PHOSPHORUS CONTROL ACTION PLAN

and Total Maximum Daily (Annual Phosphorus) Load Report

LOVEJOY POND - Albion

Kennebec County, Maine

Lovejoy Pond PCAP-TMDL Report

Maine DEPL 2005 - 0711

Maine Department of Environmental Protection

and Maine Association of Conservation Districts

Final EPA Submittal - 15 September 2005

LOVEJOY POND - Albion

Phosphorus Control Action Plan (PCAP)

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ACKNOWLEDGMENTS

In addition to Maine DEP (DEA - Lakes Assessment Section and Watershed Division) and U.S. EPA New England Region I staff, the following individuals, groups and agencies were instrumental in the preparation of this Lovejoy Pond combined Phosphorus Control Action Plan and Total Maximum Daily Load report: MACD staff (Jodi Michaud Federle, Fred Dillon, Forrest Bell, and Tim Bennett); Kennebec County Soil and Water Conservation District (Nate Sylvester, Josh Platt, Melissa Halsted, Jennifer McLean and Dale Finseth); Maine Department of Agriculture (David Rocque); Maine Forest Service (Chris Martin); Maine Department of Inland Fisheries and Wildlife (Bill Woodward); Maine Department of Marine Resources (Gail Wippelhauser); local Lovejoy Pond stakeholders (Larry Blaisdell and Matt Vitale), and the Maine Volunteer Lake Monitoring Program (Lovejoy Pond water quality monitor Roberta Morin - retired).

Lovejoy Pond - Albion
Phosphorus Control Action Plan
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Background

LOVEJOY POND is a 329-acre colored waterbody located in the Town of Albion in Kennebec County, Maine. Lovejoy Pond has a direct **drainage** (see map at right and on pg. 8) area of approximately 8.2 square miles; a maximum depth of 32 feet (10 meters), a mean depth of 13.8 feet (4.2 meters); and a **flushing rate** of 2.6 times per year.

Lovejoy Pond has a history of supporting excessive amounts of algae in the late summer-early fall, due in large part to the contribution of **total phosphorus** that is prevalent in area soils and has accumulated in the pond bottom sediments. Soil erosion in the 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 have shown that as lake water clarity decreases, lakeshore residential property values also decline.

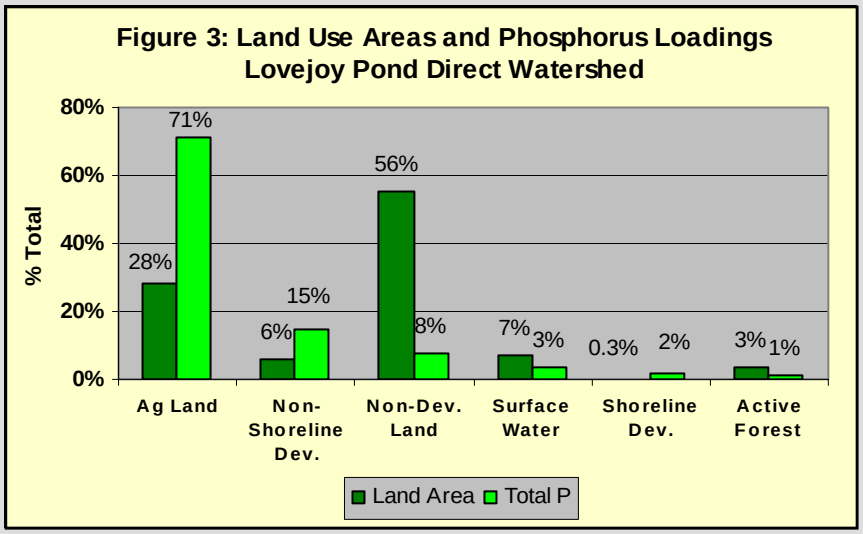
Stakeholder Involvement

Historically - federal, state, county, and local groups have been working together to effectively address the nonpoint source water pollution problem in Lovejoy Pond. From 2003 – 2005, the Maine Department of Environmental Protection (Maine DEP) funded a project in cooperation with the Maine Association of Conservation Districts (MACD) to locate and estimate existing sources of phosphorus and identify phosphorus export prevention needs in the Lovejoy Pond watershed. A final report, completed in the summer of 2005, is entitled "Lovejoy Pond Phosphorus Control Action Plan" (PCAP) and doubles as a **TMDL** (Total Maximum Daily - Annual Phosphorus - Load) report, submitted to the U.S. Environmental Protection Agency, New England Region, for their review and final approval.

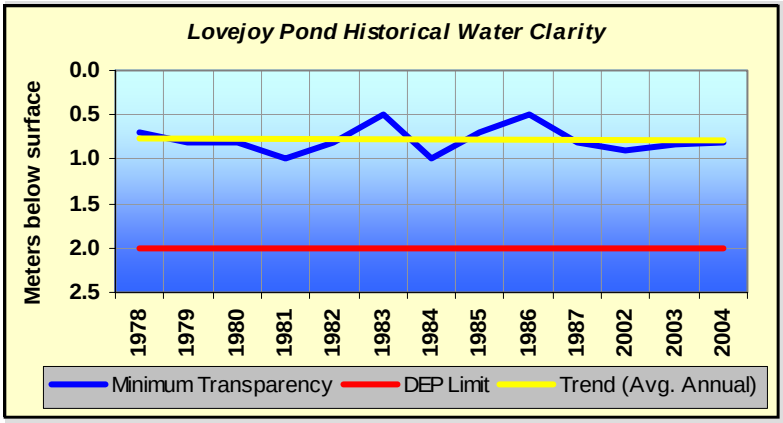
What We Learned

A land use assessment was conducted for the Lovejoy Pond watershed to determine 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.

Figure 3: Land Use Areas and Phosphorus Loadings
Lovejoy Pond Direct Watershed



An estimated 763 kilograms (kg) of phosphorus is exported annually to Lovejoy Pond from the direct watershed. The bar chart (left) illustrates the land area representative land uses as compared to the phosphorus



As the yellow trend line indicates, Lovejoy Pond's water clarity has been well below the DEP's two meter minimum since, and no doubt, prior to, 1978.

export load for each land use.

The total phosphorus contribution from indirect drainage sources was estimated at 31 kg/year. During the past three years, the amount of phosphorus being recycled internally (217 kg/year = average value) from Lovejoy Pond bottom sediments during the summer-time is equal to 57 percent of Lovejoy Pond's natural capacity (380 kg/year.) for in-lake phosphorus assimilation.

Phosphorus Reduction Needed

The natural capacity of Lovejoy Pond to effectively process 380 kg of TP on an annual basis without harming water quality equals an in-lake phosphorus concentration of 16 ppb. Lovejoy Pond's average summertime TP concentration is 52 ppb - equal to an additional 888 kg (37 ppb x 24 kg). Accounting for a 12 kg allocation for future development, the total amount of phosphorus needed to be reduced to attain water quality standards (algal bloom-free conditions) in Lovejoy Pond is 900 kg.

What You Can Do To Help!

As a watershed resident, there are many things you can do to protect the water quality of Lovejoy Pond. Lakeshore owners can use phosphorus-free fertilizers and maintain natural vegetation adjacent to the lake. Agricultural and commercial land users can consult the Kennebec County Soil and Water Conservation District or Maine Department of Environmental Protection for information regarding Best Management Practices (BMPs) for reducing phosphorus loads. Watershed residents can always become involved by volunteering to form a Lovejoy Pond Association and participating in events sponsored by State agencies and local organizations. The estimated phosphorus loading to Lovejoy Pond originates from both shoreline and non-shoreline areas (see graph on previous page), so all watershed residents must take ownership of lake restoration. Lake stakeholders and watershed residents can learn more about their lake and the many resources available, including review of the Lovejoy Pond Phosphorus Control Action Plan. Following final EPA approval, copies of this detailed report, with recommendations for future NPS/BMP work, will be available online at www.maine.gov/dep/blwq/docmonitoring/tmdl2.htm, or can be viewed and/or copied (at cost) at Maine DEP offices in Augusta (Bureau of Land and Water Quality, Ray Building, AMHI Campus).

Key Terms

- ***Colored*** *lakes or ponds occur when dissolved organic acids, such as tannins or lignins, impart a tea color to the water, which results in reduced transparencies and increased phosphorus values.*
- ***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.*
- ***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****, an acronym for Total Maximum Daily Load, 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 lakes PCAP-TMDL project, funded through a Clean Water Act Section 319-grant from the United States Environmental Protection Agency (EPA), was directed and administered by the Maine Department of Environmental Protection (Maine DEP) under contract with the Maine Association of Conservation Districts (MACD), from the summers of 2003 thru 2005.

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 Lovejoy Pond watershed. Simply stated, a TMDL is the total amount of phosphorus that a lake can receive without harming water quality. Maine DEP, with assistance from the MACD, will fully 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 assessment work, including a shore-line and septic survey evaluation, was conducted by the Maine DEP-MACD project team to help assess **total phosphorus** reduction techniques that would be beneficial for the Lovejoy Pond watershed. The results of this assessment report include recommendations for future conservation work in the watershed to help citizens, organizations, and agencies restore and protect Lovejoy Pond. **Note:** *To protect the confidentiality of landowners in the Lovejoy Pond watershed, site-specific information has not generally been provided as part of this PCAP-TMDL 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 land use data derived from various sources, including the Maine Office of Geographic Information Systems, the Kennebec County Soil & Water Conservation District (KC-SWCD), and the Maine Forest Service (MFS). Local citizens, active and/or developing watershed organizations, and conservation agencies will benefit from this compilation of both historical and recently collected data as well as the watershed assessment and the NPS Best Management Practice (BMP) recommendations. Above all, this document is intended to help Lovejoy Pond stakeholder groups to effectively prioritize future BMP work in order to obtain the funding resources necessary for further NPS pollution mitigation work in their watershed - if and when they become organized.

