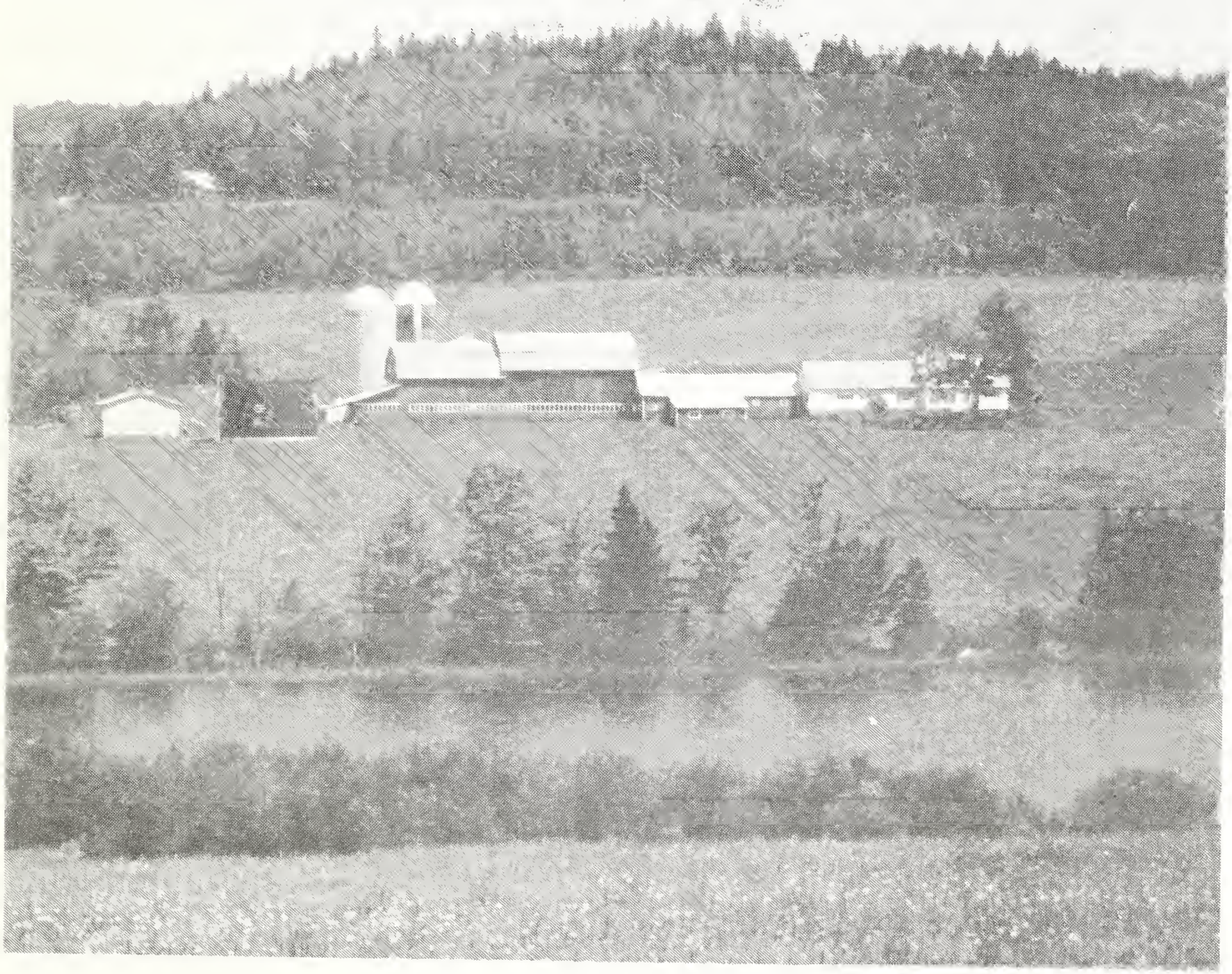
Capsule Report Protecting Vermont Lands and Lakes

A Summarization of Findings of the Agricultural Runoff in Selected Vermont Watersheds Study



CAPSULE REPORT

PROTECTING VERMONT LANDS AND LAKES

Executive Summary of the Special Study
Agricultural Runoff in Selected Vermont Watersheds

U.S. Department of Agriculture,
Soil Conservation Service,
Economic Research Service,
Forest Service

and

Vermont Agency of Environmental Conservation,
Vermont Department of Agriculture.

February 1983

Thousands of tons of topsoil and valuable nutrients are needlessly washing into Vermont streams and lakes every year. The quality of some of our best lakes and bays is deteriorating due to human activity. Farming and logging without conservation is a main reason the quality of Vermont's land and water resources is decreasing. New and vigorous approaches are needed to change these downward trends in water quality and soil resource conditions.

This study examined soil erosion and nutrient losses in five of the State's major agricultural counties. We believe that a 10 year, $13 million dollar program of accelerated resource conservation is necessary to protect and preserve Vermont resources. With technical and financial help, Vermont farmers and loggers can play a major role in the drive to clean-up Vermont lakes and keep soil in its place...on the land.

