have adverse impacts on riverine systems, destroying natural habitat, increasing summer water temperatures and acting as physical barriers to fish

Table 1: Monitoring Summary of Streams in the Tomorrow/Waupaca River Watershed

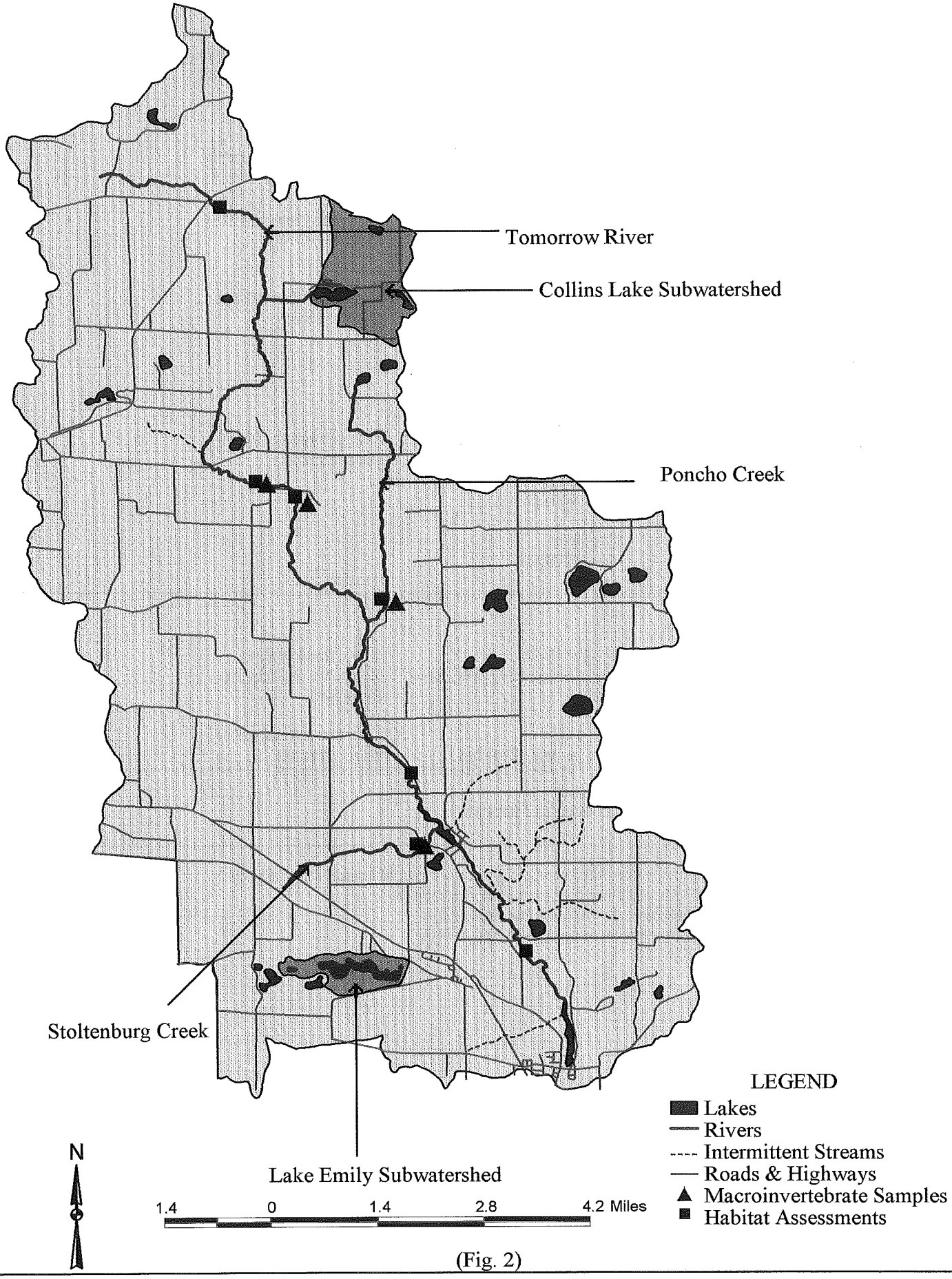
Subwatershed	Stream Name	Habitat Rating ** (Locations)	FBI Rating*** (Location)	HBI Rating**** (Locations)
	Tomorrow/Waupaca R.	154 - Fair (Blw. STH 66) 129 - Good (Abv. barnyard at CTH I) 157 - Fair (Blw. barnyard at CTH I) 102 - Good (Abv. Loberg Road) 85 - Good (Blw. Lake Meyers Road) 100 - Good (Abv. CTH A) 80 - Good (Abv. Bucholtz Road) 66 - Excellent (Abv. Otto Road) 72 - Good (Abv. CTH D) 75 - Good (Spring) (Riverside Park - STH 54 - 22) 78 - Good (Fall) (Riverside Park - STH 54 - 22)	2.78 - Excellent (10/94) (Abv. barnyard at CTH I) 3.2 - Excellent (10/94) (Blw. CTH I) 2.7, 2.8, 3.3 - Excellent (04/94) (Riverside Park, Hwy. 54/22)	*1.64 - Excellent (6/80) *1.47 - Excellent (11/80) (Blw. Cobb Town Rd.) *1.90 - Excellent (6/80) *1.94 - Excellent (11/80) (Abv. Anderson Rd.) *1.45 - Excellent (6/80) *1.46 - Excellent (11/80) (Abv. Harrington Rd.) 3.30 - Excellent (10/93) (Riverside Park, Hwy. 54 /22)
Chain O' Lakes	Allen Creek	-----		
	Carden Feeder	-----		
	Emmons Creek	75 - Good (Spring) 87 - Good (Summer) (West Road)	3.08 - Excellent (04/94) (West Road)	
	Hartman Creek	101 - Good (Spring) 128 - Good (Summer) (Rural Road)	2.80 - Excellent (04/94) (Rural Road)	
Crystal River	Crystal River	65 - Excellent (Spring) 78 - Good (Fall) (Shadow Lake Road) 79 - Good (Sanders Road)	3.00 - Excellent (04/94) (Shadow Lake Rd.)	3.72 - Very Good (10/93) (Shadow Lk. Rd.)
	Murry Creek	112 - Good (Spring) 121 - Good (Summer) (West Dayton Road)	3.61 - Excellent (04/94) (West Dayton Rd.)	
	Naylor Creek	-----		
	Radley Creek	129 - Good (West Dayton Road) 94 - Good (STH 22) 107 - Good (Spring) 110 - Good (Summer) (Dayton Road) 104 - Good (Lake Stratton Road)	2.60 - Excellent (04/94) (Dayton Rd.)	3.08 - Excellent (10/93) (Dayton Rd.)

Table 1: Monitoring Summary of Streams in the Tomorrow/Waupaca River Watershed

Subwatershed	Stream Name	Habitat Rating ** (Locations)	FBI Rating*** (Location)	HBI Rating**** (Locations)
Spring Creek	Bear Creek	188 - Fair (Townline Road) 132 - Fair (At the mouth, upstream) 153 - Fair (Abv. CTH Q)	4.4, 4.5, 4.7 - Good (05/94) (Blw. Fountain Grange Rd.) 3.93 - Very Good (11/94) (Abv Maves Rd.)	
	Mack Creek	207 - Poor (Abv. Townline Road) 134 - Fair (Abv. Maves Road) 214 - Poor (Blw. Maves Road)	3.34 - Excellent (11/94) (Blw. Maves Rd.) 3.12 - Excellent (05/94) (Abv. CTH D)	
	Spring Creek	159 - Fair (Abv. Spring Creek Road) 97 - Good (Abv. CTH D) 139 - Fair (Abv. & Blw. CTH A)	 3.70 - Excellent (05/94) (Abv. CTH D)	
	Stedman Creek	151 - Fair (Abv. CTH D)		
	Upper Spring Creek	136 - Fair (Abv. CTH Q)		
Up. Tomorrow R.	Eske Creek	-----		
	Poncho Creek	69 - Excellent (Off public parking area, River Road)	4.84 - Good (05/94) (Off public parking area, River Rd.)	
	Stoltenburg Creek	165 - Fair) (Abv. & Blw. CTH SS)	6.0 - Fairly Poor (05/94) (Blw. CTH SS)	
Waupaca/ Weyauwega	Unn. Trib. (T22N - R12E - S35, SE,SE)	154 - Fair (US Hwy 10 / STH 49)		

* Data pre 1982, index values have changed, for explanation of scores see Appendix A.
** Habitat Ratings - for explanation of scores see Appendix B.
*** FBI Rating - for explanation of scores see Appendix A.
**** HBI Rating - for explanation of scores see Appendix A