Study Methodology

Lovejoy Pond background information was obtained using several methods, including a review of previous studies of the pond and watershed, 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 area.

Land use data were determined using several methods, including (1) **Geographic Information System (GIS)** map analysis, (2) analysis of topographic maps, (3) analysis of aerial photographs and (4) **ground-truthing**. Much of the non-developed land use area (i.e., forest, wetland, grassland) was determined using a GIS layer which is a combination of Maine Gap Analysis (GAP) landcover and USGS Multi Resolution Landcover Characterization (MRLC) landcover layers. It was created at the request of Maine DEP Bureau of Land and Water Quality (BLWQ) staff. It includes those classes in each layer which are best suited to calculating impermeability of watersheds. Both MRLC and GAP (and so Maine COMBO) are based on 1992 Landsat imagery. The developed land use areas were obtained using the best possible information available through analysis of methods 2 through 4 listed above.

> ***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.*

> ***Ground-truthing** involves conducting field reconnaissance in a watershed to confirm the relative accuracy of computer generated maps.*

All land use GIS data was compiled under subcontract by the Kennebec County Soil and Water Conservation District (KC-SWCD). Final adjusted phosphorus loading numbers (see Table 3, page 25) were modeled using overlays of soils, slope, and installed Best Management Practices. All of the land use coverage data for agricultural areas was re-configured using aerial overlays in conjunction with ground-truthing throughout the watershed.

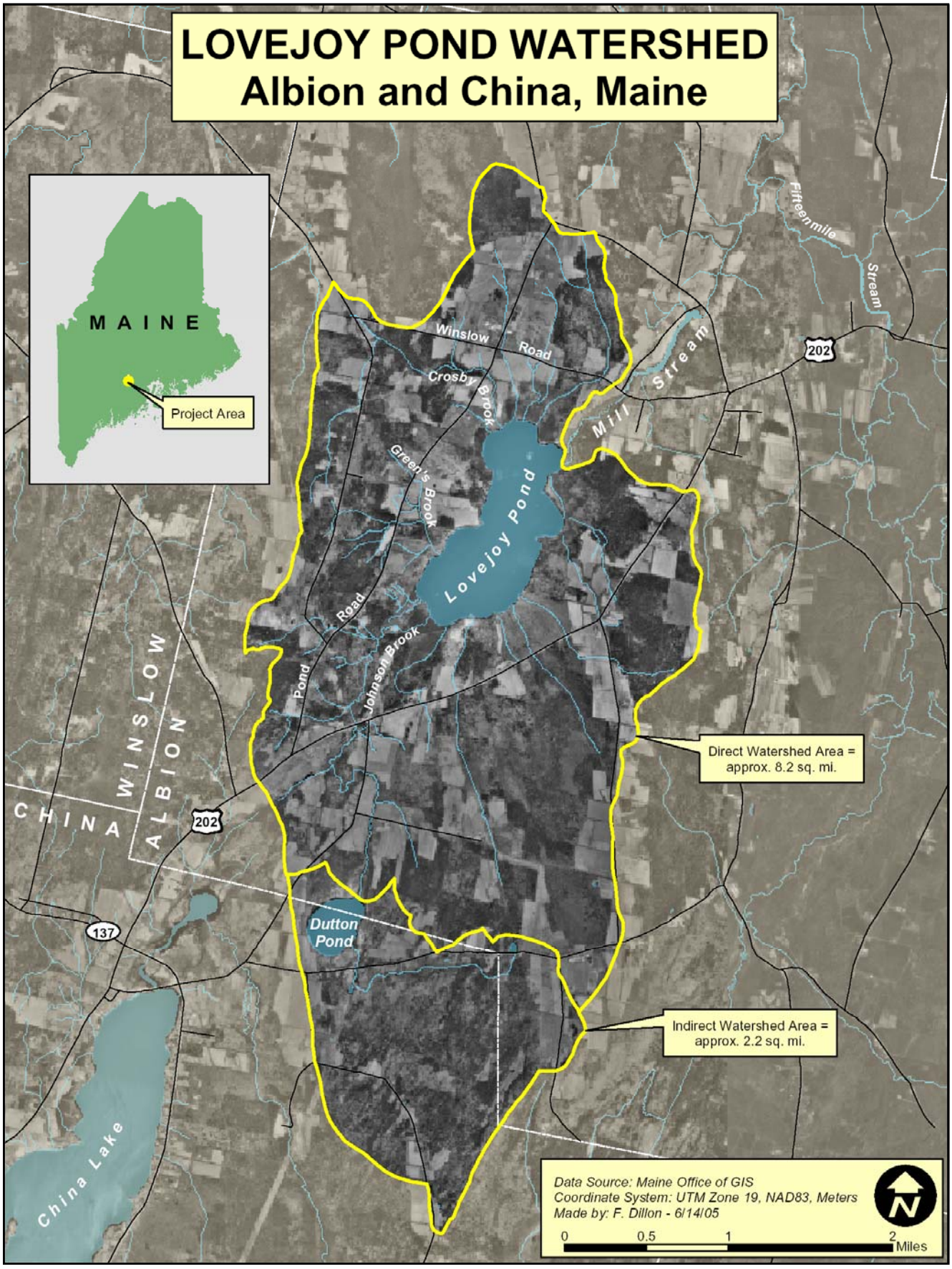
Roadway widths were estimated from previous PCAP reports where actual measurements were made for the various road types. In general, state-owned roads were found to be 22 meters wide; town-owned roads were found to be 16 meters wide; and privately-owned roads were found to be 6 meters wide. GIS was used to calculate total road surface area.

Agricultural information within the Lovejoy Pond watershed was reviewed by the Kennebec County Soil and Water Conservation District (KC-SWCD). Information regarding forestry harvesting operations was reviewed by the Maine Forest Service, Department of Conservation.

Study Limitations

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

Figure 1. Map of Lovejoy Pond Direct & Indirect Watersheds



LOVEJOY POND Phosphorus Control Action Plan

DESCRIPTION of WATERBODY (MIDAS Number 5176) and WATERSHED

> *The **direct watershed** refers to the land area that drains to a waterbody without first passing through an associated lake or pond.*

LOVEJOY POND is a 329 acre single-basin colored waterbody (133 hectares), located in the town of Albion (DeLorme Atlas, Map 21), within Kennebec County in central Maine. Lovejoy Pond has a **direct watershed** area (see Figure 1) of approximately 5,568 acres (8.7 square miles) including lake surface area. The Lovejoy Pond direct watershed is located within the towns of Albion (85%) and China (15%). Lovejoy Pond has a maximum depth of 32 feet (10 meters), overall mean depth of 13.8 feet (4.2 m), and a flushing rate of 2.6 times/year.

Drainage System: Four major tributaries empty into Lovejoy Pond, the largest of which, Johnson Brook, drains 57-acre (23 ha) Dutton Pond (Figure 1). The remaining tributaries are identified as intermittent streams on the United States Geological Survey's 1:24,000 topographic map. Lovejoy Pond's outlet, Mill Stream, drains into Fifteen Mile Stream which flows into the Sebasticook River and then into the Kennebec River. Mill Stream is also reported (personal communication, Josh Platt - KC-SWCD) to have beaver dam blockages and an abandoned privately owned dam that may affect Lovejoy Pond's water level, and, by extension, its annual flushing rate.

Water Quality Information

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

> ***Chlorophyll-a** is a measurement of 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.*

Lovejoy Pond is listed on the Maine DEP's 2004 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, this Phosphorus Control Action Plan (and TMDL) was prepared, publicly reviewed, and completed during the summer of 2005.

Based on **Secchi disk transparencies,** measures of both TP and **chlorophyll-a**, the water quality of Lovejoy Pond is considered to be poor and the potential for nuisance summertime algae blooms is extremely high (Maine VLMP 2005). Together, these water quality data document a trend of increasing **trophic state,** in direct violation of the Maine DEP Class GPA water quality criteria requiring a stable or decreasing trophic state.

Nonpoint source pollution is the main reason for declining water quality in Lovejoy Pond. During storm events, nutrients, such as phosphorus—naturally found in Maine soils– drain into the lake from the surrounding watershed by way of streams and overland flow and are deposited and stored in the lake bottom sediments.

Phosphorus is naturally limited in lakes and can be thought of as a fertilizer, a primary food for plants, including algae. When lakes receive excess phosphorus from NPS pollution, it "fertilizes"

the lake by feeding the algae. Too much phosphorus can result in nuisance algae blooms, which can damage the ecology/aesthetics of a lake, as well as the economic well-being of the entire lake watershed. Previous Maine DEP investigations (1984) showed that realtors serving the Albion area reported that property values around Lovejoy Pond were about one third the value of similar shoreline properties on area pond and lakes having clearer/cleaner water.

