

PROGRAM OF THE RENSSELAER  
FRESH WATER INSTITUTE AT LAKE GEORGE

by

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## Program of the Rensselaer Fresh Water Institute at Lake George

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Water despoliation is not a unique ecological malady; this pattern is evident today in connection with virtually all of man's resources. However, the availability of potable freshwater has progressed from a stage of abundance to one of critical insufficiency. Man has caused this situation to accelerate through his unchecked introduction of excessive quantities of wastes into routes, resulting in a national water supply which is increasingly overfertilized and polluted. This process is demonstrated by the numerous water resources currently useless for economical, industrial, or recreational purposes. The contrast of a growing population with a fixed amount of these natural resources dictates that a thorough understanding of the processes responsible for or related to resource degradation is necessary to preserve these assets for widespread use by society.

Early in this century environmentalists, conservationists, and some dedicated citizens were primarily concerned with preserving wildlife and selected natural areas. By the 1950's, Federal air and water pollution laws were enacted which prompted the rate of environmental legislation to increase during the 1960's. This legislation has currently broadened itself to include the total environment, and emphasizes ecology, population,

pollution, urban settings, and man. Today, citizens are anxious to learn about the alternative measures available or being formulated to rectify the conditions existing in the environment. There is increasing awareness that the abatement of pollution will decrease the danger of disease; produce better potable water; attract new and environmentally responsible industries to communities; increase property values; provide more recreation in the form of fishing, boating, hunting and swimming; and enhance supplies of known and potential food products. The interdependencies occurring within the environment affect everything—including man.

Rensselaer Polytechnic Institute has kept pace with the rapid rates of change that occur within this complex world. Due to these changes, a newly defined role has evolved for technology, and its application in solving environmental problems without discouraging basic scientific investigations. One example of this at RPI was the establishment of the Rensselaer Fresh Water Institute at Lake George (FWI) in 1967. Lake George, located in the southeastern portion of New York's Adirondack State Park, lies within the basin boundaries of latitude 43°22' and 43°51' North and longitudes 73°24' and 73°47' West. The lake is a mesotrophic/oligotrophic softwater lake with a drainage basin covering 606 sq. km. (234 sq. mi.), 114 sq. km. (44 sq. mi.) or 19% of which is occupied by the lake itself. Lake George is divided into a southern and northern basin separated, in essence, by the Narrows at the lake's mid-point. The FWI is situated at Smith Bay on the northeastern shore of Lake George.

### **Objectives of the Freshwater Institute.**

The basic purpose of the FWI is the in-depth study of biological, chemical, physical, and social interactions in and around freshwaters via a multidisciplinary program. The data generated by these field and laboratory studies are stored, analyzed, and mathematically modeled. Computer technology is used to assist the researchers in the analysis and assessment of their data and also affords them the opportunity to evaluate future environmental conditions which would result from increased human activities in the environment. This approach provides methodologies for preventing subsequent environmental degradation and allows for its maintenance at a predetermined level of quality. The FWI has as one of its objectives the realization of research endeavors adequately describing environmental systems in order that they can be more intelligently managed for the benefit of mankind. In addition, this program is directed at further catalyzing the development of a research team with expertise to analyze freshwater problems, at providing the training of new personnel who will have the advantage of multidisciplinary exposure, and at fostering the development of new ecological theory to aid in abating the degradation of the quality of freshwater resources. Lastly, the FWI facilities afford a site attractive to the scientific community as a place where permanent and visiting researchers can work together with their peers in an atmosphere conducive to the exchange of ideas. The studies already completed at Lake George provide a firm foundation upon which to build. Additional manpower and major resources will be committed to insure the FWI's continued and accelerated contribution to solving the problems of freshwater pollution.

**Program Development.** Since its inception, the Institute has experienced growth in several areas of research and physical development. The research program now encompasses many avenues of environmental investigation, some of which are listed below.

### **PROJECTS AT FWI**

#### **Basic Ecological Studies**

- Diatoms as Environmental Indicators in Lake George
- Changes in the Diatom Populations of Lake George
- Diatom Changes in Recent Sediments
- Effect of Organic Fractions on Algal Growth
- Activity Estimation of Aquatic Fungal and Bacterial Decomposers
- Presence and Survival of Viruses in Aquatic Environments
- Chlorinated Hydrocarbon Pesticide Residues in Lake George Sediments
- A Study of the Effects of Polychlorinated Biphenyls on CO<sub>2</sub> Fixation Capacity of Freshwater Algae
- Hydrologic Study of Lake George
- Nitrogen Phosphorus Cycles in the Lake George Ecosystem
- Nutrient Kinetics for Algal Productivity in the Lake George Ecosystem
- Evaluating Analytical Techniques for Determining Mercury in Chemical Effluents
- Organic Sedimentation in Lake George