I urge you to read this report and to get involved with your local natural resource conservation district. The care and determination we show now, will pay resource dividends for many years to come.

John C. Titchner
State Conservationist
Soil Conservation Service

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INTRODUCTION

Vermonters prize the waters of the Green Mountain State. True to a tradition of quiet but purposeful change, Vermont farmers and loggers cautiously joined the ranks of local industries and communities to reduce water pollution in 1978. Since the adoption in that year of State management plans for the control of agricultural and forestry pollutants, government agencies at all levels have intensified their efforts to improve water quality.

Through educational programs and self-regulation, loggers throughout Vermont are being encouraged to protect water quality by minimizing soil losses from all logging areas. In contrast, agricultural programs have targeted high priority problem areas within the Lake Champlain and Lake Memphremagog drainage basins. Since 1978, an unprecedented $5 million has been committed by the U.S. Department of Agriculture to help landowners install special soil and water conservation measures which will reduce polluted agricultural runoff. Shelburne Bay, at the mouth of the LaPlatte River in Chittenden County and St. Albans Bay in Franklin County have been the principal beneficiaries of these accelerated efforts.

Favorite summer pastimes on Lake Champlain. Vermont Travel Division.

Knowing that more would need to be done, the Vermont Agency of Environmental Conservation requested the U.S. Department of Agriculture to survey other watersheds most likely to have serious agricultural and/or forestry related pollution problems. Seventeen small watersheds close to Lake Champlain and Lake Memphremagog, as well as watersheds surrounding two small Vermont lakes were selected for study (See Fig. 1).

A study of runoff from these watersheds was designed to answer five basic questions.

1. What is the extent of the non-point source pollution problem from farming and logging in Vermont's most heavily farmed watersheds?

2. What specific conservation practices could be used to most effectively reduce pollution sources and how would they impact soil and water resources?

3. What specific factors could control the proper location of logging roads to minimize pollution runoff in our forests?

4. How would the installation of selected soil and water conservation practices affect the income of Vermont farmers?

5. How should the 19 watersheds studied be prioritized for future federal funding in the next decade?

It has taken over two years to answer these questions. This capsule report summarizes the methods, principal findings and recommendations of the federal and state agencies that conducted the study.

The results will play a fundamental role in determining how and where future millions of dollars will be spent on Vermont farms.

VERMONT'S TROUBLED WATERS

Lake Eutrophication

A thick, greenish algal soup engulfs acres of Missisquoi Bay and halts all forms of recreation on the bay in Vermont and Quebec. A reddish scum covers the water and can make an otherwise rewarding trout fishing experience less so at Harvey's Lake in Caledonia County. A fourth of July picnic and lake outing along the Addison County shore on Lake Champlain is dampened by the presence of thick aquatic weeds and an explosion of blue-green algae.

