PHOSPHORUS CONTROL ACTION PLAN

and Total Maximum Daily (Annual Phosphorus) Load Report

SABATTUS POND

Androscoggin County, Maine

Sabattus Pond PCAP-TMDL Report

Maine DEPLW 2004 - 0649

Maine Department of Environmental Protection

and Maine Association of Conservation Districts

Final EPA Document - August 12, 2004

SABATTUS POND Phosphorus Control Action Plan (PCAP)

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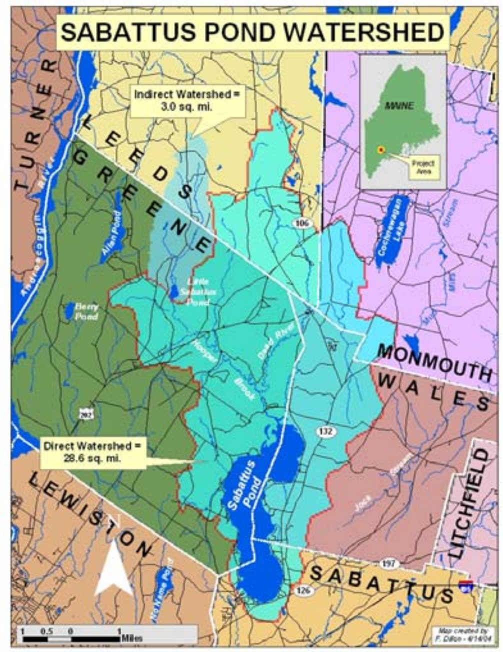
Sabattus Pond Phosphorus Control Action Plan
Summary Fact Sheet

Background

SABATTUS POND is a 2,036 acre, relatively shallow waterbody located in the Towns of Sabattus, Wales, and Greene in Androscoggin County, within south central Maine. Sabattus Pond has a direct **watershed** (see map) area of 25 square miles; a maximum depth of 19 feet, a mean depth of 14 feet; and a non-enhanced **flushing rate** of 1.52 times per year. The total Sabattus Pond watershed drainage area, including upstream situated Little Sabattus Pond, is 31.6 square miles.



Sabattus Pond has a history of supporting excessive amounts of algae in the late summer, due in large part to the historical contribution of excess nutrients, particularly **phosphorus** from the watershed, which have accumulated in the pond bottom sediments. Soil erosion (see photo below) in the Sabattus Pond watershed can have far-reaching consequences, as soil particles effectively transport phosphorus, which serves to "fertilize" the lake and decreases water clarity. Excess phosphorus can also harm fish habitat and lead to nuisance algae blooms—floating mats of green scum—or dead and dying algae. Studies, on lakes in general, show that - as water clarity decreases, lakeshore property values also decline.

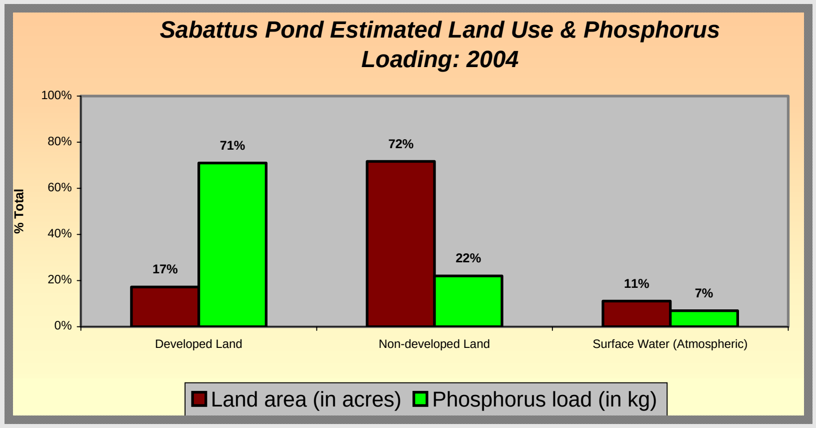
Stakeholder Involvement

Federal, state, county, and local groups have been working together to effectively address this **nonpoint source water pollution** problem over the past 25 years. In 2002, the Maine Department of Environmental Protection funded a Clean Water Act Section 319(h) project in cooperation with the Maine Association of Conservation Districts, Androscoggin Valley County Soil and Water Conservation District (AVSWCD), and the Sabattus Pond Watershed Partnership (SPWP) to identify and quantify the potential current sources of phosphorus and identify the **Best Management Practices (BMPs)** that need to be installed in the watershed. A final report, completed in the spring of 2004, is entitled "Sabattus Pond Phosphorus Control Action Plan" and doubles as a technical **TMDL** report, to be submitted to the U.S. Environmental Protection Agency, New England Region I, for their approval.

Shoreline erosion along the eastern shore of Sabattus Pond

What We Learned

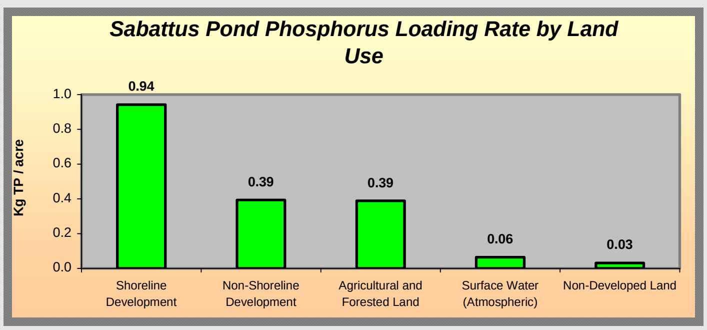
A land use assessment was conducted for the Sabattus Pond watershed to determine current potential sources of phosphorus that may run off from land areas during storm events and springtime snow melting. This assessment utilized many resources, including generating and interpreting maps, inspecting aerial photos, and conducting field surveys. An estimated 1,819 kilograms (kg) of phosphorus per year is exported to Sabattus Pond from its direct watershed. The bar chart (right) illustrates the land area for developed and undeveloped land uses relative to their estimated total phosphorus export load. This information, detailed in the full PCAP-TMDL report, can assist Sabattus Pond stakeholder groups to effectively prioritize future BMP's for nonpoint source (NPS) pollution mitigation in the watershed.



Phosphorus Reduction Needed

Sabattus Pond has a natural capacity to effectively process up to 1,155 kg of Total Phosphorus (TP) on an annual basis without harming water quality, which equals an in-lake phosphorus concentration of 15 ppb. Sabattus Pond's current (2000-2003) average summertime TP concentration is 35 ppb - equal to an additional 1,540 kg TP. Taking into account a 38 kg allocation for future watershed development, the total amount of phosphorus needed to be reduced to attain water quality standards (algal bloom-free conditions) in Sabattus Pond is 1,578 kg.

What You Can Do To Help!



Even though the water quality of Sabattus Pond has shown some gradual improvement over the past quarter of a century, late summertime nuisance algae blooms are still prevalent. As a watershed resident, there are many things you can do to further enhance the water quality of Sabattus Pond. Shoreline property owners can reduce what can be significant phosphorus loads (see graph at left) by using phosphorus-free fertilizers and maintaining natural vegetation adjacent to the lake. Agricultural and commercial land users can consult the AVSWCD or Maine Department of Environmental Protection for information regarding Best Management Practices for reducing phosphorus loads. Watershed residents can also get involved by volunteering to help the SPWP and participating in events sponsored by the AVSWCD. Stakeholders and watershed residents can learn more about their lake and the many resources available, including review of the Sabattus Pond Phosphorus Control Action Plan. Following final EPA approval, copies of this detailed report will be available online-computer at: www.state.me.us/dep/blwq/docmonitoring/tmdl2.htm, or can be viewed and/or copied (at cost) at Maine DEP offices (Bureau Land & Water Quality, Ray Building) in Augusta.

Key Terms

- ***Watershed*** *is a drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.*
- ***Flushing rate*** *refers to how often the water in the entire lake is replaced on an annual basis..*
- ***Phosphorus****: is one of the major nutrients needed for plant growth. It is naturally present in small amounts and limits the plant growth in lakes. Generally, as phosphorus increases, the amount of algae also increases.*
- ***Nonpoint Source Pollution*** *is polluted runoff that cannot be traced to a specific origin or starting point, but appears to flow from many different sources.*
- ***Best Management Practices*** *are techniques to reduce sources of polluted runoff and their impacts. BMP's are low cost, common sense approaches to reduce storm runoff and velocity to keep soil out of lakes and tributaries.*
- ***TMDL*** *is an acronym for Total Maximum Daily Load which represents the total amount of a pollutant (e.g., phosphorus) that a waterbody can receive on an annual basis and still meet water quality standards.*

Project Premise

This project, funded through a Clean Water Act Section 319(h) grant from the United States Environmental Protection Agency (EPA) was directed and administered by the Maine Department of Environmental Protection (Maine DEP), in partnership with the Maine Association of Conservation Districts (MACD), from the summer of 2002 through the late spring of 2004.

The objectives of this project were twofold: first, a comprehensive land use inventory was undertaken to assist Maine DEP in developing a Phosphorus Control Action Plan (PCAP) and a Total Maximum Daily Load (TMDL) report for the Sabattus Pond watershed. Simply stated, a TMDL is the total amount of phosphorus that a lake can receive without harming water quality. Maine DEP, with the assistance of the MACD Project Team, will address and incorporate public comments before final submission to the US EPA. *(For more specific information on the TMDL process and results, refer to the Appendices or contact Dave Halliwell at the Maine DEP Augusta Office at 287-7649 or at David.Halliwell@maine.gov*).

Secondly, watershed survey work, including a shoreline evaluation, was conducted by the Maine DEP-MACD project team to help assess **total phosphorus** reduction techniques that would be beneficial for the Sabattus Pond watershed. Watershed survey work included assessing high impact direct drainage **nonpoint source (NPS) pollution** sites that were not identified during the Sabattus Pond Watershed Nonpoint Source Pollution Survey previously conducted in 1995. The results of this 1995 assessment report includes recommendations for future conservation work in the watershed to help citizens, organizations, and agencies restore and protect Sabattus Pond. **Note:** *To protect the confidentiality of landowners in the Sabattus Pond watershed, site-specific information has generally not been provided as part of this report.*

Total Phosphorus (TP) - *is one of the major nutrients needed for plant growth. It is generally present in small amounts and limits the plant growth in lakes. Generally, as the amount of lake phosphorus increases, the amount of algae also increases.*

Nonpoint Source (NPS) Pollution *- is polluted runoff that cannot be traced to a specific origin or starting point, but appears to flow from many different sources.*

This Phosphorus Control Action Plan (PCAP) report compiles and refines data derived from various sources, including the municipalities of Sabattus, Wales, Leeds, Monmouth and Greene, the Sabattus Pond Watershed Partnership, and the Androscoggin Valley Soil & Water Conservation District (SWCD). Local citizens, watershed organizations, and conservation agencies should benefit from this compilation of data as well as the watershed assessment and the NPS Best Management Practice (BMP) recommendations. Above all, this document is intended to help Sabattus Pond stakeholder groups to effectively prioritize future BMP work in order to obtain the funding resources necessary for NPS pollution mitigation work in their watershed.

This Phosphorus Control Action Plan (PCAP) report compiles and refines data derived from various sources, including the watershed municipalities, the Sabattus Pond Watershed Partnership, and the Androscoggin Valley Soil & Water Conservation District (SWCD).

Study Methodology

Sabattus Pond background information was obtained using several methods, including a review of previous studies of the lake and watershed area, numerous phone conversations and personal interviews with municipal officials, regional organizations and state agencies, and several field tours of the watershed, including boat reconnaissance of the lake and shoreline.

Land use data were determined using several methods, including (1) **Geographic Information System (GIS)** map analysis, (2) analysis of topographic maps, (3) analysis of town property tax maps and tax data, (4) analysis of aerial photographs (US-FSA 1997—2002) and (5) field visits. The majority of the land use data provided in this report were calculated as part of an extensive pilot project aimed to improve the accuracy of currently available GIS-based land use coverage. A complete summary and accompanying methodology for this pilot project appears on pages 38—39.

> ***GIS****—or* ***geographic information system*** *combines layers of information about a place to give you a better understanding of that place. The information is often represented as computer generated maps.*

Roadway data were gathered by taking actual road width measurements of the various types of roads (state, town, private/camp) in the watershed. Roads were measured between the two outer edges of the roadside ditches or berms. An average width (15 m for state roads, 10.5 m for town roads, and 6.3 m for private roads) was used for each of the three road types. Final measurements for all roadways within the watershed were extrapolated using GIS (Field– verified data from the Maine GAP Analysis Program), and USGS topographical maps. Finally, the roadway area was determined using linear distances and average widths for each of the three main road types.