Upper Tomorrow River Subwatershed

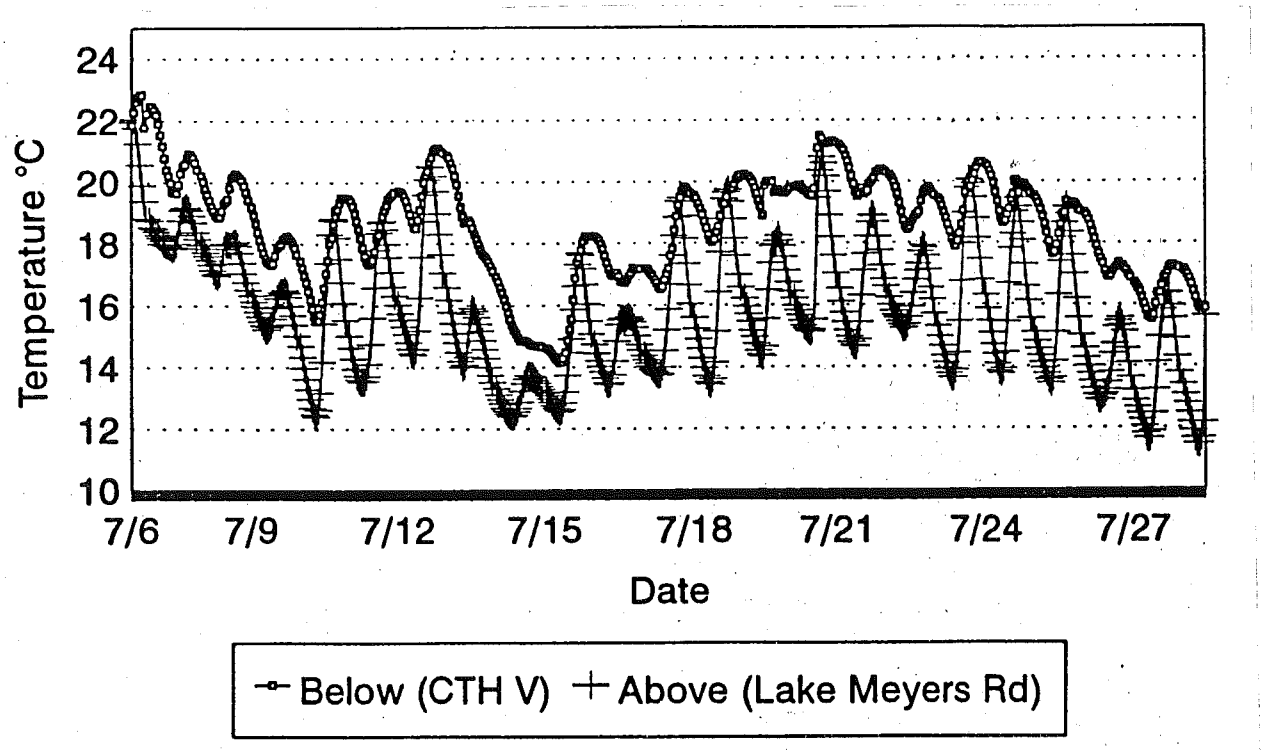


(Fig. 2)

migration. Sediment trapped in impoundments is occasionally flushed out when higher velocities of stream flow are allowed through the gates. This slug of sediment has a negative impact on downstream habitat.

Dissolved oxygen and temperature monitoring were conducted on the Tomorrow River above the Amherst Millpond at Lake Meyers Road and below the Millpond at CTH V from July 6 to 28, 1994 to determine the effects of the impoundment on water quality. Generally, the millpond has a significant dampening effect on normal daily temperature and dissolved oxygen fluctuations.

Figure 3. Summer 1994 water temperatures above and below Amherst Millpond



Temperatures were on an average 2.7°C higher below the dam than above, although at both locations water temperature remained cool enough to support trout. Temperatures of 22-23°C are close to the tolerable limits for trout. (During this period, air temperatures averaged approximately 2°C below the 27 year average as recorded at U.W. Madison's Hancock Experimental Farm which is located approximately 25 miles southwest of Amherst) At no time did dissolved oxygen fall below the 6 mg/l state standard even during a two to three inch rain event that occurred on July 6, 1994. While the water was clear at the downstream site after the event, it was turbid with high suspended solids at the upstream site. This indicates that the Amherst Millpond acts as a settling basin for sediments.

Eske Creek is a small feeder stream located north of Nelsonville. The classification is unknown.

Poncho Creek is a five-mile-long, clear, hard water, Class I brook and brown trout stream that enters the Tomorrow River about two miles north of Nelsonville. The stream is designated as an Exceptional Resource Water. The creek is contained within the Richard Hemp Fishery Area.

Shifting sand and gravel are the primary bottom materials. Gravel and rubble riffles provide spawning areas for trout. Natural and artificial in-stream cover is adequate, and the supply of food is plentiful.

The majority of the land composition is upland forest and wetland, creating excellent habitat for deer, furbearers and songbirds.

An aquatic habitat assessment and macroinvertebrate sampling conducted approximately one-quarter mile above the confluence with the Tomorrow River indicate "excellent" habitat and "good" water quality with some organic pollution probable (Table 1) (Fig.2).

Siltation is present in some areas, but it is believed to be due to natural conditions and is uncontrollable.

Stoltenburg Creek is a three-mile-long, clear, hard water, Class I brook trout fishery that enters the Tomorrow River below Nelsonville. The stream is designated as an Exceptional Resource Water.

The sand, gravel, and rubble bottom is silted in in places. The upper end of the stream has been ditched, but overall in-stream cover is considered good. Bank cover includes overhanging grasses and woody vegetation.

Riparian land composition consists mainly of agricultural fields, with wetlands, meadows and fragmented forest present.

Macroinvertebrate sampling conducted just below CTH SS at Nelsonville indicates "fairly poor" water quality with substantial pollution likely, while instream habitat rates "fair" for this reach of stream (Table 1)(Fig 2.).

Undesirable siltation of the stream is evident. The stream is fairly well buffered even though much of it flows through agricultural lands. A good portion of the stream above Five Corners Road has been channelized in the past.

Surface Water Resources Goals and Objectives

The following surface water resources goals and objectives are recommended for the Upper Tomorrow River Subwatershed:

1. Maintain wildlife habitat by:

    a. preserving the stream wetland and woodland corridors that currently exist within the subwatershed.

2. Maintain and improve, aquatic habitat and water quality by:

    a. limiting livestock access to the Tomorrow River above CTH I (this will reduce habitat destruction, instream sedimentation and nutrient loading).

    b. preserving existing wetland and woodland buffers that filter sediments and pollutants, provide canopy shading and help stabilize streambanks.

    c. controlling runoff to reduce the frequency of flooding and transport of sediment, nutrients and pesticides. Where feasible, fish habitat improvement structures should be considered at locations of streambank erosion control installations.

Collins Lake Subwatershed

The Collins Lake Subwatershed is contained within the Upper Tomorrow River Subwatershed and is approximately 1.7 square miles surface in area. (Fig. 2)

Land composition in the watershed is 61% agricultural, 29% forested, 5% wetlands and 5% developed areas.

Surface Water Resource Conditions

Collins Lake is a 49 acre, 56 foot deep soft water mesotrophic lake located three miles southwest of Rosholt. The lake is classified as a seepage lake, but has a channelized intermittent inlet and outlet. The water color has a light brown tinge. Littoral bottom materials consist of sand, gravel, muck, and marl with rubble and boulder also present. Collins Lake is primarily a largemouth bass fishery with northern pike, and panfish present.

There is a large county park located on the north shore. Development is limited to less than ten dwellings, leaving the lake relatively scenic.

Surface water resource problems influencing Collins Lake are rather limited, but nutrient loading from naturally drained wetlands to the north and irrigated agricultural practices to the east are believed to be impacting water quality.

Surface Water Resources Goals and Objectives

The following surface water resource management goals and objectives are recommended for the Collins Lake Subwatershed:

1. Reduce nutrient loading from agricultural practices to the northeast by:

    a. improving buffer strips along the lakeshore, and along the drainage way, which enters the lake on the eastern end.

Spring Creek Subwatershed

The Spring Creek Subwatershed is 81.7 square miles in surface area and is located in southeast Portage and southwest Waupaca Counties (Fig.1). Perennial rivers and streams in the subwatershed include Bear, Mack, Spring, Upper Spring, and Stedman Creeks, along with the mainstem of the Tomorrow River.

Land composition in the watershed is approximately 59% agricultural, 33% forested, 3% wetlands and 5% developed areas.

(Within this subwatershed there is a calcareous fen complex located on private property. Calcareous Fens are wetlands, with an internal flow of water rich in calcium and magnesium bicarbonates and sometimes calcium and magnesium sulfates

as well. These communities are ranked as rare or uncommon natural communities within the state of Wisconsin. Protection from future degradation can be achieved by obtaining Conservation Easements and/or educating the landowners as to the uniqueness and importance of these wetlands.)

Surface Water Resource Conditions

Tomorrow River

From a quarter-mile south of the Amherst Dam (the upstream border of the subwatershed) to approximately CTH T, the Tomorrow River is managed as a Class II brown trout fishery and is designated as an Exceptional Resource Water. From CTH T to the Waupaca County border, the river is managed as a Class I brown trout fishery and is designated as an Outstanding Resource Water. From the county line to approximately the Waupaca High School grounds (the downstream border of the subwatershed), the river is classified as a Class II brown and rainbow trout fishery.

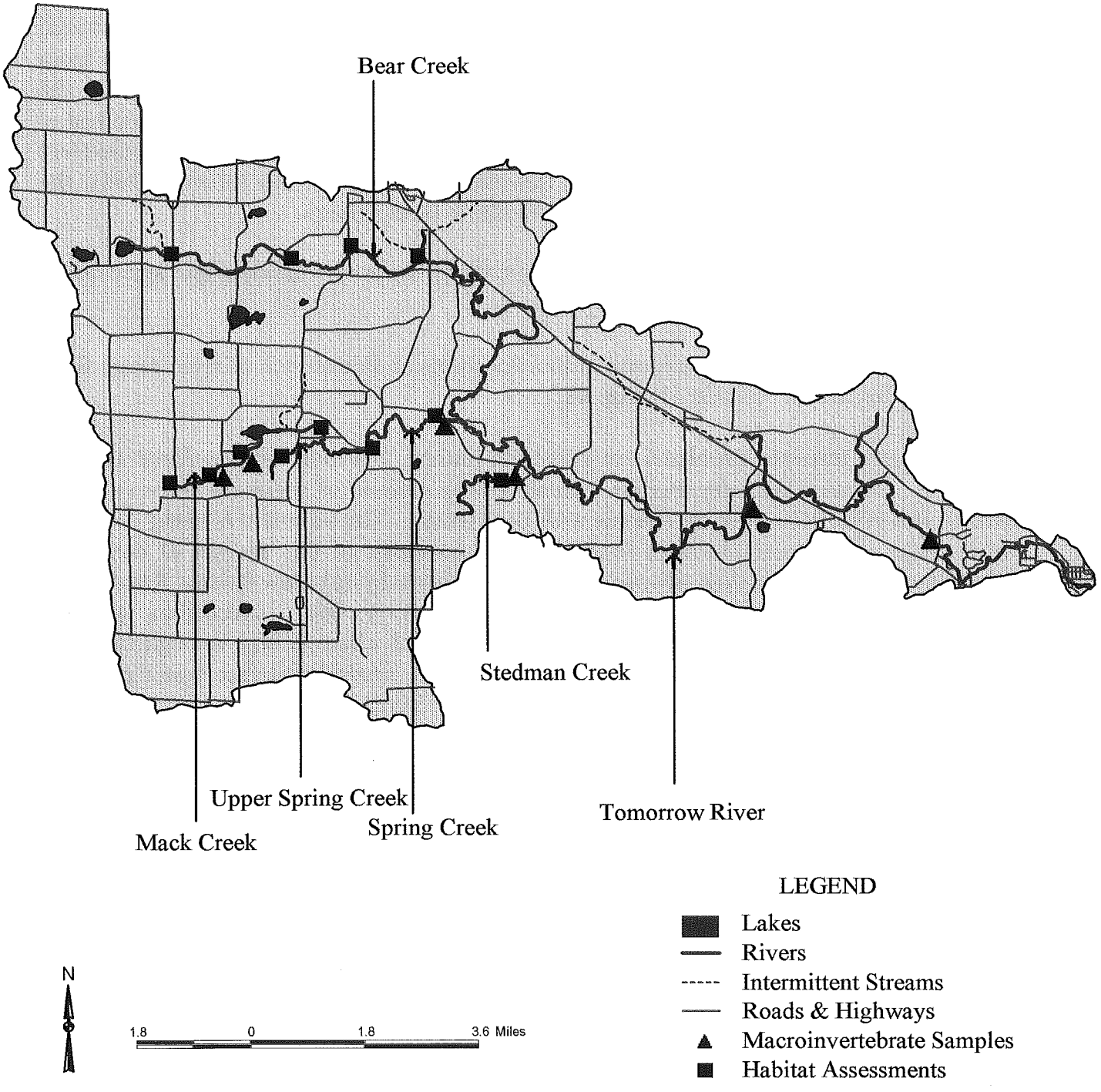
Riparian land composition includes wetlands, forests, buffered corridors and agricultural practices.