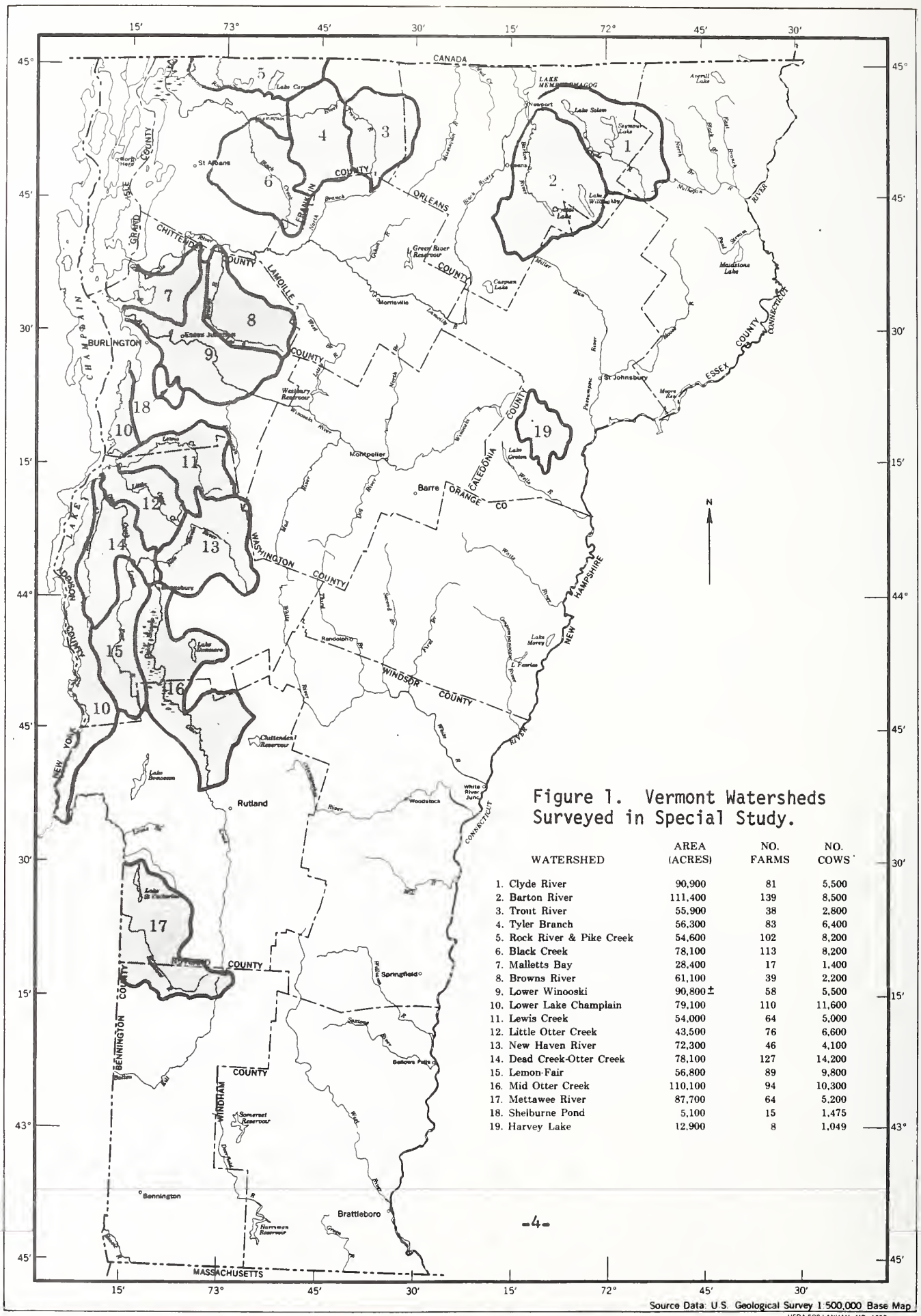
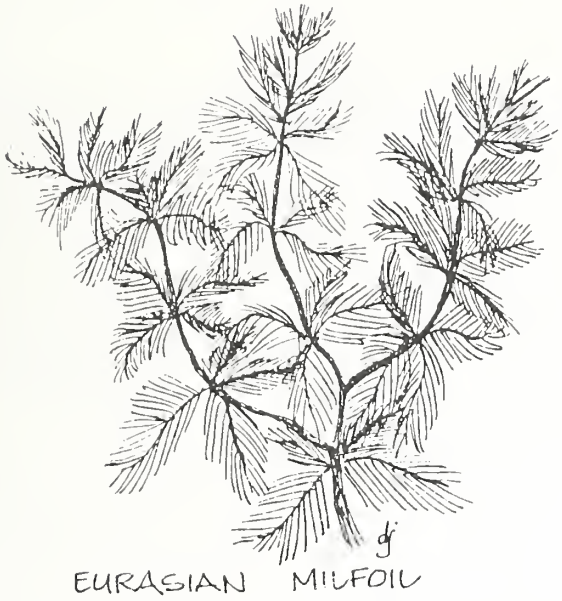


Figure 1. Vermont Watersheds Surveyed in Special Study.

WATERSHED	AREA (ACRES)	NO. FARMS	NO. COWS
1. Clyde River	90,900	81	5,500
2. Barton River	111,400	139	8,500
3. Trout River	55,900	38	2,800
4. Tyler Branch	56,300	83	6,400
5. Rock River & Pike Creek	54,600	102	8,200
6. Black Creek	78,100	113	8,200
7. Malletts Bay	28,400	17	1,400
8. Browns River	61,100	39	2,200
9. Lower Winooski	90,800 ±	58	5,500
10. Lower Lake Champlain	79,100	110	11,600
11. Lewis Creek	54,000	64	5,000
12. Little Otter Creek	43,500	76	6,600
13. New Haven River	72,300	46	4,100
14. Dead Creek-Otter Creek	78,100	127	14,200
15. Lemon Fair	56,800	89	9,800
16. Mid Otter Creek	110,100	94	10,300
17. Mettawee River	87,700	64	5,200
18. Shelburne Pond	5,100	15	1,475
19. Harvey Lake	12,900	8	1,049

Source Data: U.S. Geological Survey 1:500,000 Base Map

USDA SCS LANHAM MD 1982



Common nuisance weed found in near-shore zones of Vermont lakes.

Complaints like these portend serious water quality problems for Vermont lakes. To assure continued public use of Vermont's waters, government officials and scientists want to understand what man is doing to cause our lakes and bays to "explode" with weeds and algae. With that knowledge in hand, specific solutions to the problems can be devised to control the undesirable water quality effects. Simple as it sounds, complete understanding of the causes and effects of poor water quality in many Vermont lakes remains elusive. Using the best available information and scientific analysis, some facts are now known.

1. The primary cause of deteriorating water quality in Vermont lakes and streams is the introduction of excessive quantities of nutrients like nitrogen and phosphorus. These nutrients, in combination with other factors such as light and water temperature, stimulate the over-production and accumulation of millions of minute aquatic plants called algae. Considerable evidence from around the country shows that the culturally-induced nutrient enrichment of lakes is a reversible process.