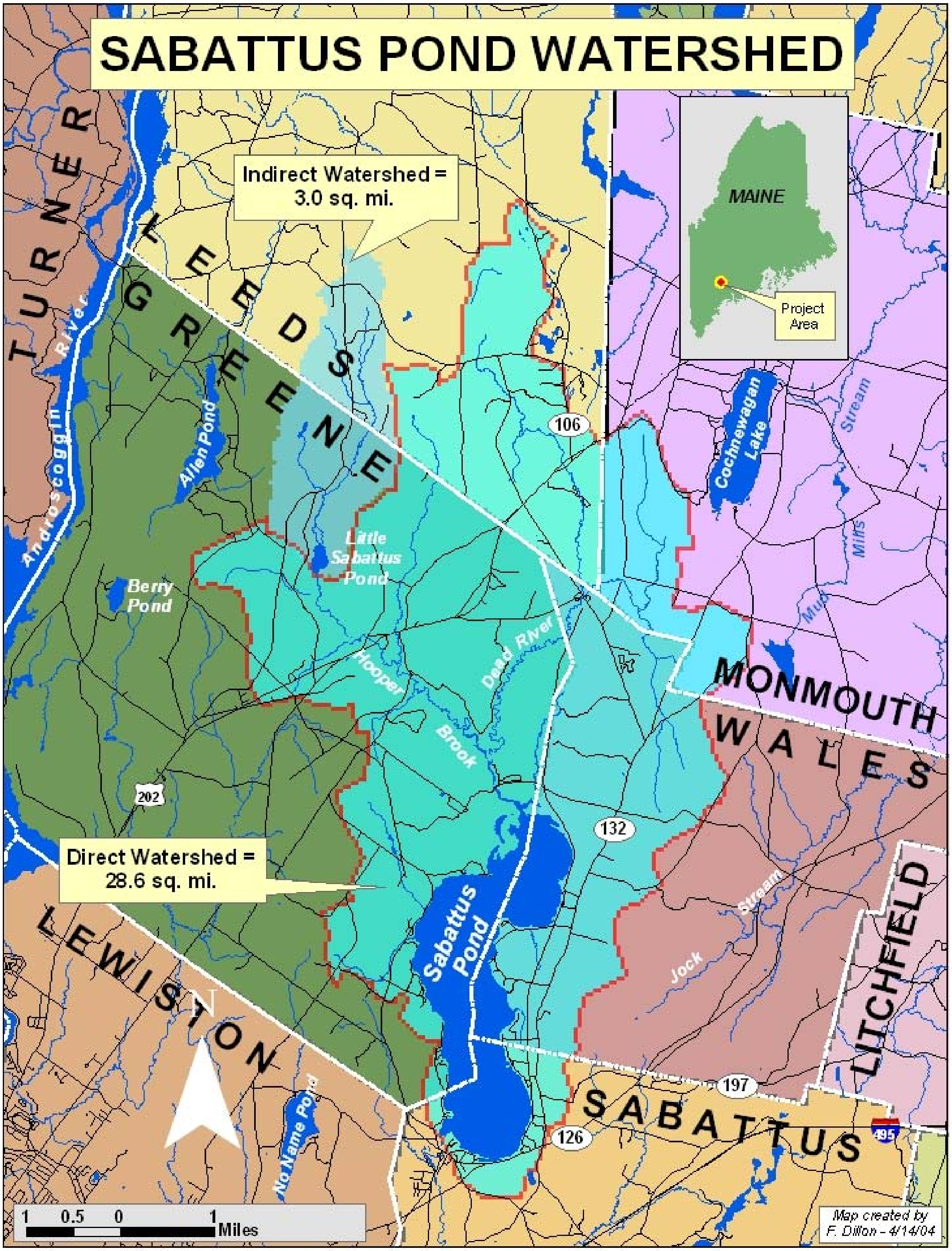
Agricultural information within the Sabattus Pond watershed was compiled from aerial photos and field surveys; tilled cropland acres were validated by NRCS staff." Information regarding forestry harvesting operations was reviewed by the Maine Forest Service, Department of Conservation.

Study Limitations

Land use data gathered for the Sabattus Pond watershed is as accurate as possible given available information and resources utilized. However, the final numbers for the land use analysis and phosphorus loading numbers **are approximate,** and should be viewed as carefully researched estimations only.

> ***Development of the Sabattus Pond PCAP-TMDL report included a pilot study that utilized extensive field-verification of data and digitally incorporated soils, slope, and installed BMP data. For a complete summary and methodology of this study, please see Appendices, pages 38—39.***

Figure 1. Map of Sabattus Pond Watershed



SABATTUS POND Phosphorus Control Action Plan

DESCRIPTION of WATERBODY (MIDAS Number 3796) and WATERSHED

SABATTUS POND is a 2,036 acre single-basin waterbody, located within the towns of Sabattus, Wales, and Greene (DeLorme Atlas, Map 12), in Androscoggin County, located in south central Maine. Sabattus Pond has a **direct watershed** area (see Figure 1) of 16,192 acres (25.30 square miles) not including the surface area of the lake. Sabattus Pond is relatively shallow, with a maximum depth of 6 meters (19 feet), an overall mean depth of 4.3 meters (14 feet), and a flushing rate of 1.52 times per year. The total Sabattus Pond watershed drainage area, including the upstream Little Sabattus Pond subwatershed, is 18,330 acres (28.6 square miles).

*The **direct watershed** refers to the land area that drains to the lake without first passing through another lake or pond.*

Drainage System – The total Sabattus Pond watershed includes the Little Sabattus Pond Watershed (Hopper Brook inlet) to the north. Sabattus Pond has a single outlet at the southern dam, 303(d) listed Sabattus River (Class C to below Lisbon), a major tributary to the Androscoggin River (10 miles distant). Maine DEP is currently completing a TMDL report for the Sabattus River (Maine DEP 2004). A number of streams drain into Sabattus Pond, including the Dead River at its northern end, by far the largest tributary, contributing a great majority of the total tributary water input to Sabattus Pond.

Water Quality Information

Sabattus Pond is listed on the Maine DEP's Clean Water Act Section 303(d) list of lakes that do not meet State water quality standards as well as the State's Nonpoint Source Priority Watersheds list; hence, the preparation of a Phosphorus Control Action Plan (and TMDL) was prepared, publicly reviewed, and completed in the late spring of 2004.

Water quality data for Sabattus Pond has been collected from the deep hole station (01) since 1977. Based on observed **Secchi disk transparencies** and total phosphorus & **chlorophyll-a** concentrations, the water quality of Sabattus Pond has shown some improvement over time, however, the potential for nuisance summertime algae blooms is still moderate to high (Maine VLMP 2002). Together, these data document an overall gradual trend of decreasing **trophic state,** in direct support of the Maine DEP Class GPA water quality criteria requiring a stable or decreasing trophic state.

Historical improvement in Sabattus Pond water quality may be due to a combination of events, including successful watershed improvement activities and late summer-fall outlet dam phosphorus-

Secchi Disk Transparency*—a measure of the transparency of water (the ability of light to penetrate water) obtained by lowering a black and white disk into water until it is no longer visible.*

***Chlorophyll-a** is the green pigment found in all plants including microscopic plants such as algae. It is used as an estimate of algal biomass; the higher the Chl-a number, the higher the amount of algae in the lake.*

***Trophic state—**the degree of eutrophication of a lake. Transparency, chlorophyll a levels, phosphorus concentrations, amount of macrophytes, and quantity of dissolved oxygen in the hypolimnion can be used to assess trophic state.*

laden water releases. Water quality relationships in Sabattus Pond appear to be quite different than that found in any of the 303(d) lakes previously studied. Measures of in-lake total phosphorus (TP) below 20 parts per billion (ppb) have been rarely observed, regardless of season, while Secchi disk transparencies of 2.0 meters or more are commonly encountered at higher P-concentrations, in excess of the standard DEP (non-algal bloom) target goal of 15-17 ppb. These anomalous findings may be due, at least in part, to characteristic shallow lake properties, including the mass re-suspension of inorganic sediment phosphorus due to continual wind disturbance. Also, suspected changes in trophic relationships due to possible favorable shifts in zooplankton population dynamics resulting from observed changes in resident fish populations may also be an operative factor.

Principal Uses: The dominant human uses of the Sabattus Pond shoreline are residential (both seasonal and year-round occupancy) and recreational—boating, fishing and swimming/beach use. There is public access to the lake at the Town of Sabattus boat launch (see photo below) and swim area located on the southwestern shore of the pond.

Sabattus Pond boat launch and town landing

Human Development: Sabattus Pond is a moderately developed lake with the majority of the shoreline developed with the exception of the northern portion of the lake (MACD 2002). There are 269 shoreline dwellings, of which an estimated 58% are seasonal cottages and 42% year-round homes (1973: 84% seasonal, 16% year-round).

The total direct watershed of Sabattus Pond is located within the towns of Sabattus, Green, Leeds, Monmouth and Wales. The watershed's populaton within the Town of Greene is 46%, while 24% of the watershed is located within the Town of Wales, 16% is located within the Town of Leeds, 8% is located within the Town of Monmouth, and 6% is located within the of the Town of Sabattus (GIS estimations, 2004).   While only 6% of the watershed lies within the town boundaries of Sabattus, a large portion of the watersheds population resides in this community. Sabattus is part of the Lewiston-Auburn metropolitan area, located five miles north of Lewiston and 15 miles southwest of Augusta in central Androscoggin County. Sabattus is known as a Stormwater Phase II community under the **National Pollutant Discharge Elimination System** (**NPDES)** permit program, with requirements that will affect new development that disturbs between 1 and 5 acres of land ("small construction

As authorized by the Clean Water Act, the ***National Pollutant Discharge Elimination System (NPDES)*** *permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.*

activities"), and urban areas within 28 municipalities in Maine that are designated under federal regulations as having regulated small Municipal Separate Storm Sewer Systems (MS4s).

*Waterbodies within designated **NPS priority watersheds** have significant value from a regional or statewide perspective and have water quality that is either impaired or threatened to some degree due to NPS water pollution. This list helps to identify watersheds where state and federal agency resources for NPS water pollution prevention or restoration should be targeted.*

Sabattus Pond is on the State's **Nonpoint Source Priority Watersheds** list due primarily to nuisance algal blooms. In addition to NPS pollution, high population growth rates, including increases in the number of homes, are a concern for the watershed. According to the 2000 US Census, there are 4,486 people currently residing in Sabattus, 1,322 in Wales, and 4,076 in Greene. The town of Sabattus experienced a 21.5% increase in the number of households for the 1990s, while the towns of Greene and Wales experienced a 12.6 and 8.1 percent increase in the number of households, respectively.

Outlet Dam Management - The outlet dam (Sleeper Dam) is owned by the Town of Sabattus and operated by the Sabattus Lake Dam Commission. The dam was originally built circa 1860. A major rebuild was undertaken in 1979 or 1980. A change in gate configuration was completed in 2002. One gate was changed to a top draw gate. The current water level order calls for the draw down to begin on October 15th, lower the water level 3 feet and then maintain the water level at 2-3 feet below full pond until spring. (Dan Guerette, personal communication). The Sabattus River flow is regulated at the outlet dam - minimum flow 2.5 cfs (Maine DEP 2004).

MACD project team members Forrest Bell and Jodi Federle consult with Phoebe Hardesty (AVSWCD) on the potential impact of this eroding roadside site to Sabattus Pond.

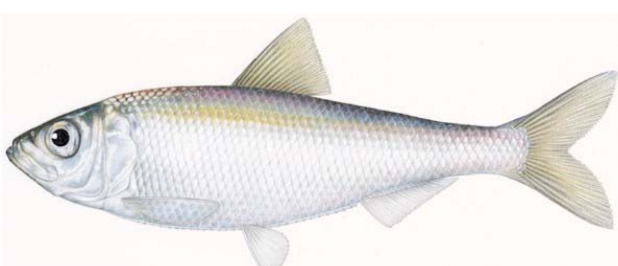
Sabattus Pond Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIFW) and a recent conversation with fish biologist Bill Woodward (Region B, Sidney DIFW office), **Sabattus Pond** (towns of Sabattus, Greene, and Wales - Androscoggin River drainage) is currently managed as warmwater fishery (pickerel, perch, and bass) and was last surveyed in 1960 (MDIFW fisheries report last revised in 1989). A total of **13** fish species are listed, including: **8** native indigenous fishes (American eel, golden shiner, fallfish, white sucker, brown bullhead, chain pickerel, pumpkinseed, and yellow perch); **4** previously introduced fishes (white perch, smallmouth and largemouth bass and **anadromous** alewife (currently under restoration by Maine Department of Marine Resources—see below); and **1** illegally introduced top predator, northern pike in the early 1990's.

***Anadromous** fish are born in fresh water, migrate to the ocean to grow into adults, and then return to fresh water to spawn.*

Sabattus Pond has been plagued with annually occurring severe summertime algal blooms for many years. Given that reducing algal productivity will restore/maintain suitable water quality conditions and fishery habitat conditions, then a significant reduction in the total phosphorus load in Sabattus Pond can lead to maintaining in-lake nutrient levels - within the assimilative capability of this lake to effectively process available phosphorus existing warmwater fisheries.

Anadromous Alewife Stocking: based on a recent conversation with Nate Gray (Maine DMR, Hallowell office), the restoration of alewives into Sabattus Pond began in 1983. However stocking of alewives was discontinued for 12-years (1986 to 1997) due to objections by Sabattus Pond stakeholders. As long as migratory alewives, both spawning adults and subsequent juveniles, have the capability to exit Sabattus Pond in a timely manner, then there is no direct evidence that their introduction/restoration will be detrimental to host lake water quality goals. Given this fact, the restoration of alewives to Sabattus Pond was resumed in 1998 and continues through the present (Table 1).