Stream habitat evaluations conducted at four locations on this stretch of river range from "good" to "excellent" (Table 1) (Fig. 4).

Surface water resource problems are generally limited, but there are localized areas of concern. Sediment delivery models indicate a high amount of sediment delivery to the stream at a point below the confluence with Bear Creek. The sediment is being delivered from large agricultural practices located to the northeast of this section of the river. Also, there is a remnant dam structure on the river located just below Keener Road which may be physically prohibiting upstream migration by fish. According to Jack Zimmermann, there is a slab of cement in the river bed which is high enough to create a falls and act as a physical barrier to fish migration. Overall, surface water resource conditions are good in this stretch of the Tomorrow River.

Bear Creek is an eight-mile-long, hard water, spring fed trout stream which flows east out of Adams Lake into the Tomorrow River. The first 6.6 miles of the stream are Class I brook and brown trout waters and designated as an Exceptional Resource Water. The remainder of the stream is managed as a Class II brook and brown trout stream.

Spring Creek Subwatershed



(Fig. 4)

Bottom substrate at the upper end of the creek is comprised of sand, gravel and marl. Closer to the mouth, shifting sand, gravel and rubble are the predominant bottom materials. In-stream cover consists of logs, rocks and undercut banks.

Replicate (3) macroinvertebrate samples collected below Fountain Grange Road indicate "good" water quality with some organic pollution probable. Habitat ratings conducted at three sites rank "fair" (Table 1)(Fig. 4).

For much of its course, Bear Creek is a well buffered waterway flowing through open fields, wetlands and forested upland corridors. Surface water resource conditions of concern include areas of heavy deposits of sediment, increased nutrient loading, bank and in-stream habitat destruction, along with degradation of headwater wetlands due to livestock grazing. The stream potential in impacted areas is very likely being adversely affected, therefore nonpoint management practices should address these concerns.

Mack Creek is a two-mile-long, clear, cold water Class I brook and brown trout spring feeder to Spring Lake which drains to Spring Creek. Mack Creek is designated as an Exceptional Resource Water.

Sand, gravel and rubble are the primary bottom materials. In-stream cover includes wood, rubble, undercut banks, overhanging grasses and several nice pools.

Habitat ratings conducted above Townline Road and below Maves Road indicate "poor" habitat conditions for both reaches. Stream FBI's conducted above and below a barnyard at Maves Road indicate "very good" water quality with possible slight organic pollution above the barnyard and "excellent" water quality with organic pollution unlikely below the barnyard. It is believed that more suitable habitat for macroinvertebrates at the downstream site most likely accounts for the better rating (Table 1)(Fig. 4).

Riparian land composition includes wetland, open fields, agricultural lands and fragmented woodlands.

Though Mack Creek is classified as a Class I trout stream, it is believed that stretches of the creek are not meeting their biological potential. Surface water resource problems include lack of instream habitat, streambank erosion, sedimentation of pools and riffles and organic loading from animal waste, along with wetland destruction. As with Bear Creek, the headwater area wetlands are heavily pastured and degraded. Above Townline Road, it appears that a channel has been dug from the creek to a constructed pond which has a channelized outlet back to the creek. Jack Zimmermann, DNR fish manager for

Portage County, believes that the lower reach of the creek is in good shape, but trout habitat is severely degraded in the mid to upper reaches.

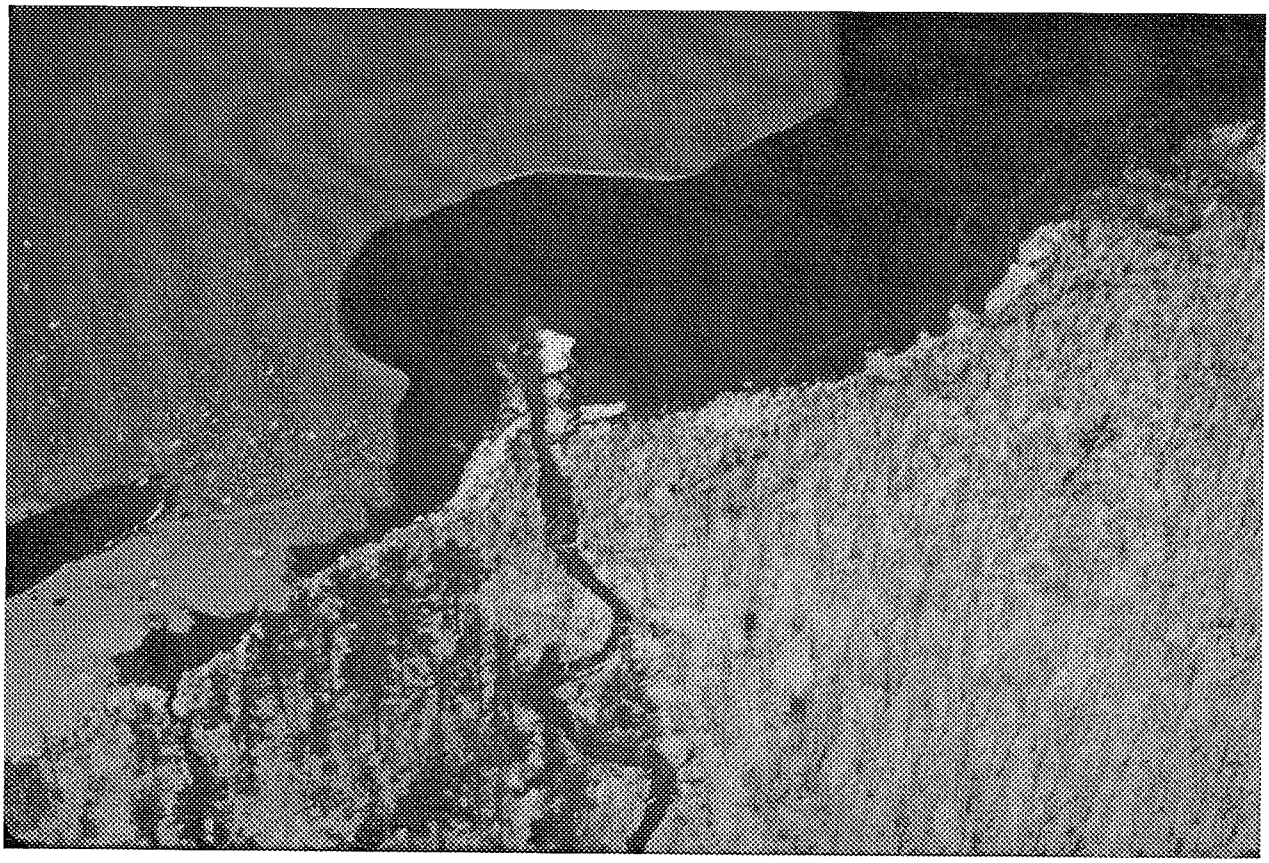
Spring Lake is a 36.5 acre, 42-foot-deep clear, hard water, eutrophic lake located five miles southwest of Amherst. One inlet, Mack Creek, and numerous springs provide a good supply of cold water to the lake. Spring Creek, the outlet, is an important trout stream. Large portions of the lake bottom are covered with marl. Sand, silt, and rubble comprise the remainder of the littoral bottom materials. The lake is managed for both warm and cold water species of fish. Brook, brown, and rainbow trout make up the cold water fishery. The warm water fishery composition includes perch, largemouth bass, bluegills, rock bass, pumpkinseed, and forage fish make up .

The shoreline is well protected and rather natural looking. Development is limited to less than five dwellings.

Observations made during the 1994 sampling season noted abundant macrophyte growth heavy mats of filamentous algae. The species of algae forming these mats was identified as Spirogyra. The abundant macrophyte growth in Spring Lake may be attributed to phosphorus loading via Mack Creek. Even though phosphorus is absorbed by the lakes marl sediments (a process that reduces the lakes overall phosphorus concentrations and blue-green algae production) it is readily available to rooted aquatic vegetation.

Nitrate levels recorded at spring turnover were 2.7 MG/L. Levels above 0.3 MG/L are considered elevated, providing sufficient nitrogen to support summer algae blooms. It is suspected that this nitrogen input is groundwater influenced. The combination of high nitrate levels, cold groundwater discharge, quiet waters and a supplemental supply of carbon dioxide from the lakes marl bottom makes Spring Lake very susceptible to substantial green algae production such as Spirogyra.

Surface water resource conditions influencing Spring Lake include phosphorus and nitrogen loading which are facilitating abundant macrophyte and filamentous algae growth. Also, as can be seen by the January 1994 photograph on the following page, there is a substantial delta of sediment at the mouth of Mack Creek. It is believed that this sediment loading is occurring due to agricultural practices along the creek. The headwater wetlands have loose soils that are disturbed due to grazing in this area. At times of heavy rain or during spring snow-melt it is believed that these soils are carried downstream to Spring Lake. Also, livestock have direct access to Spring Creek causing bank erosion and transportation of soil downstream to the lake.