2. Phosphorus is indeed the nutrient which limits the biological productivity of algae in Vermont lakes and is the only nutrient that can feasibly be controlled by man. However, phosphorus is found in many chemical forms throughout the environment. It is present in most living (organic) things and attached to many non-living (inorganic) objects such as soil and rocks in the earth. When scientists analyze water to determine its <u>total phosphorus</u> content, they use techniques which extract and measure the amount of phosphorus associated with the living and non-living things which are present in the water sample. Researchers are now finding however, that only certain chemical forms of phosphorus in the waters which reach lakes should be considered readily available to support algae or nuisance weed growth.

Taken together these forms of biologically available phosphorus represent a small but very important fraction of the total amount of phosphorus in runoff waters.

3. Phosphorus management strategies in Vermont to date have been based on measuring and controlling total phosphorus from point and nonpoint sources. This runoff study broadens previous Vermont studies of agricultural watersheds by estimating both biologically available phosphorus and total phosphorus. Consideration of both phosphorus forms has important implications for the selection of soil and water conservation practices which are both cost-effective and most likely to result in improved lake quality.

4. In any lake, water clarity, phosphorus loading, and lake productivity vary with changes in weather and runoff volumes throughout the year and from year to year. This fact makes it difficult to predict with certainty what future water quality conditions are likely to exist at any given time. Statistical, mathematical models are used wherever practicable to simplify and simulate a highly complex lake environment. Much more research on the behavior of phosphorus in aquatic systems is needed to predict with certainty the effects of phosphorus management plans.

Lands and Lakes Under Study

Lake Champlain and Lake Memphremagog form Vermont's borders with New York to the west and Quebec to the north. Rain and snow falling on over half of the Green Mountain State ultimately pass through these lakes in their long route to the Atlantic Ocean. Within this 5,200 square miles of land drainage area, small inland lakes serve as temporary storage basins for these flowing waters. Concern for water quality in Vermont in the last decade has focused on the effects that man-caused pollution is showing on these important lake resources.

Boating near Newport, Vermont on Lake Memphremagog.

While water quality in Vermont streams is generally good, nutrients, organic waste, and sediment from domestic, industrial and nonpoint sources are building up in lakes and bays causing increasing public concern over the future of these resources.

During the mid-seventies federal and state investigators and researchers found that just over half of the annual phosphorus load to reach Lakes Champlain and Memphremagog came from sources other than domestic and industrial wastewater (point) sources. Agricultural lands were cited as the largest contributor of all nonpoint sources of phosphorus in each lake basin. To learn more about agricultural pollution, 19 small watersheds which directly impact four Vermont lakes were selected for intensive study. These lakes are Lake Champlain, Lake Memphremagog, Harvey's Lake and Shelburne Pond. At the same time, forest land conditions in these watersheds were surveyed to assess erosion and sediment resulting from the construction of logging roads.

PHOSPHORUS SOURCES FROM FARMS AND LOGGING SITES

The Vermont Scene

Vermont is a rural state best known for its New England villages, beautiful lakes, rolling farmland, maple products, spectacular fall foliage, and bountiful winter snowfall. The watersheds studied lie mainly in Addison, Chittenden, Franklin, Orleans, and Rutland Counties and drain Vermont's major dairy farming areas. Some 30% of Vermont dairy farms and over 40% of the milk cows are located in the study area. Except for the intensively farmed watersheds in Addison County, the majority of the watersheds are heavily forested, with cropland and pastures covering less than 20% of the landscape. See Table 1 for more lake basin facts.

Table 1. Lake Basin Facts

	Watersheds Under Study			
Resource Facts	15 Watersheds in Champlain Basin	2 Watersheds in Memphremagog Basin	Harvey's Lake	Shelburne Pond
. Land Area	1,006,800 acres	202,300 acres	12,970 acres	4,960 acres
. Cropland	161,000 acres	23,000 acres	1,200 acres	1,000 acres
. Dairy Farms	1,100	220	16	8
. Soils	Fertile, but highly erodible	Stony, moderate fertility, low erodibility	Fertile, low erodibility	Fertile, highly erodible
. Climate	150 day growing season	110 day growing season	140 day growing season	150 day growing season
. Major Urbanized Areas	Greater Burlington, Middlebury	Newport	None	None

Some disturbing trends have developed on Vermont dairy farms since the mid-1960's. The dominant trend is toward fewer farms, which raise more cows, using less crop and pasture land. Today just 75% of the farms in the watersheds raise dairy cows compared to 90% less than 20 years ago. Those dairy farms remaining have become more commercial, more consolidated, and more capital intensive. The average Vermont dairy farm in 1978 covered 362 acres with over one quarter of a million dollars invested in land, buildings and machinery.

The typical Vermont farmer in 1979 netted an income of less than $600 for each milking cow in production on his farm. Since 1979, his income has been affected by two major factors. First, there has been an unprecedented rise in interest rates from the then prevailing 10% level to the 20% level of 1981. Secondly, changes in the Federal program for dairy price supports indicate that prices farmers receive for their milk will remain essentially constant for the next three to five years. Regardless of farm size, this economic squeeze is forcing Vermont dairy farmers to make hard decisions about their futures, and about new major investments in pollution reduction measures.