Alewife (*Alosa pseudoharengus*)

Table 1. ***History of Alewife stocking in Sabattus Pond (Maine DMR)***

YEAR	# ALEWIVES STOCKED
1983	2,022
1984	2,047
1985	17,261
1998	10,783
1999	4,958
2000	10,783
2001	9,997
2002	9,308
2003	10,518

Watershed Topography and Characteristic Soils (Source: USDA SCS 1970): Soils dominating the Sabattus Pond drainage area are:

The southwestern portion of the Sabattus Pond watershed is dominated by the **Hollis-Sutton-Buxton soil association.** These soils are characterized as shallow to deep, medium-textured and moderately coarse textured, well drained and moderately well drained, nearly level to steep soils, generally on the tops of low hills and ridges. These soils fall within the C or D hydrologic soil group.*

The majority of the watershed to the north of Sabattus Pond, including the Hooper Brook drainage area are dominated by the **Scantic-Leicester-Scarboro association.** These are characterized as deep, medium-textured and moderately coarse textured, poorly drained and very poorly drained, level to gently sloping soils. These soils also fall within the C and D hydrologic soil group and have a high potential for surface runoff.

The southern, eastern, and northeastern portion of the Sabattus Pond watershed is dominated by the **Buxton-Hartland-Belgrade association).** These are deep, medium-textured, moderately well drained , nearly level to moderately steep soils. This association (hydrologic soil groups B and C) generally has moderate to slow infiltration rates.

***** For more information on the analysis of hydrologic soils please see pages 38-39.

Land Use Inventory

The results of the Sabattus Pond watershed land use inventory are depicted in Table 2 (following page). The various land uses are categorized by developed land vs. non-developed land. The developed land area comprises approximately 17% of the watershed and the non-developed land including the water surface area of Sabattus Pond, comprise the remaining 83% of the watershed. These numbers may be used to help make future planning and conservation decisions relating to the Sabattus Pond watershed. The information in Table 2, described on pages 31-32, is used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Descriptive Land Use and Phosphorus Export Estimates

Agriculture: In 1967 a large egg farm began operation of an egg production complex, housing 360,000 laying hens, with the daily production of 50 tons of manure, which was stored behind the complex in "non-overflowing" lagoons about 0.5 km from Sabattus Pond. The lagoons periodically overflowed and eventually washed out, allowing tons of semi-liquid waste to flow into the Dead River, and Lombard Brook, tributaries to the lake. The State Water Improvement Commission, through the Attorney General's Office then instituted legal proceedings which eventually resulted in a system of disposal on agricultural lands in and out of the watershed. Waste disposal continued to be a problem and Tolman and Morrison (1970 cited in Maine DEP 1987 document) noticed manure entering the Dead River in the summer of 1969 and concurrently measured high levels of nitrogen and phosphorus in the river. The farm ceased production in the 1970s (Source: Maine DEP 1987).

In another study, Morrison (1973 cited in Maine DEP 1987 document) measured high levels of nutrients in influent tributaries and concluded that the problem of increased eutrophication of Sabattus Pond was more likely due to the egg farm and other agricultural activities in the

Table 2. SABATTUS Pond Direct Watershed - Land Use and P-Loads.				
LAND USE CATEGORY	**Total Land Area Acres**		**Total Land Area %**	**TP Export Total %**
Agricultural & Forested Land		**Sabattus Pond**		
Cropland	26		0.1	1.3
Hayland (Manured)	79		0.4	2.8
Low-Intensity Hayland	632		3.4	9.9
Orchard	65		0.4	0.6
Pasture/Barnyard	106		0.6	2.2
Operated Forest Land	72		0.4	0.7
Sub-Totals	**1,010**		**6%**	**18%**
Shoreline Development		**Sabattus Pond**		
Low Density Residential	47		0.3	0.5
Medium Density Residential	22		0.1	0.6
High Density Residential	79		0.4	3.4
Septic Systems	—		0.0	2.1
Camp/Private Road	22		0.1	2.3
Recreational	2		0.0	0.0
Sub-Totals	**173**		**1%**	**9%**
Non-Shoreline Development		**Sabattus Pond**		
State and Town Roadways	272		1.5	10.1
Low Density Residential	1,045		5.7	12.9
Medium Density Residential	38		0.2	1.0
High Density Residential	2		0.0	0.0
Commercial Property	163		0.9	6.0
Gravel Pits	155		1.0	0.0
Institutional (Public)	5		0.0	0.1
Golf Course	146		0.8	5.4
Parks/Cemeteries	2		0.0	0.0
Urban Stormwater—Sabattus	131		0.7	7.2
Sub-Totals	**1,960**		**11%**	**43%**
Total: DEVELOPED Land	**3,143**		**17%**	**70%**
Non-Developed Land		**Sabattus Pond**		
Inactive/Passively Managed Forest	8,807		48.0	9.3
Wetlands	1,547		8.4	0.0
Scrub Shrub	324		1.8	0.8
Reverting Fields	2,473		13.5	12.6
Total: NON-DEVELOPED Land	**13,151**	**Sabattus P.**	**72%**	**23%**
Total: Surface Water (Atmospheric)	**2.036**		**11%**	**7%**
TOTAL: DIRECT WATERSHED	**18,330**	**Sabattus P.**	**100%**	**100%**

watershed than a result of input from cottage septic systems. However, no effort was made to assess the relative contribution of each activity.

In the 1980's, the USDA Soil Conservation Service (SCS) worked with area landowners in cooperation with the Maine DEP and the Androscoggin Valley Soil and Water Conservation District to develop Best Management Practices for eleven watershed farms. Long term agreements were developed between SCS and the landowner for needed work. Continuous changes in the farming industry resulted in modifications in farm operations and in some BMPs from the original schedule (Maine DEP 1987).

As a result of the extensive amount of conservation measures employed, in addition to less intensive farming practices and changes in land use patterns, a significant reduction in external loading from agricultural sources has likely occurred. In fact, much of the reduction of phosphorus export since the Maine DEP's estimated watershed export of 1987 (2,700 kg/yr) compared to current estimates (1,819 kg/yr) may be attributed to the extensive work of the USDA SCS, now referred to as the Natural Resources Conservation Service, and the Androscoggin Valley SWCD.

During the last decade (1991 to 2001), there have been fewer agricultural conservation practices installed by the Lewiston NRCS office, with the exception of the development of nutrient management plans for farms in the watershed. Agricultural data were compiled from aerial photo analysis by project staff using 2001 data. Lewiston NRCS staff verified cropland acres only. Some discrepancies between acreage types as identified in the report, and known land use, were noted.

Currently, the agricultural land area of the Sabattus Pond drainage area comprises 6% of the total watershed area and 17% of the external phosphorus load.

Forestry: Generally, poorly managed forestry operations have the potential to negatively impact a waterbody by erosion and sedimentation from logging sites. Local foresters within the Sabattus Pond watershed have worked with the AVSWCD to minimize potential impacts and many are Certified Logging Professionals trained to reduce potential environmental impacts associated with forest practices.

The estimated "operated forestland" acres for Sabattus Pond, based on GIS analysis, average 72 acres per year. This estimate was verified by ground-truthing of the watershed.

Harvested forest acres in Maine typically regenerate as forest, whether or not they are under any type of planned forest management or under the supervision of a Licensed Forester. Forest areas without harvesting may be managed passively, or may be under an active management program with no commercial activity occurring in 1998-2001. Landowner Reports also reflect forest acres that which have been cleared with the intention of converting the land to another use, such as cropland, pasture, or residential use. There were a total of 2 acres of "forest conversion" reported during this four-year time period. The operated forestland area within the watershed approximates 0.4% of the total land area and an estimated 0.7% of the total phosphorus load to Sabattus Pond.

Shoreline Residential (House and Camp Lots):

In order to evaluate the impact of lake shoreline homes, project staff conducted a shoreline residential survey in the summer of 2002 with the assistance of Maine DEP, the Sabattus Pond Watershed Partnership and the Androscoggin Valley SWCD. This visual survey was carried out while observing the Sabattus Pond shoreline from boats and the results are based on subjective determinations of potential impact rates using best professional judgment. The visual survey included a residential structure tally along with estimating a potential impact rating ranging from 5 to 17, with 5 being "undisturbed", 6-7 being "low-impact", 8-12 being "medium impact", and 13-17 being "high-impact". A lot given a score of 5 would be a best case scenario, generally undeveloped and having a full naturally occurring vegetated buffer. Conversely, a lot given a score of 17 would be a worst case scenario, exhibiting little or no vegetative buffer (natural or ornamental) and supporting bare (eroding) soil - a visible source of phosphorus input to the lake. In addition to the impact rating, project staff estimated the residency status of the dwelling (seasonal vs. year-round), the relative distance of the dwelling to the lake, the percent slope of the lot, the presence or lack of vegetated buffers, presence of bare soils, existing rip rap, and other notable features such as presence of retaining walls or boat launches. A summary of the findings for Sabattus Pond is depicted in Table 3. In order to protect landowner confidentiality, detailed spreadsheets (by map and lot #) developed as part of the survey will be distributed to the local stakeholders for use in future non-point source BMP implementation work.

Table 3: Results of 2002 Sabattus Pond Shoreline Survey

Variable	Number	Percent
Total number of lots surveyed	297	n/a
Number of developed lots	285	n/a
Average impact rating	10.1	n/a
Dwellings less than 75' from lake	187	63%
Lot on steep slope of more than 20%	75	25%
Inadequate shoreline buffer	139	47%
Bare soil evident	102	34%
Significant shoreline erosion*	41	14%
Existing shoreline riprap evident	166	56%
"Good" natural vegetation present	62	21%
"High impact" lots	72	24%
"Medium impact" lots	169	57%
"Low impact" lots	39	13%
"Undisturbed" lots	7	6%

* Although significant shoreline erosion was only noted on 41 lots, 13 of the sites were "severe" in nature and should be addressed in lakefront restoration efforts.

Overall, 81% of the developed shoreline lots on Sabattus Pond have a moderate to high impact due to inadequate or nonexistent vegetative buffers and/or close proximity to the lake. Many of the shoreline areas have been adequately rip-rapped at the toe of the slopes, but lack vegetative plantings (other than mowed lawns) above the rip-rapped areas. Vegetative buffers help to decrease the amount and flow of run-off from the site. Many of the homes and cottages have mowed grass lawns that stretch down to the lake and do not serve as adequate vegetated buffers.

- *To convert kg of total phosphorus to pounds—multiply by 2.2046*
- *To convert kg/hectare to lbs/acre—multiply by .892*

Phosphorus loading from Sabattus Pond shoreline residential areas is categorized into low, medium, and high impact rating classes. These ratings are derived directly from the shoreline visual survey impact classes. For Sabattus Pond, shoreline residential sites (not inclusive of septic systems) are estimated to contribute 4.5% of the total watershed (external) phosphorus load. Low impact sites contribute only 0.5% of the TP-load, medium impact sites contribute 0.6%, and high impact sites contribute 3.4% of the external, watershed derived TP-load to Sabattus Pond. However, it should be noted that these figures can be misleading. Shoreline residential areas, if properly vegetated, can provide extensive buffering from the export of P from watershed and are crucial areas for focusing on the reduction of pollutants.

Shoreline Septic Systems:

It is important to consider the potential for phosphorus loading from septic systems due to the high number of dwellings in close proximity to the lake, coupled with the sandy soils of some shoreline areas of Sabattus Pond.

In 1970 the Environmental Improvement Corporation contracted with the firm of Wright, Pierce, Barnes and Wyman to do a physical survey of the lake. The consultants concluded that a substantial part of the Sabattus Pond water quality problem was due to malfunctioning septic systems and recommended that 9 miles of the shoreline and the town to be sewered at a cost of $6 million. Since the towns of Greene and Wales did not elect to join the sewer district, only the village of Sabattus and shoreline of the pond within the Sabattus town line was sewered. This included approximately 140 dwellings on the lake. Construction was completed in 1983.

Currently, there are no public sewer services for the Towns of Wales or Greene within the Sabattus Pond watershed. The Town of Sabattus is sewered. Consequently, all Sabattus Pond watershed dwellings within the Town of Sabattus were not included in the septic survey.

For this study, in order to estimate total phosphorus loading from shoreline septic systems, a simple model was used based on the following attributes: seasonal or year-round occupancy; estimated age of the system; estimated distance of the system to the lake; and an estimated 3 people per dwelling. These attribute values were determined by shoreline survey, town records, and using model assumptions. Loading from residential septic systems on Sabattus Pond range from a low of 22 to a high of 68 kg total phosphorus per year. Residential shoreline septic loading approximates an average total phosphorus export of 2.1% or 38 kg.

Recreational (Shoreline): Included in this category are the public boat launch/swim area (approximately 2 acres) on the southwestern shore of Sabattus Pond. Estimates of loading from recreational (shoreline) development approximates an average TP export of less than 1% or 1 kg of TP annually.

Shoreline Erosion: Some areas of the shoreline where erosion is on-going, in part due to natural causes of wind, wave and ice action, have not been included as a source of phosphorus due to the difficulty in quantifying the size of the impacted area and assigning suitable coefficients. Of particular interest to AVSWCD personnel at this time is an area along the southeast shoreline of the pond that has been estimated to have regressed by 40 to 50 feet in the last 50 years (personal communication from D. Guerette; comparison of aerial photos, 1946 and 1998), and where erosion appears to have accelerated in the last 10 years after shoreline vegetation was removed (see Action Item #2, page 22).

