

Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program



**Lake Champlain
Basin Program**

Executive Summary

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for
Lake Champlain Management Conference

March 1995

PRELIMINARY ECONOMIC ANALYSIS OF THE DRAFT PLAN FOR THE LAKE CHAMPLAIN BASIN PROGRAM

Executive Summary

**Submitted to
THE LAKE CHAMPLAIN MANAGEMENT CONFERENCE**

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March, 1995

This technical report is the twelfth in a series of reports prepared under the Lake Champlain Basin Program. Those in print are listed below.

Lake Champlain Basin Program Technical Reports

1. *A Research and Monitoring Agenda for Lake Champlain.* Proceedings of a Workshop, December 17-19, 1991, Burlington, VT. Lake Champlain Research Consortium. May, 1992.
2. *Design and Initial Implementation of a Comprehensive Agricultural Monitoring and Evaluation Network for the Lake Champlain Basin.* NY-VT Strategic Core Group. February, 1993.
3. (A) *GIS Management Plan for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc., and Associates in Rural Development. March, 1993.

(B) *Handbook of GIS Standards and Procedures for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.

(C) *GIS Data Inventory for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.
4. (A) *Lake Champlain Economic Database Project. Executive Summary.* Holmes & Associates. March 1993.

(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin.* Holmes & Associates. March 1993

(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin. Appendices.* Holmes & Associates. March 1993

(C) *Potential Applications of Economic Instruments for Environmental Protection in the Lake Champlain Basin.* Anthony Artuso. March 1993.

(D) *Conceptual Framework for Evaluation of Pollution Control Strategies and Water Quality Standards for Lake Champlain.* Anthony Artuso. March 1993.
5. *Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1.* Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.

Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1. Executive Summary. Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.
6. (A) *Lake Champlain Nonpoint Source Pollution Assessment.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

(B) *Lake Champlain Nonpoint Source Pollution Assessment. Appendices A-J.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

7. *Internal Phosphorus Loading Studies of St. Albans Bay. Executive Summary.* VT Dept of Environmental Conservation. March 1994.
 - (A) *Dynamic Mass Balance Model of Internal Phosphorus Loading in St. Albans Bay, Lake Champlain.* Eric Smeltzer, Neil Kamman, Karen Hyde and John C. Drake. March 1994.
 - (B) *History of Phosphorus Loading to St. Albans Bay, 1850 - 1990.* Karen Hyde, Neil Kamman and Eric Smeltzer. March 1994.
 - (C) *Assessment of Sediment Phosphorus Distribution and Long-Term Recycling in St. Albans Bay, Lake Champlain.* Scott Martin, Youngstown State University. March 1994.
8. *Lake Champlain Wetlands Acquisition Study.* Jon Binhammer, VT Nature Conservancy. June 1994.
9. *A Study of the Feasibility of Restoring Lake Sturgeon to Lake Champlain.* Deborah A. Moreau and Donna L. Parrish, VT Cooperative Fish & Wildlife Research Unit, University of Vermont. June 1994.
10. *Population Biology and Management of Lake Champlain Walleye.* Kathleen L. Newbrough, Donna L. Parrish, and Matthew G. Mitro, Fish & Wildlife Research Unit, University of Vermont. June 1994.
11. (A) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin. Executive Summary.* Yellow Wood Associates, Inc. January 1995.
 - (B) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin.* Yellow Wood Associates, Inc. January 1995.
 - (C) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin. Appendices.* Yellow Wood Associates, Inc. January 1995.
12. (A) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program. Executive Summary.* Holmes & Associates and Anthony Artuso. March 1995
 - (B) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program.* Holmes & Associates and Anthony Artuso. March 1995

This report was funded and prepared under the authority of the Lake Champlain Special Designation Act of 1990, P.L. 101-596, through the U.S. Environmental Protection Agency (EPA grant #EPA X 001840-01). Publication of this report does not signify that the contents necessarily reflect the views of the States of New York and Vermont, the Lake Champlain Basin Program, or the U.S. Environmental Protection Agency.

March 1995

Acknowledgments

The study team appreciates the assistance of the Lake Champlain Management Conference (LCMC), the Technical Advisory Committees, the Plan Formulation Team, and the Economics Subcommittee in the successful completion of this project. The Project Review Panel, who met with us on three occasions and in one conference call to review project scope and progress, motivated the study team to continually clarify the economic concepts and findings. The Panel members included John Banta, Mark Barie, Eleanor Berger, Greg Campbell, David Coen, Monty Fischer, Lori Fisher, Sandy LeBarron, Rose Paul, James Connolly, and Eric Perkins. We are especially indebted to John Banta, who chaired the Review Panel and provided project oversight, for his economic and project management expertise, as well as his ability to recognize the broad variety of economic interests in the Basin. We would also like to extend our thanks to the members of the Lake Champlain Basin Agricultural Advisory Council who offered a number of suggestions on our economic analysis of agriculture in the Basin.

The staff of the LCMC and the Lake Champlain Basin Program provided an enjoyable work atmosphere at the Grand Isle office, and were consistently generous with their time and information, most notably Jim Connolly, Kim Locke, and Eric Perkins. We also appreciate the assistance of Lee Steppacher and Wendy Cohen of the U.S. Environmental Protection Agency, and Jennie Bridge of the New England Interstate Water Pollution Control Commission.

We would like to thank a few individuals who were especially helpful in providing detailed information to the study team, or who reviewed early drafts of the report. They include:

Mark Barie, Champlain Development Corporation;
Phil Benedict, Vermont Department of Agriculture, Food, and Markets;
Reenie De Geus, Vermont Department of Agriculture, Food, and Markets;
Alice Doyle, Vermont Geographic Information System, University of Vermont;
Kelly Dziekan, New York State Office of Parks, Recreation & Historic Preservation;
Robert Genter, Lake Champlain Research Consortium;
Robert Inslerman, New York Department of Environmental Conservation;
William Johnston, Essex County NY Planning Office;
Kevin Kaija, Natural Resources Conservation Service;
Mary Jo Kealy, EPA Office of Policy, Planning, and Evaluation, Economic Analysis Division;
Bob Kort, Natural Resources Conservation Service;
Paul Leduc, Quebec Richelieu Valley Committee;
Mark Montgomery, Grinnell College, Economics Department;
Rose Paul, Vermont Agency of Natural Resources;
Marc Simoneau, Quebec Ministere de l'Environnement, Water Quality Division;
Maja Smith, Vermont Department of Forests, Parks and Recreation; and,
Ollie Trahan, District Advisor, Vermont Division of Property Valuation and Review.

Eric Smeltzer, Vermont Department of Environmental Conservation, and Dick Croft, Natural Resources Conservation Service (NRCS) deserve special notes of thanks for their significant effort in providing the study team with data, insights, and contacts, in addition to reviewing and editing draft materials. We would also like to express our appreciation to Dr. A. H. Gilbert, University of Vermont, for sharing his unpublished research findings of direct relevance to the recreation and fish & wildlife economic analyses undertaken for this work.

Robin Ulmer, director of the Boquet River Association (BRASS) compiled the detailed outline on the many programs and projects of BRASS displayed in Chapter 8, and provided valuable insights on the importance of education and outreach in watershed planning and protection.

Executive Summary

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NOTICE

The dollar amounts used in this report represent the best available data at the time of this research. Much of the economic data presented are based on averages, and the source of some of those average figures was research done outside the Lake Champlain Basin. The process of refining the benefits and costs of Lake Champlain restoration and protection activities is on-going. A major purpose of this work was to develop an economic analysis model that is responsive to incremental changes in any of the benefit or cost estimates, and that can be easily up-dated with new data, information, and scenarios as they become available through the work of the Lake Champlain Management Conference and the Lake Champlain Basin Program.

PRELIMINARY ECONOMIC ANALYSIS OF THE DRAFT PLAN FOR THE LAKE CHAMPLAIN BASIN PROGRAM

Executive Summary

1. Introduction

The Lake Champlain Management Conference (LCMC) is charged with creating a comprehensive plan for protecting and enhancing Lake Champlain and its watershed area. Now that the LCMC has put the draft Plan *Opportunities for Action* before the public for review and discussion, the difficult process begins of selecting and prioritizing the elements into a final plan. The draft Plan contains 11 major "Plans for Action" and approximately 170 individual Plan elements. In their deliberations and decision making, the LCMC will be evaluating each Plan element on a wide variety of criteria, including the degree of public support, the reliability of possible funding sources, and the cost effectiveness of the element in addressing a particular Lake Champlain issue. It is in realm of cost effectiveness, and the associated issue of the equitable distribution of costs, where this report provides guidance to the LCMC and the public.

This report provides a partial assessment of the overall fiscal and economic implications of the Lake Champlain management options described in the *Opportunities for Action*, released by the Lake Champlain Basin Program (LCBP) in October 1994. This research attempts to fill many of the economic data gaps and to provide an economic analysis for six of the eleven major Plans for Action. The economic analyses and discussion of pollution control costs herein focus on cost efficiency, and on the equitable distribution of costs; while the review of literature and discussion of the economic benefits of pollution control illuminate a wide array of benefits that can result from water quality improvement.

In consideration of the need to quickly compile economic information for use in the up-coming public meetings on the draft Plan, the study team focused the majority of their work on four of the six Plans for Action selected for study: Reducing Nutrients, Managing Nonpoint Source Pollution, Managing Fish And Wildlife, and Managing Recreation. Two other Plans: Watershed Planning, and Educating and Involving the Public, were discussed more briefly. This is not to say that the other 5 Plans are less important (i.e., Preventing Pollution from Toxic Substances, Protecting Human Health, Protecting Wetlands, Managing Nuisance Aquatics, and Protecting Cultural Heritage Resources), and the LCMC is encouraged in the *Recommendations for Further Research* section to extend the economic analysis to the rest of the Plans for Action.

The scope of this work was limited to the collection and analysis of secondary data, such as in published research reports and databases. The study team did endeavor to look beyond the published data and glean previously unpublished work from many researchers in state and federal agencies around the Basin. In addition, we relied on the expertise and insights of those most familiar with information for their best interpretation of related economic costs and benefits. As a

result, this report presents new Lake Champlain related economic data that was either previously unavailable, or that had not as yet been directly applied to Lake Champlain issues.

The major area of focus in this research is on Phosphorus Reduction, as represented in the Reducing Nutrients and Managing Nonpoint Source Pollution sections of the draft Plan. Actions related to phosphorus reduction would appear to have the greatest tangible benefits in terms of water quality, and potentially could have the largest economic benefit to the region in terms of recreation and tourism. These actions would also be among the most costly in the draft Plan, and could result in additional economic costs to two vulnerable economic sectors in the Basin: agriculture and New York State local governments. Therefore, a major portion of our work assists the LCMC in determining the most cost effective, and equitable, means of phosphorus control.

In addition to this report and the data, information, and research findings it presents, three important economic analysis tools resulted from this work that did not exist previously. First, and most importantly, Anthony Artuso created an "Optimization Model for Phosphorus Control" that accounts for over 100 variables related to phosphorus control in each of the 13 Lake segments. The optimization model incorporates information on point and nonpoint source load and control costs as well as hydrodynamic information on the movement of phosphorus within the Lake. The model has a built in optimization function that computes the least cost phosphorus control measures for a given set of in-lake phosphorus targets. The model operates in a relatively easy-to-use spreadsheet program (i.e., Microsoft EXCEL 5.0), and organized so that the variables, parameters, and assumptions are all clearly identified. The full report describes various scenarios examined by Artuso for this project, and the complete output of one scenario is presented as an appendix. The Artuso model is one of the project deliverables and will be available to all interested researchers. Its real value the ease in which it can be easily up-dated with new data, information, and alternative scenarios as they become available. As improved information becomes available on phosphorus loads, control costs, and effectiveness, the model can provide new estimates of the most cost effective means of achieving any given set of in-lake phosphorus standards.

The second economic analysis tool created by this work is dairy farm "Manure Management Economic Model" developed by Robert Bancroft. This is also a spreadsheet model and it links the six tables presented in Section 5.3 in the full report. The model accounts for three sizes of dairy farms and thirteen manure collection, transfer, storage, and application practices. The model computes the costs and benefits of the various practices for each of the three farm sizes. The data are then linked into government cost share percentage tables that estimate the percentage of cost share required to make it economically feasible for a given farm size to incorporate a new manure management practice. As with the Artuso model, the assumptions and base economic data are clearly presented in the model, and appropriate cells are linked, so that as new information becomes available the manure management analysis can be easily updated.

The third economic analysis tool that is new to the Lake Champlain Basin Program is an accounting spreadsheet of all cost estimates contained in the Plan for Action. The study team worked closely with the Basin Program staff to itemize the cost of each Plan element, and to identify key players, potential funding sources, and time frames. A new addition in the draft Plan accounting process is an initial attempt to categorize cost among five kinds of costs (i.e., capital costs, operation & maintenance, education & outreach, administrative, and research costs). This preliminary accounting has already identified areas of duplication and overlap between Plans for Action, and points to the need for continual cost refinement within individual Plan elements.

The report concludes with a discussion of sustainability in the context of the draft Plan. The concept of sustainability is relevant in terms of what can we do to sustain the present use of Lake Champlain and improve its water quality that is affordable, equitable, and that will maintain the

Lake for future generations. Those are difficult questions, and the answers basically rely on an on-going, cooperative effort at Lake and Basin management that includes citizens, local communities, state agencies, the federal government, and Quebec. As demonstrated by the Artuso model, significant cost efficiencies and cost savings are possible through the use of a creative mix of point source and nonpoint source phosphorus controls, combined with modest adjustments to current in-lake phosphorus targets. Such modifications to relevant Plan elements could lead to a more sustainable protection and restoration effort.

This and prior research demonstrates the significant economic value of Lake Champlain as a tourism and recreation resource, so in that respect its maintenance and improvement is important to a sustainable economy. While protecting Lake Champlain should be among the major economic and social priorities of residents and Basin communities, it is still only one among many priorities that include education, safety, health, jobs, etc. The findings of this work help to establish why protecting and restoring Lake Champlain is a high priority for sustaining the economy of the region, and help to determine realistic goals for a management program that is efficient and equitable.

It must be recognized that a full cost/benefit analysis requires that all probable economic costs and benefits of a given action be identified and quantified. That level of economic detail is currently unavailable for all the Lake Champlain draft Plan elements. The goal for this work was to compile and analyze as much of the needed economic information as possible within the project time frame and budget. The study team sought to maximize the utility of this work by focusing on the Plans for Action that potentially pose the greatest costs, and offer the greatest benefits, of the eleven Plans presented to the public for review; and, by creating economic modeling tools that can be used to illuminate costs and benefits throughout the planning and implementation process.

2. Summary of Major Findings

Before presenting a summary of each of the chapters in the full report, the following items provide an overview of many of the major findings and conclusions.

1. Four important products resulted from this work that did not exist previously:
 - a. Estimates of water quality improvement benefits derived from twenty contemporary studies from other parts of the country and applied to the Lake Champlain Basin.
 - b. An Optimization Model for Phosphorus Control that incorporates information on point and nonpoint source control costs as well as hydrodynamic information on the movement of phosphorus within the Lake.
 - c. A spreadsheet model of manure management costs and benefits, allowing analysis of the economics pertaining to small, medium, and large dairy farms. As in the optimization model, all variables and assumptions are clearly presented, and it is easily updated with new data and information.