Farmers and other landowners also use the forests of the watersheds for timber, fuel, game, outdoor recreation and aesthetic pleasure. The forests of Vermont produce clean, high quality water to serve many uses. However, careless logging practices can adversely affect small areas of streams and ponds. Sediment which leaves poorly managed logging roads and log landing areas are the principal sources of nonpoint pollution. While logging is not presently intensive in the watersheds, the potential for serious water quality deterioration of localized streams is very real where logging does exist.

Agriculture Today

Dairy farming operations produce, use, and lose large amounts of phosphorus. Each year, farmers apply thousands of pounds of phosphorus to their fields as commercial fertilizer to maximize crop production. Dairy cows excrete manure containing phosphorus, nitrogen, and potash...the same valuable nutrients contained in commercial fertilizer.

Farmers must, therefore, handle thousands of tons of nutrient-rich manure every year. These facts have prompted a closer look at all major agricultural sources of phosphorus which may be entering Vermont waterways.

Manure stack on a farm near Lake Memphremagog in Orleans County.

Phosphorus comes from the following five major sources on dairy farms: manured fields, barnyards, milkhouse waste, manure stacks, and soil erosion. As with phosphorus-laden water discharged from Vermont sewage treatment plants, nearly all of the phosphorus leaving barnyards, manure stacks, milkhouse waste, and manured fields is dissolved in water and is completely available for algae and other plant growth in streams and lakes. In contrast, some phosphorus is very tightly attached to small soil particles which also move in runoff waters. While less is scientifically known about this adsorbed (attached to) phosphorus, researchers have found that a small fraction (about 20%) of soil-bound phosphorus can be released and also made available to support biological growth. Table 2 summarizes the estimated amounts of phosphorus from each agricultural source.

Soil erosion and crop damage in Addison County

Dissolved phosphorus provides the largest proportion of available phosphorus loads to the Champlain and Memphremagog basins and Shelburne Pond. In the Harvey's Lake Watershed, the adsorbed percentage of total available phosphorus exceeds the dissolved portion.

All major studies of phosphorus runoff in Vermont have shown that a majority of the runoff and a high percentage of total phosphorus is delivered in the spring rain and winter melt-off period. Major storm events which can occur at any time of the year also carry substantial phosphorus loads to rivers and lakes. Based on these assumptions, the study results indicate seasonal patterns of phosphorus loadings from each of the watersheds with a major "pulse" (over 60%) of the annual dissolved phosphorus loads occurring during the winter melt-off period.

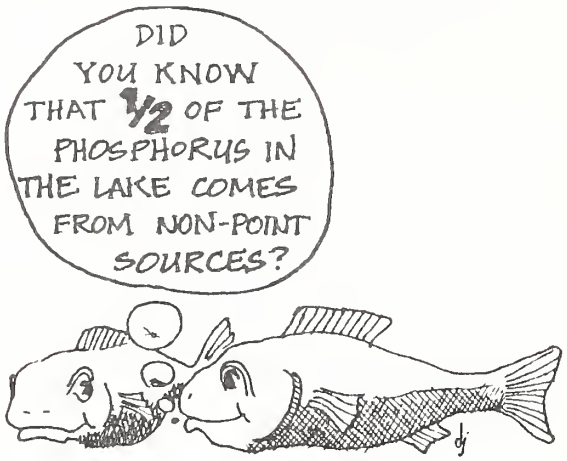


Table 2. Annual Phosphorus Loads from Agriculture Sources in Selected Vermont Watersheds.

Agriculture Sources	Champlain Watersheds		Memphremagog Watersheds	
	Total Phosphorus	Biologically Available Phosphorus	Total Phosphorus	Biologically Available Phosphorus
Total Agricultural Load, including:	338,300 lbs.	124,500 lbs	16,700 lbs	10,000 lbs
- Barnyards	7%	20%	21%	35%
- Manure Stacks	1%	2%	6%	10%
- Milkhouse Waste	3%	6%	2%	3%
- Manured Fields	10%	29%	21%	35%
- Soil Erosion	79%	43%	50%	17%

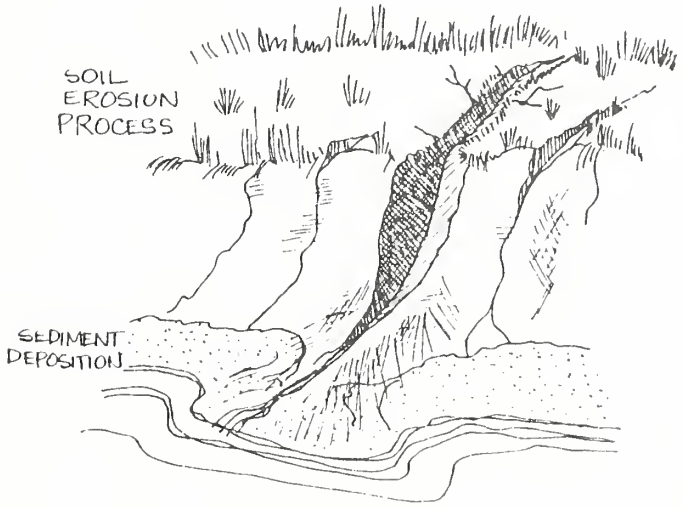
Agriculture Sources	Harvey's Lake		Shelburne Pond	
	Total Phosphorus	Biologically Available Phosphorus	Total Phosphorus	Biologically Available Phosphorus
Total Agricultural Load, Including:	3,400 lbs	1,000 lbs	900 lbs	600 lbs
- Barnyards	5%	17%	20%	30%
- Manure Stacks	1%	2%	0	0
- Milkhouse Waste	3%	9%	9%	13%
- Manured Fields	5%	16%	29%	43%
- Soil Erosion	86%	56%	42%	14%

Manure spread on frozen soils near streams is lost during spring melt-off.