Reports from long-time residents of the Lovejoy Pond watershed indicate that summer-time nuisance algae blooms date back to around the mid 1960's. Consequently, by the mid-1970's organized recreational swimming was mostly restricted to the month of June since water clarity was greatly reduced and odors from decaying algae became too objectionable in July and August. These poor water quality conditions persist to the present day. While algae blooms have been a frequent subject of complaint, aquatic plants are also a nuisance. Large portions of the shore are fringed by wetlands (Figure 2) and expanses of submergent and aquatic plants extend up to 250 feet into the pond shallows at depths of 3 to 4 feet.

During the mid 1980's, the Maine DEP collected data from Johnson Brook to determine the effectiveness of agricultural BMP implementation on reducing phosphorus loading to Lovejoy Pond. The results from this study concluded that there were significant phosphorus reductions, though eutrophic conditions were expected to continue given the high concentrations of phosphorus in the water column and bottom sediments.

Principle Uses & Human Development: The prevalent human uses of the Lovejoy Pond shoreline are agricultural and residential (Figure 2). The sparsely developed shoreline consists of 44 residential units, 75% of which are seasonal. No official public access sites to Lovejoy Pond currently exist, although area residents infrequently use an informal and poorly maintained boat launch at the end of the unpaved road that runs through the gravel pit on the west side of the pond.

NPS pollution is a significant concern for the watershed. Consequently, Lovejoy Pond is on the State's **Nonpoint Source Priority Watersheds** list due primarily to excessive phosphorus, lake enrichment and the prevalence of late summer and early fall nuisance algal blooms.

*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 due to NPS water pollution. This list identifies watersheds where state and federal agency resources for NPS water pollution prevention or restoration should be targeted.*

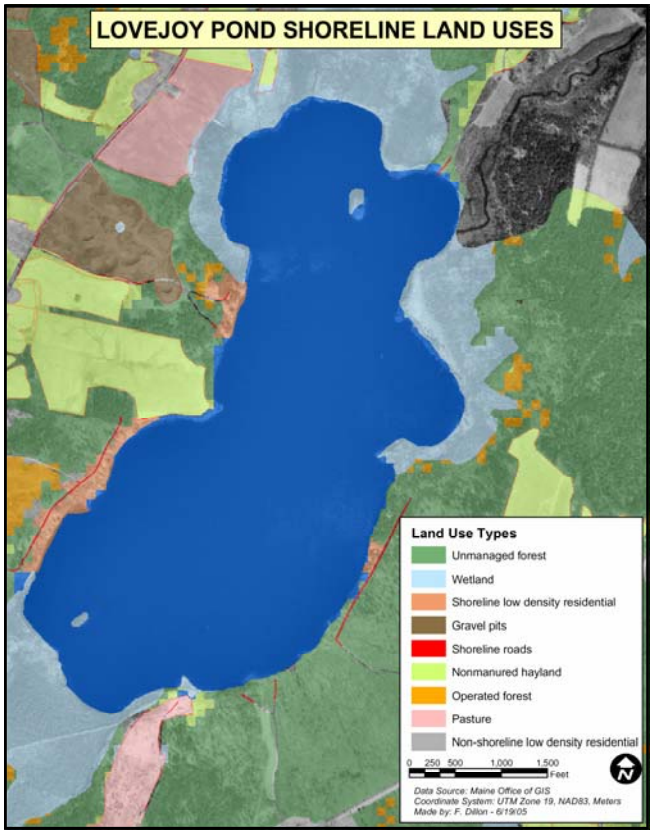


Figure 2: *shoreline land uses around Lovejoy Pond are primarily agriculture and seasonal residential. Note also the large extent of wetlands (light blue) along the shoreline.*

Lovejoy Pond Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIFW) and recent conversations with fisheries biologist Bill Woodward (Region B, Sidney DIFW office), Lovejoy Pond (town of Albion - Kennebec River drainage) is managed as a warmwater (black bass, white perch and chain pickerel) fishery. Lovejoy Pond was originally surveyed by Maine DIFW in 1941, while their lake fisheries report was revised in 1953 and 1997. A total of **13** fish species are listed, including: **9** native indigenous fishes (American eel, sea-run alewife, golden shiner, white sucker, brown bullhead, chain pickerel, banded killifish, yellow perch, and pumpkinseed); and **4** previously introduced fishes: white perch and smallmouth bass and more recently illegally introduced largemouth bass (ca. 1992-93) and northern pike (2002-03). Lovejoy Pond is also included in the list for the Maine Department of Marine Resources anadromous alewife restoration project and has been annually stocked since 1987, with the exception of 1999 (personal communication, Gail Wippelhauser, Maine DMR - see Maine DEP Fact Sheet on pg. 38).

Chain pickerel

Largemouth bass

White perch

Smallmouth bass

Based on recent Maine DEP summertime temperature-oxygen profile measures, a 50% oxygen deficiency (**anoxia**) exists in the deeper water of Lovejoy Pond which can effect the potential for warmwater fisheries management. According to Maine DIFW, past fish kills were reported on June 4, 1990 (white perch) and June 1, 1996 (largemouth bass and pumpkinseed). Over time, considerable improvements in water quality may serve to enhance fisheries conditions in Lovejoy Pond. Given that the trophic state of Lovejoy Pond has been disturbed by cumulative human impacts over the past several decades, then a significant reduction in the total phosphorus load in the Lovejoy Pond watershed may lead to improving early summertime **dissolved oxygen** levels and maintaining in-lake nutrient levels within the natural assimilative capacity of this lake to effectively process total phosphorus.

Anoxia—*a condition of no oxygen in the water. Often occurs near the bottom of fertile, stratified lakes in the summer and under ice in late winter.*

Dissolved Oxygen—*refers to the amount of oxygen measured in the water. It is used by aquatic organisms for respiration. The higher the temperature, the less oxygen the water can hold. Oxygen will naturally decline during the summer months as water temperatures rise.*

General Soils Description (Source: USDA SCS 1978)

The Lovejoy Pond Watershed is characterized by the following general soil associations: Hollis-Paxton-Charlton-Woodbridge (35%), which is shallow and deep, somewhat excessively drained to moderately well drained, gently sloping to moderately steep, with moderately coarse textured soils formed in glacial till on hills and ridges; Buxton-Scio-Scantic association (45%), which is deep, moderately well drained to poorly drained, nearly level to sloping, medium textured soils, formed in lacustrine or marine sediments in flat areas and near waterways; and Scantic-Ridgebury-Buxton association (20%), which is deep, poorly drained to moderately well drained, nearly level to sloping, medium textured soils formed in marine or lacustrine sediments in valleys, and moderately coarse textured soils formed in glacial till in flat areas or depressions on upland ridges. All general soil associations fall within the C, C/D and D hydrologic soil groups, which have fairly low permeability rates and allow for greater amounts of surface runoff.

Land Use Inventory

The results of the Lovejoy Pond watershed land use inventory are depicted in Table 1 and Figure 3 (following page). The various land uses are categorized by developed land vs. non-developed land. The developed land area comprises approximately 38% of the watershed and the undeveloped land including the water surface area of Lovejoy Pond, comprises the remaining 62% of the watershed. These numbers may be used to help make future planning and conservation decisions relating to the Lovejoy Pond watershed. The information in Table 1 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Descriptive Land Use and Phosphorus Export Estimates

- *To convert kilograms (kg) of total phosphorus to pounds - multiply by 2.2046*

Agriculture: Historically, agriculture has been the dominant land use in the Lovejoy Pond watershed. This trend continues to the present day as agriculture still plays a very significant role in the local economy and the amount of land used for agricultural purposes in the Lovejoy Pond direct watershed is substantial when compared to other land uses. Agricultural land is estimated to comprise 1,576 acres (28.2%) of the watershed area and contribute nearly 544 kg (71%) of the total direct phosphorus loading to Lovejoy Pond. These data were mapped using GIS software and verified by aerial photography in consultation with the Kennebec County SWCD office.

Actively Managed Forest Land: The estimated operated forest land for the Lovejoy Pond direct watershed consists of 187 acres. This estimate is based on a GIS analysis of land uses and represents slightly more than 3% of the total land area and less than 1% of the total phosphorus load to Lovejoy Pond. While poorly managed forestry operations have the potential to negatively impact a waterbody through erosion and sedimentation from logging sites, properly managed forestry operations generally do not. Sustainable forest management can enhance water quality through sequestering excess nutrients, particularly in forested riparian areas. 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.