- d. An accounting spreadsheet of all cost estimates contained in the Plan for Action. By working closely with the Basin Program staff, the study team itemized the cost of each Plan element, and identified key players, potential funding sources, and time frames.
2. Based on benefit estimates derived from studies conducted in other parts of the country the total use (e.g. fishing, swimming, boating) and non-use benefits (aesthetic, option, bequest and existence value) of the water quality improvements in Lake Champlain envisioned in the draft Plan could range from \$11 to \$80 million per year, with most estimates clustering in the range of \$11 to \$30 million per year.
 3. Direct use benefits of the water quality improvements envisioned in the draft Plan (e.g. fishing, swimming, boating) could range from \$2.4 million to \$28 million per year with several detailed studies indicating total direct use benefits be in the vicinity of \$9 million.
 4. In a study of the Galveston Bay (Texas) Management Plan which is a comprehensive pollution control program developed through a process very similar to the Lake Champlain Management Plan, households in the Galveston bay area indicated that they would be willing to pay from \$60 to \$252 per year to implement the Plan. Transferring that water quality improvement benefit measure to 211,000 households in the Lake Champlain Basin, total benefits of the Lake Champlain Management Plan might range from \$12.6 million to \$31.2 million annually.
 5. Even with full implementation of all point and nonpoint source controls for which information is currently available, phosphorus concentrations in the South Lake B Lake segment would remain significantly above its currently established in-lake standard, and phosphorus concentrations in Mississquoi Bay would exceed the in-lake standard by approximately 5%. Given currently available information, it is not possible to estimate the costs of the specific phosphorus reduction objectives of the draft Plan.
 6. The annualized cost of a mid-range phosphorus reduction strategy that would cost-effectively achieve all in-lake phosphorus standards except those established for South Lake B and Mississquoi Bay is estimated to be approximately \$12.6 million. This scenario does not include any phosphorus concentration target for South Lake B, and a phosphorus concentration for Mississquoi Bay that is 10% higher than the in-lake standard.
 7. The minimum annualized cost of achieving the same in-lake phosphorus targets using point source Policy 2 as outlined in the draft Plan together with the most cost-effective combination of nonpoint source controls is estimated to be \$19.2 million or more than a 50% increase over the most cost-effective strategy. The minimum annualized cost of achieving the same in-lake phosphorus targets using point source Policy 3 as outlined in the draft Plan together with the most cost-effective combination of nonpoint source controls is estimated to be \$15 million, an 18% increase over the most cost-effective strategy.
 8. This analysis indicates that it may be cost-effective to set point source phosphorus discharge permits in accordance with Policy 3 but allow point source discharges the choice of whether to achieve the necessary reductions at their facilities, or to obtain phosphorus discharge reduction credits by financing less expensive phosphorus reductions at other point or nonpoint sources. Point source dischargers could also be given the option of making a specified payment into a Basin-wide phosphorus reduction fund for every pound of phosphorus discharge in excess of their Policy 3 allocation.

9. Based on the analysis of other phosphorus reduction scenarios analyzed with the aid of the Phosphorus Control Model, it is clear that relatively small adjustments in the in-lake phosphorus concentration targets established for critical lake segments such as South Lake B, South Lake A, the Main Lake, and Mississquoi Bay can have very substantial impacts on total control costs.
10. Total cost for all draft Plan items averages \$19 million per year over a ten year period, using the mid-range phosphorus reduction strategy identified in number 6., above.
11. Due to lower fiscal capacity than average, New York local governments in the Lake Champlain Basin are less able than those of other areas of the state to fund significant new local expenditures for wastewater treatment or any other local program depending totally or primarily on local-source revenues. The combination of below-average local ability to pay for improvements and above-average dependence on external aid payments suggests that any proposed improvements should have substantial non-local funding if they are to be accepted locally. The approach used in Vermont could provide a model for New York. In Vermont, compliance with a state wide phosphorus reduction statute is required only to the extent that 100% state funding is available for necessary upgrade and construction costs.
12. While the profitability of dairy farming in the Northeast has been relatively stable for the last three years, future prospects are not encouraging. If a modest compensation of \$20,000 a year for owners' labor and management is assumed, each of three small dairy farm sizes (i.e., 32, 59, and 105 cow farms) realizes a negative return on investment. It will get increasingly difficult for dairy farms with less than 100 cows to remain economically viable in the Northeast, and it is reasonable to expect the recent acceleration in dairy farms leaving the industry to continue. While farm size will undoubtedly get larger, offsetting some of this decline, the industry as a whole will get smaller in the Northeast.
13. The primary conclusion to be drawn from the manure management analysis is that the need for government cost sharing tends to decline with increases in farm size. Moving from daily spreading to an alternative manure storage option will be a costly proposition for the 60 cow farms. The costs are not nearly so severe for the 120 cow operation, particularly when viewed on a per cow basis. With the exception of the above ground storage option, shifting from daily spreading to alternative manure management is economically attractive on the 240 cow dairy farms, given the increased nutrient value of manure. Another conclusion to be drawn is that the construction of above ground manure storage tanks should be avoided whenever feasible. The cost of this storage option, assuming no cost sharing, is 23% to 76% more expensive than alternative storage options. These findings represent average costs and benefits based on best available data, and could vary considerably from farm to farm.
14. Although the compiled data does not include the percentage of farms for each farm size that already incorporate manure storage in their farm practices, it appears that the majority of farms in need of a manure management system are the smaller farms. Since it is on those small farms where the economic cost of moving from daily spreading outweighs the benefits, a conclusion is that a significant infusion of cost sharing will be necessary to incorporate phosphorus control measures on agricultural land in the Basin. In the short term, careful targeting of livestock Best Management Practices (BMPs) by critical sub-basins, by farm location, and by farm size appears to be the most equitable and cost effective approach to reducing phosphorus input from dairy farm manure. This research did not examine cropland BMPs; agricultural research in that regard is on-going in the Basin.

15. Residents of the region have long held an interest in protecting the natural environment. With the advent of ecotourism, many tourists who visit the region share this interest. Studies elsewhere have shown that threatened and endangered species have significant existence values among the general public. For example, the general public in New England was willing to pay an average of \$18 per person to protect bald eagles.
16. Private landowner cooperative programs with the U.S. Fish and Wildlife Service have generally been popular with landowners in the Northeast and have led to mutual benefits for the landowner and for fish and wildlife conservation. In the Lake Champlain Basin, such programs could also contribute to improved water quality by implementing practices that reduce erosion and control nonpoint source pollution. Thus, expansion of this program is likely to produce tangible benefits.
17. We recommend that sizable federal public acquisition programs not be undertaken without a careful cost - benefit analysis. Brown et al. (1993) showed in the case of a proposed national wildlife refuge in Northern New York that even where willing landowners are paid a market price for their property, costs could outweigh benefits if substantial agricultural acreage is taken out of production in a federal program. On the other hand, smaller State acquisition programs involving wetlands and riparian habitats could very likely have net economic benefits.
18. Gilbert (1991) found that anglers were willing to pay a median annual value of \$11.64 for sea lamprey control related to lake trout, and \$11.47 related to salmon. Gilbert assumes anglers were willing to pay one and not both values and thus places an aggregate annual value of sea lamprey control to anglers at \$1.1 million. The sea lamprey control will generate an estimated additional 65,000 angler days by 1998 (Gilbert 1995).
19. Gilbert (1991) estimated that in 1991, 88,961 anglers spent 5,147,291 angler days fishing Lake Champlain and spent \$81.7 million in nondurable expenditures related to their fishing. New York residents spent \$43.3 million, and Vermont residents spent \$33.7 million. However, New York anglers had substantial expenditures in Vermont. As a result, total fishing-related expenditures made in New York and Vermont were almost equal.
20. Gilbert (1991) provides expenditures associated with each species which show specific expenditure categories. For lake trout during the open-water season, the species that generates the most expenditures, a comparison of lodging expenses for New York residents, Vermont residents, and "nonresidents," suggests that the vast majority of Vermont and New York residents either live near the Lake or have a second home near the Lake.
21. Aquatic pollutants can have a direct -- and indirect -- adverse impact on tourism and recreation economies. Once a pollutant is recognized and warnings or prohibitions are put in place, these actions, in turn, are picked up and often exploited (i.e., over-reported) by the media. Negative publicity by the media can adversely impact public perceptions of the water body or locality affected, and the negative image often remains even after the problem has been alleviated. In some cases, the economic losses due to the tarnished image are even greater than the actual clean-up costs.
22. In order to address the Action Plans on Watershed Planning and Educating and Involving the Public, the study team chose to study the benefits of a watershed organization currently active in the Lake Champlain Basin, the Boquet River Association (BRASS). An outline of the benefits presented in the report clearly demonstrates BRASS's contribution to

the environment, quality of life, and economy of the Boquet River area. Important activities that contribute to the economic well-being of local residents are BRASS's water testing laboratory, employment opportunities for college students, its local purchases, its leveraging of cost share dollars, and improved fishing and spawning habitat. BRASS has also worked to develop and support other watershed organizations in the Basin, such as the AuSable River Watershed Association. The tangible economic benefits of such organizations, in addition to their capacity for encouraging local participation in protecting and improving water quality in the Basin, justify support and encouragement of their work throughout the Lake Champlain planning and implementation effort.

23. In terms of sustainability, there are three sources of market failure that could adversely impact water quality and create potentially non-sustainable economic activities in the Basin, namely: externalities, common property resources, and intertemporal allocation of resources. Nine different types of sustainability are outlined in the report, along with examples of activities or resources that might be sustained in the Lake Champlain Basin. Although some political agendas may benefit from deliberately vague use of the term sustainability, the examples help to clarify many of the different perspectives.

The remaining Executive Summary, as well as the full report, provide additional detail on the above items. The reader should take special notice of the caveats related to economic costs and benefits provided in many sections of the report, and be reminded of the general notice displayed near the front of this document:

The dollar amounts used in this report represent the best available data at the time of this research. Much of the economic data presented are based on averages, and the source of some of those average figures was research done outside the Lake Champlain Basin. The process of refining the benefits and costs of Lake Champlain restoration and protection activities is on-going. A major purpose of this work was to develop an economic analysis model that is responsive to incremental changes in any of the benefit or cost estimates, and that can be easily up-dated with new data, information, and scenarios as they become available through the work of the Lake Champlain Management Conference and the Lake Champlain Basin Program.

3. Overview of the Lake Champlain Basin Economy

The Lake Champlain Economic Database Project (Holmes & Associates 1993) established a socio-economic profile for the Basin that was further refined in two community economic case studies (Economic and Financial Consulting Associates, Inc. 1993; Yellow Wood Associates 1993). Primary conclusions in terms of the Lake related economy are that tourism is a key component of most local economies around the Lake; Lake Champlain is a major tourist attraction to residents, as well as to visitors to the region; and that more could be done to promote and develop Lake-related tourism opportunities.

The economy of the Basin exhibits a diversity that helped it weather the late 1980's recession fairly well. In addition to tourism, major sectors represented in the Basin economy include manufacturing, agriculture, retail and wholesale trade, health care, universities, prisons, and state gov-

ernment. The Economic Database Project found that Service sector employment comprises 35% of Basin employment by industry, followed by Trade (22%), and Manufacturing (15%). The trend since 1980 has been towards an increase in the Service and Trade sectors and a decrease in the Manufacturing sector.

If there is a general over-dependence on a single sector throughout the Basin, it would be government employment. Over 20% of all employed persons work for state or local government in the New York portion of the Basin, while 12% are similarly employed on the Vermont side. Reliance on governmental employment is even greater in the Adirondack Park portion of the Basin, comprising close to one-third of all employed persons.

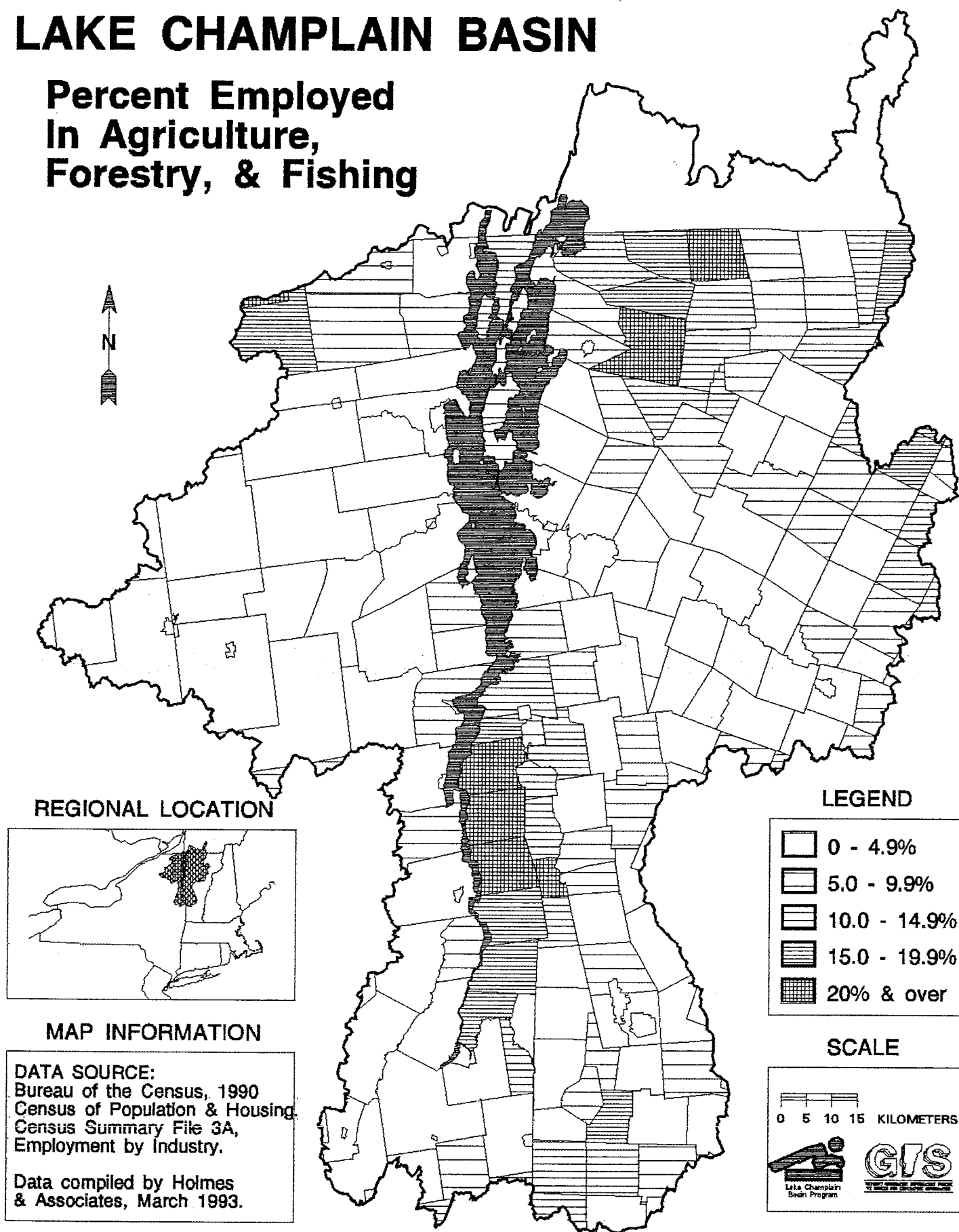
Vermont's travel and tourism industry is not keeping pace with the nation-wide growth in the travel industry, according to a recent study of tourism in the state (Ramaswamy and Kuentzel 1994). Major travel indicators (e.g., travel expenditures, tourism generated employment) have been steadily increasing across the United States, while in Vermont the travel indicators peaked in 1978 and have been in decline ever since. This finding is mirrored in the attendance figures at Vermont State Parks along Lake Champlain for the five year period 1990 through 1994. Total attendance data for the nine parks indicate a general decline in attendance during the five year period (Larry Simino, personal communication 11/16/94).

In New York, attendance appears to be trending upward at the five parks, boat launches, and historic sites on Lake Champlain operated by the NYS Office of Parks, Recreation, and Historic Preservation (Kelly Dziekan, personal communication 11/94). While attendance at the 44 NYS Department of Environmental Conservation campgrounds in the Adirondack Park was down slightly in 1992 and 1993, it has remained fairly steady, fluctuating between 105,000 and 122,000 annually from 1987 to 1993 (Dawson et al. 1994). So in general, participation in recreation and tourism around Lake Champlain appears to have been decreasing somewhat on the Vermont side, and increasing slightly on the New York side.

The proportion of Basin residents employed directly in Agricultural and Forestry (4%) is twice that of the U.S. as a whole. The importance of agriculture in the Basin is further illuminated by Map 1, showing employment in agriculture by Basin town. Six towns in the Basin owe 20% or more of their employment directly to agriculture or forestry (fishing is an employment option for very few Basin residents). Secondary agricultural employment, such as in dairy product processing industries, is not reflected on the map. Agricultural is the dominant industrial sector in towns along the southern shore of the Lake in Vermont, while other agricultural centers include the most northern Basin towns in both Vermont and New York.

LAKE CHAMPLAIN BASIN

Percent Employed In Agriculture, Forestry, & Fishing



IMPORTANT NOTE: Every effort has been made to ensure the quality and accuracy of this map. However, VCGI was not responsible for developing all of the data used herein, and cannot guarantee the accuracy of any features shown on this map. This map is intended for planning purposes only; it is NOT intended for navigational use, or for any other use not specifically authorized by the Lake Champlain Management Conference.

4. Economic Benefits of Lake Champlain Water Quality Improvement

The economic benefits of water quality improvement include an enhanced tourism and recreation economy, as well as consumer economic benefits from commercial uses of the Lake (e.g., water supplies drawn from the Lake). In addition to these direct use benefits there are potential non-use benefits (i.e., benefits accruing to people who are not actively using the resource at the present) which economists have categorized as option, existence, and bequest values. Option value is simply the value to the individual of preserving the opportunity to use a clean environment and is therefore closely related to -- but nevertheless conceptually distinct from -- direct use benefits. Bequest values are based on the satisfaction that individuals derive from knowing their children, or future generations in general, will be able to enjoy a clean(er) environment. Existence value is any additional satisfaction, apart from direct use, option, or bequest values, that individuals receive simply from knowing that an important ecosystem has been protected. To the degree that improvements in water quality increase direct use of the Lake, certain secondary benefits or multiplier effects may also be realized as a result of increased recreational expenditures. There are several techniques that can be utilized to provide partial estimates of the monetary value of improving water quality (e.g., travel-cost methodology, hedonic price analysis, contingent valuation). Each of these techniques has its own set of strengths and limitations, as described in the report.