Logging Vermont Forests

Vermonters are increasingly turning to their forest resources to meet changing needs. While a very small fraction of our forests are significantly disturbed by human activity, logging operations can cause accelerated erosion and local water quality degradation.

The simple act of cutting trees does not increase erosion rates. Rather it is the act of transporting the logs through the forest and off the site that creates erosion problems. Alteration of the soil's infiltration capacity and disturbance of the forest floor are causes of accelerated erosion from roads and landings. Heavy equipment used in logging such as skidders, log loaders, and log trucks all compact the soil, which decreases the infiltration rate. Removal of the protective litter layers by bulldozers and skidded trees exposes bare mineral soil to the impact of rain. Conditions are thus created which can and do lead to overland flow and accelerated soil loss.



The Forest Service (USDA) conducted a field survey of erosion and sedimentation from 45 logging jobs which were active in the summer and fall of 1980 in the study watersheds. Logging roads and landing areas were closely examined. There were some surprising results. Nearly half of all sites studied were eroding in excess of 3 tons per acre per year; some as high as 34 tons per acre. As might be expected, the highest erosion rates were found in

mountainous regions where road grades exceeded 10%. Overall, however, the excessively eroding areas represent only about one one hundredth of one percent of the total forest area in any given year.

Logging operations in Vermont.

Excessive amounts of sediment leaving these roads and landings reached Vermont stream channels at nearly 70% of the logging sites. Erosion rates from the harvested areas as a whole were much lower, with no sites exceeding one-half ton per acre per year. Harvest sites receiving technical help from a county forester showed half the erosion from planned logging roads compared to sites where the landowner had no technical assistance.

This study found serious erosion on a portion of Vermont's active logging roads. Measures to control erosion are not always applied and stream quality is being affected although the areas contributing are not large. Quantities of soil loss and associated phosphorus loss from forest lands and logging roads are shown in Table 3.

Table 3. Annual Phosphorus and Sediment Loads from Forestry Sources in Selected Vermont Watersheds.

Study Watersheds	Total Sediment (Tons)	Biologically Available Phosphorus (lbs)	Percent Available NPS-P
Champlain Watersheds	19,500	4,300	3
Memphremagog Watersheds	4,600	1,000	9
Harvey's Lake	300	60	5
Shelburne Pond	40	10	2

MANY SOLUTIONS ARE POSSIBLE

Each of the 19 watersheds faces a common problem - the loss of nutrients and soil from the lands which need them most. These losses are adversely affecting water quality, recreational use and fish habitat in their receiving waters. The study has found that special soil, water, and manure management practices will need to be emphasized to reduce nonpoint pollution.

Six pollution reduction strategies were deveised so that a specific plan could be suggested to suite each of the 19 watersheds. Each of the six strategies had a unique goal or desired effect as a central theme.

Combinations of agricultural conservation practices were studied for their ability to achieve the goals and solve the problems found in each watershed. The adoption of forest management practices to prevent erosion and nutrient loss was judged to be essential and was included under each alternative strategy.

The principal features of the six plan strategies developed for controlling agricultural runoff in each watershed are shown below.

The study shows how each strategy affects phosphorus and erosion losses from cropland and forested areas. In addition, the study documents that changes in cropland conservation practices such as conservation tillage, contour plowing, contour stripcropping, cropland conversion to hayland, and diversions would be needed to improve water quality. Finally, the study estimates the price tag for installing needed practices and shows how they might change a farmer's net annual income if no government funds were available to share in the cost of installation.

Alternative Plan	Plan Features
Plan 1	Continue the ongoing program and current level of conservation practices into the future.
Plan 2	Install only manure management systems.
Plan 3	Install conservation practices that minimize losses of biologically available phosphorus.
Plan 4	Install conservation practices which minimize erosion and sediment losses.
Plan 5	Install conservation tillage practices to reduce erosion while retaining corn yields.
Plan 6	Install practices which are most cost-efficient in reducing phosphorus.

Using 114 alternative watershed plans (6 plans for each of the 19 watersheds), unique plans were finally selected for each watershed. Taken together, they comprise the study's Suggested Plan for Managing Agricultural and Forestry Runoff.

A SUGGESTED PLAN FOR MANAGING AGRICULTURAL AND FORESTRY RUNOFF

Choosing the Best Path

The study sponsors now have a firm basis for solving identified watershed problems.