Table 1. Lovejoy Pond Direct Watershed Land Use Inventory and Phosphorus Loads			
LAND USE CLASS	Land Area Acres	Land Area %	TP Export Total %
Agricultural Land			
Hayland	1,208	22%	47%
Mixed Agriculture	64	1%	9%
Row Crops	164	3%	8%
Pasture	139	3%	7%
Actively Managed Forest	187	3%	1%
Sub-Totals	**1,763**	**32%**	**72%**
Shoreline Development			
Shoreline Septic Systems	**Lovejoy Pond Septic Model**		1%
Low Density Residential	14	0.2%	<1%
Private/Camp Roads	3	0.1%	<1%
Sub-Totals	**16**	**0.3%**	**2%**
Non-Shoreline Development			
Roads	119	2%	11%
Low Density Residential	131	2%	4%
Gravel Pits	72	2%	0%
Sub-Totals	**322**	**6%**	**15%**
Total: DEVELOPED LAND	**2,101**	**38%**	**89%**
Non-Developed Land			
Inactive/Passively Managed Forest	2,675	48%	7%
Grassland/Reverting Fields	61	1%	1%
Scrub-Shrub	29	1%	0%
Wetlands	343	6%	0%
Total: NON-DEVELOPED LAND	**3,109**	**56%**	**8%**
Total: Surface Water (Atmospheric)	**384**	**6%**	**3%**
TOTAL: DIRECT WATERSHED	**5,594**	**100%**	**100%**

Shoreline Residential (House and Camp Lots): Shoreline lake residences can have a comparatively large total phosphorus loading impact to lakes in comparison to their relatively small percentage of the total land area in the watershed. This is not the case for Lovejoy Pond given the sparse extent and seasonal nature of shoreline development. Shoreline residential land use is estimated to consist of only 0.3% of the total watershed land area and contribute approximately 2% of the total phosphorus load to Lovejoy Pond.

MACD project staff determined the residential phosphorus load estimate by conducting a shoreline survey in the early summer of 2002. This visual survey was carried out while observing the Lovejoy Pond shoreline from a boat and using best professional judgment to establish subjective determinations of potential impact ratings. The visual survey included a residential dwelling tally along with rating estimates for potential NPS pollution impacts based on the presence or lack of vegetated buffers, distance of dwelling from shoreline, shoreline erosion, presence of bare/exposed soil and percent slope of the lot. In addition to the impact rating, project staff estimated the residency status of the dwelling (seasonal vs. year-round) and other notable features such as retaining walls or boat launches (see Table 2).

Table 2. Lovejoy Pond Shoreline Survey Results (2002)

Buffer Rating	Number (%) of shoreline sites identified within each category
1 = Best Buffer	4 (9%)
2 = Good Buffer	1 (2%)
3 = Some Buffer	8 (17%)
4 = Sparse Buffer	19 (41%)
5 = No Buffer	14 (31%)

Shoreline Septic Systems: Total phosphorus export loading from residential septic systems within the 100-foot shoreline zone was assessed for Lovejoy Pond based on the shoreline survey. A simple model used the results from the shoreline survey to estimate total phosphorus loading from shoreline septic systems. The following attributes were included in the model: seasonal or year-round occupancy status; estimated age of the system; estimated distance of the system to the lake; and an estimate of 3 people per dwelling. A range of low, medium and high groundwater flow

values were also factored into the model.

For purposes of these calculations it was assumed that 50% of the dwellings along the shoreline had septic systems installed after 1974. Based on the results of the shoreline survey, 86% of residences (and their septic systems) were estimated to lie less than 50' from the shoreline while the remainder were estimated to lie beyond 50' from the shoreline. Approximately 75% of the shoreline dwelling units were assumed to be occupied on only a seasonal basis while the remainder were assumed to be year-round residences.

The ability of shoreline soils to filter and purify septic tank effluent is also a critical consideration in determining the suitability of septic systems for treating domestic wastewater (Cinnamon 1993). Much of the Lovejoy Pond shoreline is dominated by Hollis-Paxton-Charlton-Woodbridge very stony fine sandy loams, with slopes ranging from 3 – 30% (USDA SCS 1978). These soils are nearly ideal for septic systems with enough silt and clay for treatment of the effluent, but coarse enough to handle the hydraulics as well as a restrictive layer that protects the true water table (David Rocque, Maine Department of Agriculture, personal communication). There are no public sewer services within the Lovejoy Pond shoreline zone area (Town of Albion).

Based on all of these factors, estimates of the loading from residential septic systems on Lovejoy Pond range from a low of 5.1 kg to a high of 15.9 kg of total phosphorus per year. Assuming a mid-range value of 8.9 kg of total phosphorus per year, shoreline septic systems represent a relatively insignificant contribution (at approximately 1.2%) of the total phosphorus loading to Lovejoy Pond.

Private/Camp Roads: NPS pollution associated with shoreline roads can vary widely, depending upon road type, slope and proximity to a surface water resource. Routine maintenance of unimproved roads and associated drainage structures is often inadequate. For Lovejoy Pond, total phosphorus loading from shoreline roads was estimated using GIS land use data to determine the overall area occupied by this category. The average width for shoreline roads in the Lovejoy Pond watershed was estimated to be about 6 meters (based on the findings from previous PCAP reports). Based on these factors, shoreline roads were determined to cover about 3 acres and contribute less than 0.1% (2.8 kg/yr) of the total phosphorus load to the direct watershed.

Overall, shoreline development comprises less than 1% of the total watershed area and contributes approximately 15 kg of total phosphorus annually, which is 2% of the estimated phosphorus load.

Non-Shoreline Development and Land Uses

Non-Shoreline Development consists of all lands outside the immediate shoreline of Lovejoy Pond - including public roads, low density residential areas and gravel pits. All of these land areas were calculated with GIS land use data.

Public Roads: Public road widths were estimated from previous PCAP reports (16 meters and 22 meters for town and state-owned roads, respectively) to determine the amount of total phosphorus loading from this land use category. Based on these factors, public roads contribute an estimated 83 kg/year (10.8%) of the total phosphorus load to Lovejoy Pond's direct watershed.

Low Density Residential: Low density residential land use consists of approximately 154 acres and contributes an estimated 31 kg/year (4.1%) of the total phosphorus loading to the Lovejoy Pond direct watershed.

Gravel Pits: Phosphorus contributions from gravel pits are generally assumed to be negligible since precipitation and surface water theoretically do not leave the site and instead soak completely into the ground. However, gravel pit operations can discharge phosphorus if they are not properly maintained. The gravel pit on the west side of Lovejoy Pond may be one such exceptional operation since large piles of material, including topsoil, are routinely stockpiled near the edge of a cleared area above a fairly steep slope less than a tenth of a mile from the pond. For the present report, phosphorus discharge from this gravel pit is characteristically assumed to be zero; however, further investigations should be conducted to actually confirm this assumption.

Phosphorus Loading from Non-Developed Lands and Water

Inactive/Passively Managed Forests: Of the total land area within the Lovejoy Pond watershed, 2,675 acres are forested, characterized by privately-owned non-managed deciduous and mixed forest plots. Approximately 6.8% of the phosphorus load (52 kg/year) is estimated to be derived from non-commercial forested areas within Lovejoy Pond's direct drainage area.

Other Non-Developed Land Areas: Combined wetlands, grasslands/reverting fields and scrub shrub account for the remaining 9.2% of the land area and less than 1% of the total phosphorus export load.

Atmospheric Deposition (Open Water): Surface waters for Lovejoy Pond's direct watershed comprise nearly 7% of the total land area (384 acres) and account for an estimated 25 kg of total phosphorus per year, representing 3.3% of the total direct watershed load entering Lovejoy Pond. The lower total phosphorus loading coefficient chosen (0.16 kg/ha) is similar to that used for nearby central Maine lakes in Kennebec County, while the upper range (0.21 kg/ha) generally reflects a watershed that is 50 percent forested, combined with agricultural areas interspersed with urban/ suburban land uses (Reckhow et al. 1980).

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). Please note that two methods were used in our total phosphorus loading analysis to assist with the preparation of this report: 1) a GIS-based land use and indirect load models; and 2) an in-lake phosphorus concentration model. However, the phosphorus reduction needed for the Lovejoy Pond TMDL was determined using only the in-lake phosphorus concentration model due to the inherent difficulties in linking land-based phosphorus load export estimates with actual in-lake phosphorus concentrations.

1. Modeling total phosphorus input into Lovejoy Pond

Watershed Land Uses: Total phosphorus loadings to Lovejoy Pond originate from a combination of external watershed and internal lake sediment sources. Watershed total phosphorus sources, totaling approximately 763 kg annually (corrected GIS) have been identified and accounted for by land use (See Table 3 - page 25), while internal phosphorus loading from Lovejoy Pond lake sediments average 217 kg/yr - for a combined total phosphorus input of 980 kg annually.

Loading from the Indirect Watershed: Total phosphorus loading from associated upstream sources accounts for an estimated indirect watershed average load of 31 kg annually, determined on the basis of *flushing rate x volume x TP concentration* (see page 26 for more information).

The sum of these two sources of total phosphorus indicates that an estimated 1,011 kg/yr may be contributing to the current in-lake phosphorus levels of Lovejoy Pond. However, these models do not take into account many of the complex factors that affect lake water quality. Instead, these figures provide stakeholders with gross estimates that can be use to target further implementation measures in the watershed.

2. Modeling Lovejoy Pond's in-lake concentration of total phosphorus

Pond Capacity: The assimilative capacity for all existing and future non-point pollution sources for Lovejoy Pond is 380 kg of total phosphorus per year, based on a target goal of 16 ppb (See Phosphorus Retention Model - page 28).

Target Goal: A change in 1 ppb in phosphorus concentration in Lovejoy Pond is equivalent to 24 kg. The difference between the target goal of 16 ppb and the measured average summertime total phosphorus concentration (52 ppb) is 37 ppb (x 24) or 888 kg.

Future Development: The annual total phosphorus contribution to account for future development for Long Lake is 12 kg (0.50 x 24) (see page 27 for more information).

Reduction Needed: Given the target goal and a 12 kg allocation for future development, the total amount of phosphorus needed to be reduced, on an annual basis, to restore water quality standards in Lovejoy Pond is estimated to be 900 kg (888 + 12).