The report summarizes the findings from 18 studies of the economic benefits of water quality improvement that are of direct relevance to Lake Champlain. It is important to note that the listed studies document use and non-use values, so economic benefits are not solely attributable to active lake users only. Similarly, there are benefits documented for "former" users, those who were discouraged by the water quality problems, but who may return after elimination of the problems. Two of the studies document water quality influences on property values, a topic addressed in more detail in a later section. One important distinction between the various studies is that some use a "Travel Cost" methodology that estimates actual expenditures that would result from water quality improvement, based on past recreational activity and expenditures. Others estimate how much households and individuals might pay to obtain improved water quality. These "Willingness to Pay" studies provide an indicator of the importance of water quality improvements to the local population, but do not measure actual payments by individuals for water quality improvement.

The direct benefits of water quality improvement in Lake Champlain, or alternately the costs of water quality degradation that could result from no action, are quite diverse. They include recreational and/or health benefits for anglers, swimmers and boaters; aesthetic benefits for both local residents and visitors; increased property values and assessments to local governments; and the bequest and existence values that residents within the Basin and elsewhere might place on a cleaner lake. These benefits are quite difficult to quantify even based upon studies designed for and conducted within the Lake Champlain Basin. Benefit estimates developed by transferring per household or per user values from studies in other regions to Lake Champlain must therefore be interpreted with great care.

The transfer of benefit estimates from other regions is further complicated by differences in water quality among segments of Lake Champlain. Benefits from improvement, or costs of degradation, of one Lake segment may be tempered by the availability of relatively clean recreational sites at other parts of the Lake. Without detailed studies of the factors which influence recreational use patterns around the Lake, it may be most appropriate to consider changes in water

quality for the Lake as a whole. Since changes in water quality throughout the Lake would affect all recreational sites, the per user net benefits of water quality improvements, or costs of water quality degradation would be expected to be greater than for more localized changes. Of course it is possible that realistic improvements or foreseeable reductions in water quality in the Main Lake are not significant enough to affect user values, in which case more detailed analyses of the benefits of improvements to individual Lake segments would be required. Given these caveats, it is still instructive to interpret some of the results of other benefits studies and apply the benefit estimates to Lake Champlain using Basin population and use data, as is presented in the following paragraphs and Table 1.

The average of the more conservative estimates of net benefits of water quality improvement developed for 44 sites by Smith and Desvouses is approximately \$10 per user per trip in 1994 dollars. Multiplying this value by the 469,000 visits to New York and Vermont State Parks along Lake Champlain in 1994 (Simino 1994, NYOPRHP 1994c) would yield annual benefits of \$4.69 million.

The study by Kaoru et al. (1995) showed benefits to anglers of \$1.27 to \$6.52 per trip due to reductions in pollutants responsible for eutrophication of the Albermarle and Pamlico estuaries. Total angler days on Lake Champlain were estimated to be 5,147,291 in 1990 (Gilbert 1991). If the benefits of water quality improvement are valued at \$4 per angler day, total benefits to Lake Champlain anglers would be nearly \$21 million per year.

The analysis conducted by Bockstael et al. (1989) for Chesapeake Bay indicated water quality benefits to boaters ranging from \$75 to \$140/yr. in 1994 dollars. Given a total of more than 3,000 boat slips and moorings on Lake Champlain (Farnum 1994), aggregate benefits to Lake Champlain boaters from similar water quality improvements would range from approximately \$225,000 to more than \$420,000 per year. If we use Farnum's higher estimate of approximately 7,900 boat launches then the estimated benefits to boaters would range from \$585,000 to approximately \$1.1 million.

The economic value in terms of swimming for eliminating eutrophication and bacteria from 51 New Hampshire lakes was recently estimated at \$3.29 per New Hampshire resident over the age of 18. Applying that value to Lake Champlain results in an estimated benefit of \$1.5 million for the 450,000 Basin residents over age 18.

Several of the studies discussed above also estimated benefits of moderate water quality improvements for both current users and potential users of the affected water bodies. As might be expected, all of these studies found that benefits to nonusers were less than the estimated benefits to users. Consequently, benefits to nonuser household can be understood as the low end of the potential benefits to the average household. Estimated benefits to non-user households ranged from approximately \$11.50 (Desvouses et al. 1987) to \$131 (Ribaudo et al. 1984) per year in 1994 dollars. If we use these estimates as the average benefit received by the 211,000 households in the Basin, then the estimated value of water quality improvements would range from \$2.4 million to \$27.6 million.

The estimates developed above do not include benefits to Basin residents other than those associated with direct recreational use, or the option to engage in such use. The contingent valuation (CV) studies by Greenley et al. (1981), Sanders et al. (1990), and Bockstael et al. (1989), provide the basis for broader benefit estimates that include bequest and existence values as well as direct use and option values. Total willingness to pay of the average household for water quality improvements in 1994 dollars ranged from \$101 to \$387 per year in the vicinity of the South Platte River in Colorado (Greenley et al. 1981), to \$53 per

year for non-users and nearly \$170 per household per year for users in the Chesapeake Bay area (Boeckstael et al 1989), to an average of \$139 per household per year for preservation of eleven rivers in Colorado (Sanders et al. 1990). Using the range of total benefit estimates for the average household contained in these contingent valuation studies, and a total of 211,000 households in the Lake Champlain Basin, aggregate benefits for Basin residents due to water quality improvements might range from \$11.2 million per year to a high-end estimate of more than \$80 million per year.

A final benefit estimate that is worth highlighting separately can be derived from the CV study by Whittington et al. (1994), which estimated the total willingness to pay for implementation of a water quality management plan for Galveston Bay. The process by which the Galveston Bay plan was developed and the difficulties involved in implementation closely parallel the development and implementation process for the Lake Champlain Management Plan. In addition, the benefit study did not examine the willingness to pay for a specifically defined degree of environmental improvement, but rather willingness to pay for implementation of the plan. The average willingness to pay of non user households ranged from \$60

**Table 1: Estimated Economic Benefits of Lake Champlain
Water Quality Improvement**

Water Quality Improvement Benefit Transferred	Lake Champlain Measure	Estimated Lake Champlain Benefit per Year (\$ millions)	Dollar Year	Source
\$10 per recreation trip	469,000 VT & NY State Park visits	\$4.7	1994	Smith & Desvousges (1985)
\$4 per angler day	5,147,291 angler days (Gilbert 1991)	\$20.6	1982	Kaoru et al. (1995)
\$75 to \$140 per boater	7,900 boat launches	\$6 to \$1.1	1994	Bockstael et al. (1989)
\$3.29 per resident, swimming	450,000 Basin residents > age 18	\$1.5	1989	Needelman & Kealy (1994)
\$11.50 to \$131 per non-user household	211,000 Basin households	\$2.4 to \$27.6	1994	Desvousges et al. (1987); Ribaud et al. (1984)
\$53 to \$387 per household (including bequest, existence, option, and direct use values	211,000 Basin households	\$11.2 to \$80	1994	Greenley et al. (1981); Sanders et al. (1990); Bockstael et al. (1989)
\$60 to \$148 per non-user household	211,000 Basin households	\$12.6 to \$31.2	1993	Whittington et al. (1994)

Source: Data compiled for this study (Holmes et al. 1995).

to \$148, while the average user household indicated a willingness to pay that ranged from \$156 to \$252 per year, depending on what information they were given and whether they were interviewed in-person or responded to a mail-in survey. Again, utilizing the non-user willingness to pay data as a conservative estimate in applying the data to Lake Champlain Basin households, total benefits to Basin residents from implementation of the Plan might range from \$12.6 million to \$31.2 million.

Table 1 displays the estimated benefits of Lake Champlain discussed above. It is worth reiterating that the benefit estimates were developed by applying per user or per household estimates from studies in other regions of the country where recreational use patterns, recreational opportunities, income levels and other factors may differ significantly from the Lake Champlain Basin. For this reason the benefit estimates should be regarded simply as indications of the range of potential benefits that could result from implementation of the water quality and recreational improvement elements of the Plan.

It is important to note that the estimated Lake Champlain benefits displayed in Table 1 are not all cumulative. The first four rows might be considered as cumulative since they represent different types of recreation activities, while the last three rows represent similar types of benefits, measured at the household level. Based on this summary of benefit estimates derived from studies conducted in other parts of the country the total use (e.g. fishing, swimming, boating) and non-use benefits (aesthetic, option, bequest and existence value) of the water quality improvements in Lake Champlain envisioned in the draft Plan could range from \$11 to \$80 million per year, with most estimates clustering in the range of \$11 to \$30 million per year.

Of course any estimates of the benefits of water quality improvement must be considered in relation to the costs of realizing that improvement. The mid-range phosphorus reduction scenario described in this report would result in reductions of phosphorus concentrations of greater than 20% in most segments of the Lake. The annualized cost of this phosphorus reduction scenario is estimated to be \$12.7 million, which is well within the range of benefit estimates derived above. Annualized costs for the high phosphorus reduction scenario described in this report are approximately \$24 million per year, which is toward the upper end of the partial benefit estimates derived above.

At this point it is important to note that the benefit amounts are only estimates and that there is a high degree of uncertainty when transferring benefits estimates from other lake and coastal areas. Issues such as comparable lake uses, changing income levels, accuracy of the original study, and uncertainty in the results, are a few items that need to be examined in each benefits study in order to evaluate its applicability to Lake Champlain. This type of analysis is beyond the scope of this study, however, many of the issues and concerns are discussed in a report by the USEPA Office of Policy, Planning, and Evaluation (1993).

4.1 Lakefront Property Values

A section of the Benefits chapter on property values suggests that the contribution of water quality to the value of lakefront property on Lake Champlain is substantial in limited geographic areas where pollution is clearly in evidence and where nearby substitute properties that are unaffected by the problem are available. The tremendous appreciation of lakefront land seen in the late 1980s dramatically increased the dollar value of the price differential attributable to water quality. Given the size of the differential as estimated for the St. Albans Bay area, it would appear that highly targeted pollution reduction measures would yield significant benefits -- at least to the affected property owners.

It must be stressed, however, that value ascribed to water quality as measured by real estate price differences is only one component of its total value. If it contributes significant value to shoreline land in a given lakefront area, it no doubt contributes additional but lesser value to nearby land with no water frontage. And, it undoubtedly conveys values to persons other than local property owners, such as those using water from Lake Champlain for residential consumption or industry and those using it for recreational activities but owning no real property in the immediate vicinity.

4.2 Implications of Doing Nothing

The public choice of continuing to protect and improve the water quality of Lake Champlain, versus doing nothing in terms of reducing nutrient pollution, is a matter of protecting an investment and expanding its economic and quality of life potential. As evidenced in lake and coastal areas around the country, water front areas are valuable assets, however, their value hinges on the quality of the water and shoreline areas. Clean water is a valuable, limited commodity that serves multiple uses, including recreation, drinking water, industrial uses, supporting an ecosystem, and aesthetic enjoyment. The cost of cleaning and purifying water for those uses increases as the water quality decreases. By doing nothing and refraining from making any public investment in Lake Champlain, its economic and social values will deteriorate, as with any neglected public or private property, and the costs of future clean-up will be greater than at present. Doing nothing does not appear to be economically in the best interest of the region. The issue then becomes how to most efficiently and most equitably distribute the costs and benefits of maintaining and improving Lake Champlain. This report, and especially the Optimization Model for Phosphorus Control, provide the foundation for making those decisions.

5. Action Plans for Reducing Nutrients and Managing Nonpoint Source Pollution

5.1 Analysis of Phosphorus Control Costs

One of the principal tasks outlined in our proposal was an economic analysis of phosphorus control in the Lake Champlain Basin. Recognizing that the budget and schedule for this project would not permit reliable quantification of the benefits of different levels of phosphorus control, we chose to give additional attention to the question of how to achieve phosphorus reductions and in-lake phosphorus concentrations most cost-effectively. The model that we have developed incorporates information on point and nonpoint source control costs as well as hydrodynamic information on the movement of phosphorus within the Lake. As improved information becomes available on phosphorus loads, control costs and effectiveness, the model can be updated to provide new estimates of the most cost effective means of achieving current in-lake phosphorus standards or any set of interim targets that might be established for in-lake phosphorus concentrations. The model should be a useful tool in examining different regulatory measures and economic incentives as well as in designing nonpoint source control programs. With further refinement of cost and benefit estimates for reducing in-lake phosphorus concentrations, the model should also prove useful in reviewing the existing in-lake phosphorus standards.

Several scenarios have been developed using the phosphorus control model to illustrate its potential applications and as a first step toward quantifying the costs of achieving the in-lake phosphorus standards. The scenarios that are presented below should not be understood as providing definitive estimates of control costs or as suggesting any changes in the current in-lake phosphorus standards. There are still too many gaps in the data on nonpoint source phosphorus

loadings and on costs and effectiveness of both point and nonpoint source control measures, to develop reliable cost estimates. Nor is there yet sufficient information on the benefits of phosphorus reductions in various parts of the Lake. Nevertheless, even with currently available data, the model can provide some indication of what a cost-effective control strategy might consist of and how the costs of phosphorus control vary with changes in the phosphorus targets established for a few critical Lake segments.

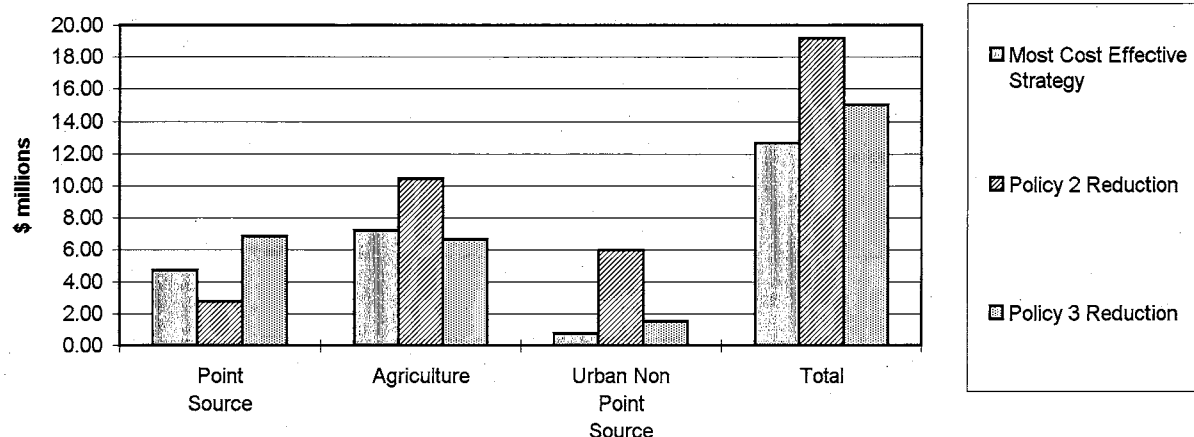
Even with full implementation of point and nonpoint source controls for which information is currently available, phosphorus concentrations in the South Lake B Lake segment would remain significantly above its currently established in-lake standard. Phosphorus concentrations in Mississquoi Bay would also still exceed the in-lake standard by approximately 5%. Improved data on nonpoint source phosphorus loads and control costs for the Quebec portion of the Mississquoi Bay watershed could change this conclusion. Nevertheless, given currently available information, it is not possible to estimate the costs of the specific phosphorus reduction objectives of the draft Plan.

The Diagnostic Feasibility Study, which forms the basis for the phosphorus reduction objectives of the draft Plan, acknowledges that the in-lake standard established for South Lake B are not attainable and does not include any target for phosphorus concentrations in South Lake B in its analysis of phosphorus reduction strategies. A realistic but still reasonably close approximation of the phosphorus reduction objectives of the draft Plan might therefore involve no phosphorus concentration target for South Lake B, an interim phosphorus concentration target for Mississquoi Bay of 27.5 ug/l (which is 10% above its in-lake standard), and the actual in-lake standards that have been established by all other Lake segments. For purposes of this report, this shall be referred to as the mid-range phosphorus reduction scenario. The minimum present value cost of achieving this reasonably close approximation of the draft Plan's phosphorus reduction objectives is estimated to be \$196 million or \$12.65 million on an annualized basis.