A suggested plan which stressed one of the six alternative plans was developed for each of the 19 watersheds. Each watershed plan addresses the special nature of local problems and applies solutions which will work there. Each suggested plan represents those agricultural management practices which most effectively reduce soil erosion and phosphorus losses, while minimizing reductions in net farm income. Suggested plans for the Lake Champlain Basin and the Lake Memphremagog basin were developed by aggregating the suggested plans for all the watersheds in each basin.

Hayfields often produce two or three cuttings in Vermont.

Table 4 displays some of the plan's principal features. The suggested plan reduces up to 60% of total phosphorus and soil losses in each watershed. In addition the plan reduces nearly 70% of the biologically available phosphorus in some of the problem watersheds. The cost of installing the suggested management practices in all of the 19 watersheds is tagged at $13.5 million. If implemented without government financial assistance the plan could reduce the annual net income to Vermont dairy farmers by these amounts: Champlain Basin - 10%; Memphremagog Basin - 16%; Harvey's Lake - 5%; and Shelburne Pond - 2%.

However, analysis shows that farms greater than 54 cows can actually increase farm income by improved manure management.

Savings in operating costs, labor, fertilizer and income taxes offset the debt service for manure storage. Small farms have little economic incentive to control phosphorus losses. Pound for pound, phosphorus control on large farms will be more cost-effective than phosphorus control on small farms.

Setting Priorities for Action

Work has already been done or is planned for 4 of the 19 watersheds studied. These include Lower Otter-Dead Creek Watersheds; Lower Winooski River (incorporating Shelburne Pond), and Lemon Fair River.

Stripcropping on Charlotte farms near Lake Champlain.

Table 4. Suggested Plan Features.

Study Watershed	Principal Management Practices	Percent Phosphorus Reduction: Total Phosphorus	Percent Phosphorus Reduction: Biologically Available Phosphorus	Plan Installation Cost ($1,000)	Cost per Pound of Annual Available Phosphorus Reduced
Champlain Basin -Missisquoi Bay Watersheds including: . Trout River . Tyler Branch . Rock River and Pike Creek . Black Creek	. Contour stripcropping, . Installation of: - 65 manure storage facilities - 45 barnyard runoff facilities - 35 milkhouse waste facilities . Erosion control on 81 miles of logging roads	54%	58%	1,634	$39 to $103
-Malletts Bay Watersheds including: . Malletts Bay . Browns River	. Contour tillage . Installation of: - 36 manure storage - 33 barnyard runoff facilities . Erosion control on 35 miles of logging roads	55%	64%	588	$74 to $335
-Central Main Lake including: . Lower Winooski	. Conservation tillage, contour stripcropping . Installation of: - 29 manure storage facilities - 20 barnyard runoff facilities . Erosion control on 53 miles of logging roads	37%	56%	415	$98
-South Main Lake Watersheds including: . Portion of Lower Lake Champlain . Little Otter Creek . New Haven River . Lower Otter-Dead Creeks . Lemon Fair River . Middle Otter Creek	. Contour tillage - 10,600 acres . Contour Stripcropping - 18,000 acres . Diversions . Cropland conversion to hay . Installation of: - 400 manure storage facilities - 327 barnyard runoff facilities - 250 milkhouse waste facilities . Erosion control on 145 miles of logging roads	59%	68%	7,954	$27 to $124
-South Lake including: . Portion of Lower Lake Champlain . Mettawee River	. Contour Stripcropping . Contour tillage . Diversions . Installation of: - 77 manure storage facilities - 51 milkhouse waste facilities . Erosion control on 39 miles of logging roads	51%	59%	1,295	$196
-Memphremagog Basin Watersheds, including: . Clyde River . Barton River	. Conservation tillage . Contour stripcropping . Installation of: - 33 manure storage facilities - 82 barnyard runoff facilities - 13 milkhouse waste facilities	46%	56%	1,634	$122 to $177
Shelburne Pond Watershed	. Installation of: - 4 manure storage facilities - 2 barnyard runoff facilities - 1 milkhouse waste facility	26%	50%	68	$183
Harvey's Lake Watershed	. Conservation tillage 280 acres . Installation of: - 9 manure storage facilities - 7 barnyard runoff facilities - 9 milkhouse waste facilities	66%	65%	73	$ 30

Since fewer than two watersheds each year are likely to receive special funds for implementing the plan, study sponsors have ranked the remaining 15 watersheds in order of their importance.

Special consideration has been given to the following factors in the ranking system:

- The percentage of total annual phosphorus loads entering from agricultural nonpoint sources.
- The trophic and physical conditions of the receiving lake.
- The recreational and economic value of the receiving lake.
- The proximity of the watershed to the receiving lake.
- The cost of agricultural phosphorus reduction.
- Special needs.

Each year watershed rankings will be reassessed and may change the priorities suggested below. (Watershed numbers in parenthesis).