Private/Camp Roadways: There are approximately 25 private camp roads around Sabattus Pond. As of March 2004, there was 1 formal road association for the private camp roads around Sabattus Pond (Phoebe Hardesty, personal communication) while two others are considering establishing associations. Total phosphorus loading from private camp roads comprises only 0.1% of the land area and approximates 2.3% of the total watershed TP export annually.

Overall, <u>shoreline development</u> comprises only 1% of the total watershed area however it contributes an average of 163 kg of total phosphorus annually which approximates 9% of the estimated phosphorus load.

<u>Other Development and Land Uses</u>

Non-Shoreline Development - All lands outside the immediate shoreline area of Sabattus Pond, including state and town roadways, non-shoreline residential areas, commercial, institutional (public) areas and the public golf course. These land use areas were calculated using GIS land use coverage provided by Orbis, as well as tax data, aerial photos and field visits (groundtruthing).

Public Roadways: There are 125 total miles of roads within the Sabattus Pond watershed. Public roadways account for a much greater percentage of the phosphorus load (10.1%) versus its land area (1.5%) in the Sabattus Pond watershed.

Residential Homes: Field reconnaissance of all roads in the watershed was undertaken to determine the number of non-shoreline residential dwellings (n = 968) within the Sabattus Pond watershed. This land use is characterized by dispersed, single-family homes. Non-shoreline residential areas account for 13.9% of the total phosphorus load to Sabattus Pond.

Commercial: Commercial development within the watershed is primarily located in the southern reaches of the watershed and accounts for less than 6% of the total phosphorus load to the Pond.

Gravel Pits, Parks and Cemeteries: Gravel pits, parks and cemeteries are not listed as a contributor of phosphorus to Sabattus Pond but may have a negative impact if not properly maintained and stabilized.

Institutional: Institutional areas include schools and municipal buildings. Institutional land areas account for less than 0.1% of the total phosphorus load to Sabattus Pond.

Golf Course: A popular golf course is located within the watershed. During the spring of 2004, MACD project staff toured the golf course with the superintendent in order to assess the need for on-site NPS-BMPs. Total phosphorus loading estimates from the golf course area comprise 0.8% of the total land area and 5.4% of the total phosphorus load.

Overall, non-shoreline development accounts for 11% of the total land area and contributes about 43% of the total phosphorus load to Sabattus Pond.

Phosphorus Loading from Non-Developed Lands

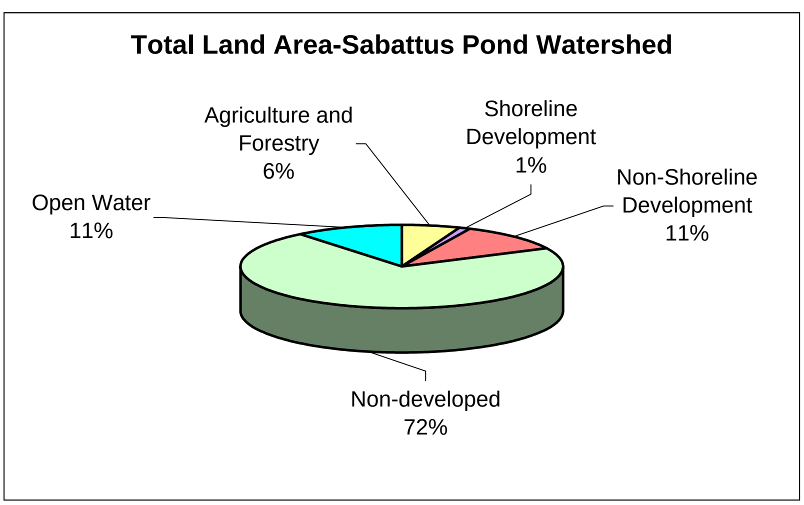
Inactive/Passively Managed Forests: Of the total land area within the Sabattus Pond watershed, 48% (8,807 acres) is forested, characterized by privately-owned non-managed deciduous and mixed forest plots (GIS, MACD 2004). About 9.3% of the phosphorus load is estimated to be derived from non-commercial forested areas within Sabattus Pond's direct drainage area.

Other Non-Developed Land Areas: Combined wetlands, scrub shrub, and reverting fields account for the remaining 23.7% of the land area and 13.4% of the non-developed total phosphorus export load.

Atmospheric Deposition (Open Water): Includes phosphorus from atmospheric sources depositing onto Sabattus Pond surface waters (2,036 acres) which comprise 11% of the total watershed area (18,330 acres), representing 7% of the total phosphorus load entering Sabattus Pond.

Figure 2 (below) depicts the percentage of total land area covered by each land use.

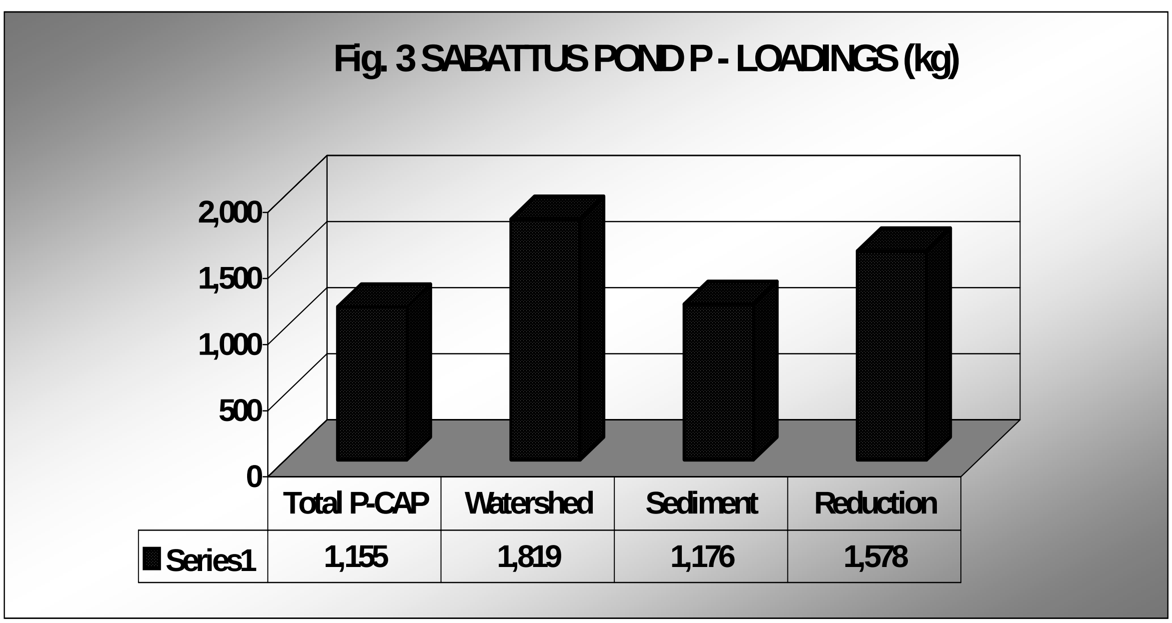
Figure 2. Sabattus Pond Direct Watershed - Total Land Area



PHOSPHORUS LOADS – Watershed, Sediment and In-Lake Capacity

Supporting documentation for the phosphorus loading analysis includes the following: water quality monitoring data from Maine DEP and the Volunteer Lake Monitoring Program, and the development of a phosphorus retention model (see Appendices for detailed information).

- Total phosphorus loadings to Sabattus Pond originate from a combination of watershed and pond sediment sources. Watershed total phosphorus sources, averaging 1,819 kg annually have been identified and accounted for by land use (See Table 4—page 30.).
- Total phosphorus loading from the associated upstream Little Sabattus Pond accounts for indirect watershed average load of 42 kg annually, as determined on the basis of *flushing rate x volume x TP concentration (*15 x 252,747 x 11 ppb = 42 kg/yr*),* representing typical area gauged streamflow calculations.
- The contribution of sediment sources of total phosphorus within Sabattus Pond range from 637 to 1,893 kg with an average annual value approximating 1,176 kg (see page 33 for more information).
- The annual TP contribution to account for future development for Sabattus Pond is 38 kg.
- The load allocation for all existing and future non-point pollution sources for Sabattus Pond is 1,155 kg of total phosphorus per year, based on a non– algal bloom target goal of 15 ppb.
- A change of 1 ppb in phosphorus concentration in Sabattus Pond is equivalent to 77 kg. The difference between the target goal of 15 ppb and the measured average summertime total phosphorus concentration (35 ppb) is 20 ppb (20 x 77) or 1,540 kg.
- Given a 38 kg allocation for future development (0.5 x 77), the total amount of phosphorus needed to be reduced to maintain water quality standards in Sabattus Pond is estimated to be 1,578 kg (1,540 + 38).



SABATTUS POND

PHOSPHORUS CONTROL ACTION PLAN

Recent and Current NPS/BMP Efforts

In 1973, the Maine DEP compiled a “Report on the Sabattus Pond Problem”. This study documented significant water quality impairment to Sabattus Pond due to agriculture, shoreline septic systems, and long term historical impairments. The report also recommended several steps for restoration, including recommendations for agricultural conservation practices, suggestions on water level management, and solutions to address waste water management.

Maine DEP completed a Diagnostic Feasibility Study (1978) for the Sabattus Pond watershed. Results of this study showed two significant sources of total phosphorus input to Sabattus Pond, 2700 kg/year from the watershed and 700-2000 kg/year from lake sediments. Based on the results of this study a two phase restoration project was developed in cooperation with the Town of Sabattus, Sabattus Lake Association, AVSWCD, and the Androscoggin Valley Regional Planning Commission with matching funds from EPA under section 314 of the Clean Water Act. Phase I involved enhanced seasonal flushing by lake drawdown at the height of algal blooms to export total phosphorus from the lake. Phase II was the installation of BMPs on 11 area farms.

In 1995 a volunteer watershed survey, sponsored by the Maine DEP, was completed for the Sabattus Pond watershed. The watershed was split into sectors and trained volunteers surveyed their sectors for evidence of soil erosion and sedimentation. 110 problem sites were identified in the 1995 survey, including 21 private road sites, 28 state and town road sites, 18 residential sites, and 12 shoreline sites.

A second survey of the Sabattus Pond watershed was conducted in October and November of 2000. The purpose of the survey was to train a new group of watershed volunteers on nonpoint source pollution, and to expand upon existing information about the area. Volunteers, with resource professionals from Maine DEP and the Androscoggin Valley SWCD, worked in three sectors, and also assessed sites along the Sawyer Road. Neither of the two surveys were all-encompassing and more survey work is needed.

A total of 34 sites in Greene and Sabattus were identified during the 2000 survey. The majority of the sites were road related. A total of 15 sites were documented on town roads, 14 on private roads, and five were categorized as residential. Although the survey was publicized, and volunteers carried information packets, there was some reluctance on the part of volunteers to enter private properties; many of the properties are seasonal. On roads, problems that were noted included poor grading, insufficient ditching, use of poor materials, lack of maintenance, and improperly installed culverts. Residential sites included such things as unstable driveways, and insufficient vegetation. Overall, 11 of the sites were determined to be in the high cost range for stabilization ($2500 to $22,000), 18 in the moderate range ($500 to $2500), and the remaining 5 sites in the low cost range (under $500).

Currently, the AVSWCD has entered into three letters of agreement for construction projects beginning in the spring of 2004, two shoreline stabilization projects and a small project at the Sabattus Town Beach. Also, AVSWCD along with the Maine DOT is preparing a grant application for MDOT's Surface Water Quality Protection Program along Route 126. AVSWCD has and will continue to focus on technical assistance and outreach and education programs.

Recommendations for Future Work

Sabattus Pond is a waterbody that has impaired water quality due mostly to nonpoint source (NPS) pollution and resultant internal sediment recycling of phosphorus. Specific recommendations regarding recent and current efforts in the watershed, Best Management Practices (BMPs), and actions to reduce external watershed total phosphorus loadings in order to improve water quality conditions in Sabattus Pond are as follows:

Watershed Management: Since the mid-1990's, the AVSWCD and Sabattus Pond Watershed Partnership (SPWP) have taken an active role in documenting and mitigating nonpoint source (NPS) pollution sites throughout the Sabattus Pond watershed. The last documented survey was performed in by Maine DEP and volunteers in 1995. Watershed residents, municipal officials and the Maine DEP should continue to support the AVSWCD and SPWP in its continued efforts to implement BMPs and promote conservation education in the Sabattus Pond Watershed.

Action Item # 1: Coordinate Existing Watershed Management Efforts

Activity	Participants	Schedule & Cost
Develop a Sabattus Pond Leadership Team	AVSWCD, SPWP, Maine DEP, municipalities, local business, watershed citizens	Annual Roundtable Meetings beginning in 2004 **$2,500/yr**

Shoreline Residential: These areas have the potential to negatively impact the water quality of Sabattus Pond. The 2002 MACD shoreline survey found that many of the residential shoreline lots have inadequate or nonexistent vegetative buffers. Some of the shoreline areas have been rip-rapped, however, there is a noticeable lack of vegetative plantings above these rip-rapped areas, necessary to decrease and slow run-off from shore land sites. An effort should be undertaken to encourage landowners to establish adequate and effective vegetated buffers along the shoreline. Free technical assistance (funded through a 319 grant) by the AVSWCD should be well-publicized to all shoreline landowners.