PHOSPHORUS CONTROL ACTION PLAN

Recent and Current NPS/BMP Efforts

The Kennebec County Natural Resources Conservation Service (NRCS) has an ongoing relationship with land owners in the Lovejoy Pond watershed and has helped them establish voluntary conservation management plans to reduce nutrient export from agricultural operations. There are also conservation management plans currently awaiting implementation pending the availability of federal funding.

Beginning in 2003, Maine DEP worked with the Maine Association of Conservation Districts (MACD) and the Kennebec County Soil and Water Conservation District (KC-SWCD) to form a stakeholder group/pond association that would promote practices to improve the water quality of Lovejoy Pond. Meetings were held for area residents interested in assisting with this effort and a grant proposal was submitted to provide funding for a watershed survey project. Unfortunately, assistance funds were not approved and the pond association never developed. Two members of this group did volunteer to measure Secchi disk transparencies on a bi-weekly basis through the Maine Volunteer Lakes Monitoring Program (Maine VLMP). Hopefully, this PCAP-TMDL report will serve as an added catalyst to renew interest in the formation of a Lovejoy Pond Association.

Recommendations for Future NPS/BMP Work

Lovejoy Pond has impaired water quality due mostly to nonpoint source (NPS) pollution and resultant internal lake sediment recycling of phosphorus. Specific recommendations regarding recent and current efforts in the watershed, Best Management Practices (BMPs), and actions to reduce (1) external watershed and (2) accumulated bottom sediment phosphorus total phosphorus loadings in order to improve water quality conditions in Lovejoy Pond are as follows:

Watershed Management: Several agencies (i.e., Maine DEP, KC-SWCD, USDA-NRCS) have been involved in attempting to restore the water quality of Lovejoy Pond. This PCAP-TMDL report will serve as a compilation of existing information about the past and present restoration projects that have been undertaken in order to adequately assess future NPS BMP needs in the watershed.

Action Item # 1: Coordinate Existing Watershed Management Efforts		
Activity	**Participants**	**Schedule & Cost**
Continue efforts to develop a Lovejoy Pond Restoration Steering Team	KC-SWCD, NRCS, Maine DEP, KV-COG, towns of Albion and China, interested watershed citizens - stakeholders	Annual Roundtable Meetings beginning in fall 2005 - minimal cost

Shoreline Residential: Even though Lovejoy Pond's shoreline is sparsely developed with residential dwellings, there is still the potential to negatively impact water quality with this land use. According to the 2002 shoreline survey conducted for this PCAP report, there are 44 shoreline dwellings, over 70% of which were identified as having inadequate or nonexistent vegetated

buffers. The survey also estimated that 85% of shoreline dwellings are situated less than 50-feet from the lake. With homes in close proximity to the water's edge, it is critical that adequate and effective vegetative buffers are in place to decrease and slow down run-off from shoreland sites.

An effort should be undertaken to encourage landowners to establish adequate and effective vegetated buffers along the shoreline. For a copy of The Buffer Handbook, contact the Maine DEP's Bureau of Land & Water Quality in Augusta (287-2112) or for technical assistance regarding buffers, contact the KCSWCD (622-7847 ext 3).

Action Item # 2: Educate Watershed Citizens About Shoreline Buffers		
Activity	**Participants**	**Schedule & Cost**
Develop a Buffer Awareness Campaign for Watershed Citizens	Maine DEP, KC-SWCD, Town of Albion, interested watershed citizens	Begin immediately— **$2,500/year**

Roadways: A common cause of NPS pollution in lake watersheds is often related to roads, which if not properly designed and maintained can be a major source of erosion and sedimentation into ponds, lakes and streams. This PCAP report estimates that public and private roads combined contribute slightly more than 11% of the total phosphorus load per year to Lovejoy Pond. As such, efforts should be undertaken to identify pollution sources from roads so that appropriate BMPs can be designed and installed to remediate problem areas.

Action Item # 3: Implement Roadway Best Management Practices		
Activity	**Participants**	**Schedule & Cost**
Conduct survey of public and private roads in watershed to determine NPS pollution sources and establish / implement roadway BMPs	Maine DEP, KC-SWCD, Towns of Albion and China, interested watershed citizens	Annually beginning in 2006 **$10,000**

Agriculture: Agricultural activities are among the most dominant land uses in the watershed and in all likelihood contribute the greatest proportion of phosphorus loading to Lovejoy Pond. BMP recommendations for agricultural land uses include providing education on conservation practices and planning assistance. The Natural Resources Conservation Service provides technical assistance for using proper agricultural BMPs. For more information contact the NRCS office in Kennebec County (622-7847).

Action Item # 4: Conduct Workshops for Agricultural Landowners		
Activity	**Participants**	**Schedule & Cost**
Conduct workshops encouraging the use of phosphorus control measures within the Lovejoy Pond watershed.	NRCS, agricultural landowners and watershed municipalities (Albion & China).	Annually beginning in 2006 Variable cost depending on type of activities

Forestry: Forestry activities are much more limited both from a land use and phosphorus loading perspective. However, existing voluntary state guidelines for simplified pre-harvest plans, filter areas and proper erosion control as described in *Best Management Practices for Forestry: Protecting Maine's Water Quality* would minimize erosion and sedimentation during harvesting. Watershed municipalities should adopt new Statewide Standards for Timber Harvesting and Related Activities in Shoreland Areas. For more information contact the Maine Forest Service (1-800-367-0223).

Action Item # 5: Promote Sound Forest Management in Shoreland Areas		
Activity	**Participants**	**Schedule & Cost**
• Promote use of voluntary forestry BMPs • Adopt statewide Standards for Timber Harvesting and Related Activities in Shoreland Areas • Encourage landowner participation in Be Woods Wise, MFS's education, technical and financial assistance program for forest landowners.	Watershed municipalities, forest landowners, logging professionals, local land trusts, Maine Forest Service	Beginning 2006 Cost dependent on activities. Financial cost-share assistance available to develop long-term forest management plans and implement sustainable forestry projects including NPS corrective action.

Non-Shoreline Development: Combined, these types of land uses are estimated to contribute nearly 6% of the total phosphorus load to Lovejoy Pond. Therefore, particular attention should be given to properties adjacent to Lovejoy Pond watershed brooks and streams.

Action Item # 6: Develop Stewardship Initiatives for Lovejoy Pond Tributaries		
Activity	**Participants**	**Schedule & Cost**
"Adopt" local streams to promote stewardship efforts including education and water quality monitoring.	Maine DEP, KC-SWCD, Stream Team, local schools and watershed citizens.	Annually beginning in 2005 **$2,500/yr**

Septic Systems: Older, poorly designed and installed septic systems within the shoreland zone may contribute significantly to water quality problems, adding to the cumulative phosphorus load to Lovejoy Pond. While Lovejoy Pond septic systems – when properly sited, constructed, maintained, and set back from the water – should not affect water quality, many septic systems do not meet all of these criteria and thus have the potential to contribute phosphorus and other contaminants to lake water. Septic systems around Lovejoy Pond which are sited in coarse, sandy soils with minimal filtering capacity are especially likely to contribute nutrients to lake waters, as are older septic systems which pre-date Maine's 1974 Plumbing Code.

Recommendations for reducing existing phosphorus inputs to lakes include seeking replacement of pre-Plumbing Code septic systems and other poorly functioning systems within the shoreland zone of Lovejoy Pond. Identification of potential problem systems can be accomplished

by conducting sanitary surveys. Lakeshore residents who believe they may have problems with their septic systems are encouraged to contact their town office for possible technical and/or financial assistance. In some cases, a revolving loan fund could be established to assist in the replacement of malfunctioning septic systems. Above all, educational efforts should make residents aware of impending problems and possible cost-effective solutions.

Action Item # 7: Expand Homeowner Education & Technical Assistance Programs		
Activity	**Participants**	**Schedule & Cost**
Increase outreach and education efforts to watershed citizens including technical assistance to landowners	Maine DEP, KC-SWCD, Lovejoy Pond Association	Annually beginning in 2005 $2,500/yr includes printing of educational materials

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.

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.

WATER QUALITY MONITORING PLAN

Historically, the water quality of Lovejoy Pond has been monitored via measures of Secchi disk transparencies during the open water months since 1975 (Maine DEP and VLMP). Continued long-term water quality monitoring of Lovejoy Pond will be conducted monthly, from May to October, through the continued efforts of Maine DEP and VLMP. Under this planned, post-TMDL water quality-monitoring plan, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Lovejoy Pond. A post-TMDL adaptive management status report will be prepared five to ten years following EPA approval.

PCAP CLOSING STATEMENT

The Maine Association of Conservation Districts and Kennebec County Soil and Water Conservation District (KC-SWCD), in cooperation with lake stakeholders, have initiated the process of addressing nonpoint source pollution in the Lovejoy Pond watershed. Technical assistance by KC-SWCD is available to both watershed towns (Albion and China) to mitigate phosphorus export from existing NPS pollution sources and to prevent excess loading from future sources. It is critical that the Towns of Albion and China recognize the inherent value of Lovejoy Pond and its vital link to the community by providing strong support to restoration efforts. Both towns should cooperate with KC-SWCD and NRCS in the pursuit of local and regional lake protection and improvement strategies. This teamwork approach should result in an eventual and overall improvement in Lovejoy Pond through NPS-BMP implementation and increased public involvement and awareness.