An important comparison for policy purposes is between the most cost-effective means of achieving the phosphorus concentration targets of the mid-range scenario and the Policy 2 and Policy 3 options described in the draft Plan. Under these options, all point sources greater than 0.2 mgd would be required to meet effluent concentration limits of either 0.8 mg/l in the case of Policy 2 or 0.5 mg/l in the case of Policy 3. Implementation of point source Policy 2 together with cost-effective targeting of nonpoint source controls to achieve the phosphorus concentration targets of the mid-range scenario, would have an estimated present value cost of \$295 million or \$19.2 million on an annualized basis. This is an increase of nearly \$100 million or 50% relative to the present value costs of the most cost-effective strategy of achieving the mid-range scenario. If point source Policy 3 were implemented and nonpoint source control measures were targeted cost-effectively to achieve the interim targets included in the mid-range scenario, the estimated present value cost would be \$231 million or \$15 on an annualized basis. This is an increase of \$35 million or 18% over the most cost-effective means of achieving the in-lake phosphorus concentrations outlined in the mid-range scenario. The point and nonpoint source control costs of the cost-effective mid-range scenario and together with the Policy 2 and Policy 3 alternative approaches of achieving the same in-lake concentrations are summarized in Figure 1.

A high reduction scenario has also been examined that includes a target of 35 ug/l for South Lake B and an interim target of 26 ug/l for Mississquoi Bay. The present value minimum cost of achieving this high reduction scenario is estimated to be \$372 million or \$24.2 million on an annualized basis.

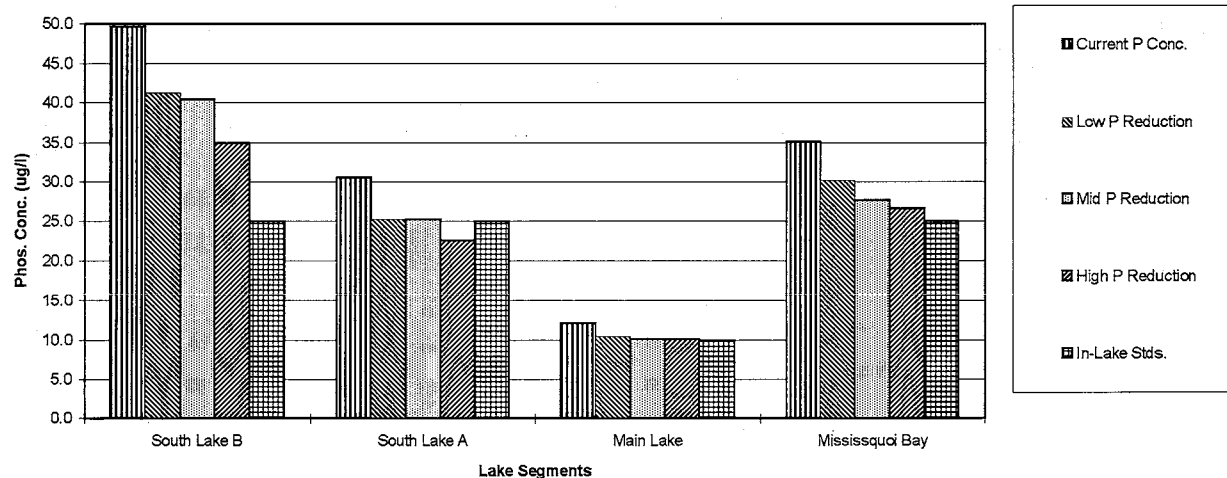
Figure 1: Comparison of Control Costs for Achieving Phosphorus Concentration Targets of the Mid-Range Scenario



Finally, a low phosphorus reduction scenario was developed with no phosphorus concentration target for South Lake B, an interim target of 30 ug/l for Mississquoi Bay and an interim target of 10.5 ug/l for the Main Lake. The minimum cost of achieving this low reduction scenario is estimated to be \$131 million or approximately \$8 million on an annualized basis.

The phosphorus concentrations for critical Lake segments under the low, mid, and high reduction scenarios are summarized in Figure 2 in relation to the current concentrations and in-lake standards of these Lake segments. Figure 3 compares the estimated point and nonpoint source control costs of the low, mid and high reduction scenarios.

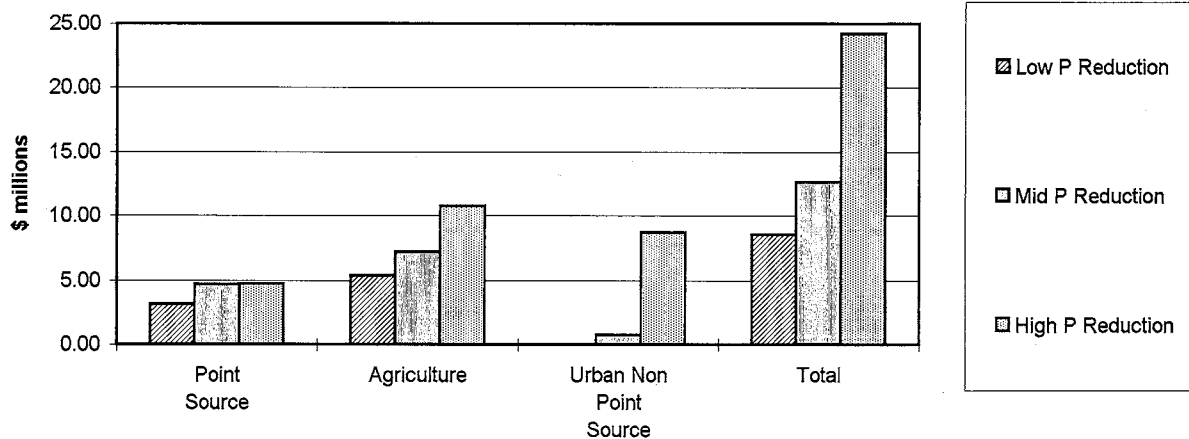
Figure 2: Comparative Analysis of Scenarios for Critical Lake Segments



Given the generally poor quality of the data currently available, it may be most useful to interpret the preliminary cost estimates of the several scenarios presented above on a relative basis. An instructive comparison can be made between the high and mid range phosphorus reduction scenarios. The interim phosphorus concentrations that are achieved in South Lake B, the Main Lake and Mississquoi Bay Lake segments in the high phosphorus reduction scenario are less than 10% below those achieved in the mid-range phosphorus reduction scenario. However, the costs of the high reduction scenario are almost twice as high as the costs of the mid-range scenario. What is clear from this analysis and from the modeling results summarized in Figures 2 and 3, is that relatively small adjustments in the standards established for a few Lake segments can result in very significant reductions in control costs.

Given the significant uncertainty over phosphorus control costs and effectiveness it seems appropriate to pursue an incremental phosphorus control strategy that can be adjusted as new information becomes available. For example managers of point source discharges should be al-

Figure 3: Comparative Analysis of Annualized Costs



lowed and encouraged to investigate how to achieve phosphorus reductions most cost-effectively. This would require setting specific phosphorus reduction requirements for point sources while allowing facility managers some time to investigate and experiment with how to achieve these reductions. Programs designed to reduce agricultural nonpoint sources of phosphorus should be targeted to critical Lake segment and toward farms with lower per unit costs of phosphorus control. Resources should not be expended on point or nonpoint source controls where the cost per pound of phosphorus removed is greater than other available control alternatives. As more accurate information on phosphorus control costs and benefits becomes available, phosphorus reduction targets and strategies can be adjusted accordingly.

In the above discussion it was indicated that it would be less expensive to achieve in-lake phosphorus concentrations that approximate the in-lake standards under Policy 3 than with Policy 2. However, even further cost savings could be realized if the most cost-effective mix of Policy 2, Policy 3 and nonpoint source controls were implemented. This suggests that it may be beneficial to make point source phosphorus discharge allocations in accordance with Policy 3 but allow

point source discharges the choice of whether to achieve the necessary reductions at their facilities, or obtain phosphorus discharge reduction credits by financing less expensive phosphorus reductions at other point or nonpoint sources. Point source dischargers could also be given the option of making a specified payment into a Basin-wide phosphorus reduction fund for every pound of phosphorus discharge in excess of their Policy 3 allocation. New nonpoint sources of phosphorus (e.g. new developments) could also be required to purchase phosphorus reduction credits by making payments into this fund. Payments would be used to finance cost-effective point or nonpoint source controls. The fund could also be used to promote demonstration projects of new technologies. Additional information on this and other market-based approaches to phosphorus control in the Lake Champlain Basin can be found in Volume III of the Lake Champlain Economic Database report (Artuso 1993).

A critical distinction should be made between the most cost effective means of achieving phosphorus reductions and the actual distribution of costs between point and nonpoint sources. For example in the mid-range phosphorus reduction scenario, implementation of agricultural BMP's account for more than two thirds of total phosphorus control costs. The distribution of funding between federal, state, and local sources, and the distribution of local funding between taxes, user fees and increased expenditures by farmers should be treated as separate issues from the determination of how to achieve phosphorus reductions at least cost. A wide array of subsidies and cost sharing mechanisms as well as a system of tradable phosphorus discharge allocations can be utilized to distribute the ultimate costs of the program in an equitable manner while still pursuing the goal of minimizing total costs.

5.2 Point Source Economics: New York Wastewater Treatment

This section is devoted to economic impacts on New York local governments because in New York, that appears to be where the expense of wastewater treatment improvements would fall. In Vermont, the state has made a commitment to funding wastewater treatment improvements at the state level. Compliance with Vermont's state wide phosphorus reduction statute is required only to the extent that 100% state funding is available for necessary upgrade and construction costs. The issues, costs, and alternatives involved in wastewater management in Vermont are discussed in detail in the 1991 publication, *Cleaner Water for the 21st Century: Environmental and Economic Wastewater Imperatives* (Vermont Business Roundtable 1991).

When local-source revenue is viewed on a per-capita basis for New York Lake Champlain counties, it is apparent that area local governments collected revenues of about \$1,400 per capita in 1992, or about two-thirds of the state average for all local governments (\$2,145). Locally-generated revenue was most scarce in Washington County, at \$1,328 per capita, and most plentiful in Essex County, at \$1,860.

These figures might be taken as evidence of insufficient fiscal effort on the part of the local governments in the area (i.e., they are imposing below average per-capita taxes). This conclusion is premature, however, because any differences in fiscal capacity between the region and the state must be accounted for. Personal income per capita in the three-county area was slightly more than \$15,500 in 1992, with Washington County once again below this average and Essex County above it. This was only approximately two-thirds of the statewide average of nearly \$23,000. Thus, the fiscal capacity of the region, as measured by the incomes of residents, is substantially below the average for New York as a whole.

The revenue and income data may be combined to develop a measure of fiscal effort. When local-source revenue is divided by personal income, the result is an overall tax rate which includes the full range of local taxes, fees, and other charges. For New York as a whole, this overall local tax rate was 0.093, or 9.3 cents per dollar of income, in 1992. In Clinton and Washington Counties, the rate was very close to the state average, at 9.1 cents and 8.9 cents, respectively, and the rate in Essex County, at 11.2 cents, was substantially higher than the state average. It is thus not surprising to find that in all three counties the local sales tax rate imposed is the 3 percent maximum allowed under state law.

Another perspective on local government finances can be had from looking at intergovernmental aid. This revenue source is comprised of a variety of state and federal programs, with state aid to school districts being the largest single component. For the three Lake Champlain counties, another important source of state funds consists of payments made on taxable state land. As can be seen from Table 1, aid payments amounted to nearly \$1,200 per capita in 1992, or nearly 22 percent more than the statewide average of \$962. Local governments in Washington County, the poorest of the three counties, received 27 percent more aid dollars than the average municipality in New York.

The picture that emerges is thus one of a region with income levels that are substantially below the state norm, with the resulting limitations on local government spending that these income levels imply. Consistent with this picture is the region's relatively high level of dependence on resources supplied from outside in the form of aid payments from other governments. Despite the region's ability to generate tax revenue from non-residents, its ability to tax residents is still limited by their relatively low incomes.

The report provides a detailed analysis of wastewater expenditures for facilities needing upgrades in relation to fiscal capacities. In the Village of Granville, on which the most severe costs would be imposed by all three policy options, per-capita debt (all purposes) is relatively low (\$85.80), and the percentage of the debt limit that has been used up is similarly low (1%). The Village of Dannemora, on which similarly burdensome costs would be imposed, also has low per-capita debt (\$81.10) and none of its debt limit had been used as of 1992. On the other hand, the four villages which would see no cost increases under the mid-range policy option -- Whitehall, Ticonderoga, Champlain and Rouses Point -- all have debt levels that are substantially greater than similar municipalities in either the region or the state. The City of Plattsburgh, on which relatively modest costs would be imposed by any of the three policy alternatives, has a per-capita debt level which is about 15 percent lower than the state average for cities but it has used more than 50 percent of its constitutional debt limit where the average city in New York has used only 21 percent of its limit. The differences in these figures is no doubt attributable to the presence of a relatively large amount of non-taxable property in Plattsburgh which serves to reduce its debt limit. (At present, the great majority of New York municipalities are using a relatively modest percentage of their debt limits because the latter reflect the rapid appreciation of real estate that occurred in the middle and late 1980s.)

This analysis thus suggests that the mid-range policy scenario is not only an important choice from the standpoint of maximizing the level of phosphorus reduction for a given cost: it also deserves serious consideration because it minimizes costs in some of the municipalities that are (arguably) least able to pay for the cost of plant upgrades. Nevertheless, the distribution of costs under this option remains relatively lumpy, with some municipalities bearing none at all, and others seeing annual increases of more than 200 percent. The unequal fiscal burdens imposed by each of the policy options become even clearer when they are examined in the context of the population served by each of the plants.

The overall annual cost of plant upgrading per person served ranges from \$11 to \$27, depending on the policy option chosen. Once again, the overall average is dominated by the City of Plattsburgh, where the total additional cost would be relatively low and it would be spread among the approximately 30,000 persons the plant serves (more than 37 percent of the population served by all municipal treatment facilities on the New York side). Under Policy 2, most of the other municipalities would need to increase their expenditures by around \$20 per capita or less, with Dannemora, Champlain, and Rouses Point needing to charge significantly more than this. Policy 3 would more than double this additional expense for most of the municipalities. Saranac Lake's increased expenditure is relatively low under Policy 2, having recently financed a significant upgrade to its facilities, however, Policy 3 would increase the Policy 2 expenditures of Saranac Lake by a factor of six. The mid-range proposal would, as already indicated, free four villages of any additional costs, and it would generally limit annual per-capita cost increases in the remaining municipalities to \$12 or less, significant exceptions being Dannemora (\$74), Granville (\$55), and Keeseville (\$20). As mentioned above, the first two of these severely affected villages have relatively low debt burdens. However, the per-capita debt load of Keeseville is more than twice the state average for villages.

Due to lower fiscal capacity than average, New York local governments in the Lake Champlain are less able than those of other areas of the state to fund significant new local expenditures for wastewater treatment or any other local program depending totally or primarily on local-source revenues. Consistent with their relative economic status within the state, the area local governments currently benefit from state and federal aid programs that provide funds in per-capita amounts significantly above the state average. The combination of below-average local ability to pay for improvements and above-average dependence on external aid payments suggests that any improvements proposed should have substantial non-local funding if they are to be accepted locally. State-wide rather than local funding for phosphorus reduction at wastewater treatment plants is the approach used in Vermont.

Another reason for considering non-local funding for such improvements in New York is that in many cases a significant share of the benefits attributable to the improvements accrue to persons other than local residents and property owners. While there may be nearshore local benefits, such as improved water quality at a local beach area that benefits local users and local businesses, the major goal is in the improvement of Lake Champlain as a tourism and recreation resource, thus benefiting the full spectrum of visitors and recreationists, as well as the regional tourism economy.

Non-local funding is also especially critical if the improvements to treatment plants are to take place in the foreseeable future. The sharply increased pressure placed on local taxes as federal and state aid funds (for a whole range of programs as well as wastewater treatment) have dried up over the past decade is now forcing local governments to make increasingly difficult choices between competing "goods," including water quality improvement. They may be expected to concentrate their resources on goods that primarily benefit local voters in such a fiscal environment. For this reason, there is a real need to develop funding sources that shift upgrading costs away from the region in keeping with the wider distribution of benefits.

Special attention to the intra-regional distribution of costs is also warranted. Of the many local governments on the New York side of the Basin, a relative few are heavily impacted by the projected costs of any level of treatment upgrade while others would see very modest cost increases under some or all upgrading proposals. Choice among the alternative proposals should recognize the disproportionate fiscal burdens the improvements would create and the need to steer any non-local funds toward those municipalities facing high per-capita upgrading costs.

5.3 Nonpoint Source Economics: Dairy Farming and Manure Management in the Lake Champlain Basin

While the profitability of dairy farming in the Northeast has been relatively stable for the last three years, future prospects are not encouraging. Profit margins in dairying, as in most agricultural enterprises, are very slim. The price of milk in the Northeast for 1995 is forecast to decline about 4% from 1994 levels, while input prices should remain stable. The net result will be a further tightening of dairy profit margins.