Action Item # 2: Implement a Shoreline Erosion Control & Planting Campaign

Activity	Participants	Schedule & Cost
Develop a Shorefront Restoration Campaign, improve vegetative buffer zones and stabilize eroding banks.	AVSWCD, SPWP, Maine DEP, watershed citizens, local nurseries	Annually beginning in 2002 **$25,000/yr**

Roadways: Several watershed roads have the potential to be a major source of erosion and sedimentation to the lake. During the MACD Sabattus Pond watershed inventory in 2003, 20 road crossings or segments were noted as potential NPS sites. Road problems noted include moderate to severe surface erosion, poor shaping, moderate to severe shoulder erosion and an unstable culvert. For free technical assistance about proper camp road maintenance and potential cost-share funds, contact the AVSWCD (Lewiston).

Action Item # 3: Implement Road Best Management Practices		
Activity	**Participants**	**Schedule & Cost**
Continue to Implement Roadside BMPs watershed-wide	AVSWCD, SPWP, Maine DOT, Maine DEP, road associations	Ongoing, beginning in 2002 **$20,000/yr**

Agriculture: Since the early 1980's, the Androscoggin Valley Soil and Water Conservation District and the USDA Natural Resources Conservation Service (NRCS) have worked cooperatively with landowners to install agricultural conservation practices in the watershed. For free technical assistance, potential cost-share funds or for more information about proper agricultural BMPs, contact the AVSWCD or NRCS offices in Lewiston.

Forestry: Landowners, loggers and foresters working within the watershed should contact the Maine Forest Service (1-800-367-0223) for a copy of Forestry BMP guidelines and other forest management assistance. Special attention should be given to forest access roads and proper erosion control measures should be utilized.

Action Item # 4: Conduct Workshops for Agriculture and Forestry Operators		
Activity	**Participants**	**Schedule & Cost**
Conduct workshops encouraging the use of phosphorus control measures	AVSWCD, NRCS, MFS, forestry and agriculture community	Annually beginning in 2004 **$3,000/yr**

Non-Shoreline Residential and Commercial: These properties should be considered as potential problem areas for phosphorus input, especially those adjacent to Sabattus Pond watershed brooks and streams. These areas should be included in future education and outreach efforts as all residents within the watershed will benefit from improved water quality in Sabattus Pond. Note: Lois Ongley (educator) is working with Oak Hill High School students to monitor some Sabattus Pond watershed tributaries.

Action Item # 5: Develop Stewardship Initiatives for Sabattus Pond Tributaries		
Activity	**Participants**	**Schedule & Cost**
"Adopt" local streams to promote stewardship efforts including education and water quality monitoring	AVSWCD, SPWP, Maine DEP Stream Team, local schools, golf courses, and watershed citizens	Annually beginning in 2004 **$15,000/yr**

Individual Action: All watershed residents should be encouraged through continued education and outreach efforts, including: retention or planting of natural vegetation of buffer strips, use of non-phosphate cleaning detergents, elimination of phosphorus-containing fertilizers, adequate maintenance of septic systems.

Action Item # 6: Expand Homeowner Education & Technical Assistance Programs		
Activity	**Participants**	**Schedule & Cost**
Increase outreach and education efforts to watershed citizens including technical assistance to landowners	AVSWCD, WPA, watershed municipalities	Annually beginning in 2004 **$15,000/yr includes printing of educational materials**

Municipal Action: Should include ensuring public compliance with local and state water quality laws and ordinances (Shoreland Zoning, Erosion and Sedimentation Control Law, plumbing code) through education and enforcement action, when necessary. The Androscoggin Valley Council of Governments is actively working with watershed municipalities to train municipal officials on nonpoint source pollution issues.

Water Level Management: The continuance of the current water level management plan is a means for partially controlling total phosphorus concentrations in Sabattus Pond via the constant summer time surface flushing of phosphorus-laden algae from the lake. This management tool should be an effective means for helping to restore water quality.

Action Item # 7: Utilize Water Level Management Plan		
Activity	**Participants**	**Schedule & Cost**
Utilize existing water level plan for phosphorus control and keep log of drawdown (duration and water level)	Sabattus Lake Dam Commission, Maine DEP	ongoing **No cost**

WATER QUALITY MONITORING PLAN

Historically, the water quality of Sabattus Pond has been monitored via measures of Secchi disk transparencies during the open water months since 1977 (Maine DEP and VLMP). Continued long-term water quality monitoring within Sabattus Pond will be conducted bi-weekly, from May thru September, through the continued efforts of the Maine Volunteer Lake Monitoring Program (VLMP) in cooperation with Maine DEP. Under this planned, post-TMDL water quality monitoring scenario, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Sabattus Pond. A post-TMDL adaptive management status report will be prepared five to ten years following EPA approval.

PCAP CLOSING STATEMENT

The Androscoggin Valley Soil and Water Conservation District (AVSWCD), in cooperation with lake stakeholders, have worked diligently since the early to mid-1990's addressing nonpoint source pollution in the watershed of Sabattus Pond. Technical assistance by AVSWCD is available to all watershed towns to mitigate phosphorus export from existing NPS pollution sources and to prevent excess loading from future sources through the AVSWCD and the Androscoggin Valley Council of Governments technical advice to local planning boards. Sabattus Pond watershed towns recognize the value of their water resources and its link to the local way of life in the respective communities as well as the local economies by providing strong support to lake restoration and protection efforts. These towns should be commended for their continued support of and cooperation with AVSWCD and the SPWP in the pursuit of regional lake protection and improvement. This teamwork approach by regional and local groups, in conjunction with the continued water quality protection efforts of AVSWCD and the Sabattus Pond Watershed Partnership lends a high probability that NPS awareness and NPS-BMP implementation within the watershed will increase in future years.

During the past 23 years of monitoring records, the average annual (growing season) transparency of Sabattus Pond has gradually improved, from a low-point of 1.65 meters (1977-1981) to a current average of 2.43 meters (Figure 4). Average annual (growing season) in-lake total phosphorus measures have declined 10 ppb, from 45 to 35, based on historical epilimnetic core samples. Nuisance summertime algal blooms are still occurring in Sabattus Pond, however, the prevalence of such events are more apt to occur later in the summer, particularly in August through September. Continued focus on restoring the entire Sabattus Pond watershed should help continue this improving trend in water quality over time.

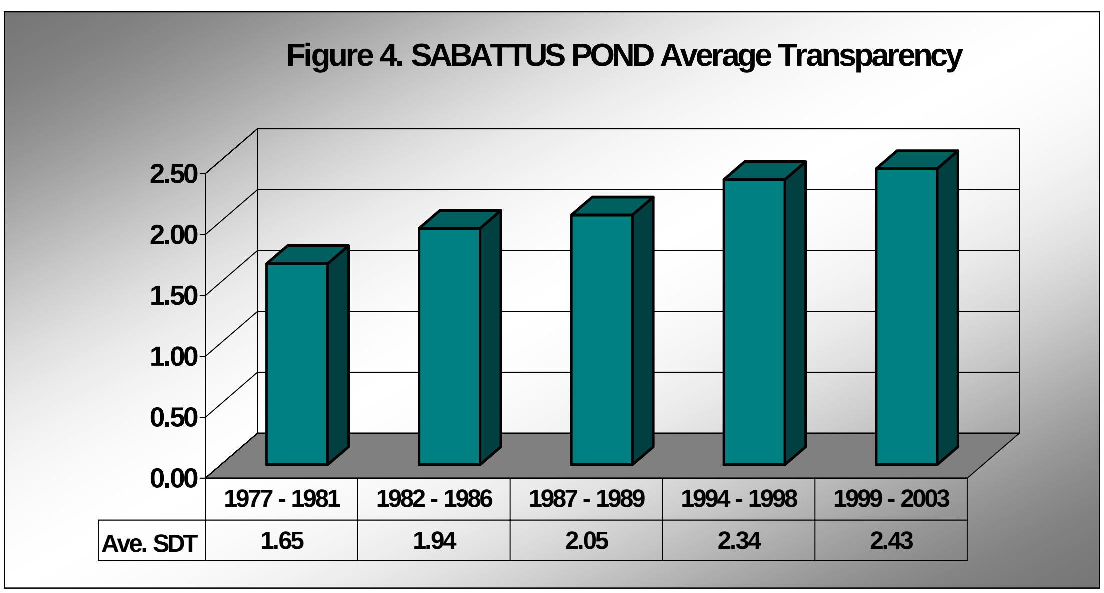


Figure 4. SABATTUS POND Average Transparency

APPENDICES

SABATTUS POND

Total Maximum Daily (Annual Phosphorus) Load

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Introduction to Maine Lake TMDLs and Phosphorus Control Action Plans (PCAPs)

You may be wondering what the acronym 'TMDL' represents and what it is all about. TMDL is actually short for 'Total Maximum Daily Load.' This information, no doubt, does little to clarify TMDLs in most people's minds. However, when we think of this as an annual phosphorus load (*Annual Total Phosphorus Load),* it begins to make more sense.

Simply stated, excess nutrients or phosphorus in lakes promote nuisance algae growth/blooms - resulting in the violation of water quality standards as measured by water clarity depths of less than 2 meters. A lake TMDL is prepared to estimate the total amount of total phosphorus that a lake can accept on an annual basis without harming water quality. Historically, development of TMDLs was first mandated by the Clean Water Act in 1972, and was applied primarily to *point sources* of water pollution. As a result of public pressure to further clean up water bodies, lake and stream TMDLs are now being prepared for watershed-generated *Non-Point Sources* (NPS) of pollution.

Nutrient enrichment of lakes through excess total phosphorus originating from watershed soil erosion has been generally recognized as the primary source of NPS pollution. Major land use activities contributing to the external phosphorus load in lakes include residential-commercial developments, roadways, agriculture, and commercial forestry. Statewide, there are 38 lakes in Maine which do not meet water quality standards due to excessive amounts of in-lake total phosphorus.

The first Maine lake TMDL was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with Maine DEP and US-EPA. TMDLs have also been approved by US-EPA for Madawaska Lake (Aroostook County), Sebasticook Lake, East Pond (Belgrade Lakes), China Lake, Webber, Threemile and Threecornered Ponds (Kennebec County), and Mousam and Highland lakes in southern Maine. PCAP-TMDLs are presently being prepared by Maine DEP, with assistance from the Maine Association of Conservation Districts (MACD) and County Soil and Water Conservation Districts (SWCDs) - for Pleasant Pond and Annabessacook Lake, Sabattus, Unity, and Toothaker ponds, and Highland Lake (Bridgton - with assistance from Lakes Environmental Association). PCAP-TMDL studies have also been initiated for Togus and Lovejoy ponds, Little Cobbossee Lake and Upper Narrows Pond (under contract with CWD) and Long Lake (Bridgton - with assistance from LEA). Duckpuddle and Lilly ponds in Knox-Lincoln County SWCD will be studied next, along with Hermon and Hammond ponds, and the remaining seven 303(d) listed PCAP-TMDL waterbodies in Aroostook County.

Lake PCAP-TMDL reports are based in part on available water quality data, including seasonal measures of total phosphorus, chlorophyll-a, Secchi disk transparencies, and dissolved oxygen-water temperature profiles. Actual reports include: a lake description; watershed GIS assessment and estimation of NPS pollutant sources; selection of a total phosphorus target goal (acceptable amount); allocation of watershed/land-use phosphorus loadings, and a public participation component to allow for stakeholder review.

PCAP-TMDLs are important tools for maintaining and protecting acceptable lake water quality and are designed to 'get a handle' on the magnitude of the NPS pollution problem and to develop plans for implementing Best Management Practices (BMPs) to effectively address the lake's water pollution problem. Landowners and watershed groups are eligible to receive technical and financial assistance from state and federal natural resource agencies to reduce watershed total phosphorus loadings to the lake. **Note:** for non-stormwater regulated lake watersheds, the *development of phosphorus-based lake PCAP-TMDLs are not intended by Maine DEP to be used for regulatory purposes*.

For further information, you may contact Dave Halliwell, Maine Department of Environmental Protection, Lakes PCAP-TMDL Program Manager, SHS #17, Augusta, ME 04333 (287-7649).

Water Quality Monitoring: (Source: Maine DEP and VLMP 2003) Water quality monitoring data for Sabattus Pond has been collected annually from 1977 to 1989 and 1994 to the present. This water quality assessment is based on 23 years of Secchi disk transparency (SDT) measures, combined with 20 years of epilimnion core total phosphorus (TP) and water chemistry data and 23 years of chlorophyll-a monitoring data.

Water Quality Measures: (Source: Maine DEP and VLMP 2003) Sabattus Pond has a range of SDT measures from 0.5 to 5.5 meters, with an average of 2.1 m, an epilimnion core TP range of 24 to 63 with an average of 40 parts per billion (ppb), and chlorophyll-a measures ranging from 2.5 to 134, with an average of 25 ppb. Recent dissolved oxygen (DO) profiles indicate well-mixed water conditions and moderate levels of DO in deep areas of the lake. The potential for total phosphorus to leave the bottom sediments and become available to algae in the water column (internal loading) is high (Maine DEP 2001).