Spring Creek (Howard Creek) is a five-mile-long stream originating as the outlet from Spring Lake. The first 1.5 miles of the stream is heavily influenced by the lake and an impoundment. This stretch is classified as a warm water sport fishery. Below CTH A, the creek is classified as a Class I brook and brown trout fishery and designated as an Exceptional Resource Water.

Sand, gravel, rubble, and boulders are the primary bottom materials. Some of the in-stream cover includes wood, boulders, rubble, and undercut banks.

A macroinvertebrate and habitat rating conducted near the mouth at Morgan Road indicate "excellent" water quality with organic pollution unlikely and "excellent" habitat composition. Upstream habitat at CTH A is "good" (Table 1)(Fig. 4).

Riparian land composition includes wetland, open fields, woodlands and agricultural lands.

The impoundment above CTH A has an adverse impact on the upper reach of Spring Creek due to a loss of habitat, heavy siltation, lower stream velocity and increased water temperatures. Heavy mats of filamentous algae present on the impoundment, along with the stream itself, indicate that nitrogen input via the groundwater is having a negative impact.

Upper Spring Creek (Upper Howard) is a one-mile-long, clear, hard water Class I brook trout stream which enters Spring Creek above the impoundment. The stream is designated as an Exceptional Resource Water.

Bottom substrate is basically gravel with sand and rubble present. Undercut banks and other cover are abundant. Habitat conditions at CTH Q are "fair" (Table 1)(Fig.4). A ranking of "fair" at this stretch of stream is believed to be due to a lack of water depth and not attributed to human impacts.

The creek is fairly well buffered, flowing through woodlands, wetland forest, open fields and some agricultural lands.

Silt was present at bends and obstructions, but appeared to be natural and uncontrollable.

Stedman Creek is a two-mile-long clear, hard water, Class I brook and brown trout stream that is designated as an Exceptional Resource Water.

The gravel and sand bottom contains some rubble and boulders. Undercut banks, bends and woody cover is present. Bank cover is mainly dense with overhanging woody vegetation.

Habitat composition rated at Morgan Road is "fair," while macroinvertebrate sampling indicates excellent water quality with organic pollution unlikely (Table 1) (Fig.4). The stream reach in which the FBI and habitat ratings were conducted appears to have been pastured at one time. The low habitat rating is due to eroded banks and sediment. Improvement is already taking place, with vegetation naturally reestablishing on many of the previously eroded areas.

Stedman Creek is fairly well buffered, flowing through woodlands, wetlands, open fields and some agricultural lands.

Generally, the resource is in good shape. Personal observation by Bob Hunt (retired WDNR fisheries researcher) indicates that Stedman Creek is an important tributary used

for spawning by brown trout from the mainstem of the Tomorrow River. Acquisition of land or obtaining Conservation Easements along the stream corridor will ensure the protection of this valuable resource.

Surface Water Resources Goals and Objectives

The following surface water resources goals and objectives are recommended for the Spring Creek Subwatershed:

1. Provide protection for the Calcareous Fen communities by:

    a. obtaining Conservation Easements and/or educating the private landowners as to the uniqueness of these communities.

2. Maintain and improve wildlife habitat by:

    a. preserving and or developing stream wetland and woodland corridors within the subwatershed.

    b. removing livestock from the headwater wetlands of Bear and Mack Creeks.

3. Maintain and improve aquatic habitat and water quality by:

    a. preserving existing wetland and woodland buffers that filter sediments and pollutants, provide canopy shading and help stabilize streambanks.

    b. controlling runoff to reduce the transport of sediment, nutrients and pesticides. Where feasible, fish habitat improvement structures should be considered at locations of streambank erosion control installations.

    c. limiting livestock access to Bear and Mack Creeks and their associated headwater wetland areas.

4. Protect Stedman Creek's valuable spawning habitat by:

    a. Acquisition of land or obtaining Conservation Easements along the stream.

5. Reduce sediment, phosphorus and nitrogen loading to Spring Lake by:

   a. Reducing runoff and limiting livestock access to Mack Creek and its headwater wetlands.

   b. Reducing nitrate input to the groundwater. (See Groundwater Appraisal Report)

Lake Emily Subwatershed

The Lake Emily Subwatershed is contained within the Upper Tomorrow River Subwatershed and is approximately 0.6 square miles in surface area. (Fig. 1)

Land composition in the watershed is 45% agricultural, 45% forested, 2% wetlands and 8% developed areas.

Surface Water Resource Conditions

Lake Emily is a 105 acre, 38-foot-deep moderately hard water mesotrophic seepage lake located one-half mile west of Amherst Junction. Water clarity is clear, but the lake is subject to mild algae blooms. Marl and sand are the primary bottom materials in the littoral zone with gravel and rubble areas also present. Northern pike, perch, largemouth bass and black crappie are common.

The lake is one of the more popular recreational lakes in Portage County. There is a large county park with campgrounds, swimming beach and picnic areas situated on the eastern one third of the lake. The remaining shoreline is overcrowded and overdeveloped with permanent resident dwellings and cottages. The remainder of the rather small watershed is agricultural.

Surface water resource conditions possibly influencing Lake Emily may include nutrient input from septic systems and from excess use of chemical fertilizers and pesticides by lake property owners.

Surface Water Resources Goals and Objectives

The following surface water resource management objectives are recommended for the Lake Emily Subwatershed:

1. Maintain the good water quality that already exists in Lake Emily through:

    a. educational efforts by the watershed education staff.

    b. development of a Lake Emily lake association. (The DNR has no records of an existing lake association)

    c. recruitment of a self-help monitoring volunteer to carry out long term monitoring.

Chain O' Lakes Subwatershed

The Chain O' Lakes subwatershed is approximately 52.8 square miles in surface area and is located in the eastcentral and southwest portions of Portage and Waupaca counties respectively. Perennial waterbodies include Emmons, Hartman, and Allen Creeks, and all the lakes in the Waupaca Chain O' Lakes.

Land composition is approximately 57% agricultural, 32% forested, 5% wetlands, and 6% developed areas.

Water Resource Conditions

Emmons Creek is a nine-mile-long, clear, hardwater Class I stream that sustains a sport fishery for brook and brown trout. The stream is designated as an Outstanding Resource Water. The upper reaches are within the Emmons Creek State Fishery Area. Emmons Creek discharges to Long Lake in the Chain O' Lakes.

The substrate consists of a good mix of gravel, rubble, and sand which provides a diverse habitat for aquatic life. Stream banks are stable and shaded with a diverse mix of trees and shrubs.

The riparian zone is mainly forested and well buffered with little agriculture.

Habitat, rated at West Road is "good," while FBI sampling indicates that this stretch of Emmons Creek has excellent water quality with no apparent organic pollution. Samples in 1980 at Rural Road received "very good" and "excellent" ratings with possible slight organic pollution present (Table 1) (Fig. 5).

Some silt has accumulated in the slow areas of bends and near bridge abutments , but is mainly thought to be from natural conditions and is uncontrollable.

Bob Hunt commented that a rare strain of brown trout utilizes Emmons Creek for part of its life cycle, spawning in the stream and using the stream during juvenile life stages, then migrate to the Chain O' Lakes where adult life stages are sustained between spawning runs. This strain of brown trout has important genetic characteristics that need special protection to maintain. A DNR investigation by the Wautoma office fisheries program is in progress to determine the magnitude and timing of spawning runs.

Hartman Creek is a two-mile-long warm water sport fish community. This perennial stream is dammed to form Hartman Lake in Hartman Creek State Park. Hartman Creek discharges to Pope Lake in the Waupaca Chain O' Lakes.

Instream substrate is mostly rock, rubble, and gravel with some sand present.

The riparian corridor is mostly wooded with stable banks.

A habitat rating and macroinvertebrate sampling conducted at Rural Road rate Hartman Creek as having "good" instream habitat and excellent water quality indicating no apparent organic pollution at this stretch of stream (Table 1)(Fig. 5).

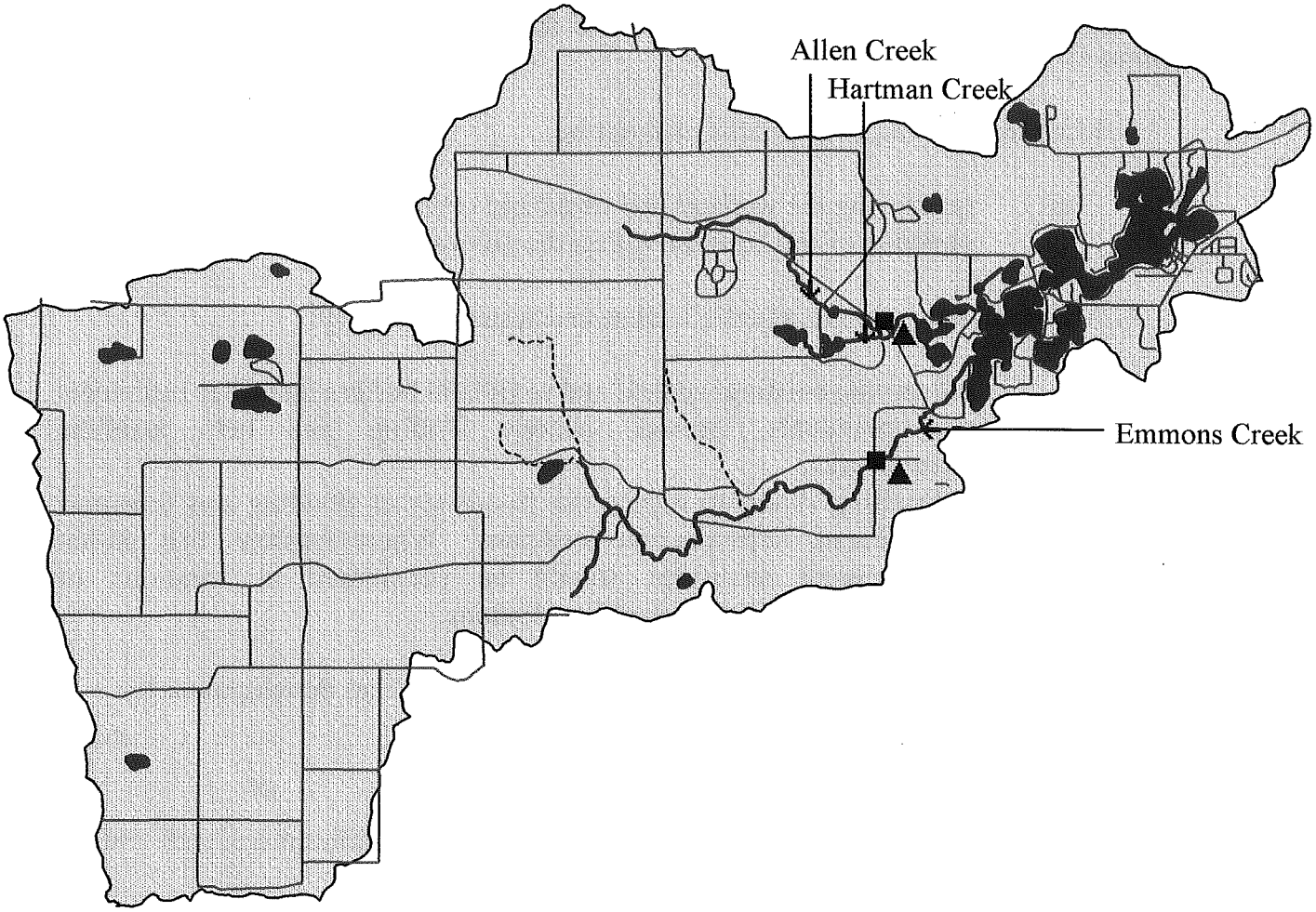
There is slight, but insignificant accumulation of silt on the lower banks and inside curves.