APPENDICES

LOVEJOY POND (Albion)

Total Maximum Daily (Annual Phosphorus) Load

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 32 lakes in Maine which do not meet water quality standards due to excessive amounts of in-lake total phosphorus - the great majority of which are located in south-central Maine (Kennebec County).

The first Maine lake TMDL was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with Maine DEP and U.S. EPA. TMDLs have been approved by U.S. EPA for Madawaska Lake (Aroostook County), Sebasticook Lake, East Pond (Belgrade Lakes), China Lake, Webber, Threemile and Threecornered ponds (Kennebec County), Mousam Lake, the Highland lakes in Falmouth and Bridgton, Annabessacook Lake, Pleasant Pond, Upper Narrows Pond and Little Cobbossee Lake (under contract with CWD), Sabattus and Toothaker ponds and Long Lake (with assistance from Lakes Environmental Association). 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 Togus and Duckpuddle ponds. PCAP-TMDL studies have also been initiated for Lilly, Hermon-Hammond, and Sewall ponds, as well as several of the remaining seven 2004 303(d) listed PCAP-TMDL waterbodies in Aroostook County.

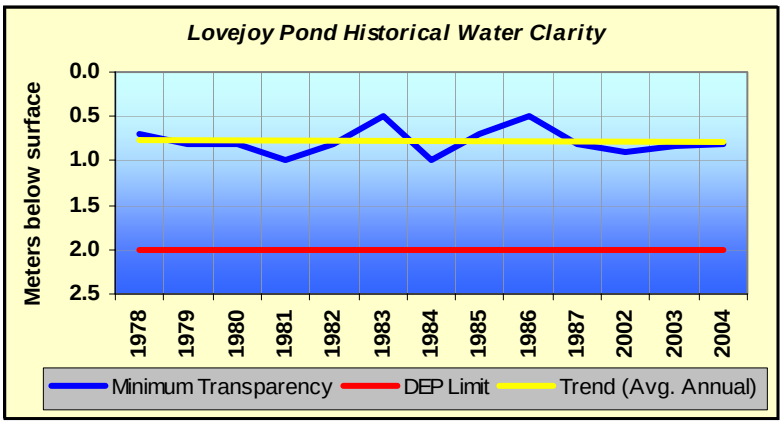
Lake PCAP-TMDL reports are based in part on available water quality data, including seasonal measures of total phosphorus, chlorophyll-a, Secchi disk transparencies, and dissolved oxygen-water temperature profiles. Actual reports include: a lake description; watershed GIS assessment and estimation of 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 generally intended by Maine DEP to be used for regulatory purposes*.

For further information, 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 2004) Water quality monitoring data for Lovejoy Pond (station 1, deep hole) has been collected annually since 1975. Hence, this present water quality assessment is based on 20 years of Secchi disk transparency (SDT) measures, combined with 10 years of epilimnion core total phosphorus (TP) data, 13 years of water chemistry and 15 years of chlorophyll-a monitoring data.

Water Quality Measures: (Source: Maine DEP and VLMP 2004) Historically, Lovejoy Pond has had a range of SDT measures from 0.5 to 4.4 meters, with an average of 1.8 m; an epilimnion core TP range of 22 to 100 with an average of 52 parts per billion (ppb), and chlorophyll-a measures ranging from 3.3 to 99.7, with an average of 29.2 ppb. Recent dissolved oxygen (DO) profiles indicate excessively low levels of DO in deep areas of the lake. Late summer dissolved oxygen levels in 2003 and 2004 remained low (0-4 ppm) with 50% of the water column (lower 5 meters) unsuitable for fish. The potential for total phosphorus to leave the bottom sediments and become available to algae in the water column (internal loading) is very high (Maine DEP 2003).



As the yellow trend line indicates, Lovejoy Pond's water clarity has been well below the DEP's two meter minimum since, and no doubt, prior to, 1978.

Priority Ranking, Pollutant of Concern and Algae Bloom History: Lovejoy Pond is listed on the State's 2004 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 the need to complete an accelerated approach to lakes TMDL development. This Lovejoy Pond TMDL has been developed for total phosphorus, the major limiting nutrient to algae growth in freshwater lakes in Maine.

The water quality of Lovejoy Pond during the summers of 1987-2004 appears to be improved in contrast to 1976-78 and the preceding 18 years of record. Minimum transparencies averaged below 2 meters and total phosphorus (52 ppb) and chlorophyll-a (mean 29.2 ppb) levels have been fairly high. On the basis of measured water transparencies below 2 meters in the summertime, nuisance algae blooms were prevalent during 15 of the last 16 years, with only a suitable low measure of 2.2 meters observed in the summer of 1988.

Total phosphorus loading from associated upstream sources (31 kg/TP/yr) accounts for loading from the indirect watershed, determined on the basis of flushing rate x volume x TP concentration, and typical area gauged streamflow calculations (Jeff Dennis, personal communication).

Natural Environmental Background levels for Lovejoy Pond were not separated from the total non-point source load because of the limited and general nature of available information. Without more and detailed site-specific information on non-point source loading, it is very difficult to separate natural background from the total non-point source load (US-EPA 1999). There are no known point sources of pollutants to Lovejoy Pond.

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 (<30 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Lovejoy Pond is a colored lake (average color 40 CPUs), with relatively low late summer SDT readings (annual average of 1.8 meters), in association with moderate/high chlorophyll a levels (29.2 ppb annual average). Currently, Lovejoy Pond does not meet water quality standards due to consistently poor water transparency (1978-2004), combined with monitored annual summertime hypolimnetic dissolved oxygen deficiencies (50% of water column). This water quality assessment uses historic documented conditions as the primary basis for comparison.

Designated Uses and Antidegradation Policy: Lovejoy 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 numeric (in-lake) water quality target for Lovejoy Pond is set at 16 ppb total phosphorus (380 kg/yr). Since numeric criteria for phosphorus do not exist in Maine's state 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. Spring-time (late May - June) total phosphorus levels in Lovejoy Pond historically approximated 16 - 22 ppb during the time period 1976-1977, however summertime levels ranged from 80-100 ppb. Since that time, springtime phosphorus levels have ranged from 35-52 ppb while In-lake (epilimnion core) total phosphorus summer-time (July through September) measures have ranged from 25-74 ppb, averaging 52 ppb (algal bloom conditions).

In summary, the numeric water quality target goal of 16 ppb for total phosphorus in Lovejoy Pond was based on hypothetical late spring - early summer pre water column stratification estimates, generally corresponding to non-bloom conditions, as reflected in suitable (water quality attainment) measures of both Secchi disk transparency (> 2.0 meters) and chlorophyll-a (< 8.0 ppb).

ESTIMATED PHOSPHORUS EXPORT BY LAND USE CLASS

Table 3 details the numerical data used to determine external phosphorus loading for the Lovejoy Pond watershed. The key below Table 3 on the next page explains the columns and the narrative that follows (pages 26-27) relative to each of the representative land use classes.

Table 3. Lovejoy Pond Direct Watershed - Estimated 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 %
Agricultural Land								
Hayland	1,208	22%	0.35-1.34	0.64	489	313	358	47%
Row Crops	64	1%	0.26-18.6	2.24	26	58	67	9%
Pasture	164	3%	0.14-4.9	0.81	67	54	62	8%
Mixed Agriculture	139	3%	0.08-3.25	0.91	56	51	57	7%
Actively Managed Forest	187	3%	0.04-0.6	0.08	76	6	7	1%
Sub-Totals	**1,763**	**32%**			**713**	**482**	**551**	**72%**
Shoreline Development								
Shoreline Septic Systems						9	9	1%
Low Density Residential	14	0.2%	0.25 - 1.75	0.5	6	3	3	<1%
Private/Camp Roads	3	0.1%	0.60 - 10.0	2	1	2	3	<1%
Sub-Totals	**16**	**0.3%**			**7**	**14**	**15**	**2%**
Non-Shoreline Development								
Roads	119	2%	0.60 - 10.0	1.5	48	72	83	11%
Low Density Residential	131	2%	0.25 - 1.75	0.5	53	27	31	4%
Gravel Pits	72	2%	0.0	0	29	0	0	0%
Sub-Totals	**322**	**6%**			**130**	**99**	**114**	**15%**
Total: DEVELOPED LAND	**2,101**	**38%**			**850**	**595**	**679**	**89%**
Non-Developed Land								
Inactive/Passively Managed Forest	2,675	48%	0.01-0.08	0.04	1,083	43	52	7%
Grassland/Reverting Fields	61	1%	0.1 - 0.2	0.2	25	5	6	1%
Scrub-Shrub	29	1%	0.1 - 0.2	0.1	12	1	1	0%
Wetlands	343	6%	0-0.05	0	139	0	0	0%
Total: NON-DEVELOPED LAND	**3,109**	**56%**			**1,258**	**49**	**59**	**8%**
Total: Surface Water (Atmospheric)	**384**	**6%**	**0.11-0.21**	**0.16**	**156**	**25**	**25**	**3%**
TOTAL: DIRECT WATERSHED	**5,594**	**100%**			**2,264**	**669**	**763**	**100%**

Key for Columns in Table 3

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

TP Coeff. Value kg/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

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

Total Phosphorus Land Use Loads

Estimates of total phosphorus export from different land uses found in the Lovejoy Pond watershed as presented on the previous page in Table 3 represent the extent of the current direct watershed phosphorus loading to the lake (763 kg/yr). Total phosphorus loading from the associated upstream source of Dutton Pond (31 kg/yr) accounts for loading from the indirect watershed, determined on the basis of *flushing rate (2.84) x volume (1.1) x TP concentration (10 ppb),* representing typical area gauged stream flow calculations.