Financial data from 1992 for 35 dairy farms enrolled in ELFAC, a farm accounting service for Vermont farmers, are presented in the table below. Little change is expected between these figures and those for 1994.

Table 2:
1992 ELFAC (Vermont) Dairy Farm Business Analysis

	Farm Size (average # of cows)		
	32	59	105
	<i>Average per Reporting Farm</i>		
Total Farm Cash Receipts	\$92,691	\$141,426	\$326,252
Total Farm Cash Expenses	\$88,851	\$128,449	\$309,814
Cash Income	\$3,840	\$12,977	\$13,021
Change in Assets	(\$774)	\$10,955	\$20,208
Net Farm Income	\$3,066	\$23,955	\$33,229
Net Worth	\$122,815	\$392,530	\$615,815
Number of Owners/Operators	1	1.25	1.73

The financial data presented in Table 2 indicates, quite clearly, the very low profitability of dairy farming in the Northeast. The net farm income, which comprises the difference between cash receipts and expenses plus increases (decrease) in asset investment, is extremely low for all farm sizes. The net farm income figures represents both the return on the farmer's investment (net worth) and compensation for his or her labor and management (not included in cash expenses). If a modest compensation of \$20,000 a year for owners' labor and management is assumed, each of the farm sizes realizes a negative return on investment.

Nationally, milk production is increasing faster than consumption. As long as this trend continues, milk prices will remain depressed. Dairy farmers have historically responded to lower profit margins by expanding their production. As profit margins get tighter, the trend to larger farms will continue and in all likelihood accelerate. Increased milk production and the prospect of reduced government involvement in the dairy industries does not bode well for the future of dairy farming.

in the Northeast. Increased production in the West and Mid-West, where production costs are lower, will place additional pressures on the Northeast dairy industry.

It will get increasingly difficult for dairy farms with less than 100 cows to remain economically viable in the Northeast. It is reasonable to expect the recent acceleration in dairy farms leaving the industry to continue. While farm size will undoubtedly get larger, offsetting some of this decline, the industry as a whole will likely get smaller in the Northeast.

5.3.1 Cost and Benefits of Selected Manure Management Options

The reduction in nonpoint pollution from agriculture will require many farms to change their manure management practices. Ecologically sound manure management practices include diversion of barn yard runoff, maintenance of grass cover between water ways and cultivated fields, and elimination of manure spreading on frozen ground. Each of these practices are designed to eliminate or reduce the amount of manure runoff into adjoining waterways.

The most costly of these environmental sound animal waste management practices is the elimination of manure application on frozen ground. The elimination of daily spreading in the winter will require farmers to store their manure and apply it during periods where the danger of runoff is minimal. The cost to dairy farmers of alternative manure management practices to daily spreading are examined in this section.

In addition to cost estimates, the crop nutrient (fertilizer) value of manure in each alternative management practice is estimated. The nutrient values in conjunction with the cost estimates are used to project the net benefit or cost of each alternative manure management practice relative to daily spreading. The sensitivity of each alternative's annual cost and net benefit to changes in government cost sharing of capital expenditures associated with building a storage structure is also examined.

It should be pointed out that the optimal management regime (environmental and economic) will vary from farm to farm depending upon its unique circumstances. To accurately assess the cost and benefits of implementing a particular manure management option on a farm, the unique circumstances of that farm must be considered. The cost and benefits of adopting an alternative manure management regime will vary widely from one farm to another. Site location and soil types will dictate the types and construction costs of feasible manure storage structures. Given the wide variability in costs and the problematic nature of determining the effective nutrient value of manure to crops for different farms with unique management, emphasis should be placed on the *relative costs and benefits* of the various options and less emphasis should be placed on the absolute values presented in the attached budgets.

Several factors can affect the capital and annual operating cost of various manure management regimes. The distance manure is hauled will have a significant effect on costs, especially on the larger farms. The nutrient benefit value of manure will vary widely from farm to farm. The types and quantities of bedding and milk house wastes included in the manure will influence the nutrient content of manure. The economic value of manure will be affected by the fertility of the soils on a particular farm. The value of phosphate in manure may be zero if applied to soils with high levels of reserves. To maximize the value of manure, it should be applied to land growing crops that will fully utilize the nutrients contained in it, although one must weigh these benefits with increased transportation costs.

5.3.2 Annual Net Benefit/Cost of Alternative Manure Management Options

In each of the 60 cow budgets, there is a net cost associated with manure handling. The lowest is daily spreading which has a net annual (7 months of storage) farm cost of \$2,007 for the stall barn and \$1,803 for the free stall barn. The highest cost alternative is the above ground storage in both the tie stall and free stall barns. For the stall barn, the net cost is 5.25 times higher while above ground storage in the free stall barn is over 5.63 times higher than daily spreading. The concrete slab is the least expensive alternative for the 60 cow tie stall barn, with net costs being 266% higher than daily spreading. The net cost of the earthen pit with concrete floor in the stall barn is \$7,788 or \$5,781 higher than daily spreading.

For the 60 cow free stall barn, the second most expensive alternative to daily spreading is the earthen pit with pump loading. This option has a net cost of \$6,682 or \$4,878 higher than the net cost of daily spreading. The net cost of the earthen pit with gravity loading is \$2,032 or 213% higher than daily spreading.

For the 120 cow operation, the construction of an earthen pit with gravity loading increases the net cost of manure handling by \$639 over daily spreading. The net annual farm cost of installing an earthen pit with pump load is \$9,431, or \$5,708 more than the net cost of daily spreading. The use of an above ground tank has a net cost \$17,304 which is 464% more expensive than daily spreading.

For the 240 cow operation the net annual farm benefit of installing an earthen pit with gravity load is \$436, an increase of \$3,917 over daily spreading. The net annual farm cost of an earthen pit with pump loading is \$4,623 or 133% more than the net cost of daily spreading. The use of an above ground tank has a net cost of \$18,826 which is \$15,345 more expensive than daily spreading.

Each of the alternative manure management options for the 60 and 120 cow operations has a higher cost associated with it than daily spreading. The above ground tank, due to increased construction costs, is the most expensive alternative. For the 60 cow operations, the least expensive option is a concrete slab for the tie stall barn, and earthen pit with gravity flow for the free stall barn. For the 120 cow farm, the least expensive option to daily spreading is an earthen pit with gravity load.

With the exception of above earthen pit with gravity load, there is a net cost to all manure handling options on the 240 cow operations. The earthen pit with gravity loading has a net benefit of \$436 a year, which represents a \$3,917 annual benefit over daily spreading. The above ground storage, as in the 60 and 120 cow operations, is the most expensive option.

5.3.3 Sensitivity of Alternative Manure Management Option Annual Costs to Government Cost Sharing

The sensitivity of alternative manure management option annual costs to government sharing of capital expenditures was examined. Separate budgets for each of the alternative manure management practices on different farm sizes were run assuming 0%, 25%, 50%, 75% and 100% cost sharing of storage structure expenses.

The government cost sharing percentage only applies to the cost of constructing the storage facility. The cost share percentage is not applied to the capital expenditures associated with the purchase and installation of loading mechanisms (e.g., pumps, gravity systems, tractor loaders). It is assumed that 95% of the annual storage costs are attributable to capital cost and the remaining 5% to operating costs. The costs account for only that portion of equipment and labor used in a given manure management practice.

Even if government fully subsidizes the cost of storage construction, there is an increase in costs over daily spreading in all manure management alternatives for the 60 cow tie stall barn operations. Each 25% increase in cost sharing reduces the net annual cost by approximately 13% for the earthen pit with concrete floor; 18% for the above ground tank; and 6% for the concrete slab. To fully subsidize the additional cost of these options, farms would need, in addition to 100% cost sharing, annual cost subsidies of \$3,076, \$3,215 and \$2,519 for the earth pit, above ground tank and slab, respectively.

For the 60 cow free stall barn, there would be additional annual costs of switching from daily spreading to any of the alternative options, although a 100% cost share would nearly negate the additional cost of an dirt bottom earthen pit with gravity load. Each 25% increase in cost sharing reduces the net annual cost by approximately 33% for the dirt floor earthen pit with gravity load; 19% for the above ground tank; and 11% for the dirt floor earthen pit with pump load. To fully subsidize the additional cost of the above ground and earthen pit with pump loading, the 60 cow free stall farms would need, in addition to 100% cost sharing, annual cost subsidies of \$3,054, and \$2,880, respectively.

For the 120 cow farms, there would be additional annual costs of switching from daily spreading to the above ground tank and earthen pit with pump loading. Minimal cost sharing (between 8% and 9%) is needed to fully subsidize the cost of the earthen pit with gravity load. Each 25% increase in cost sharing reduces the net annual cost by approximately 26% for the above ground tank; and 20% for the earthen pit with pump load. To fully subsidize the additional cost of the above ground and earthen pit with pump loading, the 120 cow free stall farms would need, in addition to 100% cost sharing, annual cost subsidies of \$2,218, and \$1,824, respectively.

The above ground storage tank is the only alternative manure storage system on the 240 cow farm that would need significant capital cost sharing to fully mitigate the additional expense of moving from daily spreading. The earthen pit with gravity load option yields positive benefits to the 240 cow farm over daily spreading without any subsidy. The earthen pit with pump load option would only need a subsidy of approximately 23% to fully mitigate the additional cost over daily spreading. To fully subsidize the additional annual cost of the above ground tank, cost sharing would have to be approximately 85%. Each 25% increase in cost sharing reduces the net annual cost of the above ground tank by 43%.

The primary conclusion to be drawn from this analysis is that the need for government cost sharing declines with increases in farm size. Moving from daily spreading to an alternative manure storage option will be a costly proposition for the 60 cow farms. The costs are not nearly so severe for the 120 cow operation, particularly when viewed on a per cow basis. With the exception of the above ground storage option, shifting from daily spreading to alternative manure management is economically attractive on the 240 cow dairy farms, given the increased nutrient value of manure. However, as stated in a previous section (i.e., Cost and Benefits of Selected Manure Management Options) the value of manure could vary considerably by farm, and the transportation costs may be considerably higher for larger farms.

The second conclusion to be drawn is that the construction of above ground manure storage tanks should be avoided whenever feasible. The cost of this storage options, assuming no cost sharing, is 23% to 76% more than alternative storage options.

The preceding discussion of costs and cost sharing illustrates the strong influence of dairy farm size on the economics of manure management. As concluded above, the reliance on government cost share for reducing phosphorus loading in the Basin sharply declines with increases in farm size. In reality, close to three-fourths (74%) of all dairy farms in the Vermont Lake Champlain Basin area are in the smaller farm category (i.e., less than 90 cows). About 20% fall in the medium size category, and 5% of the dairy farms are in the large farm category (i.e., over 180 cows). Although this data does not include the percentage of farms that already incorporate manure storage in their farm practices, it appears that the majority of farms in need of a manure management system are the small farms. As presented above, it is on those small farms where the economic cost of moving from daily spreading outweighs the benefits. A conclusion is that a significant infusion of cost sharing will be necessary to incorporate phosphorus control measures on all agricultural land in the Basin.

Given the reliance on cost share by small farms to improve the economic feasibility of constructing manure management facilities, it is important to note that the possibilities for federal cost share are not very bright at all. According to Roberta Perry (personal communication), a researcher in the EPA's Agricultural Policy Branch, the Agriculture Conservation Program (ACP) was funded at \$200 million 2 years ago, \$100 million last year, and now the 1995 Clinton budget allocates \$50 million to the program. However, it is possible that other agricultural programs could be used for cost share dollars on manure management facilities.

6. Action Plan for Managing Fish and Wildlife, Economic Analysis

Fish and wildlife recreation activities are popular both to local residents and to tourists who visit the Lake Champlain Basin. In 1990-91, anglers purchased nearly 108,000 fishing licenses in the Vermont area of the Basin, and 60,000 licenses in the New York area of the Basin. About 35% of licenses are purchased by nonresidents of the basin. Approximately 41,000 anglers licensed in New York fished Lake Champlain approximately 482,000 angler days in 1988 and spent approximately \$9.5 million (\$19.61 per day) in the area of Lake Champlain (Connelly and Brown 1988).

Gilbert (1991) estimated that in 1991, 88,961 anglers spent 5,147,291 angler days fishing Lake Champlain. New York anglers accounted for 39.9% of all Lake anglers in 1991, but 62.4% of all angler days. Of the total number of days spent fishing in 1991, 70% occurred during the open water season.

Of all New York trips taken during open water, more were taken to fish for yellow perch (16% of the total) than for any other species. Other popular species and percent of total trips were: lake trout (12%), bass (12%), no particular species (12%), landlocked salmon (10%), walleye (10%), and other species such as white perch, crappie, and bullheads (9%). Ice fishing was primarily for white and yellow perch, with significant effort also for walleye and northern pike.

Vermont residents preferred to fish for bass (17% of trips), followed by lake trout (14%), yellow perch (12%), walleye (12%), landlocked salmon (12%), and northern pike and pickerel (10%). Most ice fishing trips also were for yellow or white perch.

A total of 35,788 hunting licenses were sold in the New York area of the Basin in 1993. State-wide, Vermont had an estimated 107,162 hunting license holders in fiscal 1992. Nonconsumptive wildlife activities such as observing, feeding, and photographing wildlife are also very popular in the Lake Champlain basin. Approximately 62% of Vermont residents participated in these activities away from their residence in 1991 (U.S. Fish and Wildlife Service 1992).

Residents of the region have long held an interest in protecting the natural environment. With the advent of ecotourism, many tourists who visit the region share this interest. Studies elsewhere have shown that threatened and endangered species have significant existence values among the general public (Stevens et al. 1990, Bowaker and Stoll 1988). For example, the general public in New England was willing to pay an average of \$18 per person to protect bald eagles (Stevens et al. 1990). Other studies have shown that the public is willing to pay more to preserve endangered species if it has information on the status of those species (Samples et al. 1986). Thus, educational programs are valuable in attempts to protect these species.

Bishop (1990) has pointed out that threatened and endangered species have potential future economic values beyond current existence values. In recent years science has discovered important medical uses for a wide variety of plant and wildlife species (Fuller 1991). Thus, a species that may seem to have no current economic value could conceivably be exceedingly valuable to saving human lives or for some other purpose at some point in the future. As a result, Bishop argues that extinction of species should be avoided unless the social costs of doing so are unacceptably large. Ascertaining what "unacceptably large" means is as much an ethical as an economic question.

Private landowner cooperative programs with the U.S. Fish and Wildlife Service have generally been popular with landowners in the Northeast and have led to mutual benefits for the landowner and for fish and wildlife conservation. In the Lake Champlain basin, such programs could also contribute to improved water quality by implementing practices that reduce erosion and control nonpoint source pollution. Thus, expansion of this program is likely to produce tangible benefits.

We recommend that sizable federal public acquisition programs not be undertaken without a careful cost-benefit analysis. Public acquisition is often the most straightforward way for conservation agencies to protect or restore fish and wildlife habitat. However, Brown et al. (1993) showed in the case of a proposed national wildlife refuge in Northern New York that even where willing landowners are paid a market price for their property, costs could outweigh benefits if substantial agricultural acreage is taken out of production in a federal program. Losses also can occur because federal in-lieu-of-tax payments to local governments may be considerably less than the taxes paid when the land is in private ownership. On the other hand, smaller State acquisition programs involving wetlands and riparian habitats could very likely have net economic benefits.

Although not specifically covered or budgeted for in this Action Plan, the sea lamprey program could be considered a form of fisheries enhancement or restoration. Sea lamprey control will almost certainly generate additional angler days fishing. Gilbert (1991) found that 80% of 1991 lake trout anglers and 91% of salmon anglers indicated they would fish more if sea lamprey control meets its objective. Furthermore, 50% of non-lake trout anglers and 61% of non-salmon anglers indicated they would start fishing for these species if sea lamprey control meets its objec-

tive. Approximately 80% of respondents indicated that catching fish without lamprey scars was an essential or important factor in a really satisfying fishing trip.

Using a willingness to pay question, Gilbert (1991) found that anglers were willing to pay a median annual value of \$11.64 for sea lamprey control related to lake trout, and \$11.47 related to salmon. This translates into total willingness to pay values which Gilbert estimated at approximately \$1.1 million per year each for lake trout and salmon-based lamprey control. Gilbert assumes anglers were willing to pay one and not both values and thus places an aggregate value of sea lamprey control to anglers at \$1.1 million.

Working with private landowners to reduce discharges into the Lake could have potential benefits for recreational fishing. An Indiana study found that 1-15% reductions in suspended solids and associated pollutants may provide net benefits of \$250,000 to \$5.5 million to recreational anglers (Patrick et al. 1991). Achieving those benefits would require substantially greater percentage reductions in erosion from cropland, however.