Allen Creek is a four-mile-long Class I brook and brown trout tributary to Hartman Creek. The stream is also designated as an Outstanding Resource Water.

The bottom substrate is primarily naturally occurring sand with little gravel or rubble present. The corridor of this small clear water stream is wooded with stable banks.

Since the existing water resource condition of the Chain O' Lakes subwatershed streams are good, protecting these valuable resources from land use changes will ensure good future water quality.

Chain O'Lakes Subwatershed



LEGEND

- Lakes
- Rivers
- Intermittent Streams
- Roads & Highways
- ▲ Macroinvertebrate Samples
- ■ Habitat Assessments

N

1.6 0 1.6 3.2 Miles

(Fig. 5)

Surface Water Resources Goals and Objectives

The following surface water resource management goals/objectives are recommended for the Chain O' Lakes Subwatershed:

1. Maintain and improve wildlife habitat by:

    a. preserving the wetland and woodland corridors that currently exist on portions of the streams within the subwatershed.

2. Maintain and improve aquatic habitat and water quality by:

    a. preserving existing wetland and woodland buffers that filter sediments and pollutants, provide canopy shading and help stabilize streambanks.
    b. controlling runoff to reduce the frequency of flooding and transport of sediment, nutrients and pesticides. Where feasible, fish habitat improvement structures should be considered at locations of streambank erosion control installations.

3. Reduce nutrient and sediment loading from lake riparian development by:

    a. stabilizing eroding shorelines.

4. Preserve the migrating strain of brown trout inhabiting Emmons Creek and Chain O' Lakes.

Crystal River Subwatershed

The Crystal River Subwatershed is approximately 47.3 square miles in area and is located in the southeast, northcentral and southwest portions of Portage, Waushara, and Waupaca counties respectively. Perennial streams include Radley, Murry, and Naylor Creeks, and the Crystal River.

Land composition is approximately 56% agricultural, 38% forested, 1% wetlands, and 5% developed areas.

Water Resource Conditions

Pearl Creek turns into Radley Creek at the Waupaca County line. This 13-mile-long creek is classified as a Class I brook and brown trout fishery and is designated as an Outstanding Resource Water. Stratton Lake, a spring fed drainage lake, discharges to Radley Creek. Radley Creek drains to Junction Lake on the Crystal River.

The substrate is mostly sand, however silt has accumulated in the slow areas near bridges and along the lower banks. The shifting sand substrate appears to be natural. Water celery and filamentous algae are abundant in some reaches.

Stream bank vegetative cover is generally greater than 90%, with diverse trees and shrubs. Most of Radley Creek flows through the Radley Creek State Fishery Area.

Habitat evaluations conducted at four different stream reaches all rated Radley Creek as having "good" aquatic life habitat. Macroinvertebrate samples collected at Dayton Road in 1993 and 1994 rank this section of Radley Creek as having "excellent" water quality with no apparent organic pollution. Samples collected in 1980 at Lake Stratton Road also received "excellent" ratings (Table 1)(Fig. 6).

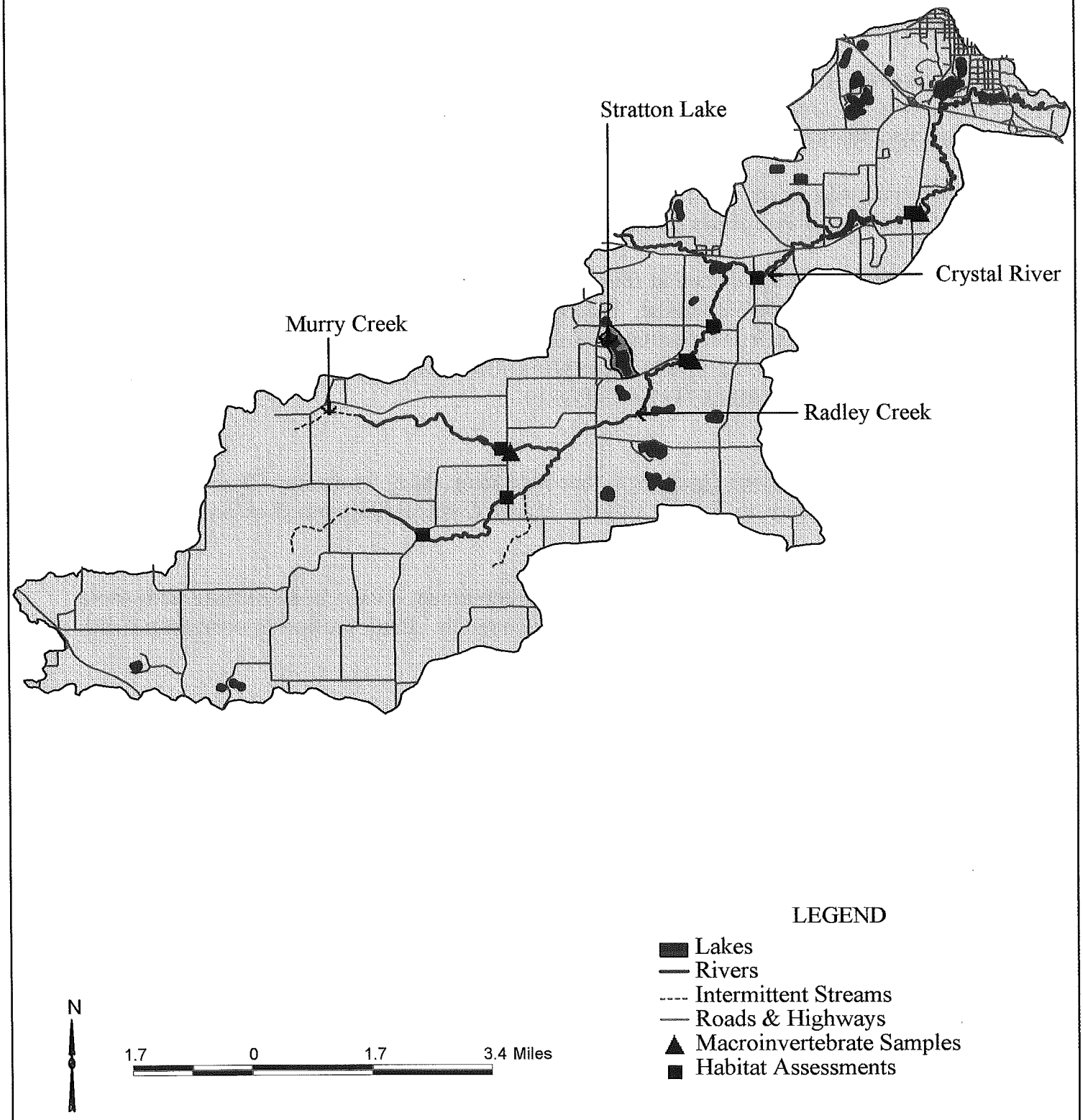
Murry (N. Fork Radley) Creek is a four-mile-long clear, hardwater Class I brook and brown trout tributary to Radley Creek. Murry Creek is designated as an Exceptional Resource Water.

The naturally occurring shifting sand is the predominant stream bed substrate with some silt near the banks. Rocks and gravel are uncommon. Bank erosion is nonexistent with a diverse wooded riparian corridor.

Instream aquatic life habitat is "good". Macroinvertebrate samples collected at West Dayton Road in 1993 and 1994 rate this section of Murry Creek as having very good water quality with no apparent organic pollution (Table 1)(Fig.).

Crystal River is a 13-mile-long clear, hard water stream that begins as the outlet of Long Lake on the Waupaca Chain O' Lakes, flows through Junction Lake, is dammed at Little Hope and again in the city of Waupaca forming Cary Millpond, and eventually discharges to the Waupaca River southeast of Waupaca. The first eleven miles of the river are managed as Class II brown and rainbow trout waters, and the lower two miles below Cary Millpond are classified as a warm water sport fish community.

Crystal River Subwatershed



(Fig. 6)

The Crystal River is not only known for its fishery, but it is also a very popular recreational stream for float trips, especially by canoers. It is estimated that thousands of people partake in these trips each year. There is concern that heavy use by these activities could disturb areas of the stream bed. Also, there are times when conflicts arise between anglers and canoeists. There is virtually no public access with most of the shoreline a series of small private properties and year-round homes.

Although sand is common, rocks and rubble are the predominant substrate type. Silt and sedimentation do not appear to be a problem. The stream banks are well protected from erosion.