Priority Ranking, Pollutant of Concern and Algae Bloom History: Sabattus Pond is listed on the State's 2002 303(d) list of waters in non-attainment of Maine state water quality standards and was moved up in the priority development order due to stakeholder interest and need to complete an accelerated approach to lakes TMDL development. The Sabattus Pond PCAP-TMDL has been developed for total phosphorus, the major limiting nutrient to algae growth in other 303(d) listed freshwater lakes in Maine.

The water quality of Sabattus Pond during the summers of 2002-2003 appears to be somewhat improved in contrast to the preceding 20+ years of record. Average historical water transparencies were 2.1 meters (vs. 2.6) and total phosphorus averaged 40 ppb (vs. 30 ppb), while chlorophyll-a (mean 16 ppb) levels averaged 25 (vs. 15). Nuisance algae blooms were still prevalent in Sabattus Pond during the summers of 2002-2003, but generally occurred later in the season, in contrast to earlier algal blooms in past years.

Natural Environmental Background Levels: Were not separated for the total nonpoint source load for Sabattus Pond from because of the limited and general nature of available information. Without more and detailed site-specific information on nonpoint source loading, it is very difficult to separate natural background from the total nonpoint source load (US-EPA 1999).

WATER QUALITY STANDARDS & TARGET GOALS

Maine State Water Quality Standard for nutrients which are narrative, are as follows *(July 1994 Maine Revised Statutes Title 38, Article 4-A*): "Great Ponds Class A (GPA) waters shall have a stable or decreasing trophic state (based on appropriate measures, e.g., total phosphorus, chlorophyll a, Secchi disk transparency) subject only to natural fluctuations, and be free of culturally induced algae blooms which impair their potential use and enjoyment."

Maine DEP's functional definition of nuisance algae blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<26 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Sabattus Pond is a moderately colored lake (average color 32 SPU), with an average SDT of only 2.1 m, in association with elevated average chlorophyll a levels of 25 ppb (1977 - 2003). Currently, Sabattus Pond does not meet water quality standards due to the prevalence of annual summertime nuisance algae blooms. This water quality assessment uses historic documented conditions as a primary basis for comparison.

Designated Uses and Antidegradation Policy: Sabattus Pond is designated as a GPA (Great Pond Class A) water in the Maine DEP state water quality regulations. Designated uses for GPA waters in general include: water supply; primary/secondary contact recreation (swimming and fishing); hydro-electric power generation; navigation; and fish and wildlife habitat. No change of land use in the watershed of a Class GPA water body may, by itself or in combination with other activities, cause water quality degradation that would impair designated uses of downstream GPA waters or cause an increase in their trophic state. Maine's anti-degradation policy requires that "existing in-stream water uses, and the level of water quality necessary to sustain those uses, must be maintained and protected."

Numeric Water Quality Target: The water quality goal for Sabattus Pond is to ensure a continuing trend of decreasing trophic state so that it can maintain the Maine DEP standard of stable or decreasing trophic state. The numeric (in-lake) water quality target for Sabattus Pond, to meet this goal, is set at 15 ppb total phosphorus (1,155 kg TP/yr). Maine DEP considered the water quality standards in downstream 303(d) listed Sabattus River (Maine DEP 2001, 2003) when setting the in-lake TMDL target for Sabattus Pond. Since numeric criteria for total phosphorus do not exist in Maine's water quality regulations - and would be less accurate targets than those derived from this study - we employed best professional judgment to select a target in-lake total phosphorus concentration that would attain the narrative water quality standard. This water quality target is also stringent enough to protect downstream uses and provide for the attainment and maintenance of Sabattus River (listed for dissolved oxygen and nutrient loading), provided other sources of impairment to the river are also addressed (municipal point source and agricultural non-point source). Low-level spring-time (early May to late June) total phosphorus levels in Sabattus Pond averaged 18.9 ppb (range 13 - 22 ppb) during only eight of the 24 years of recorded data (1977-2003). In direct contrast, in-lake (epilimnion core) total phosphorus summer-time (June through August) measures generally averaged 25-50 ppb (severe algal bloom conditions). Given adequate and timely funding, pilot studies may be initiated by Maine DEP to investigate and explore the nature of past and present trophic state interactions on Sabattus Pond.

Key for Columns in Table 4

Land Use Class: The land use category that was analyzed for this report

Land Area in Acres: The area of each land use as determined by GIS mapping, aerial photography, Delorme Topo USA software, and field reconnaissance.

Land Area %: The percentage of the watershed covered by the land use.

TP Coeff. Range kg TP/ha: The range of the total phosphorus coefficient values listed in the literature associated with the corresponding land use.

TP Coeff. Value kg TP/ha: The selected coefficient for each land use category. The total phosphorus coefficient is determined from previous research – usually the median value, if listed by the author. The coefficient is often adjusted using best professional judgment based on conditions including soil type, slope, and best management practices (BMP's) installed.

Land Area in Hectares: Conversion, 1.0 acre = 0.404 hectares

TP Export Load kg P: Total hectares x applicable total phosphorus coefficient

GIS Adjusted kg TP: Total hectares x total phosphorus coefficient x GIS-based adjustments for soil type, slope and Best Management Practices installed throughout the watershed.

TP Export Total %: The percentage of estimated phosphorus exported by the land use.

Table 4. SABATTUS Pond Direct Watershed - Phosphorus Export by Land Use Class

LAND USE CLASS	Land Area Acres	Land Area %	TP Coeff. Range kg TP/ha	TP Coeff. Value kg TP/ha	Land Area Hectares	TP Export Load kg TP	GIS Adjusted kg TP	TP Export Total %
			0.404686					
Agricultural and Forested Land			**Sabattus**	**Pond**				
Cropland	26	0.1%	0.26 - 18.6	2.24	11	24	24	1.3%
Hayland **(Manured)**	79	0.4%	0.65 - 1.81	1.51	32	48	51	2.8%
Low Intensity Hayland	632	3.4%	0.35 - 1.35	0.64	256	164	180	9.9%
Orchard	65	0.4%	0.06 - 0.75	0.40	26	11	11	0.6%
Mixed Agriculture	31	0.2%	.08 - 3.25	0.91	13	11	12	0.7%
Pasture	106	0.6%	0.14 - 4.90	0.81	43	35	40	2.2%
Operated Forest Land	72	0.4%	0.20 - 0.60	0.40	29	12	14	0.7%
Sub-Totals	**1,010**	**6%**	**Sabattus**	**Pond**	**409**	**304**	**332**	**18%**
Shoreline Development								
Low Density Residential	47	0.3%	0.25 - 1.75	0.5	19	10	10	0.5%
Medium Density Residential	22	0.1%	0.40 - 2.20	1.0	9	9	11	0.6%
High Density Residential - **Stormwater**	79	0.4%	0.77 - 4.18	1.9	32	61	62	3.4%
Residential Septic Systems	**Sabattus**		**Pond**	**Septic**	**Model**	38	38	2.1%
Private/Camp Roadways	22	0.1%	0.60 - 10.0	4.00	9	36	41	2.3%
Recreational	2	0.0%	0.25 - 1.75	0.50	1	1	1	0.0%
Sub-Totals	**173**	**1%**	**Sabattus**	**Pond**	**70**	**154**	**163**	**9%**
Non-Shoreline Development								
State/Town Roadways	272	1.5%	0.60 - 10.0	1.50	110	165	184	10.1%
Low Density Residential	1,045	5.7%	0.25 -1.75	0.50	423	212	235	12.9%
Medium Density Residential	38	0.2%	0.40 - 2.20	1.00	16	16	18	1.0%
High Density Residential - **Non-Stormwater**	2	0.0%	0.56 - 2.70	1.40	1	1	1	0.0%
Commercial	163	0.9%	0.77 - 4.18	1.50	66	99	109	6.0%
Gravel Pits	155	0.8%	0.00-0.00	0.00	63	0	0	0.0%
Parks/Cemeteries	2	0.0%	0.14 - 4.90	0.80	1	1	1	0.0%
Institutional	5	0.0%	0.77- 4.18	1.50	2	3	2	0.1%
Golf Course	146	0.8%	0.70 - 4.50	1.50	59	89	98	5.4%
Urban Stormwater - Town of Sabattus	131	0.7%	0.77 - 4.18	1.90	53	101	131	7.2%
Sub-Totals	**1,960**	**11%**	**Sabattus**	**Pond**	**793**	**585**	**779**	**43%**
Total: DEVELOPED LAND	**3,143**	**17%**	**Sabattus**	**Pond**	**1,272**	**1,042**	**1,274**	**70%**
Non-Developed Land								
Inactive/Passively Managed Forest	8,807	48.0%	0.01 - 0.04	0.04	3,564	143	169	9.3%
Wetlands	1,547	8.4%	0.00 - 0.05	0	626	0	0	0.0%
Scrub Shrub	324	1.8%	0.10 - 0.20	0.1	131	13	15	0.8%
Reverting Fields (Grassland)	2,473	13.5%	0.10 - 0.21	0.2	1,001	200	230	12.6%
Total: NON-DEVELOPED Land	**13,151**	**72%**	**Sabattus**	**Pond**	**5,322**	**356**	**414**	**23%**
Total: Surface Water (Atmospheric)	**2,036**	**11%**	0.11 - 0.21	0.16	**824**	**132**	**131**	**7%**
TOTAL: DIRECT WATERSHED	**18,330**	**100%**	**Sabattus**	**Pond**	**7,418**	**1,530**	**1,819**	**100%**

Total Phosphorus Land Use Loads

Estimates of total phosphorus export from different land uses found in the Sabattus Pond direct watershed are presented in Table 4 representing the extent of current external phosphorus loading to the lake. Total phosphorus loading from the associated upstream Little Sabattus Pond (41.6 kg TP/yr) accounts for loading from the indirect watershed, determined on the basis of *flushing rate x volume x TP concentration (*15 x 252,747 x 11 ppb = 42 kg/yr*),* and typical area gauged streamflow calculations (Jeff Dennis, Maine DEP).

Total phosphorus loading measures are provided as a range of values to reflect the degree of uncertainty generally associated with such relative estimates (Walker 2000). The watershed total phosphorus loadings were primarily determined using literature and locally-derived phosphorus export coefficients as found in Schroeder (1979), Reckhow et al. (1980), Dennis (1986), Dennis et al. (1992), and Bouchard et al. (1995) for residential properties, roadways, agriculture and other types of land uses (e.g., recreational, commercial).

In some cases (primarily non-shoreline roads) selected phosphorus loading coefficients were reduced (from total P values) to account for the estimated bioavailability of the soil runoff sources according to available literature (Lee et al. 1980 and Sonzogni et al. 1982) and to better account for algal available-P export values as reflected in Dennis et al. (1992) - realizing that direct delivery of phosphorus to lakes are not occurring in most cases. These adjustments accounted not only for the readily available SRP (soluble-reactive-phosphorus) in the runoff, but also a substantial portion of the particulate inorganic component, particularly the P which is weakly adsorbed on the surface of soil particles (relative to discussion in Chapra 1997, pg. 524). **Note:** *These adjustments in P-load coefficients did not effectively alter the overall conclusions and final recommendations of the Sabattus Pond PCAP-TMDL report regarding identified needs and NPS/BMP implementation plans for the Sabattus Pond watershed.*

Agricultural and Forest Operational Lands: Phosphorus loading coefficients as applied to agricultural land uses were adopted, in part, from Reckhow et. al. 1980: manured hayland 1.51 kg TP/ha, pasture 0.81 kg TP/ha; and Dennis and Sage 1981: low-intensity hayland 0.64 kg TP/ha; and from past Maine DEP 1982 studies: row crops 2.24 kg TP/ha. The phosphorus loading coefficient applied to operated forestlands (0.40 kg TP/ha) was derived (best estimate) from the original Cobbossee Lake TMDL report (Monagle 1995).

Shoreline Residential Lots (House and Camp): The range of phosphorus loading coefficients used (0.25 – 2.70 kg TP/ha) were developed using information on residential lot stormwater export of algal available phosphorus as derived from Dennis et al (1992) .

Private Camp Roads: The total phosphorus loading coefficient for private camp roads (4.00 kg/ha) was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997), as well as best professional judgment (Jeff Dennis, Maine DEP).

Non-Shoreline Development

Residential: Non-shoreline residential areas in the watershed are best characterized as low, medium, and high density residential - reflected in the 0.50 - 1.4 kg TP/ha P loading coefficients.

Golf Courses: The total phosphorus loading coefficient range (0.70 – 4.50 kg TP/ha) applied to the golf course area takes into account the fertilizer used on tees, greens, fairways and "rough" as well as proximity to the resource and the area drained with direct flow to a tributary.

Public Roadways: Town and state roadways (110 ha) were assigned a total phosphorus loading rate of 1.50 kg per hectare per year. This coefficient was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997).

Total Developed Lands Phosphorus Loading: A total of 70% (1,274 kg) of the total phosphorus loading to Sabattus Pond is estimated to have been derived from the cumulative effect of the preceding cultural land use classes: agriculture and forestry (18% - 332 kg); non-shoreline development (43% - 779 kg) and shoreline development (9% - 163 kg), including septic systems (2.1% - 38 kg) and shoreline roads (2.3% - 41 kg) – as depicted in Table 4.