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 loading values were primarily determined using literature and locally-derived 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).

Agriculture: Phosphorus loading coefficients as applied to agricultural land uses were adopted from past Maine DEP 1982 studies for non-manured hayland (0.64 kg/ha/yr). This coefficient was used for all hayland in the watershed and may actually underestimate its impact since some hayland receives manure or commercial fertilizer.

Actively Managed Forest Land: The phosphorus loading coefficient applied to actively managed forest land (0.08 kg/ha/yr) was changed beginning with the Long Lake PCAP-TMDL report following consultation with Lakes Environment Association and Maine Forest Service staff. The rationale for this change was based on the fact that properly managed harvest areas will generally act as phosphorus sinks during periods of regeneration. According to the Maine Forest Service, of the nearly 3,500 water quality inspections conducted throughout the state in 2003, approximately 7% of the harvested sites posed "unacceptable" risks to water quality.

PCAP-TMDL reports prior to the Long Lake report identified a "worst case" upper limit phosphorus loading coefficient of 0.6 kg/ha/yr for operated forestland. Therefore, for any given watershed in Maine we determined that applying this "worst case" coefficient to 7% of operated forest land while applying the "best case" coefficient (0.04 kg/ha/yr) to the remaining operated forest land would provide a relatively accurate estimate of total phosphorus loading from operated forest land. Combining worst case and best case coefficients yields the new phosphorus loading coefficient for operated forest land of 0.08 kg/ha/yr [(0.07 x 0.6) + (0.93 x 0.04)].

Residential Lots (House and Camp): The range of phosphorus loading coefficients used (0.25 – 2.70 kg/ha/yr) was developed from information on residential lot stormwater export of phosphorus as derived from Dennis et al (1992). Phosphorus loading coefficients for low density residential development was estimated to be 0.50 kg/ha/yr.

Private and Public Roads: The total phosphorus loading coefficient for private/camp and public roads (2.0 kg/ha/yr for private/camp roads and 1.50 kg/ha/yr for public roads) was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997) and phosphorus research by Jeff Dennis (Maine DEP).

Total Developed Lands Phosphorus Loading: A total of 89% (679 kg) of the phosphorus loading to Lovejoy Pond is estimated to have been derived from the cumulative effect of the preceding cultural land use classes: agriculture and forestry (72.1% - 551 kg); shoreline development (2% - 15 kg), including septic systems (1.2% - 8.99 kg) as depicted in Table 3.
and non-shoreline development (14.9% - 114 kg).

Non-Developed Lands Phosphorus Loading: The phosphorus export coefficient for inactive/ passively managed forest land (0.04 kg/ha/yr) is based on a New England regional study (Likens et al 1977) and phosphorus availability recommendation by Jeff Dennis. The phosphorus export coefficient for grassland/reverting fields (0.20 kg/ha/yr) and scrub/shrub (0.10 kg/ha/yr) is based on

research by Bouchard in 1995 (0.20 kg/ha/yr). The export coefficient for wetlands is based on research by Bouchard 1995 and Monagle 1995 (0.0 kg/ha/yr). The phosphorus loading coefficient chosen for surface waters (atmospheric deposition) was (0.16 kg/ha/yr), as was originally used in the China Lake TMDL (Kennebec County), and subsequent PCAP-TMDL lake studies in Maine.

Shoreline Erosion: Undeveloped areas of the lake shoreline that may be eroding due to natural causes (i.e., wind, wave and ice action) are not included as a source of phosphorus due to the difficulty in quantifying impact area and assigning suitable phosphorus loading coefficients.

Phosphorus Load Summary

It is our professional opinion that the selected export coefficients are appropriate for the Lovejoy Pond watershed. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external nonpoint source nutrient pollution (direct and indirect drainages) approximates 794 (763+31) kg/yr.

LINKING WATER QUALITY and POLLUTANT SOURCES

Assimilative Loading Capacity: The Lovejoy 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 Lovejoy Pond TMDL as an annual load because the lake basin has an annual flushing rate of 2.6, in contrast to the 1.5 overall average flushing rate for Maine lakes.

The Lovejoy Pond basin lake assimilative capacity is capped at 380 kg TP/yr, as derived from the empirical phosphorus retention model based on a target goal of 16 ppb. This value reflects the modeled annual phosphorus loading responsible for current trophic state conditions, based on a long term goal of maintaining average phosphorus concentrations at or below 16 ppb.

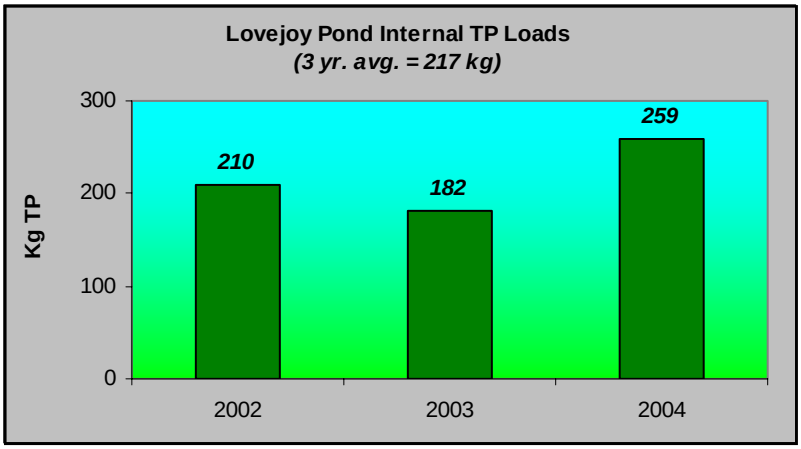
Future Development: The Maine DEP water quality goal of maintaining a stable trophic state includes a reduction of current P-loading which accounts for both recent P-loading as well as potential future development in the watershed. The methods used by Maine DEP to estimate future growth (Dennis et al. 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 Lovejoy Pond watershed approximates 12 kg annually (0.5 x 1 ppb change in trophic state or 24 kg).

Human growth will continue to occur in the Lovejoy Pond watershed, contributing new sources of phosphorus to the lake. Hence, existing phosphorus source loads must be reduced by at least 12 kg to allow for anticipated new sources of phosphorus to Lovejoy Pond.

Overall, the presence of nuisance algae blooms in Lovejoy Pond may be reduced, along with halting the trend of increasing trophic state, if the existing combined phosphorus loading is reduced by approximately 900 kg/yr.

Internal Lake Sediment Phosphorus Mass: The relative contribution of internal sources of total phosphorus within Lovejoy 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. The only years for which adequate lake profile TP concentration measures were available to derive reliable estimates of internal lake mass were 2002, 2003 and 2004, which ranged from a low of 182 and a high of 259, with an average of 217 kg/yr. Given the relatively high levels of phosphorus in the water column and the presence of nuisance algae blooms, it was expected that internal sediment derived phosphorus mass would be a significant problem in Lovejoy Pond.

Linking Pollutant Loading to a Numeric Target: The basin loading assimilative capacity for colored Lovejoy Pond was set at 380 kg/yr of total phosphorus to meet the numeric water quality target of 16 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 Lovejoy 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 ppb change = 24 kg**

380 = **L** = external total phosphorus load capacity (kg TP/year)
16 = **P** = total phosphorus concentration (ppb) = **Target Goal = 16 ppb**
1.33 = **A** = lake basin surface area (km^2)
4.2 = **z** = mean depth of lake basin (m) **A z p = 14.7**
2.63 = **p** = annual flushing rate (flushes/year)
0.62 = **1- R** = phosphorus retention coefficient, where:
0.38 = **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, China, Mousam, Highland (Falmouth), Webber, Threemile, Threecornered, Annabessacook, Pleasant, Sabattus, Toothaker, Unity, Upper Narrows, Highland (Bridgton), Little Cobbossee, Long (Bridgton), Togus, and Duckpuddle PCAP-TMDL reports (Maine DEP 2000-2005) have all 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 Lovejoy 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 Lovejoy Pond during the summertime, when the potential (both occurrence and frequency) of nuisance algae blooms are greatest. The loading capacity of 16 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 Lovejoy Pond equals 380 kg TP on an annual basis and represents, in part, that portion of the lake's assimilative capacity allocated to non-point (overland) sources of phosphorus (from Table 3). Direct external TP sources (totaling 763 kg annually) have been identified and accounted for in the land-use breakdown portrayed in Table 3 (corrected GIS). Further reductions in non-point source phosphorus loadings are expected from the continued implementation of NPS best management practices (see summary, pages 17-20). 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 TMDL lakes (see Sebasticook Lake, East Pond, China Lake, and subsequent TMDLs), in-lake nutrient loadings in Lovejoy Pond originate from a combination of direct and indirect external (watershed + Dutton Pond) and internal (lake sediment) sources of total phosphorus.

WASTE LOAD ALLOCATIONS (WLA's): There are no known existing point sources of pollution (including regulated storm-water sources) in the Lovejoy Pond watershed, hence, the waste load allocation for all existing and future point sources is set at 0 (zero) kg/year of total phosphorus.