Instream aquatic life habitat ranges from "good" to "excellent". Macroinvertebrate sampling conducted at Shadow Lake Road in 1993 and 1994 rate this section of the Crystal River as having "excellent" water quality with no apparent organic pollution. Samples collected below Little Hope dam in 1980 received a "good" rating with some organic pollution present (Table 1)(Fig. 6).

Dissolved oxygen and temperature monitoring, including several grab samples, conducted at Sanders Road for a 12-day period in early September, did not reveal any state standard violations at any time; although, the river does exhibit normal diurnal fluctuations.

The 26-acre Cary Millpond has an average depth of two feet. The impoundment contains dense growths of aquatic plants and filamentous algae. The City of Waupaca Inland Lakes Protection and Rehabilitation District and DNR sponsored a lake management planning grant for the Cary Millpond. The monitoring activities are currently underway.

Naylor Creek is a small, one-mile-long, Exceptional Resource Water, Class I brook and brown trout tributary to the Crystal River, upstream of the Little Hope impoundment.

Other than nonpoint source nutrient inputs which promote plant growth in the Cary Millpond, water resource conditions are generally good in the Crystal River subwatershed and, therefore nonpoint source management practices should be aimed at protecting these valuable resources.

Surface Water Resources Goals and Objectives

The following surface water resource management objectives are recommended for the Crystal River Subwatershed:

1. Maintain and improve wildlife habitat by:

    a. preserving the wetland and woodland corridors that currently exist on portions of the streams within the subwatershed.

2. Maintain and improve aquatic life habitat and water quality by:

    a. preserving existing wetland and woodland buffers that filter sediments and pollutants, provide canopy shading and help stabilize streambanks.
    b. controlling runoff to reduce the frequency of flooding and transport of sediment, nutrients and pesticides. Where feasible, fish habitat improvement structures should be considered at locations of streambank erosion control installations.

Waupaca - Weyauwega Subwatershed

The Waupaca-Weyauwega Subwatershed is 33.4 square miles in area and is located in southcentral Waupaca county. Perennial rivers and streams include the mainstem of the Waupaca River from the city of Waupaca to its mouth at the Wolf River, two perennial and several intermittent tributaries. The Waupaca River is dammed at Weyauwega forming the Weyauwega Millpond.

Land composition is approximately 59% agricultural, 24% forested, 10% wetlands, and 6% developed areas.

Water Resource Conditions

The Waupaca River below Waupaca to its mouth is classified as a warm water sport fish community. Habitat evaluations found "good" aquatic life habitat in the Waupaca River at Riverside Park located on Hwy 54 and 22 in Waupaca.

Substrate at this site is mostly rock and rubble. There is no significant erosion or bank failure. In spring 1994, replicate (3) macroinvertebrate samples collected at Riverside

Park (Hwy. 54/22) rate this section of the river as having "excellent" water quality with no apparent organic pollution. A fall of 1993 survey indicates organic pollution unlikely and "excellent" water quality. Samples collected at Harrington Road in 1980 also indicate "excellent" water quality (Table 1)(Fig. 7).

An unnamed tributary (T22N, R12E, Sec 35, SESE) to the Waupaca River received a "fair" instream habitat rating (Table 1)(Fig. 7). This perennial clear, cold water stream has predominantly shifting sand substrate that appears to be natural.

Extensive data was collected on the Waupaca River by Wisconsin Electric Power Company in 1989 and 1990 as part of the hydroelectric facility relicensing process. Monitoring results determined flowage sediments are very clean in regards to heavy metals and pesticides. Water chemistry samples collected both from the flowage and tailwater found little difference between the two locations, with acceptable concentrations of regular water quality parameters.

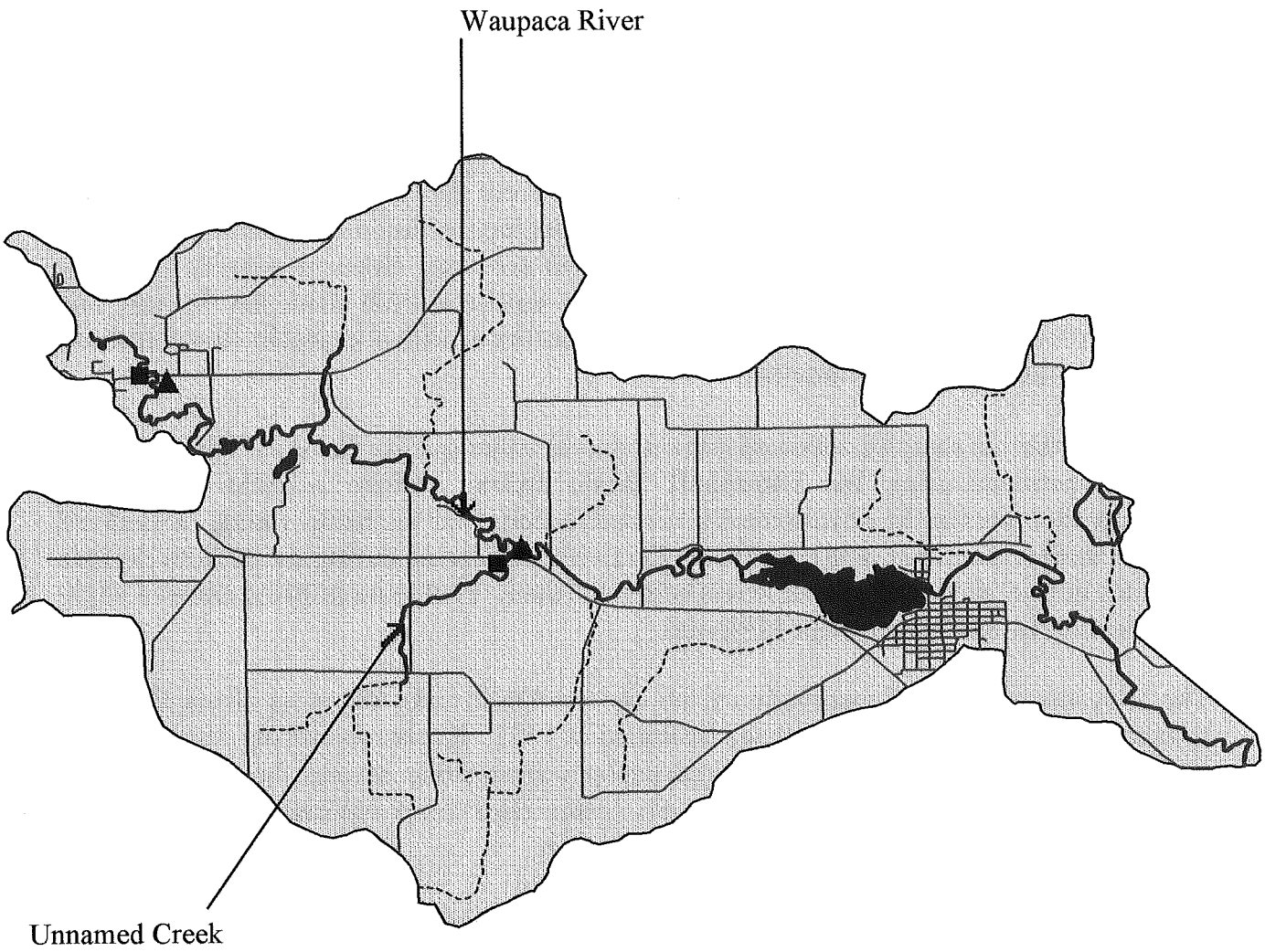
Macroinvertebrate samples collected showed poorer water quality (poor vs. fair) upstream than downstream using the Hilsenhoff Biotic Index. More suitable habitat for macroinvertebrates at the downstream site could account for the better rating. Dissolved oxygen, temperature, pH, and specific conductivity monitoring during six 24-hour periods indicates normal daily and annual levels below the dam. Profile monitoring showed slight stratification in the Weyauwega Millpond.

The Weyauwega Lake Conservation Club and the DNR Lake Planning Grant Program sponsored monitoring on Weyauwega Millpond in 1991. Event monitoring revealed high nutrient inputs from feeder creeks and particularly from storm sewers; however, regular in-lake monitoring indicates nutrient levels lower than those typically found in other impoundments and even natural lakes in the region.

A May 1994 DNR survey of freshwater mussels conducted above and below the Weyauwega dam found downstream fauna richer than upstream, indicating that the dam does have an effect on upstream species richness. Also, the tailwater area may serve as a good reintroduction site for the state endangered and federal category 2 snuffbox mussel. Run-of-the-river hydroelectric operations at the Weyauwega dam are recommended for protection of benthic habitat and organisms.

Macrophyte growth in the impoundment is widespread, very abundant, and dominated by a few species. Overabundant macrophytes are a nuisance to hydroelectric and recreational activities.

Waupaca-Weyauwega Subwatershed



(Fig. 7)

There is a significant amount of streambank erosion below the Weyauwega Millpond. The exact cause of this erosion is unknown, but may be due to peak river flows caused by heavy rain events combined with historic dam operations. Other than nonpoint nutrient inputs, which promote plant growth in the Weyauwega Millpond, surface water resource conditions are generally good in the Waupaca-Weyauwega subwatershed and therefore, nonpoint source management practices should be aimed at preserving these conditions.

Surface Water Resources Goals and Objectives

The following surface water resource management objectives are recommended for the Waupaca-Weyauwega Subwatershed:

1. Maintain and improve wildlife habitat by:

    a. preserving the wetland and woodland corridors that currently exist on portions of the streams within the subwatershed.

2. Maintain and improve aquatic life habitat and water quality by:

    a. preserving existing wetland and woodland buffers that filter sediments and pollutants, provide canopy shading and help stabilize streambanks.

    b. controlling runoff to reduce the frequency of flooding and transport of sediment, nutrients and pesticides.

Conclusion:

Nonpoint pollution sources do not appear to be causing widespread detrimental impacts to the surface water resources. This is not to say that there are no problems within the watershed, but rather, the areas of concern are limited and localized.

Where applicable, improvement of streambank cover will provide a needed buffer, reducing sediment and nutrient delivery to surface waters. A reduction in soil loss and sediment delivery to the river, its tributaries, connected lakes and impoundments will reduce sediment deposition, thereby improving aquatic habitat and water quality.