Non-Developed Lands Phosphorus Loading: The phosphorus export coefficient for forested land (0.04) is based on a New England regional study (Likens et al 1977). The lower total phosphorus loading coefficient chosen for atmospheric deposition (0.16 kg TP/ha) is similar to that used for the China Lake TMDL (Kennebec County), while the upper range (0.21 kg TP/ha) generally reflects a watershed that is 50 percent forested, combined with agricultural areas interspersed with urban/suburban land uses (Reckhow et al. 1980). Other Non-Developed Land Uses: Combined wetlands, reverting fields, and scrub shrub account for the remaining 13.4% (245 kg) of the total non-developed land total phosphorus export load of 414 kg (Table 4).

Atmospheric Deposition (Open Water): Sabattus Pond surface waters (824 ha) comprise 11% of the total watershed area (18,330 ha) and account for an estimated 131 kg of total phosphorus, representing 7% of the total phosphorus load entering Sabattus Pond.

Phosphorus Load Summary

It is our professional opinion that the selected export coefficients are appropriate for the Sabattus Pond watershed. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external (watershed generated) nonpoint source pollution approximates 1,819 kg TP/yr. Given the additional phosphorus loading contribution from indirect tributary drainages (42 kg) and internal sediment P-accumulations (1,176 kg), this annual external watershed generated load available to Sabattus Pond equates to a total phosphorus loading of 40 ppb (3,113 kg TP/year).

LINKING WATER QUALITY and POLLUTANT SOURCES

Assimilative Loading Capacity: The Sabattus Pond TMDL is expressed as an annual load as opposed to a daily load. As specified in 40 C.F.R. 130.2(i), TMDLs may be expressed in terms of either mass per unit time, toxicity, or other appropriate measures. It is thought appropriate and justifiable to express the Sabattus Pond TMDL as an annual load because the lake basin has a annual flushing rate of 1.52, approximating the average flushing rate for Maine lakes of 1.50.

The Sabattus Pond basin lake assimilative capacity is capped at 1,155 kg TP/yr, as derived from the empirical phosphorus retention model based on a target goal of 15 ppb. This value is an interim measure which does not generally reflect observed phosphorus loadings which may or may not be independently responsible for current trophic state conditions in Sabattus Pond.

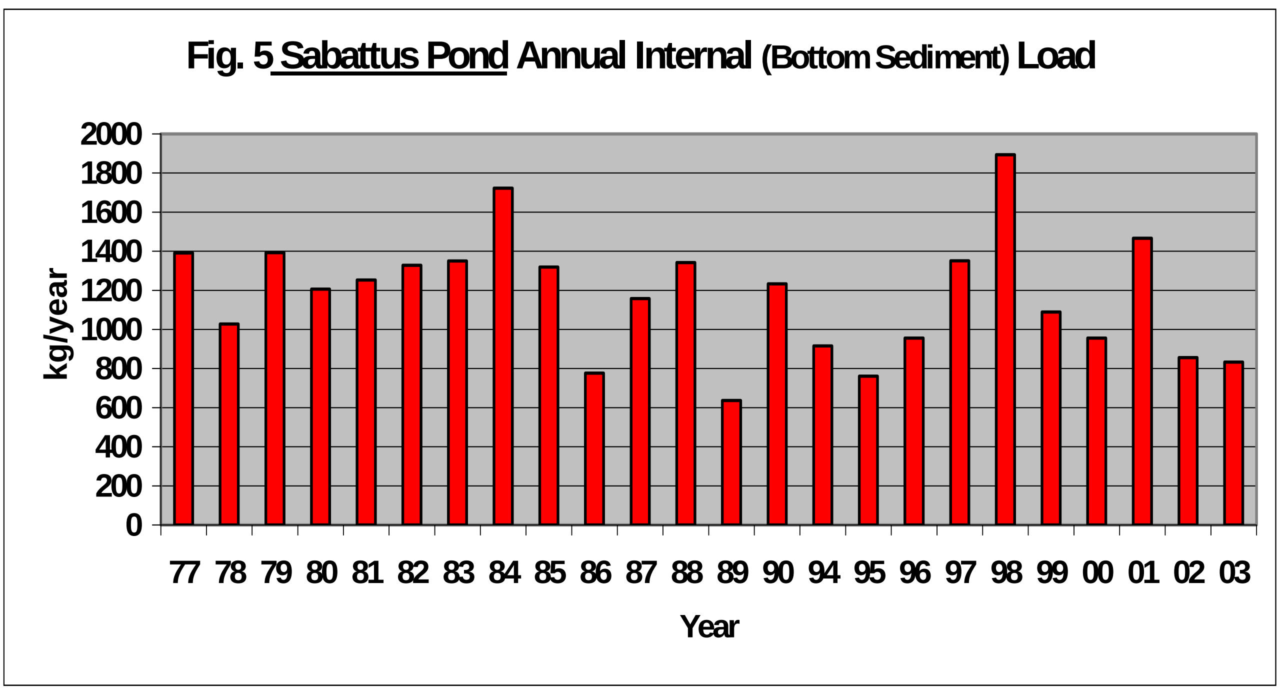
Future Development: The Maine DEP water quality goal of maintaining a stable trophic state includes a reduction of current P-loading which accounts for both recent P-loading as well as potential future development in the watershed. The methods used by Maine DEP to estimate future growth (Dennis et al. 1992) are inherently conservative, as they provide for relatively high-end regional growth estimates and largely non-mitigated P-export from new development. This provides an additional non-quantified margin of safety to ensure the attainment of state water quality goals. Previously unaccounted P-loading from anticipated future development on Sabattus Pond watershed approximates 38 kg annually (0.5 x [1 ppb change in trophic state = 77 kg]).

Undoubtedly, residential development will continue to occur in the Sabattus Pond watershed, contributing new sources of phosphorus to the lake. Hence, existing phosphorus source loads must be reduced (38+ kg) to offset anticipated new sources of phosphorus to Sabattus Pond.

Overall, the continued presence of nuisance summertime algae blooms in Sabattus Pond may be reduced, along with enhancing the trend of decreasing trophic state, if the existing combined phosphorus loading from external-internal sources is reduced by approximately 1,578 kg TP/yr. Reductions already underway in nonpoint source total phosphorus loadings are expected from the continued implementation of best management practices - primarily from improvements to roadways and residential shoreline vegetative buffer plantings (see NPS/BMP Implementation Plan and PCAP Summary).

Internal Lake Sediment Phosphorus Mass: The relative contribution of internal sources of total phosphorus within Sabattus Pond - in terms of sediment TP recycling - were analyzed (using lake volume-weighted mass differences between early and late summer) and estimated on the basis of water column TP data from 1977 to 2003 (Figure 5). Approximate internal sediment TP loads for this 24-year period ranged from 637 to 1,893 kg with an average annual value of 1,176 kg. Fairly complete lake profile TP concentration measures were made in 2002-2003 (856 and 833 kg, respectively) - to derive reliable estimates of internal lake loads. Over the past two decades (1977 to 2003), the amount of TP being released from the sediments of Sabattus Pond, during the summer period, has been fairly regular and closely approximates Sabattus Pond's capacity for in-lake phosphorus assimilation (1,155 kg TP/year).

Linking Pollutant Loading to a Numeric Target: The basin loading assimilative capacity for Sabattus Pond was set at 1,155 kg/yr of total phosphorus to meet the numeric water quality target of 15 ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data, was used to link phosphorus loading to numeric target.



Supporting Documentation for the Sabattus Pond TMDL Analysis includes the following: Maine DEP and VLMP water quality monitoring data, and specification of a phosphorus retention model – including both empirical models and retention coefficients.

Total Phosphorus Retention Model (after Dillon and Rigler 1974 and others)

L = P (A z p) / (1-R) where,

1,155 = **L** = external total phosphorus load capacity (kg TP/year)
15.0 = **P** = spring overturn total phosphorus concentration (ppb)
7.96 = **A** = lake basin surface area (km^2)
3.50 = **z** = mean depth of lake basin (m) **A z p = 42.35**
1.52 = **p** = annual flushing rate (flushes/year)
0.55 = **1- R** = phosphorus retention coefficient, where:
0.45 = **R = 1 / (1+ sq.rt. p)** (Larsen and Mercier 1976)

Previous use of the Vollenwieder (Dillon and Rigler 1974) type empirical model for Maine lakes, e.g., Cobbossee, Madawaska, Sebasticook, East Pond, China Lake, Highland Lake, Webber-Threemile-Threecornered pond complex, and Mousam Lake TMDLs (Maine DEP 2000-2003), have shown this approach to be effective in linking watershed total phosphorus (external) loadings to existing in-lake total phosphorus concentrations.

Strengths and Weaknesses in the Overall TMDL Analytical Process: The Sabattus Pond TMDL was developed using existing lake water quality monitoring data, derived watershed export coefficients (Reckhow et al. 1980, Maine DEP 1981 and 1989, Dennis 1986, Dennis et al. 1992, Bouchard et al. 1995, Soranno et al. 1996, and Mattson and Isaac 1999) and a phosphorus retention model which incorporates both empirically derived and observed retention coefficients (Vollenwieder 1969, Dillon 1974, Dillon and Rigler 1974 a and b, and 1975, Kirchner and Dillon 1975). Use of the Larsen and Mercier (1976) total phosphorus retention term, based on localized data (northeast and north-central U.S.) from 20 lakes in the US-EPA National Eutrophication Survey (US-EPA-New England) provides a more accurate model for northeastern regional lakes.

Strengths:

- ❖ Approach is commonly accepted practice in lake management
- ❖ Makes best use of available water quality monitoring data
- ❖ Based upon experience with other lakes in the northeastern U.S. region, the empirical phosphorus retention model was determined to be appropriate for the application lake.

Weaknesses:

- ❖ Inherent uncertainty of TP load estimates (Reckhow 1979, Walker 2000) and associated variability and generality of TP loading coefficients.

Critical Conditions - Occur in Sabattus Pond during the summertime, when the potential (both occurrence and frequency) of nuisance algae blooms are greatest. The loading capacity of 15 ppb of total phosphorus was set to achieve desired water quality standards during this critical time period, and will also provide adequate protection throughout the year (see Seasonal Variation).

LOAD ALLOCATIONS (LA's) The load allocation for all existing and future non-point pollution sources for Sabattus Pond is 962 kg TP/yr (LA = LC - WLA or 1,155 - 193) as derived from the empirical phosphorus retention model based on a target goal of 15 ppb. Further reductions in nonpoint source total phosphorus loadings are expected from the continued implementation of best management practices for camp roads and town roads, as well as improved shoreline and non-shoreline residential lots (see BMP Implementation Plan summary). As previously mentioned, it was not possible to separate natural background from non-point pollution sources in this watershed because of the limited and general nature of the available information.

As in other Maine 303(d) listed TMDL lakes (see Sebasticook Lake, East Pond, China Lake, and Webber-Threemile-Three-corner pond complex TMDLs), in-lake nutrient (phosphorus) loadings in Sabattus Pond originate from a combination of direct and indirect external (watershed + Little Sabattus Pond) and internal (lake sediment) sources of total phosphorus.

WASTE LOAD ALLOCATIONS (WLA's): The town of Sabattus is a regulated urbanized area that is directly subject to Maine's National Pollution Discharge Elimination System (NPDES) Phase II Stormwater Program. With the assumption that all urban runoff is occurring in regulated areas, the WLA for the Sabattus Pond Watershed is derived from the (GIS calculated and field verified) TP export percentage from selected developed urban-type sub-categories (See Table 4, page 30 - developed selected shoreline and non-shoreline sub-totals). The WLA is the sum of the following existing estimated loads (62 + 131 kg TP/yr) or <u>193</u> kg TP/yr.

MARGIN OF SAFETY (MOS): An implicit margin of safety was incorporated into the Sabattus Pond TMDL through the conservative selection of the numeric water quality target, as well as the selection of relatively conservative phosphorus export loading coefficients for cultural pollution sources (Table 4). Based on both Sabattus Pond historical records and a summary of statewide Maine lakes water quality data for non-colored (< 26 SPU) lakes - the target of 15 ppb (1,155 kg TP/yr in Sabattus Pond) represents a highly conservative goal to assure attainment of Maine DEP water quality goals of non-sustained and non-repeated blue-green summer-time algae blooms due to NPS pollution or cultural eutrophication and stable or decreasing trophic state. The statewide data base for non-colored Maine lakes indicate that summer nuisance algae blooms (growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at 18 ppb or above. A range of 15 to 17 ppb (1,155 to 1,308 kg TP/yr in Sabattus Pond) is unlikely to result in nuisance algae blooms. The difference between the in-lake target of 15 ppb and 17 ppb (153 kg) represents a 11.7 (12%) percent implicit margin of safety for Sabattus Pond. A non-quantified margin of safety for attainment of state water quality goals is also provided by the inherently conservative methods used by Maine DEP to estimate future growth in the Sabattus Pond watershed.

SEASONAL VARIATION: The Sabattus Pond TMDL is protective of all seasons, as the allowable annual load was developed to be protective of the most sensitive time of year – during the summer, when conditions most favor the growth of algae and aquatic macrophytes. With an average flushing rate of 1.52 flushes/year, the average annual phosphorus loading is most critical to the water quality in Sabattus Pond. Maine DEP lake biologists, as a general rule, use more than six flushes annually (bi-monthly) as the cutoff for considering seasonal variation as a major factor (to distinguish lakes vs. rivers) in the evaluation of total phosphorus loadings in aquatic environments. Nonpoint source best management practices (BMPs) proposed for the Sabattus Pond watershed have been designed to address total phosphorus loading during all seasons.