Toxic substances in fish currently affect the quality and value of the Lake Champlain fisheries. Lake Champlain fish consumption health advisories exist for lake trout greater than 25" in length due to the presence of PCBs, and for walleye greater than 19" in length due to the presence of mercury. In addition, the health advisory applies to American eel and brown bullhead from a portion of Cumberland Bay. The advisory is that a maximum of one meal per month of the affected species be eaten, but that none of the affected species be eaten by children under the age of 15 and by women of childbearing age (the latter is from the New York health advisory for Lake Champlain).

Fisheries and public health agencies are concerned about the extent to which the public is aware of, and heeds these advisories. Draft findings of a 1993 study show that of those who had fished Lake Champlain in the past five years, an estimated 71% were aware of the advisories, but the majority of these were only vaguely or generally aware; they did not know which species were affected or in which area of the Lake the advisories pertain (Connelly and Knuth 1994).

This degree of awareness is less than that found in other studies of this type that have involved Great Lakes waters and the Ohio River. Demographic groups who were least aware of the advisories included those who were rural, younger, nonwhite (although the sample size for nonwhites was very low), and lower income. In addition, those who fished the far northern and southern ends of the Lake were less aware than those who fished the middle portions of the Lake. Although anglers by state had similar proportions give incorrect information pertaining to the advisories or risk reduction practices in preparing and eating fish, more Vermont than New York respondents gave "unsure" or other than correct responses. The report notes that the New York fishing guide gives far more detailed information on this topic than the Vermont guide.

Some work cited above indicates that the more knowledge the public has about aquatic environments and fish and wildlife resources, the more interested they become in them and the more highly they value them. Thus, effective public outreach activities appears to be an excellent investment of public dollars.

7. Action Plan for Managing Recreation, Economic Analysis

While many types of recreation are important in the Basin, water-based recreation provides the primary attraction for visitors and is also of greatest concern to this project because of the interface between water-based recreation, the tourism-related economic impacts it generates, and maintaining good water quality. Because of its importance, a summary of available water-based recreation is provided below.

A significant amount of recreation data and information is currently being compiled in the Lake Champlain Recreation Assessment Report (New York State Office of Parks, Recreation & Historic Preservation 1994b), and was not adequately reviewed for this report. The report is the culmination of three years of cooperative recreation research on Lake Champlain by the States of Vermont and New York, including a series of surveys of various user groups.

Dr. Al Gilbert of the University of Vermont completed a study of the 31 marinas on Lake Champlain in 1986. At that time, there were 3,112 total berths (a combination of slips, dockage, and moorings) available. Vermont's 18 marinas had 1,698 berths (54.6% of the total), while New York's 13 marinas had 1,414 berths (45.4% of the total). The 1986 summer occupancy rate for berths was 99.9% in Vermont and 97.0% in New York. The area of greatest demand for additional berths in 1986 was in the greater Burlington area. This area, which has almost half of all of the total supply of berths on the Vermont side, had 100% occupancy in the summer of 1986. It also had the longest waiting time (3.86 years) for people to obtain a berth.

By boat type, 61% of the boats at Lake Champlain marinas were sailboats and 39% were powerboats in 1986. New York had 68% sailboats, compared to 57% for Vermont. Lake-wide, half of the sailboats were 20'-29' in length, and 45% were 30' or longer. Roughly half of the powerboats were 20'-29', one-quarter were less than 20', and one-quarter were 30' or longer. New York marinas had a higher proportion of both sailboats and powerboats over 30' in length; they had approximately as many boats over 30' in length as between 20' and 29'. In 1992, it was found that there was a 47% increase since 1980 in the number of boats using Malletts Bay on a given day (Bulmer 1993).

Marinas on Lake Champlain provided a wide array of services, and the more essential services were widely provided. Two-thirds of all marinas provided fuel, all marinas provided rest rooms, and 71% of all marinas had pumpout stations (for other services see Gilbert 1986). Although most operators felt that there were sufficient pumpout facilities on the Lake, 36% did not think so; 36% felt that boaters dump holding-tank effluent in the Lake. This was felt to be a problem especially in the Burlington area, where only 14% of operators felt there were enough pumpout facilities, and 58% felt that boaters dump effluent overboard. The vast majority of operators felt that marina owners have the responsibility to provide pump-out facilities. More data on Lake Champlain marinas is available in the recently completed *Lake Champlain Recreation Resources Inventory* (Farnum 1994).

According to data recently collected on New York and Vermont public access site users on Lake Champlain, boating related expenses averaged over \$200 per trip (New York State Office of Parks, Recreation and Historic Preservation 1994a). If a boat launch parking area with a capacity of 20 cars were filled to capacity on a single two-day weekend, approximately \$8,000 would be injected into the local economy, equaling an economic impact of twice the estimated annual maintenance costs for the launch site.

Gilbert (1991) estimated that in 1991, 88,961 anglers spent 5,147,291 angler days fishing Lake Champlain and spent \$81.7 million in nondurable expenditures related to their fishing. New York residents spent \$43.3 million, and Vermont residents spent \$33.7 million. However, New York anglers had substantial expenditures in Vermont. As a result, total fishing-related expenditures made in New York and Vermont were almost equal. Only 5.4% of expenditures (\$4.5 million) came from residents outside New York and Vermont. Approximately 83% of total expenditures were associated with the open water season and 17% with ice fishing.

Gilbert (1991) provides expenditure data associated with each species that identify specific expenditure categories. For lake trout during the open-water season, the species that generates the most expenditures, a comparison of lodging expenses for New York residents, Vermont residents, and "nonresidents," suggests that the vast majority of Vermont and New York residents either live near the Lake or have a second home near the Lake. Only 7% of New Yorkers' and 6% of Vermonters' expenditures are associated with lodging, while 21% of expenditures by non-residents are associated with lodging. Another indicator that the Lake is not a major long-distance tourist attraction is that charter and guide services account for a very low proportion of expenditures (\$651,000, or 3% of total expenditures). It is possible that sea lamprey control, which should improve the quality of the Lake's fisheries, will help boost fishing-related tourism. Further information on fishing is provided in the previous section.

An unpublished draft report being prepared by Dr. A. H. Gilbert (1995) on the impacts of additional salmonid angling generated by sea lamprey control has implications for Opportunities A and B in the Action Plan. It has been estimated that sea lamprey control will generate an additional 65,000 angler days by 1998. Dr. Gilbert's study investigates the impact of that additional fishing increment on local public and private infrastructure in towns bordering the Lake. Much of the data for this study was gathered in 1990-91.

Gilbert estimated by town, based on projections from current use, where the added 65,000 additional angler days would occur. There is no indication that these projections were available or were considered when the Action Plan for Managing Recreation was developed. Thus, the results of Gilbert's work may in some cases provide justification for additional public access facilities. In other cases Gilbert's results provide additional documentation for the proposals in Opportunities A and B.

Much of the recreation management challenge concerns providing additional recreation opportunities in ways that do not significantly worsen water quality. Few studies anywhere in the world have established definitive quantitative relationships between recreation activities, tourism visitation, and water quality. Certainly at some levels or ranges these relationships exist. However, the relationships typically are not linear, and the findings concerning one water body are not necessarily exportable to another water body. Ribaudo and Piper (1991) indicate that effects of improving water quality on increased recreational fishing are theoretically measurable, but that much more work is needed to arrive at estimates that can be generalized or incorporated into national policy models. Thus, we will often lack sufficient data to give precise quantitative estimates of the impacts of the Lake Champlain recreation plan. Rather, each major planning opportunity is analyzed qualitatively for its potential advantages and the precautions that should be undertaken if the planning item is implemented.

Although a great deal of concern is often expressed about the effect of additional boating on water quality, few studies have shown significant impacts. For example, an Australian study initiated at the point of strong public concern about additional boating activity found no discernible impact

on dissolved oxygen depletion or nutrient enrichment of the water column, organic pollution, toxic pollution, or bacterial degradation of sediments (McMahon 1989).

Aquatic pollutants can have a direct -- and indirect -- adverse impact on tourism and recreation economies. It is the responsibility of state health and environmental agencies to regulate or prohibit swimming, fishing, or other forms of recreation when measurable polluted conditions are present. Although most recreation users associate shore and nearshore effluent with what can be perceived directly by the senses, many aquatic pollutants that are known to be harmful to humans are not often perceivable by the public. A primary exception occurs when a particular visual pollution event takes place or where residual effluents can be seen on the shore or in the water (West 1989). Once a pollutant is recognized and warnings or prohibitions are put in place, these actions, in turn, are picked up and often exploited (i.e., over-reported) by the media. Negative publicity by the media can adversely impact public perceptions of the water body or locality affected, and the negative image often remains even after the problem has been alleviated. In some cases, the economic losses due to the tarnished image are even greater than the actual clean-up costs, as Brown (1975) demonstrated in relation to natural disasters such as Hurricane Agnes.

The report reviews major opportunities in the Action Plan for Managing Recreation and the associated costs and benefits. In many cases this has to be done qualitatively, either because specific implementation mechanisms are not stated in the Plan, or because insufficient data are available. In making the analysis, we are especially attuned to costs that might be passed on to local government, or benefits that might accrue to local government if the opportunity comes to fruition.

8. Benefits Associated with Watershed Planning and Educating and Involving the Public

Each Plan for Action addresses the issue of watershed planning, and most designate projects that would contribute towards educating and involving the public. While these activities are widely recognized as having both short- and long-term benefits related to understanding and protecting the environment, there is little research on their economic benefits. The study team chose to study the benefits of a watershed organization currently active in the Lake Champlain Basin, the Boquet River Association (BRASS).

The activities and benefits of BRASS fall under the following eight categories:

streambank erosion control,	open space/park/recreation,
fisheries enhancement,	economic development,
nonpoint source pollution,	education, and,
water quality,	other basin watersheds.

Under each category are a wide variety of projects, described under four headings: Boquet River Association Action, If No Boquet River Association, draft Plan Action Plan, and, Type of Benefit.

An outline of the benefits presented in the report clearly demonstrates BRASS's contribution to the environment, quality of life, and economy of the Boquet River area. As can be seen under the "If No BRASS" column, without the organization's efforts, most of the river and watershed activities would not take place. Those that would occur, for example planting seedlings for erosion control, would be significantly reduced in scope. BRASS's streambank erosion control program is a prime example of the type of public/private partnerships that BRASS develops and promotes. That particular program directly contributes to reduced phosphorus loading from the Boquet, one of the goals outlined in the draft Plan.

Important activities that contribute to the economic well-being of local residents are BRASS's water testing laboratory, employment opportunities for college students, its local purchases, its leveraging of cost share dollars, and providing improved fishing and spawning habitat.

BRASS has a number of significant accomplishments and on-going programs that depend more on volunteers and community efforts than on large budgets. However, cooperation from state and federal agencies -- including expertise and funding -- is key to their success. Agency commitment and cooperation serves to maximize the effectiveness, and thus the local benefits, of volunteer and community activity. Perhaps one of BRASS's greatest accomplishments, and a testament to its recognition among local communities, is that it recently spawned another local watershed organization, in the AuSable River watershed of the Lake Champlain Basin.

9. Incorporating Sustainability Concepts into the Lake Champlain Opportunities for Action

Many large-scale planning efforts across the country and around the world are addressing the "sustainability" of the activities being considered. The Lake Champlain planning process is no exception and the concept of sustainability is implicit in the last sentence of the draft Plan Vision Statement, where the goal of implementing the plan is to "insure that the Lake and its Basin will be protected, restored, and maintained so that future generations will enjoy its benefits."

A dictionary definition of "sustainable" includes the following: to keep in existence, maintained or prolonged; able to endure or withstand. The now common phrase "sustainable development" includes all those concepts, and more. In succinct terms, sustainable development is development that lasts. The concept became popular subsequent to a United Nations report released in 1987, titled *Our Common Future* (Brundtland 1987). Its application was directed towards an obvious problem in many international development efforts, that the development ceased once the development money stopped flowing in. Another major impetus for applying sustainable development standards to international aid decisions was in an attempt to break the boom and bust cycle in many rural economies, which is due to a combination of cyclical industries and a lack of economic diversification.

In terms of maintaining the environment and economy around Lake Champlain, the following two definitions of sustainable development appear to be especially relevant:

- sustainable development uses resources at levels which assure sustainable yields and which maintain resources to meet the potential needs of future generations; and
- sustainable development provides equitable access to natural and environmental resources, and avoids shifting the costs of economic development onto the disadvantaged or transferring adverse effects to other areas or to future generations (Federal Reserve Bank of Chicago and the Great Lakes Commission 1991).

Although sustainability is often seen as a concept primarily related to economics, many of the topics to which it is applied, such as sustaining cultures, ethnic groups, certain species, certain "ways of life," etc., do not fall within the normal realm of economics (i.e., the allocation of resources among competing uses). The major issues surrounding sustainability are usually discussed in terms of philosophy, ethics, or biology, with the concepts and ideas that comprise mainstream, neoclassical economics appearing only tangentially relevant.

The concept of sustainability must be clarified if it is to survive as a serious concept within one or more well-developed disciplines. Indeed, it may well evolve into several concepts, for there will likely always remain fundamental differences between what an economist and a biologist, for example, mean by sustainability. In the meantime, however, it is possible to identify a few of the necessary components of a definition of "economic sustainability" for natural resources.

According to standard economic theory, unimpeded markets create the most efficient allocation of productive resources. Despite the attractiveness of the theory, it is recognized that individual markets often fall short of the competitive ideal and, for some goods, they may not even exist. This has given rise to the general concept of "market failure," under which economists categorize the various departures from competitive conditions. If markets are operating perfectly, the theory goes, price signals will notify us of impending scarcity in time for us to decrease our usage of a particular resource, shifting to other resources and/or instituting conservation measures as appropriate. When the price signals are wrong or absent, the market is failing to allocate efficiently. This concept of market failure is the best starting point for a discussion of the sustainability concept as viewed from the perspective of economic theory. There are three sources of market failure that create potentially non-sustainable economic activities, namely: externalities, common property resources, and intertemporal allocation of resources.

A given productive activity may not be sustainable over time if negative externalities are present because some of the costs resulting from the activity are not reflected through the price mechanism. For example, pollution of a water body by an industry or community may create major costs to other water users because the water body is being treated as a "free" vehicle for disposal of wastes. Since the costs in question are not reflected in prices the polluter must pay to engage in the activity, both theory and experience suggest that the pollution will continue unchecked if the marketplace alone guides economic decisions. Because actual prices paid by the polluter do not reflect the "external" costs, they can not signal resource depletion and scarcity, so overuse and abuse are virtually guaranteed. Solutions to this problem can take the form of a variety of regulatory tools ranging from effluent restrictions, required treatment technologies, taxes, tradable pollution rights, etc. One or more of these regulatory options can be used effectively to remove the existing bias toward over-use, depletion, or degradation of a natural resource affected by a negative externality.

The case of a common property resource also involves unrecognized public costs generated by private economic activities. In a fishery, for example, the fish are essentially a "free" good. All fishermen, competing with one another, have the economic incentive to maximize their individual catch. The overall result may be over-harvesting, depletion of fish populations, and drastic reductions in everybody's catch (as recently occurred in the Georges Banks fishery). The sum total of the actions of the individual fishermen is thus not sustainable. But, within the normal operation of markets, there is no way to avoid this "tragedy of the commons". The problem is that the costs of depletion are not appropriately felt by the individual fishermen because they have no individual property rights over the fishery. The social costs associated with depletion can only be accounted for through regulation of fishing activity and limiting the catch to sustainable levels. In Lake Champlain the fisheries are regulated through catch limits by the State conservation agencies in New York and Vermont.

In contrast to the two cases of market failure discussed thus far, both of which resulted from defective price signals in current markets, the intertemporal allocation issue involves failure of markets to allocate efficiently over a relatively long time horizon. The problem arises because the relative preferences of future generations for various natural resources are unknown. Economic decisions must thus reflect conditions in the present or near-future periods, where costs and benefits can be weighed more easily. And, even if future conditions could be projected with some degree of accuracy, the future costs and benefits would be "discounted" to the present period in recognition of the time-value of money. The result is a market bias toward present production and consumption, which raises the possibility that our inability to account for distant future conditions adequately will lead to over-use or depletion of a resource in the present or near-future periods. The long-term sustainability of an economic activity using a natural resource may thus be jeopardized by our inability to know the relative values of resources at some future date.