Although nitrate levels are elevated in surface waters throughout the watershed, a literature search did not reveal cause for great concern based on toxicity of nitrates to freshwater organisms, at the levels found within the watershed. Nitrate is considerably less toxic to aquatic organisms than are ammonia and nitrite, and consequently there have been few studies of its toxicity (Russo, 1985). Camargo and Ward (1992) state that the maximum safe criterion of nitrate ion (NO_3-) for domestic water supply established at 10 ppm might be considered protective for fish and invertebrates in freshwater ecosystems, however it is evident that aquatic insect species can be more sensitive to nitrate compounds than fish species. In this sense, it is concluded that acute and chronic studies on nitrate toxicity to freshwater invertebrates would be useful in order to improve nitrate safe criteria for aquatic life.

High nitrate levels in surface waters are believed to be supplementing excessive green algae production on Spring Lake and Spring Creek. The presence of nitrates and pesticides in baseflow does indicate these and potentially other agricultural chemicals are entering surface waters through inflow of groundwater.

In many areas, existing well vegetated stream corridors provide excellent protection to the surface waters, acting as buffers that filter sediments and pollutants, providing canopy shading, and maintenance of stable streambanks. These corridors also provide excellent wildlife habitat for nesting, feeding and travel lanes. Local fish managers indicate that the fisheries of the river and its tributaries are in good condition.

The Tomorrow/Waupaca River watershed offers a unique opportunity for the Nonpoint Source Program to help protect and preserve the existing quality of the resource. As stated in a public opinion poll "Continued urban and transportation development along the east-west U.S. 10 transportation corridor places increasing pressures upon the natural environment within an area renowned for its scenic beauty and recreational opportunities" (Thorton and Lies, 1991).

Many local organizations, including Trout Unlimited and the Tomorrow/Waupaca River Watershed Association, are very interested in preserving, protecting, and restoring the watershed. These efforts, from habitat improvement projects to educational programs, should continue to be encouraged. This local commitment, combined with innovative, well-planned, effectively enforced local zoning ordinances, will help ensure protection of the watershed for future generations.

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Wisconsin Department of Natural Resources, North Central District, Water Quality Files.

Wisconsin Department of Natural Resources, North Central District, Wisconsin Rapids Area, Fish Management Files.

Appendix A:

Evaluation of Water Quality Using Biotic Index Values

1977 scoring system

Biotic Index	Water Quality	State of the Stream
<1.75	Excellent	Clean undisturbed
1.75-2.25	Good	Some enrichment or disturbance
2.25-3.00	Fair	Moderate enrichment or disturbance
3.00-3.75	Poor	Significant enrichment or disturbance
>3.75	Very Poor	Gross enrichment or disturbance

1982 scoring system

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
4.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

Evaluation of Water Using the Family-Level Biotic Index

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very Good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.00	Very Poor	Severe organic pollution likely

Appendix B:

MACROINVERTEBRATE FIELD AND BENCH SHEET Department of Natural Resources
Form 3200-81 Rev. 4-90

Sample ID # _ _ _ _ _ _ - _ _ _ - _ _ _ (Y Y M M D D / Cnty / Field #) Waterbody Name _____

Water Temp (Celsius) _____ Dissolved Oxygen (mg/1) _____.

Sample Location: _____ (1/16 / 1/4 / Sec. / Tn. / Rng.) Master Waterbody # _____

Project Name _____ Storet Station # _____

Ave. Stream With (Ft.) at Site _____ Ave. Stream Depth (Ft.) at Site _____

Collector _____ (Last Name, First Initial) Field # ___ Rep 1 Rep 2 Rep 3
Measured Velocity (fps) _____

Sorter _____ Est. Velocity (fps) V. Slow (<-0.2) / Slow (0.2-0.5) / Moderate (0.5-1.5) / Fast (1.5-. >)

Est. % of Sample Sorted _____

Taxonomist _____

Location Description _____ Sampled Habitat: 1. Riffle 2. Run 3. Pool 4. Lake

_____

_____ Est. Time Spent Sampling (Min.) _____

Sampling Device: 1. D Frame, 2. Artificial Substrate, 3. Surber, 4. Other_____

Substrate at Site Location (%)

_____ Bedrock _____ Rubble (2.5-10.0" dia.) _____ Sand _____ Clay _____ Muck
_____ Boulders (10.0" dia.) _____ Gravel (0.1-2.5" dia.) _____ Silt _____ Detritus _____ Debris/Veg.

Substrate Sampled (%)(Same as above ___)

_____ Bedrock _____ Rubble (2.5-10.0" dia.) _____ Sand _____ Clay _____ Muck
_____ Boulders (10.0" dia.) _____ Gravel (0.1-2.5" dia.) _____ Silt _____ Detritus _____ Debris/Veg.

Aquatic Vegetation ___ % of Total Stream Channel at Sample Site

Observed Instream Water Quality Indicators (Perceived WQ: Excellent, Good, Fair, Poor)

	Not Present	Insignificant	Significant	Comments
Turbidity	1	2	3	
Chlorine or Toxic Scour	1	2	3	
Macrophytes	1	2	3	
Filamentous Algae	1	2	3	
Planktonic Algae	1	2	3	
Slimes	1	2	3	
Iron Bacteria	1	2	3	

Factors Which May Be Affecting Habitat Quality

	Not Present	Insignificant	Significant	Comments
Sludge Deposits	1	2	3	
Silt and Sediment	1	2	3	
Channel Ditching	1	2	3	
Down/Up Stream Impoundment	1	2	3	
Low Flows	1	2	3	
Wetlands	1	2	3	

Pollutant Sources

	Not Present	Insignificant	Significant	Comments
Livestock Pasturing	1	2	3	
Barnyard Runoff	1	2	3	
Cropland Runoff	1	2	3	
Tile Drains	1	2	3	
Septic Systems	1	2	3	
Streambank Erosion	1	2	3	
Urban Runoff	1	2	3	
Construction Runoff	1	2	3	
Point Source (Specify Type)	1	2	3	
Other (Specify)	1	2	3	

Stream Name: _____

Field Number: _____ Date: _____

	Value	X	Number =
Plecoptera Capniidae	1		
Chloroperlidae	1		
Leuctridae	0		
Nemouridae	2		
Perlidae	1		
Perlodidae	2		
Pteronarcyidae	0		
Taeniopterygidae	2		
Ephemeroptera Baetidae	4		
Bactiscidae	3		
Caenidae	7		
Emphemerellidae	1		
Ephemeridae	4		
Leptophlehiidae	4		
Heptageniidae	2		
Metretopodidae	2		
Oligoneuriidae	2		
Polymitarcyidae	2		
Potomanthidae	4		
Siphlonuridae	7		
Tricorythidae	4		
Odanata Aeshnidae	3		
Calopterygidae	5		
Coenagrionidae	9		
Cordulegastridae	3		
Corduliidae	5		
Gomphidae	1		
Lestidae	9		
Libellulidae	9		
Macromiidae	3		
Tricoptera Brachycentridae	1		
Glossosomatidae	0		
Helicopsychidae	3		
Hydropsychidae	4		
Hydroptilidae	4		
Lepidostomatidae	1		
Leptoceridae	4		
Limnephilidae	4		
Molannidae	6		
Odontoceridae	0		
Philopotamidae	3		
Phryganeidae	4		
Polycentropodidae	6		

	Value	X	Number =
Tricoptera Psychomyiidae	2		
Phyacophilidae	0		
Sericostomatidae	3		
Megaloptera Corydalidae	0		
Sialidae	4		
Lepidoptera Pyralidae	5		
Coleoptera Dryopidae	5		
Elmidae	4		
Psephenidae	4		
Diptera Athericidae	2		
Blephariceridae	0		
Ceratopogonidae	6		
Chironomidae (Blood red)	8		
Chironomidae (Other)	6		
Dolochopodidae	4		
Empididae	6		
Ephydridae	6		
Psychodidae	10		
Simuliidae	6		
Muscidae	6		
Syrphidae	10		
Tabanidae	6		
Tipulidae	3		
Amphipoda Gammaridae	4		
Talitridae	8		
Isopoda Asellidae	8		
Totals			

FBI = _____

Department of Natural Resources

Appendix C:

STREAM SYSTEM HABITAT RATING FORM

Form 3200-68 1-85

Stream _____ Reach Location _____ Reach Score/Rating _____

County _____ Date _____ Evaluator _____ Classification _____

Rating Item	Category			
	Excellect	Good	Fair	Poor
Watershed Erosion	No evidence of significant erosion. Stable forest or grass land. Little potential for future erosion. 8	Some erosion evident. No significant "raw" areas. Good land mgmt. practices in area. Low potential for significant erosion. 10	Moderate erosion evident. Erosion from heavy storm events obvious. Some "raw" areas. Potential for significant erosion. 14	Heavy erosion evident. Probable erosion from any run off. 16
Watershed Nonpoint Source	No evidence of significant source. Little potential for future problem. 8	Some potential sources (roads, urban area, farm fields). 10	Moderate sources (small wetlands, tile fields, urban area, intense agriculture). 14	Obvious sources (major wetland drainage, high use urban or industrial area, feed lots, impoundment). 16
Bank Erosion, Failure	No evidence of significant erosion or bank failure. Little potential for future problem. 4	Infrequent, small areas, mostly healed over. Some potential in extreme floods. 8	Moderate frequency and size. Some "raw" spots. Erosion potential during high flow. 16	Many eroded areas. "Raw" areas frequent along straight sections and bends. 20
Bank Vegetative Protection	90% plant density. Diverse trees, shrubs, grass. Plants healthy with apparently good root system. 6	70-90% density. Fewer plant species. A few barren or thin areas. Vegetation appears generally healthy. 9	50-70% density. Dominated by grass, sparse trees and shrubs. Plant types and conditions suggest poorer soil binding. 15	<50% density. Many raw areas. Thin grass, few if any trees and shrubs. 18
Lower Bank Channel Capacity	Ample for present peak flow plus some increase. Peak flow contained. W/D ratio <7. 8	Adequate. Overbank flows rare. W/D ratio 8-15. 10	Barely contains present peaks. Occasional overbank flow. W/D ratio 15-25. 14	Inadequate, overbank flow common. W/D ratio >25. 16
Lower Bank Deposition	Little or no enlargement of channel or point bars. 6	Some new increase in bar formation, mostly from coarse gravel. 9	Moderate deposition of new gravel and coarse sand on old and some new bars. 15	Heavy deposits of fine material, increased bar development. 18
Bottom Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition. 4	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools. 8	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools. 16	More than 50% of the bottom changing nearly year long. Pools almost absent due to deposition. 20
Bottom Substrate/ Available Cover	Greater than 50% rubble, gravel or other stable habitat. 2	30-50% rubble, gravel or other stable habitat. Adequate habitat. 7	10-30% rubble, gravel or other stable habitat. Habitat availability less than desirable. 17	Less than 10% rubble gravel or other stable habitat. Lack of habitat is obvious. 22
Avg. Depth Riffles and Runs	Cold >1′ 0 Warm >1.5′ 0	6″ to 1′ 6 10″ to 1.5′ 6	3″ to 6″ 18 6″ to 10″ 18	<3″ 24 <6″ 24
Avg. Depth of Pools	Cold >4′ 0 Warm >5′ 0	3′ to 4′ 6 4′ to 5′ 6	2′ to 3′ 18 3′ to 4′ 18	<2′ 24 <3′ 24
Flow, at Rep. Low Flow	Cold >2 cfs 0 Warm >5 cfs 0	1-2 cfs 6 2-5 cfs 6	.5-1 cfs 18 1-2 cfs 18	<.5 cfs 24 <1 cfs 24
Pool/Riffle, Run/Bend Ratio (distance between riffles ÷ stream width)	5-7. Variety of habitat. Deep riffles and pools. 4	7-15. Adequate depth in pools and riffles. Bends provide habitat. 8	15-25. Occasional riffle or bend. Bottom contours provide some habitat. 16	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat. 20
Aesthetics	Wilderness characteristics, outstanding natural beauty. Usually wooded or unpastured corridor. 8	High natural beauty. Trees, historic site. Some development may be visible. 10	Common setting, not offensive. Developed but uncluttered area. 14	Stream does not inhance aesthetics. Condition of stream is offensive. 16

Column Totals: _____ _____ _____ _____

Column Scores E _____ +G _____ +F _____ +P _____ = _____ = Score

<70 = Excellent, 71-129 = Good, 130-200 = Fair, >200 = Poor

FIELD MEASURMENTS

D.O. _____ TEMP. _____ pH _____ AVG. WIDTH _____

AVG. DEPTH _____ FLOW MEAS. _____ LENGTH OF SEGMENT _____

OBSERVATIONS

Scarce (S), Common (C), Abundant (A)

SLUDGE _____ MUD _____ MACROPHYTES _____ SLIMES _____

FILAMENTOUS ALGAE _____ LITTER & DETRITUS _____

PLANKTONIC ALGAE _____ IRON BACTERIA _____ TURBIDITY _____

EXTERNAL IMPACTS

Severe (S), Moderate (M), Light (L)

AGRICULTURAL _____ CHANNELIZATION _____ CONSTRUCTION _____

STORM SEWERS _____ POINT SOURCES _____

COMMENTS:

BIOTA

	HBI	FBI	OTHER
MACROINVERTEBRATES	_____	_____	
FISH OBSERVED			
WILDLIFE USES			

WATER CHEMISTRY

BOD_5 _____ TOT P _____ CHLORIDE _____ LEAD _____ MFFC _____

DISS P _____ CADMIUM _____ MAGNESIUM _____ HARDNESS _____

MFFS _____ TOT D N _____ CALCIUM _____ MANGANESE _____

COPPER _____ NH_3N _____ NICKLE _____ SUS SOLIDS _____

NO_2-N+NO_3-N _____ ZINC _____ IRON _____

CLASSIFICATION

GREAT LAKES COMMUNITY _____ WARM WATER FORAGE _____

COLD WATER COMMUNITY _____ LIMITED FORAGE FISH _____

WARM WATER SPORT FISH _____ LIMITED AQUATIC LIFE _____

WISCONSIN FROG AND TOAD SURVEY -- Field Data Sheet

Bureau of Endangered Resources
Department of Natural Resources
Box 7921, Madison, WI 53707

Observer name(s), RUN 1 Mary Reser
(Add address and phone on back.) RUN 2 Mary Reser
RUN 3 Mary Reser
IMPORTANT: Please return at the end of the season.

Nat. River Watershed
Route No.
Year 1994
County PORTAGE

INSTRUCTIONS: Use this form for new or established survey routes. Each route consists of 10 listening sites, and is repeated 3 times during the breeding season, according to the minimum water temperatures and approximate range of dates given below for each survey period. Run surveys after dark, when wind velocity is less than 8 mph. Listen 5-10 minutes at each site and record a call index value of 1, 2, or 3 (see below) for each species calling. See back of sheet for wind and sky codes and additional comments. Return to above address by 15 August.

FIRST RUN
Water 50°F; 8-30 April

BEGIN: Date 4/26/94 Time: 8:50pm Wind: 4+ Sky: 2 Air temp. (F): 67°
END: Time: 11:36pm Wind: 4+ Sky: 0 Air temp. (F): 57°

SECOND RUN
Water 60°F; 20 May - 5 June

BEGIN: Date 5/27/94 Time: 9:15pm Wind: 1 Sky: 0 Air temp. (F): 56°
END: Time: 12:10am Wind: 1 Sky: 0 Air temp. (F): 48°

THIRD RUN
Water 70°F; 1-15 July

BEGIN: Date 7/13/94 Time: 10:00pm Wind: 2 Sky: 2 Air temp. (F): 57°
END: Time: 12:25am Wind: 3 Sky: 2 Air temp. (F): 54°

SITE NAME	Site Number	Water Temp (F)	CALL INDEX* Wood frog	Chorus frog	Spring peeper	Leopard frog	Pickerel frog	Am. toad	E. gray tree frog	C. gray tree frog	Cricket frog	Mink frog	Green frog	Bullfrog
1. T-25N R9E Sec 11 Co. "CC"	1.	62°	2	3	3	1		2						
2. Collins Lake	2.	58°	2	3		2								
3. Collins Lake (OUT-FLOW)	3.	56°	2	3	3	2								
4. Hillside Road	4.	50°	2	3	3			3						
5. Loberg Road (south of curve)	5.	56°	2	3	3			3						
6. Paucski Rd.	6.	–			3			2						
7. Lime Lk. Rd.	7.	62°	1	1	2									
8. Cty "O"	8.	–			3									
9. Spring Crk Rd	9.	62°			3									
10. County Q	10.	62°	2	1	3			3						
For office use only — Mean														
For office use only — Freq.														

SITE NAME	Site Number	Water Temp (F)	CALL INDEX* Wood frog	Chorus frog	Spring peeper	Leopard frog	Pickerel frog	Am. toad	E. gray tree frog	C. gray tree frog	Cricket frog	Mink frog	Green frog	Bullfrog
1. T-25N R9E Sec 11 Co. "CC"	1.	58°		2				2				1		
2. Collins Lake	2.	62°		1				2				1		
3. Collins Lake (OUT-FLOW)	3.	58°		2								2		
4. Hillside Road	4.	–	2	2				1	1			1		
5. Loberg Road (south of curve)	5.	–		2										
6. Paucski Rd.	6.	–		2								2		
7. Lime Lk. Rd.	7.	58°		2			3					1		
8. Cty "O"	8.	–		2										
9. Spring Crk Rd	9.	–		2								1		
10. County Q	10.	–		2										

SITE NAME	Site Number	Water Temp (F)	CALL INDEX* Wood frog	Chorus frog	Spring peeper	Leopard frog	Pickerel frog	Am. toad	E. gray tree frog	C. gray tree frog	Cricket frog	Mink frog	Green frog	Bullfrog
1. T-25N R9E Sec 11 Co. "CC"	1.	57°										1		
2. Collins Lake	2.	63°										1		
3. Collins Lake (OUT-FLOW)	3.	62°										1		
4. Hillside Road	4.	–										1		
5. Loberg Road (south of curve)	5.	–												
6. Paucski Rd.	6.	–										2		
7. Lime Lk. Rd.	7.	62°										1		
8. Cty "O"	8.	–												
9. Spring Crk Rd	9.	–										1		
10. County Q	10.	–										3		
For office use only — Mean														
For office use only — Freq.														

*The call index is a rough estimate of the numbers of calling males of a particular species, according to the following index values:

1 Individuals can be counted; there is space between calls.

2 Calls of individuals can be distinguished but there is some overlapping of calls (intermediate between "1" and "3").

3 Full chorus. Calls are constant, continuous and overlapping.

Form 1700-9
6-86

Please provide names, addresses, and phone numbers of all observers.
Place asterisk by name of cooperator who should receive materials next spring.

Route No._____
Year_____
County_____

Name	Mary Reser	* Jim Krajewski		
Address	3519 Hwy EZ	WDNR - NCD		
	Hurley Inc. WI 54407			
Phone	(715) 677-3454			

Enter sky and wind codes on front of data sheet.

Sky code no.	Sky condition
0	Clear or a few clouds
1	Partly cloudy or variable
2	Cloudy (broken) or overcast
4	Fog
5	Drizzle
6	Showers

Wind code no.	Wind speed (miles per hr)	Indicators of wind speed
0	less than 1	Smoke rises vertically.
1	1-3	Wind direction shown by smoke drift.
2	4-7	Wind felt on face; leaves rustle.
3	8-12	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	Raises dust and loose paper; small branches are moved.

Comments (difficulties, background noise levels, uncertain calls, habitat changes since previous run or previous year, etc

Site	Run 1	Run 2	Run 3
1	had to do run this night but wind more than 20 MPH	Cows & calves bawling just beyond pond drowning out sound	
2	toads: intermittent "full chorus" wind may have been compromising listening - probably toads calling in distance	tree frogs calling from far across lake	
3			
4			
5			
6	Wind compromising sound		
7			
8	this stop too far above wetland couldn't distinguish peepers & chorus frogs		
9	no frogs at bridge (could hear peepers for 4th - really at stops # 10		
10	wind very loud here, too		

good conditions for listening & enter transect.

Misc. comments:

*** IMPORTANT: Documentation required for records of cricket frog and species outside known range--see instructional materials