PUBLIC PARTICIPATION: Adequate ('full and meaningful') public participation in the <u>Sabattus Pond</u> PCAP-TMDL development process was ensured through the following avenues:

1. In the Spring of 2002, MACD Project Manager, Forrest Bell met with the Board of Directors of the Androscoggin Valley SWCD to explain the TMDL process, and the scope of services that the MACD and Maine DEP would be providing in the preparation of the Sabattus Pond PCAP-TMDL.

2. MACD Project Manager, Forrest Bell, explained the Sabattus Pond TMDL to the SPWP Board during the summer of 2002. The SPWP Board of Trustees has members from each of the three watershed towns of Sabattus, Greene, and Wales. The monthly SPWP meeting was publicly noticed.

3. MACD Project Manger, Forrest Bell, met again with the AVSWCD Board of Supervisors to present the project in more detail, answer questions, and discuss the subcontract with AVSWCD.

4. During the summer of 2003, MACD staff member Jodi Federle presented information about the PCAP-TMDL report to the Sabattus Pond Watershed Partnership at their annual meeting.

5. During the summer and fall of 2003, MACD project personnel paid numerous visits to the Sabattus, Greene, and Wales town offices and to the Androscoggin Valley SWCD office in order to compile necessary watershed inventory information. MACD staff hosted Sabattus Pond technical group meetings during the fall of 2002 and the winter of 2003.

6. A shoreline survey was conducted on Sept. 6, 2002 which included several members of the Sabattus Pond watershed partnership,

7. MACD project team members Forrest Bell, Jodi Michaud Federle, Tim Bennett and AVSWCD project manager Phoebe Hardesty surveyed the lake watershed over four days in June and July of 2003 in order to field verify land use in the watershed, conduct housing counts, and identify high impact sites.

8. MACD met with key stakeholders in Lewiston on May 6th, 2004 to discuss specific questions regarding the draft stakeholder document.

STAKEHOLDER AND PUBLIC REVIEW COMMENTS

A Stakeholder Review Document was distributed electronically on April 21, 2004 to the following individuals that participated in the field work or development of the document: Androscoggin Valley SWCD Board of Supervisors, Roy Bouchard (Maine DEP) Jeff Dennis (Maine DEP), Carol Fuller (AVCOG), Dan Guerette (SPWP), Phoebe Hardesty (AVSWCD), Morten Moesswilde (Maine Forest Service), Barry Mower (Maine DEP), Kay Nickel (USDA NRCS), Lois Ongley (Oak Hill High School), Leon Rioux (SPWP), David Rocque (Maine Dept. of Agriculture) Scott Williams (VLMP), and Bill Woodward (Maine DIF&W).

Stakeholders were requested to provide comments by May 5, 2004 and were granted a one-week extension to May 12, 2004. A stakeholder meeting was held at the Androscoggin Valley SWCD office on May 6th to assist with the review process. Stakeholders had an opportunity to comment on the second stakeholder draft by May 24, 2004. The following five individuals responded to the first draft, but no one else responded in writing to the second draft review.

Dan Guerette of the Sabattus Pond Watershed Partnership provided edits on behalf of the Sabattus Pond Watershed Partnership and Sabattus Lake Dam Commission on May 3, 2004 and May 12, 2004. Most of the comments required text editing, some of which was provided by Mr. Guerette. A response letter was emailed to Dan on May 18, 2004.

Phoebe Hardesty of the Androscoggin Valley Soil and Water Conservation District provided extensive edits on May 6th and May 12th. Most of the comments required text editing. A response letter was emailed to Phoebe on May 18, 2004.

Morton Moesswilde of the Maine Forest service responded that the report looked fine in regard to forestry data.

Kay Nickel of the Lewiston NRCS field office provided edits primarily on agricultural data and the presentation of the land use table. The comments required a reclassification of agricultural land in the watershed to properly reflect current land use. Changes were incorporated into the land use table and a follow up visit was made by MACD project staff to clarify the changes.

Lois Ongley of Oak Hill High School provided extensive edits on May 4, 2004. Most of the comments required text editing and a response letter was emailed to Lois on May 18, 2004.

Public Review Comments

The following statement was advertised in the *Kennebec Journal* and *Lewiston Sun Journal* over a two weekend period (June 5-6 and 19-20, 2004):

> In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130 - the Maine Department of Environmental Protection has prepared a combined **Phosphorus Control Action Plan (PCAP)** and **Total Maximum Daily Load (TMDL)** nutrient report for the **Sabattus Pond** (DEPLW 2004-0649) watershed, located within the towns of Sabattus, Wales, and Greene. This **PCAP-TMDL** report identifies and provides best estimates of non-point source phosphorus loads for all representative land use classes in the **Sabattus Pond** watershed and the total phosphorus reductions required to establish and maintain acceptable water quality conditions.
>
> A Public Review draft of this report may be viewed at Maine DEP Central Offices in Augusta (Ray Building, Hospital Street - Route 9, Land & Water Bureau) or on-line:
>
> **http://www.state.me.us/dep/blwq/comment.htm.**
>
> Please send all comments, in writing - by June 25, 2004, to Dave Halliwell, Lakes TMDL Program Manager, Maine DEP, State House Station #17, Augusta, ME 04333. **e-mail:** david.halliwell@maine.gov.

Public review comments were submitted by two reviewers: 1) Lois Ongley of Oak Hill High School and 2) Androscoggin Valley Soil and Water Conservation District.

1) **Ms. Lois Ongley** submitted a letter outlining areas of stated concern, which were all considered and incorporated, where appropriate, in this final revision - and an explanatory letter sent addressing the following concerns:

   (a) All major known possible contributors of phosphorus in the watershed were included, to the best of our knowledge.

   (b) The in-lake phosphorus model was based on Maine DEP standard/corrected drainage and lake volumetric areas, hence revisions were not deemed to be warranted.

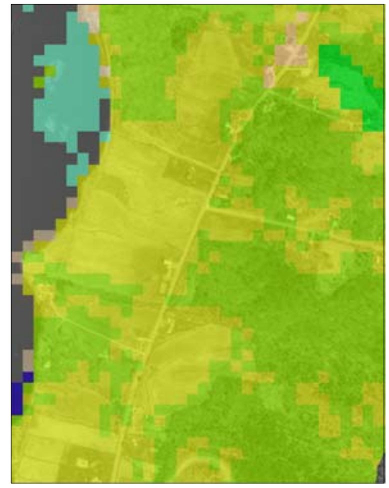
   (c) We do not routinely include a formal "literature cited" section, but prefer to include lake specific and more general relevant listings of pertinent references, which may or may not be directly cited in the text of the report.

2) The **Androscoggin Valley Soil and Water Conservation District** requested rewording of statements in the Sabattus Pond PCAP-TMDL document on page 7, 15, and 18. The requested changes were made, as requested, to the body of the document, in the final revision.

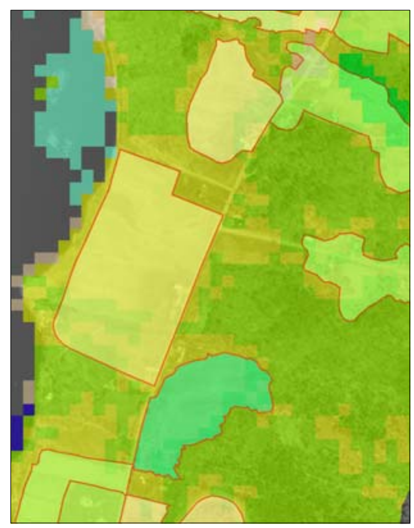
GIS Pilot Project Methodology, Results, and Conclusions

Premise

The Sabattus Pond PCAP-TMDL project included a pilot study to attempt to improve the accuracy of Geographic Information System (GIS) land use data by making adjustment based on soils, slope, and installed best management practices. The image (right) displays an example of the limits of land use imagery. The pixels in the upper left corner of the photo (Sabattus Pond surface waters) are misclassified. The purposes of undertaking this pilot study were to:



The photo (above) displays an example of the limitations of satellite-derived GIS data . This pilot project improved the accuracy by re-drawing the data based on field observation (below).



1. Improve the accuracy of satellite imagery by field-verifying land use data for developed land (eg. residential, commercial, agricultural).
2. Provide site specific adjustments for phosphorus coefficients based on hydrologic soil groups, slope and installed best management practices.
3. Provide spatial references for phosphorus export data to enable future adjustments to loading estimates by lake stakeholders and environmental professionals.
4. Provide an affordable, easy-to-use model for other Maine lake PCAP-TMDL assessments.

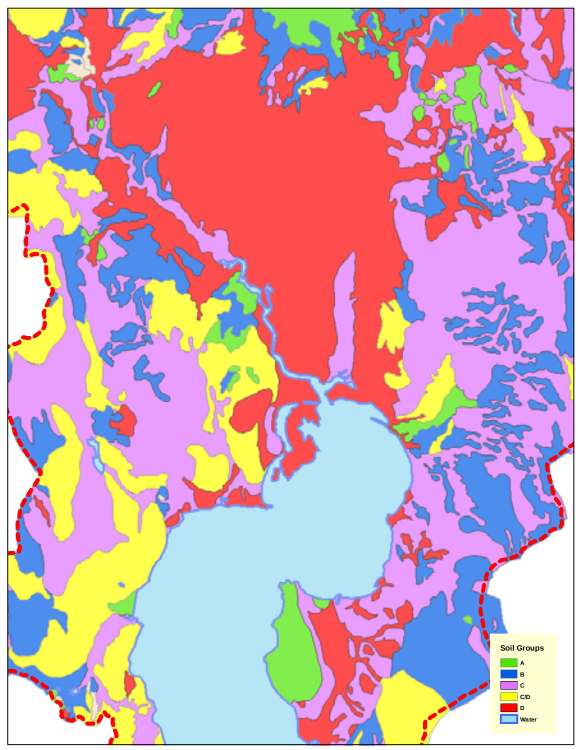
The project was directed by the MACD project team and the GIS analysis was completed by Orbis Mapping Solutions of Gray, Maine.

Methodology

1. Data were acquired prepared from USGS quads, satellite imagery and other available sources.
2. GIS –derived Land Use categories were combined as directed by MACD, and a new, aggregate Land Use layer was generated.
3. Data layers were combined into customized, draft quality field maps and modifications were digitized and used to revise the original Land Use data (see image, right).
4. Digital soil data were obtained from the state. Orbis verified the accuracy of the soil data and MACD provided the reference information for soil type and hydrologic soil class.
5. A proximity coverage was created by buffering the Pond at 250 feet. This figure was used to separate shoreline and non-shoreline areas but did not affect the final phosphorus export determination.
6. MACD and Maine DEP provided P coefficients and formulas to be used in the calculations. The soils were divided into 5 hydrologic soil classes. These soil classes relate directly to per-

meability ratings for the soils. For example, “A” soils have high a permeability rating and runoff rates would be minimal. Conversely, “D” soils have a very slow permeability ratings and the potential for surface runoff is high. Using this premise, a multiplier of .7 was used for an A soil, .9 for a B soil, 1.1 for a C soil, 1.2 for a C/D soil, and 1.3 for a D soil. A multiplier of 1.1 was used for land with a slope of more than 8% and a multiplier of 1.3 was used for areas with a slope of 30% or greater. Adjustments for BMPs installed ranged from 20% to 50% depending on the type of BMP and land use. (Source: MANAGE, University of Rhode Island and Lakes Environmental Association Hot Spots Methodology, Bridgton, Maine).

7. Aggregate Land Use data was combined with buffers, field data layers and other data as determined by MACD to create an adjusted Land Use data set.
8. A TMDL dataset was created by combining Adjusted Land Use, Hydrologic Soil Class and reductions for installed Best Management Practices.
9. Using the TMDL dataset, areas were calculated for each unique Land Use/Soil Class/BMP combination and coefficients will be applied.
10. A final land use table was generated with adjusted P coefficients for more than 19,000 polygons in the Sabattus Pond Watershed.
11. In addition to items 1-10, Orbis provided a GPS unit in order to locate several watershed NPS sites in need of immediate mitigation. This information will be provided to watershed stakeholders in future presentations.



This map displays the hydrologic soil groupings of the northern portion of the Sabattus Pond watershed. The red areas indicate “D” type soils (shown in red) which have the potential for high amounts of runoff.

Conclusion

Several factors indicate that the GIS-based model utilized for this pilot project were effective. First, the use of hydrologic soil classes provided an overlay that accurately accounted for runoff potential. In the case of Sabattus Pond—the adjusted P export value was increased 276 kg mostly due to the presence of poorly drained soils in a large portion of the watershed. This would have been difficult, if not impossible, to estimate without the assistance of a GIS-based model. Secondly, the adjustments (% reduction to P coefficients for land areas with Best Management Practices) numerically accounted for the thousands of dollars of NPS reduction work conducted by the USDA NRCS and Androscoggin Valley SWCD. Finally, the project was funded at a reasonable price that should prove to be cost effective when analyzing other Maine lakes for phosphorus export.

For more detailed information on this pilot project, please contact Forrest Bell at forrestb@maine.rr.com.

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