Watershed Rankings

High Priority Group	Medium Priority Group	Low Priority Group
Lower Lake Champlain (10)	Little Otter Creek (12)	Mettawee River (17)
Malletts Bay and Browns River (7 & 8)	Tyler Branch (4)	New Haven River (13)
Barton River (2)	Lewis Creek (11)	Trout River (3)
Clyde River (1)	Black Creek (6)	Mid Otter Creek (16)
Rock River and Pike Creek (5)		
Harvey's Lake (19)		

PUSHING RESOURCE CONSERVATION IN THE 80's

Farming and logging without conservation is one of the main reasons the quality of Vermont's land and water resources is decreasing. This study has examined and recommends specific conservation practices to cut soil erosion and reduce excessive nutrient losses in the state's major agricultural counties. The main responsibility for seeing that progress is made in the next decade rests with six natural resource conservation districts covering parts of Addison, Chittenden, Franklin, Orleans, and Rutland Counties. Voluntary action by landowners coupled with technical and financial help from several state and federal agencies will be required. The Vermont Agency of Environmental Conservation plans, wherever feasible, to provide badly needed water quality analysis and evaluations of the effects of proposed watershed projects on Vermont lakes. Each year they expect to participate along with the Vermont Department of Agriculture, in setting priorities for implementing needed pollution reduction projects. The Vermont Department of Forests, Parks and Recreation expects to intensify their education programs for loggers, especially on sites in the mountainous regions of the watersheds.

The U.S. Department of Agriculture has programs which can provide accelerated assistance to implement approved watershed projects. The agencies with key programs are the Soil Conservation Service and Agricultural Stabilization and Conservation Service and the Forest Service. Working together, as well as under separate program authorities, SCS and ASCS can help farmers qualify for high levels of financial and technical assistance from these agencies.

The Soil Conservation Service plans to help districts address the needs of the problem watersheds primarily through projects authorized by Public Law 83-566. SCS will develop land treatment plans, and offer substantial financial and technical aid to cooperating landowners in the problem watersheds. Accelerated cost-sharing on measures such as manure storage facilities and land conservation practices will be made available according to district priorities.

The U.S. Forest Service plans to continue the existing programs for technical and financial assistance to Vermont landowners and state foresters.

This is a voluntary program that works...but not overnight. Reductions of agricultural and forestry related runoff will take time to evidence themselves in improved lake quality.

With care and determination this program can make a difference in the quality of life in Vermont for generations to come.

MORE INFORMATION

Agricultural Runoff in Selected Vermont Watersheds summarizes the inventory, analysis, and evaluation of nonpoint pollution problems in 19 Vermont watersheds. The main report provides specific information on land use, soil erosion, sedimentation, phosphorus loads, conservation practices and costs estimates associated with runoff management problems in each watershed. The report contains extensive tables and charts and serves as a baseline of technical data and justification for future watershed planning and implementation projects in Vermont. There are also five technical reports available. A brief synopsis of each technical report follows:

Sunset on Lake Champlain near Burlington, Vermont.
Vermont Travel Division.

Quantification of Resources and Problems in the Vermont Agricultural Runoff Study Watersheds and Water Quality Management Areas summarizes basic data developed for the Main Report for each of the 19 watersheds. A concise description of each watershed, along with location, soil erosion, and general land use maps complement tables of resource information. Authored by U.S. Soil Conservation Service, Burlington, Vermont. September, 1982.

Computational Methods for Assessing Phosphorus Losses in the Vermont Agricultural Runoff Study describes the procedures used to estimate soil loss, and phosphorus loss from sediment and animal waste management. The logic associated with the selection of soil and water conservation practices which constitute the alternative plans is also documented. Authored by U.S. Soil Conservation Service, Burlington, Vermont. 32 pp., May, 1982.

Phosphorus Reduction and Farm Income: Modeling Efficient Responses to Phosphorus Loading Constraints on Vermont Dairy Farms summarizes studies investigating the relationship between reducing phosphorus losses and maintaining farm income. Documents the logic and results of mathematical modeling of typical Vermont dairy farms at three herd sizes. Economic and environmental aspects of farm operations are simultaneously modeled. Other analyses reported include: cost-effectiveness analysis of phosphorus control by farm size using marginal cost and aggregate analysis procedures; simulation of the long term effects of soil erosion on crop yield on a medium size farm in Vermont; economic evaluation of the changes in farm income associated with installation of selected conservation practices. Authored by R. Heimlich, U.S. Economic Research Service, Northeast Resources Group, Ithaca, New York. 130 pp. May 1982.

Erosion and Sediment Production From Logging Roads in Vermont summarizes the field survey of erosion and sedimentation from 50 logging sites in Vermont. Documents procedures used, and reports erosion and sedimentation rates found on skid trails, skid roads, log roads, landing sites, as well as entire forested areas. Recommends methods for proper design, location and maintenance of road systems. **Authored by U.S. Forest Service, Northeastern Area,** Portsmouth, New Hampshire. 40 pp. June, 1981.

Proposed Private Road System in the Browns River Watershed serves as a technical guide to the construction and maintenance of a possible logging road system for the Browns River Watershed in Chittenden County. Optimum routes for timber access are mapped on overlays designed to be used in conjunction with the published soil survey for Chittenden County, Vermont. Authored by U.S. Forest Service, Northeastern Area, Portsmouth, New Hampshire. 18 pp., 31 maps, September, 1981.

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