Unfortunately, there is no perfect solution to the intertemporal problem. Predicting the future accurately will always be difficult, and a present generation may well put its own interests ahead of the interests of future generations. Still, there are principles that can be used to reduce the possibility of premature depletion. One of these entails removal of any artificial barriers to the natural price increases that would appropriately signal the increasing scarcity of a resource (as owners begin to hold back quantities from the market in expectation of higher future prices). Another involves the conscious "holding back" by government of some stock of the resource from current or near-future consumption (often referred to as the "safe minimum standard" approach). This can be accomplished through severance taxes and other such tools.

While government can promote sustainable use of resources by pursuing the policies discussed above, this should not be interpreted to mean that a given economic activity will (or should) continue forever. Future changes in technology, relative preferences, and many other factors will alter relative demand for all resources, rendering some previously thought to be abundant suddenly scarce and others thought to be in short supply more plentiful. However, by correcting for cases of market failure with appropriate policies, governments can help to insure that individual economic incentive corresponds with rational resource management.

Despite the importance of maintaining an economic basis in discussions of sustainability, the concept will continue to be inherently political, ethical, and philosophical. Therefore, a serious lack of consensus will persist on the meaning of sustainability, especially concerning what combination of resources or practices should be sustained. In the Pacific Northwest spotted owl controversy for example, both sides advocate sustainability; with one calling for sustainable biological ecosystems, and the other pointing to the importance of sustaining the cultural and economic systems in logging communities. Gale and Cordray (1994) have tried to sharpen the focus on the

concept of sustainability by using four defining questions to present nine types of resource sustainability.

Nearly all debates over natural resources call for sustaining some resource or activity, and often there is an interest in sustaining a number of resources and activities. However, efforts to sustain one part of the ecosystem may hinder efforts at sustaining another part. Sustainability is a multifaceted concept and many different ecosystem components may be valued by society or parts of society. By answering the following four questions:

1. What is sustained?,
2. Why sustain it?,
3. How is sustainability measured?, and
4. What are the politics?,

it becomes possible to distinguish between different perspectives on sustainability (Gale and Cordray 1994).

"What is sustained?" identifies the primary focus or outcome of each sustainability type. "Why sustain it?" reflects the value (e.g., economic, biological, aesthetic, cultural, historic) of the practice or product. "How is sustainability measured?" provides some indication for determining when the item in question moves from sustainable to unsustainable. "What are the politics?" identifies key issues and constituencies involved. Based on answers to the four questions, Gale and Cordray (1994) have recently defined nine different types of sustainability. The following list provides examples of what activity or resource might be sustained in the Lake Champlain Basin for each of the nine sustainability types:

1. Dominant Product Sustainability

Milk products in the Vermont portion of the Basin, paper products in the New York portion, and tourism throughout the Basin are examples of dominant products. Dominance in these instances also relates to the relatively large number of people employed in the three sectors within the Basin, another important aspect of "Why sustain it?".

2. Dependent Social Systems Sustainability

Family farms, small timber producers, maple syrup producers, and -- to a much more limited extent -- commercial fishing, represent a few of the resource dependent social systems in the Lake Champlain Basin. The measurement is on the persistence and viability of the targeted social systems, making this the most explicitly homocentric sustainability type. Resource management recognizing this sustainability type implies a deliberate decision about which social systems should be sustained.

3. Human Benefit Sustainability

This type of sustainability emphasizes broad-based benefits to the larger society, probably best reflected by efforts to maintain and improve recreational use of Lake Champlain. The overall protection of Lake Champlain water quality as a major drinking water source is another example. Human benefit sustainability is often valued on both economic and non-economic criteria, as is common in studies of recreational benefits. Resource management focusing on this type of sustainability often favors the full hierarchy of human needs, over that which meets a narrower range; however, both economic and ecological inefficiency result when ecosystems are managed for a range of uses rather than for specialized products or uses (Gale and Cordray 1994). In addition, conflicting use remains an issue when one type of human benefit preempts or limits another.

4. Global Niche Preservation

The proposal to create a Lake Champlain Biosphere Reserve represents this type of sustainability, reasoning that the Basin area is integral to a larger goal of sustaining the entire earth.

5. Global Product Sustainability

The wollastonite mine and production facility in Essex County, New York provides a classic example of global product sustainability within the Lake Champlain Basin. The Essex County deposits are reportedly among the highest quality of known reserves in the world, and account for 45% of the total world production (Holmes & Associates 1993). Sustainability considerations for this type of resource emphasize the flow of unique or increasingly valuable natural resource commodities produced by local ecosystems for the international market. Measurement focuses on the long-term availability and price of resources in demand internationally.

6. Ecosystem Identity Sustainability

This type of sustainability would recognize specific, unique areas in the Lake Champlain Basin. For example, specific islands in the Lake are currently protected for their unique bird habitat.

7. Self-Sufficient Ecosystem Sustainability

Examples include ecosystems that are set aside because of uncertainty of how ecosystems sustain themselves, perhaps including areas of the Lake that seem deserving of further study in the absence of human impacts.

8. Ecosystem Insurance Sustainability

The emphasis here is on preserving a resource, product, or ecosystem that appears to be threatened or endangered. Key features are maintaining diversity and avoiding resource collapse or extinction. Measures to protect the Lake sturgeon reflect this type of sustainability.

9. Ecosystem Benefit Sustainability

This type of sustainability focuses most strongly on nature, and is reflected in wilderness preservation around the Basin. The measure of its sustainability is the extent to which ecosystems approximate what conditions would be if unhindered by humans. The reason for sustaining it is the respect by humans for the rights inherent in natural ecosystems.

There are obviously many other Lake Champlain-based examples for each of the sustainability types. The purpose of the preliminary examples listed is to further define and elaborate on the nine types of sustainability, and to show that they indeed reflect current activities and issues around the Basin.

In general, it appears that the use of sustainability in Lake Champlain Basin resource issues to date has focused primarily on four types of sustainability: dominant product, dependent social systems, human benefit, and ecosystem identity; although there are examples in the Basin for each of the nine types, as listed above. The Lake Champlain Management Conference, in their Vision Statement, has explicitly recognized two of these sustainability types: dominant product (i.e., "...the preservation of agriculture") and human benefit (i.e., "...supports multiple use") (Lake Champlain Basin Program 1994). In addition to these two, the other two currently dominant types of sustainability: dependent social systems and ecosystem identity, seem to be the ones most often reflected in reports and press articles about management of the Lake and Basin area. For example, a study of sustainable economic development in the Adirondack Park stresses the im-

portance of sustaining "the Adirondacker way of life" (Middlebury College Program in Environmental Studies 1992). The "ecosystem identity" sustainability type is reflected in a recent article entitled "Sustainable Watershed Management" discussing how the Boquet River Association (BRASS) focuses their efforts on a discreet ecosystem, and work towards the protection of both water quality and quality of life for watershed residents (Ulmer 1994).

10. Action Plans Not Analyzed in this Research

Because of the focus in this research, there are Plans for Action that continue to lack a detailed economic analysis of their costs and benefits. A brief overview of the economics of these Plans is provided below.

10.1 Preventing Pollution from Toxic Substances

An environment free of significant health hazards is considered a basic human right, in a way that enjoyment of certain kinds of recreational or aesthetic pleasures is not. Therefore the appropriate test for public action to reduce significant threats to public health posed by toxic pollutants may not be whether aggregate benefits exceed aggregate costs. Every effort must be made to develop the most cost-effective means of achieving certain objectives with regard to toxic pollutants but establishing those objectives will require a careful balancing of potentially conflicting rights and values. Research results to date do not indicate that toxic pollutants pose an immediate and significant threat to public health in the Champlain Basin. While a healthy environment may be considered a basic right, attempting to completely eliminate all toxic pollutants would likely cause severe economic dislocation. Consequently, even if a straightforward benefit-cost test is not adopted for establishing targets for toxic pollutants, some criteria for weighing benefits and costs will need to be developed.

Any toxic reduction program can be analyzed as an investment in a healthier environment. Depending on the nature of the program, the costs could involve installation of new pollution control technologies, administration and enforcement of new regulations, removal of contaminated sediment, and implementation of public education programs. The benefits might include reduced human health risks, increased enjoyment from recreational fishing, and improvements in ecosystem health and stability. Unfortunately, significant uncertainties still exist in almost every natural and human consideration that could affect the potential costs and benefits of a toxic reduction and control program for the Lake Champlain Basin. Significant, controllable sources of new toxic contaminants to the lake have not been identified. In addition, the costs and benefits of removing sediments with elevated levels of toxic contaminants have not been quantified. Moreover, the effects that current levels of toxic contaminants have on long term ecosystem health are also not well understood.

Given our state of ignorance about the costs and benefits of controlling and remediating toxic pollutants, application of decision techniques for analyzing investment opportunities under uncer-

tainty would lead to a strategy that emphasized additional research, data collection, and low cost control measures, combined with periodic reevaluation of more extensive toxic reduction and remediation investments as new information becomes available. To undertake an aggressive toxic pollution control program at the present time could involve significant costs and possibly yield very little in the way of public health or ecosystem benefits. Conversely, a strategy of no action would modestly reduce short term costs but at the risk of delaying future benefits and/or failing to prevent future costs from continued toxic contamination. A middle road of continued research together with prompt action on low cost prevention measures seems most appropriate.

As further research results become available, empirical data will need to be combined with expert judgment in order to make decisions about which toxic control measures to undertake and when. One benefit of using decision analysis to aide in these decisions is that decision analysis provides a logically consistent method of incorporating both hard data and subjective assessments. To the degree that probabilities can be associated with the possible costs and benefits of particular toxic pollution control or remediation measures, it is possible to use decision analysis to determine the expected net benefits of obtaining additional information prior to taking a particular action.

Most of the action items outlined in the Plan involve further research and monitoring efforts. Given current uncertainties, new information generated from these initiatives is likely to have positive net benefits by permitting the development of efficient standards for toxic pollutants and the design of a cost effective long term control strategy. The draft Action Plan should therefore be understood as an iterative process involving further research, analysis, and where appropriate, implementation of control strategies followed by redesign of research and monitoring efforts.

10.2 Protecting Human Health

The principal public health risks posed by water pollution in the Champlain Basin involve drinking or swimming in water that has been contaminated by pathogens and consuming fish that have accumulated high levels of toxic substances in their tissue. These risks have been minimized by monitoring water quality at municipal beaches and closing them when necessary, monitoring and treating public water supplies drawn from the Lake, and issuing fish consumption advisories for certain species of fish. Unfortunately, not all swimming areas are tested for pathogens, not all users of Lake water are connected to public water supplies and some persons may be unaware of or ignore warnings regarding consumption of certain fish. These simple observations create two sets of economic considerations.

First, beach closings and fish consumption advisories significantly reduce the recreational benefits that the Lake provides. They also impose psychological costs by providing the impression of environmental degradation in the Lake Champlain Basin. In addition, residents of the Basin bear the cost of water quality monitoring and treatment. While these are not costs imposed by public health problems, these costs are incurred to protect public health and as such should be considered in relation to the costs and benefits of other public health protection strategies such as pollution prevention and treatment at the source.

The second set of issues involves the individual and societal costs of using untreated Lake water, swimming in areas that could be contaminated with pathogens, or consuming fish that are likely to contain high levels of mercury or PCB's. Although there is no evidence of widespread problems, these actions can result in direct costs to the individuals involved and to society in the form of

medical expenses, lost wages, and lower productivity, as well as pain and suffering. Various strategies can be developed to reduce these costs including expanded monitoring and public information activities to pollution prevention and control programs.

The measures outlined in the Action Plan focus on monitoring, treatment, and education as the means to safeguard public health. It is important to recognize that while closing a contaminated swimming area or issuing warnings about toxic levels in certain fish can be effective means of preventing public health problems, these measures have economic costs in the form of fewer recreation days at the Lake, reduced tourist business income, and other income losses do negative publicity (see related discussions in report section 6.5 and near the end of 7.0).

10.3 Protecting Wetlands

The many function and services of wetlands are enjoyed by a broad spectrum of Basin residents and visitors, including anglers, hunters, campers, birdwatchers, and riparian landowners, as well as all those who draw their drinking water from the Lake. In economic terms, wetlands are said to provide positive externalities, i.e. benefits that are enjoyed by others beside the property owner. However, the costs of wetlands protection will largely be borne by a relatively small group of landowners if traditional land use regulation is the principal tool used to achieve a no net loss objective. Publicly funded programs to acquire priority wetlands, mitigation banking arrangements, and restoration programs all help to create a more equal distribution of costs and benefits.

Other non-regulatory approaches can also be used to distribute costs more evenly and achieve a no net loss policy in a more economically efficient manner. For example, owners of sensitive wetlands could be given partial ownership rights to some of the services these wetlands provide. To the degree that wetlands are a sink for phosphorus, developers could be given some credit on the phosphorus loading from new developments by purchasing the development rights of existing wetlands or restoring drained ones. Special tax treatment of private wetlands could also be justified on the basis of the significant public benefits that these lands provide.

Unfortunately, very little work has been done within the Basin to quantify wetland benefits in monetary terms. To the degree that no net loss policies are adhered to by federal, state and provincial governments, an analysis of the marginal benefits relative to the marginal costs of protection becomes irrelevant for determining the amount of wetlands that will be protected. However, more accurate quantification of the many benefits provided by wetlands would help public officials and private conservation organizations to prioritize their protection efforts and develop more flexible and economically efficient regulatory and non-regulatory management strategies.

10.4 Managing Non-Native Nuisance Aquatic Plants and Animals

The costs imposed by non-native nuisance aquatic species are readily apparent to a wide range of users of the Lake. Recreational boaters and swimmers must contend with invasions of eurasian millfoil and water chestnut, and the recreational and commercial benefits enjoyed by anglers

are reduced by the depredation of Lake Champlain fisheries by the sea lamprey. In the future, boaters, swimmers, and public water system users may soon be faced with the problems of zebra mussel colonies fouling beaches, boat engines, and intake pipes. Less readily apparent and more difficult to quantify are the costs of the secondary ecological impacts of non-native species. Each non-native species alters the ecology of the Lake Champlain ecosystem. Although the long term effects of these changes are difficult to predict, the cumulative effect of non-native species invasions may be a Lake ecosystem that yields less recreational and aesthetic enjoyment to residents and tourists, and significantly less hospitable habitat to rare, endangered, or otherwise valued native species.

In many cases it should be possible to conduct benefit-cost analyses of various control measures, at least in relation to direct benefits and costs. A partial benefit cost analysis was conducted prior to initiating the sea lamprey control program. Benefits were projected to be 65,000 additional fishing trips per year, with average fishing trip expenditures estimated at \$37. Direct costs of the lampricide program were expected to be approximately \$800,000 per year. In order to determine whether the program has in fact resulted in net benefits, it will be necessary to separate changes in the salmonid fishery due to the lampricide program from effects of other factors. It will also be essential to estimate the net value of additional fishing trips to anglers, with the value of each additional trip taking into account its recreational benefit to the angler less the cost of the trip. (See section 7.0 of the full report for additional discussion of fishing activity on Lake Champlain).

Similar analyses can and should be conducted for other non-native species control programs. The accuracy of such analyses will of course be dependent on information regarding the effectiveness of the proposed control measure(s). Consequently, control programs should be implemented on an experimental basis with ongoing evaluation of success in both biological and economic terms.

While the benefits of controlling non-native nuisance species will be relatively widespread, they will not necessarily be uniformly enjoyed by residents of the Basin. Recreational users of the Lake will likely benefit the most along with Lake and tourist related businesses. Distribution of the costs of controlling non-native species will be dependent on the funding mechanism. Some federal and state funding can be justified in light of the benefits that these investments will provide to tourists from outside the Basin. In addition, financing options that generate at least partial funding for control of nuisance aquatic species from groups most likely to benefit would also be justified. These targeted funding options might include surcharges on fishing and boating licenses and water system rates.

10.5 Protecting Cultural Heritage Resources

An essential goal of sustainable development is to improve the local quality of life in both economic and non-economic terms. The protection of cultural heritage corresponds directly with this goal, in that it has numerous monetary and non-monetary benefits. The major historic sites in the Basin generate millions of dollars annually in the Basin economy. Those sites are listed among the major employers in the areas where they are located. In addition, numerous small homesteads and museums scattered throughout the Basin help stimulate small, local economies by providing an enjoyable activity to both visitors and residents. Additional evidence of the economic value of cultural heritage sites is the significant effort being invested in developing new museums and interpretive efforts around the Basin. Community leaders are recognizing that

historic districts, interpretive walking tours, museums, and many other approaches for displaying an area's history and culture have a direct economic impact on their communities.