MARGIN OF SAFETY (MOS): An implicit margin of safety was incorporated into the Lovejoy 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 3). Based on both the Lovejoy Pond historical records and a summary of statewide Maine lakes water quality data for colored (> 30 SPU) lakes - the target of 16 ppb (380 kg/yr in Lovejoy 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 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.

SEASONAL VARIATION: The Lovejoy 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 2.6 flushes/year, the average annual phosphorus loading is most critical to the water quality in Lovejoy 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 in Maine. Furthermore, nonpoint source best management practices (BMPs) proposed for the Lovejoy Pond watershed have been designed to address total phosphorus loading during all seasons.

PUBLIC PARTICIPATION: Adequate ('full and meaningful') public participation in the Lovejoy Pond TMDL development process was ensured - during which land use and phosphorus load reductions were discussed - through the following avenues:

1. **March 24, 2003:** Maine DEP TMDL Lakes Program Manager David Halliwell, MACD staff member Jodi Michaud-Federle and Kennebec County Soil and Water Conservation District (KC-SWCD) staff member Nate Sylvester provided an overview of the PCAP-TMDL process to Albion residents (12) interested in Lovejoy Pond restoration efforts. Two individuals volunteered to monitor bi-weekly water (Secchi disk) transparency measures through Maine VLMP.

2. **June 11, 2003:** MACD staff member Jodi Michaud-Federle and KC-SWCD staff members Nate Sylvester and Josh Platt met with Albion residents (50) interested in Lovejoy Pond restoration efforts to discuss a watershed survey proposal. At this time, formation of lake association '*Friends of Lovejoy Pond*' was initiated.

3. **June 28, 2003:** *The Town Line* published local newspaper article describing June 11, 2003 public meeting.

4. **August 13, 2003:** MACD and KC-SWCD staff members attended '*Friends of Lovejoy Pond*' meeting at the Besse Building (Town Hall) in Albion, Maine.

5. **December 20, 2003:** *The Town Line* published a newspaper article about upcoming KC-SWCD meeting in late January 2004.

6. **January 28, 2004:** KC-SWCD staff members Nate Sylvester and Josh Platt and Natural Resources Conservation Service staff member Ron Derosiers described their respective programs to Albion residents interested in Lovejoy Pond restoration efforts.

7. **Spring 2004:** Proposed Lovejoy Pond watershed survey funding was not awarded by Maine DEP.

8. **Summer 2005:** KC-SWCD awaiting completion of Lovejoy PCAP-TMDL before re-initiating public involvement in restoration efforts.

9. **June 20, 2005:** MACD staff member Fred Dillon checked with KC-SWCD staff member Josh Platt (KC-SWCD) for update on 'Friends of Lovejoy Pond' status. Group is not currently active.

10. **Early August 2005:** contacted VLMP to provide contact information for backup volunteer monitor.

11. **August 11, 2005:** MACD staff member Fred Dillon and KC-SWCD staff members Josh Platt and Jennifer McLean met to plan public presentation of Lovejoy PCAP-TMDL report findings for area residents interested in Lovejoy Pond restoration efforts.

STAKEHOLDER AND PUBLIC REVIEW PROCESS

A draft stakeholder review document was distributed electronically on August 8, 2005 to the following individuals who expressed a specific interest, participated in the field work or helped develop the draft Lovejoy Pond PCAP-TMDL report: Kennebec County SWCD staff (Dale Finseth, Nate Sylvester, Josh Platt, and Jennifer McLean); Chris Martin (Maine Forest Service); and David Roque (Maine Department of Agriculture). All comments received were reviewed and most were incorporated into the draft Public Review document.

PUBLIC REVIEW PROCESS: The draft Public Review document of the Lovejoy Pond PCAP-TMDL was made available to the general public for the formal public review process during the August 17 to September 14 four-week period. The following statement was advertised in the *Kennebec Journal* and *Morning Sentinel* over a 2-weekend period (August 20-21 and September 3-4, 2005).

LOVEJOY POND - Albion

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 **LOVEJOY POND** (DEPLW 2005-0711) watershed, located within the Town of Albion. This PCAP-TMDL report identifies and provides best estimates of non-point source phosphorus loads for all representative land use classes in the **LOVEJOY POND** direct watershed and the total phosphorus reductions required to restore 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.maine.gov/dep/blwq/comment.htm. Please send all comments, in writing - by September 14, 2005, to Dave Halliwell, Lakes TMDL Program Manager, Maine DEP, State House Station #17, Augusta, ME 04333. or e-mail: david.halliwell@maine.gov.

PUBLIC REVIEW Comments Received

In addition to EPA New England preliminary review (31 August 2005), written public review comments were received from Jennifer McLean, Watershed Project Director for the Kennebec County Soil and Water Conservation District (KC-SWCD) in Augusta, Maine and Matt Vitale (former Lovejoy Pond watershed resident). Substantive comments from both parties are included below while many of their minor editorial remarks were incorporated into this final report where warranted.

Kennebec County Soil and Water Conservation District (August 22, 2005)

Context: The KC-SWCD has been and continues to be involved in ongoing efforts to establish a stakeholder group for Lovejoy Pond (see Public Participation section on previous page). If such a group (e.g., "The Friends of Lovejoy Pond") can be established and funding is available for implementation work, the KC-SWCD will in all likelihood be closely involved in any restoration activities to improve the water quality of Lovejoy Pond. The KC-SWCD has also previously submitted a DEP "319" NPS Program Grant proposal to conduct a watershed survey for Lovejoy Pond but did not receive funding for this proposal. Finally, the KC-SWCD provided considerable support, under contract with MACD, for the GIS land use analysis of the draft PCAP-TMDL report.

Research Lovejoy Pond hydrology: KC-SWCD suggests investigating the effects of existing beaver dam and unimproved outlet dam on the effective annual flushing rate of Lovejoy Pond.

Matt Vitale - Former Lovejoy Pond Watershed Resident (September 4, 2005)

Context: While a resident of the area, Matt Vitale was closely involved in early efforts to form a stakeholder group and increase water quality assessment and monitoring activities in the Lovejoy Pond watershed. He has maintained close contact with and provided relevant information to KC-SWCD and DEP-MACD staff working on the project. Since his departure from the area, Matt has also continued to stay abreast of the Lovejoy Pond TMDL project and offered the following comments.

Consider seasonal effects of vegetation in Mill Stream on Lovejoy Pond flushing rate: Matt believes that the increased vegetation growth during the summer months may impede the flow through Mill Stream and consequently decrease the flushing rate.

Consider possibility that gravel pit may be discharging phosphorus-laden groundwater to Lovejoy Pond: Matt suspects that the groundwater discharge zone for much of the watershed may be the pond itself and that much of this flows through the gravel pit on Lovejoy Pond's west side. As such, he is concerned that not all of the phosphorus is being attenuated through this process and may be directly entering the pond.

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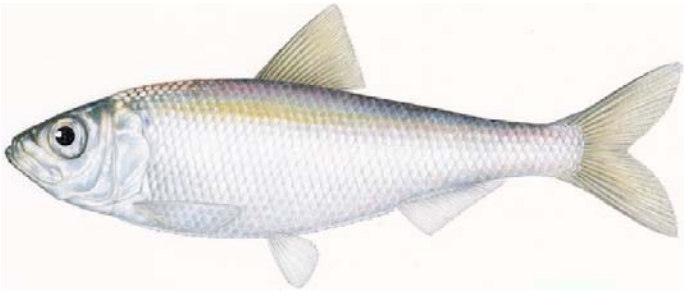
Alewife (*Alosa pseudoharengus*) Fact Sheet



- Alewife can occur in fresh waters as either historically present/restored anadromous or stocked landlocked forms. The same can be said for several other 'freshwater' fish species (Atlantic salmon, rainbow smelt, and white perch).

- Generally speaking, landlocked and anadromous forms of fish are very different in terms of their behavior and ability to adapt to various aquatic habitats. Although landlocked alewives may move between waterbodies, the population no longer has an inherent ability to migrate to the sea. Conversely, an anadromous alewife does not have the inherent ability to survive and prosper in inland lakes and ponds. Some Individual fish may survive for a time, but are not capable of over-wintering, or completing their life cycle wholly in freshwater environments.

- The historical (pre-industrial or pre-dam) natural distribution of alewife in freshwaters is well documented by the Maine Department of Marine Resources and includes all waterways and waterbodies included in the current anadromous fish restoration program - representing all three Maine-New England native and indigenous *Alosine*-type fishes (alewife, blueback herring, and American shad).

- Anadromous fish populations, including alewife, are indigenous species which were historically an integral part of the freshwater ecosystem to which they are currently being restored. The trophic status of many of these waterbodies have become increasingly eutrophic over the past century. Given the inherent capacity of anadromous alewives for entrance and departure from natal lakes and ponds are not interfered with (beaver dams, inadequate flow levels), then the lake water quality impact of their temporary presence should not be a problem.

- If for any reason (e.g., beaver dams, extended drought, dam regulation, inadequate fish passage) adult post-spawning anadromous alewives are not able to effectively exit from a given waterbody - then they will not survive, but will fall prey to avian and mammalian predators and/or scavengers and ultimately could be an additional source of nutrients to the aquatic ecosystem in which they occur.

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