The protection of cultural heritage resources is economically linked directly and indirectly to the pollution prevention and restoration efforts proposed in the Plan. Lake Champlain and its shoreland area was the major focus of the historical activity in the Basin, strongly influencing early settlement patterns, transportation, commerce, military activities, agriculture, and industry. Yet, as is repeatedly the case, communities have "turned their backs" to the water resources that gave them their existence. Many communities started out facing out over the Lake, because the Lake was their transportation link and the source of their commerce. Common are lakeshore areas where the backs of buildings face the Lake and where visitors are discouraged from walking and exploring. As specific areas are targeted for clean-up, and as others benefit indirectly from a cleaner Lake, lakeshore communities will begin to see economic opportunities in once again looking out over Lake Champlain, capitalizing on what the Lake and shoreline have to offer, both as recreation and transportation resources, and as a cultural and historic resources. The City of Burlington's considerable investment and effort to improve its waterfront, including protection of historic buildings, is a case in point and represents the economic link between the Lake, cultural heritage, and local economies.

As discussed throughout this section of the Plan, cultural heritage resources have what could be considered non-monetary benefits to a community and a region. These resources serve to link people to each other, and to their community, by providing continuity to human activities in the area. This sense of community, and sense of place, are main ingredients for enjoyable communities and satisfying lives. The educational value of these resources is also difficult to quantify monetarily, even though the enjoyment and learning offered by the cultural and historic sites to thousands of school children is obvious and significant.

However, these types of "quality of life" benefits are not all exclusively non-monetary. The residents of the Basin area, some residing there for many generations, others for only a few years, are actively supporting cultural heritage sites with their donations, memberships, and entrance fees. In addition, local residents often comprise the majority of off-season users, sometimes allowing a site to extend its period of operation and provide additional employment in the area.

The costs of protecting, maintaining, and operating cultural heritage sites are addressed in many of the individual action items. The costs associated with these activities seldom fall entirely within the public sector, rather the efforts are partnerships between the public and private sectors, with foundation grants and private donations traditionally providing a significant portion of the necessary funds. Significantly, user fees (i.e., cost of admission) are more common and accepted with visits to cultural heritage sites, than perhaps with any other type of recreational activity. People expect to pay a few dollars to visit a museum, historic site, or interpretive center, and will often make a donation and buy a gift or souvenir to help support the site. This type of expectation and expenditure is not often associated with a visit to the beach, launching a boat, or taking a hike on a trail. Cultural heritage sites pay their own way to greater extent than other recreation areas, and will continue to do so.

The costs associated with not protecting and maintaining cultural heritage resources should be factored in to the economic considerations. Ships from the Revolutionary War period will never again sail, or sink, in Lake Champlain; we will not see any new 200 year-old homestead of a writer or statesman for another 200 years; nor will traditional logging or mining equipment again be manufactured. These are only a few of the valuable, some would say priceless, economic resources embodied by the phrase "cultural heritage resources." The costs of protecting the re-

sources is to some degree an investment, and should be considered in light of the cost of replacement.

11. Recommendations for Further Research

The cost effectiveness of five of the Plans for Action: Toxics, Human Health, Wetlands, Nuisance Aquatics, and Cultural Heritage Resources, need to be examined in more detail. In addition, as the economic costs and benefits of the various Actions continue to be refined, the analyses presented in this report need to be revisited and up-dated with new information on the economic relationships within the Lake Champlain Basin. The economic analysis models created during this work should assist significantly in that regard.

In terms of the remaining economic analyses, the comments of Robert Genter, Executive Director of the Lake Champlain Research Consortium (personal communication) are worth noting.

An economic analysis of the Toxics Action Plan would be beneficial for some locations in the Lake. As an example, the 'hot spot' of PCBs off Wilcox Dock in Plattsburgh in Cumberland Bay NY is a great concern. An economic analysis should be performed to determine cleanup costs and weigh these against the ultimate benefits of not having fish advisories.

An economic analysis of the Action Plan to Manage Non-Native, Nuisance Aquatic Plants and Animals would be beneficial for a number of areas in the Lake. Nuisance aquatic plants are a deterrent to recreational boaters and swimmers, nuisance aquatic animals like the zebra mussel threaten public and private water systems, and nuisance aquatic animals in addition to the sea lamprey threaten the indigenous species of the Lake.

Similarly, more detailed economic analysis of the remaining Action Plans will lead to a more informed decision making process.

The remain recommendations for further research are organized by the full report chapter headings.

Economic Costs and Benefits of Reducing Nutrients and Nonpoint Source Pollution

- 1. Update nonpoint source phosphorus loading estimates using new land use data.** Refine agricultural loading estimates to account for animal units as well as cropland by Lake segment watershed. Also develop estimates of the phosphorus loading effects of conversion of agricultural and phosphorus land to other uses.
- 2. Refine estimates of the costs and effectiveness of nonpoint source phosphorus control measures.** Data is particularly lacking for urban BMPs and their applicability to urban and suburban areas in the Lake Champlain Basin.

3. **Conduct detailed benefit estimates for water quality improvements in the Lake Champlain Basin.** These estimates should be based on a combination of travel cost, contingent valuation, hedonic pricing and other estimation techniques and should be developed from user and household surveys and other original data for the Lake Champlain Basin.

Economic Benefits of Improved Recreational Opportunities

1. **Conduct detailed benefit estimates for water quality improvements in the Lake Champlain Basin.** These estimates should be based on a combination of travel cost, contingent valuation, hedonic pricing and other estimation techniques and should be developed from user and household surveys and other original data for the Lake Champlain Basin.
2. **Perform detailed, systematic survey research of Lake Champlain anglers that will allow a scientific analysis of the link between Lake Champlain fishing sites, catch rates, water quality parameters, and economic expenditures.** Random utility models, as applied in North Carolina's Pamlico Sound (Kaoru et al. 1995), offer a promising economic framework for integrating these variables in an estimate of how households would value the improvements in water quality associated with the Lake Champlain draft Plan.
3. **Analyze the EPA's Aquatic Based Recreation Survey data for New York and Vermont in relation to site-specific water quality data now available on Lake Champlain.**

Benefits Associated with Watershed Planning and Educating and Involving the Public

1. **The tangible economic benefits of local watershed organizations such as BRASS, in addition to their capacity for encouraging local participation in protecting and improving water quality in the Basin, justify support and encouragement of their work throughout the Lake Champlain planning and implementation effort.**

Incorporating Sustainability Concepts into the Plan

1. **A practical approach for incorporating sustainable concepts into the Lake Champlain Action Plan is to require that each "Opportunity for Action" include a sustainability assessment, as well as an economic assessment.** The four defining questions and the sustainability types described above provide a clear, comparative basis for the sustainability discussions, while relying on the experts involved in each Action Plan as the most qualified to evaluate the sustainability of a given action. Each Technical Advisory Committee (TAC) subcommittee could enhance the process by preparing both sustainability and economic summary statements for the major issues under consideration by their committee. As is apparent from the discussion of sustainability above, sustainability is complex issue involving numerous disciplines. By addressing sustainability issues within existing subcommittees, the LCMC avoids issues of representation that would arise around a dedicated "sustainability" subcommittee.

2. An accurate assessment of sustainability requires a synthesis of data from ecologic, environmental, and socio-economic research, therefore the LCMC must continue to fund research and analysis dedicated to integrating and synthesizing Lake Champlain research findings.
3. Certain sustainability types do not seem to be receiving as much attention and emphasis as others in the Lake Champlain Basin work to date (e.g., global niche preservation, global product, ecosystem insurance), therefore there may be sustainability issues that should be addressed before they become crisis issues, or embroiled in controversy. The work of the LCMC might benefit from taking a look at activities, resources, or ecosystems that should be sustained, however, that are not currently being considered in the draft Action Plan.
4. There may be human activities that in the recent past were determined to be unsustainable because of resource scarcity, but which are now sustainable in some form. Resource management decisions that have directly influenced cultural or lifestyle activities, resulting in adverse influence on communities, families, and occupations, should be continually monitored and reconsidered in light of new information, data, and especially in terms of ecosystem response to the restriction of human activity. Commercial fishing on the Lake is one example of a part-time occupation linked to the Lake that reflects the "dependent social system" sustainability type. Such activities serve to define a region's culture and way of life, and provide continuity of cultural -- and environmental -- knowledge between generations.

Plans for Action Cost Estimates

1. Each sub-committee responsible for an Action Plan should work to estimate costs for all Action Items, and to further refine costs by cost category, as outlined in the draft Plan costs spreadsheets. The numerous "to be determined" costs make it difficult to develop realistic benefit and costs estimates. It is also difficult to determine over-laps and duplication in activities without a better understanding of the intended use of financing. For example education and outreach is an implied expenditure under many items, however, is seldom identified financially. Similarly, administrative costs are undoubtedly included in many costs estimates, but are not quantified. The cost overview presented in the tables is one approach to standardizing cost categories, time-frames, fund sources, etc. The overview is available as Microsoft EXCEL 5.0 spreadsheets.
2. Because there are currently duplicate programs and overlapping projects within different Plans for Action, the total costs within the *Opportunities for Action* are higher than necessary. In the process of refining costs, Action Plan working groups need to coordinate with each other to reduce duplication of effort and cost.
3. The Lake Champlain Basin Program should have an professional economist or accountant regularly review and assess the economic aspects of the Program.

12. Conclusion

Environmental issues such as the Lake Champlain planning effort are essentially human issues, encumbered with all their political, economic, social, and cultural ramifications. Now that Lake Champlain physical science research findings have been developed into policy recommendations, the next step is for the policy recommendations to be translated into their implications for communities throughout the Basin. Economics essentially has become the "language" for making that translation, and this research has been relatively successful in engendering a cooperative effort among the social and physical sciences in illuminating the economics of phosphorus control in the Lake Champlain Basin. That type of cooperation is crucial to completing the economic analysis of the draft Plan, and to developing a sustainable Lake Champlain protection and restoration effort.

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Glossary

Benefit (Recreation) - A proxy for the economic value of all the psychological satisfactions from outdoor recreation activities. This is identical to a widely accepted meaning of the economic term "utility" (Walsh 1986:44-45).

Benefits Transfer - The use of information from existing nonmarket valuation studies to develop value estimates for another valuation problem. It can reduce both the calendar time and resources needed to develop original estimates of values for environmental commodities (USEPA Policy, Planning, and Evaluation 1993:3).

Benefit Valuation (Economic) - Measuring in dollars how much the people affected by some policy will gain from it. They are not forecasts, and they usually do not attempt to predict other exogenous influences on people's behavior. Instead, a predefined set of conditions is assumed to characterize the nonpolicy variables. Then benefit estimates are derived by focusing on the effects of the conditions assumed to be changed by the policy (USEPA Policy, Planning, and Evaluation 1993).

Bequest Values - Bequest values are based on the satisfaction that individuals derive from knowing their children, or future generations in general, will be able to enjoy a clean(er) environment.

Cost/Benefit Analysis - Ratio of dollar cost of project to dollar benefit it will produce, used to compare worthiness of various proposed projects.

Comprehensive Income - An economic measure of the total benefits from all life's activities, including recreation. It is the sum of how much consumers would be willing to pay for each of life's activities rather than forego them. There are four components of comprehensive income: (1) the market value of goods and services that consumers purchase with dollars from regular income or savings; (2) the willingness to pay for self-sufficiency goods and services that consumers produce for themselves; (3) the opportunity cost of leisure time that consumers commit to the activities; and (4) the consumer and producer surplus to individuals, representing the net benefits of all life's activities over and above consumer costs in dollars, effort, and time (Walsh 1986:57).

Contingent Valuation Approach - As a method of providing acceptable economic measures of the benefits of recreation activities and resources, this method relies on the stated intentions of a cross-section of the affected population to pay for recreation activities or resources contingent on hypothetical changes in their availability depicted in color photos or maps (Walsh 1986:195).

Culture - A system of socially acquired and transmitted standards of judgment, belief, and conduct, as well as the social and material products of the resulting conventional.

Demand - (marginal benefit) The quantity of any particular commodity that will be purchased on a market or groups of markets at a given price or series of prices.

Diminishing Marginal Utility - As the amount consumed of a good increases, the extra utility added by one extra last unit (or marginal utility) tends to decrease.

Existence Values - Existence value is any additional satisfaction, apart from direct use, option, or bequest values, that individuals receive simply from knowing that an important ecosystem has been protected.

Externalities (External Costs) - Costs of production that fall on others and for which the producer bears no financial responsibility; uncompensated adverse effects.

Hedonic Pricing - Hedonic price analysis utilizes a statistical technique known as multiple regression to estimate the effects on property values attributable solely to variations in local environmental quality.

Household Production - Household production refers to the fact that consumers provide inputs of time and effort as well as dollars. Economists suggest that there is an implicit market within each household. Recreation activity is produced by households (i.e., consumers), with purchased goods and services, as well as their own self-sufficiency, leisure time, and other inputs that are publicly provided such as park facilities and a natural environment (Walsh 1986:57).

Hypothetical Behavior Valuation Methods - The contingent valuation approach is the primary "hypothetical" behavior method for assigning nonmarket values.

Intertemporal (or Intergenerational) Transfer - Involves recognizing and accounting for future needs and conditions; not putting the interests of the present generation ahead of the interests of future generations.

Leisure Time - Discretionary time to be used as one chooses.

mg/L or mg/l - Milligrams per liter. .01 mg/l = 10 µg/l.

Nonmarket Good Valuation - Assessing the value of a good or service which is not traded in the market place and has no market value. Because it is not bought and sold some other measure than price must be used in establishing the value.

Observed Behavior Valuation Methods - Travel cost and hedonic pricing are examples of "observed" behavior methods for assigning nonmarket values.

Opportunity Costs - The return to the best alternative use by employing a unit of resource in a given manner.

Option Value - Option value is simply the value to the individual of preserving the opportunity to use a clean environment and is therefore closely related to -- but nevertheless conceptually distinct from -- direct use benefits. The annual payment of a kind of insurance premium to guarantee the possibility of future recreation use (in addition to the expected benefits of direct and indirect use)(Walsh 1986:85).

Recreation - Leisure time activity such as swimming, picnicking, boating, hunting, etc.; use of leisure time for personal satisfaction and enjoyment, a basic human need; an exceedingly variable term meaning almost anything people do with their leisure time.

A distinguishing characteristic of recreation is that individuals are producers as well as consumers of recreation activity. The individual consumer produces recreation days with a desired set of characteristics by combining: (1) his/her own inputs of knowledge, skill, and effort with non-market work time; (2) purchased goods and services produced by others; and (3) other inputs that are publicly provided such as a state park or reservoir (Walsh 1986:30).

Recreation Benefit Valuation - Total benefits are defined as the maximum amount that individuals would be willing to pay for a recreation activity -- a nonmarket good -- rather than forego it. Net benefits are total benefits less direct costs. As such, net benefits to consumers are analogous to net profits to business firms. In both cases, the value of the activity is determined by what is left over after all costs are met. Yet, some confusion results from the fact that the net benefits to consumers are not paid to anyone and thus do not appear in national accounts (Walsh 1986:59).

Recreation Day - A visit by one individual to a recreation area for recreation purposes during any reasonable portion or all of a 24-hour period of time. One person participating in an activity for any part of one calendar day (Walsh 1986:68).

Recreation Visitor Day (or User Day) - 12 person hours, which may be one person for 12 hours, 12 persons for one hour each, or any equivalent combination of individual or group use, either continuous or intermittently (Walsh 1986:68-69).

Secondary Analysis - Data collected and processed by one researcher are reanalyzed, often for a different purpose.

TP - Total phosphorus. In lake total phosphorus concentrations for Lake Champlain vary from 15 µg/l for the Main Lake, to 52 µg/l for the South Lake.

Travel Cost Method - When determining the opportunity cost of work or leisure activities that are foregone for travel to and recreation at the site, this approach supports that both travel and on-site time costs can be added to direct travel costs to determine the willingness to pay (Walsh 1986:94).

Trophic State Index (TPI) - Indicates a measure of the extent or condition of eutrophication in a body of water.

µg/L or µg/l - Micrograms per liter. 10 µg/l = .01 mg/l.

Utility - The ability of a good to satisfy human wants.

Willingness to Pay - A dollar measure of benefits, meaning how much individuals enjoy recreation activities. Usually valued over and above expenditures actually made while participating in the activity. The psychological content of benefits includes all of the feelings of pleasure which lead participants to exclaim "what a good time they had" or "what a good buy" or possibly "it wasn't worth it." The latter possibility reflects the fact that recreation economic decisions are made before the fact and that actual benefits may not come up to expectations. Federal guidelines recommend willingness to pay as the appropriate economic measure of the benefits of recreation (Walsh 1986:45). (see also: Comprehensive Income, Household Production, Recreation Benefit Valuation)

List of Abbreviations

BMP	Best Management Practices
EPA	U.S. Environmental Protection Agency
LCBP	Lake Champlain Basin Program
LCMC	Lake Champlain Management Conference
NRCS	Natural Resources Conservation Service
NYSDEC	New York State Department of Environmental Conservation
PCB	Polychlorinated Biphenyl
TAC	Technical Advisory Committee