#### **Applied Ecological Studies**

- Oil Pollution from Two-Cycle Outboard Engines
- The Effects of Outboard Motor Emissions on a Controlled Aquatic Environment
- The Pollution from Outboard Motorboats at Lake George
- The Interaction of Outboard Motor Oil and Inorganic Sediments
- Ambient Air Sampling at Lake George
- Comparison of Thin Film Evaporation and Freeze-drying Methods of Concentration of Organics in Water
- Physical-Chemical Treatment of Septic Tank Effluent
- Physical-Chemical Treatment of Wastewater from a Resort Community

## Modeling and Environmental Quality

Lake George Ecosystem Modeling

Environmental Quality Perception and Management at Lakes of Different Trophic States

A Model for Population Recreational Quality Interactions of a Fresh Water Site

The FWI research program has expanded from an activity supported by the School of Engineering at Rensselaer to a program-budgeted independent university activity. As an independent activity, the FWI is a research endeavor which is totally responsible for its financial viability; its Director, Dr. Nicholas L. Clesceri, reports to the Provost of the University, enhancing efficiency and flexibility.



Nicholas L. Clesceri

This administrative arrangement provides a strong basis for action-orientation in order that the basic research vitally necessary for the solution of today's pollution problems can be compressed into the shortest possible time-frame. The number of active participants associated with the FWI has increased from ten to more than forty faculty and staff representing several university curricular areas at RPI. These



Interior of FWI Lab

include Environmental Engineering, Biology, Chemistry, Economics, Geology, Operations Research and Statistics, and Systems Engineering. The participants have both living and laboratory facilities available to them at the research site including more than 2,500 sq. ft. of laboratory space. Instrumentation at the site provides analytical capability in atomic absorption spectrophotometry, infrared spectrophotometry, liquid scintillation counting, gas chromatography, carbon analyses, and UV-visible spectrophotometry in addition to other specialized apparatus for conducting necessary field and laboratory analyses.

**The Fresh Water Institute and the International Biological Program.** A significant portion of the FWI research activities has been part of the Eastern Deciduous Forest Biome, an area of ecosystem analysis engaged in investigating biological and chemical relationships at land-water interfaces. These activities are part of the Analysis of Ecosystems program of the United States under the International Biological Program (IBP).

The IBP wishes to increase and broaden man's insight of productivity in nature which implies an understanding of the dynamics and functioning of the ecosystems in which natural processes are integrated. The divisions of the Deciduous Forest Biome program under the IBP—terrestrial, land-water, aquatic, and biome-wide—characterize the complete and diverse approaches being employed for basic ecological investigations within this Biome. One of the five sites selected for these investigations was Lake George; the researchers involved at this site are practically experienced in aquatic research and originate from several academic institutions. The FWI serves, in essence, as the field facility for these IBP activities, and Dr. Clesceri (FWI Director) acts in the capacity of Site Coordinator.

**Ecosystems Analysis at the Fresh Water Institute.** One of the guiding principles of the FWI is that all research should contribute to a comprehensive model of the lake ecosystem. This is being achieved by appli-

cation of the systems analytical approach, which is formalized scientific methodology that follows a logical sequence of mathematical models, each representing a different level of abstraction of the real world.

Conceptual models are graphical representations of an ecosystem; they are developed in close cooperation with the principal investigators and help to determine the scope of the investigation. Functional models are intended to simulate portions of the ecosystem in a realistic manner; the test of the investigator's assumptions is whether or not the computer simulation can accurately predict observed characteristics of the ecosystem, such as heterotrophic microbial turnover rates.

Present investigations at the FWI are directed toward the dynamics of aquatic ecosystem processes in order to foster more realistic modeling at all trophic levels. The development of integrated sets of ecosystem models has, in association with IBP research activities at the FWI, been progressing satisfactorily and is most encouraging. Process-oriented functional simulation models for many biological components of the ecosystem are well advanced; and empirical models are in varying stages of completion. This approach is possible and suitable since Lake George is just beginning to experience the effects of an external impact. It is still possible, therefore, to find examples of "before" and "after" situations within this ecosystem and to observe the progression of cultural eutrophication.

The development of such ecosystem simulation models permits symbolic experimentation of perturbation analysis. In this way one can produce generalized scenarios for given management decisions and, in addition, given an objective function, optimization techniques can be employed to find an optimal solution.

**Potential Impact and Consequences.** It has become quite recognizable that the pollution of our waterways has reached an increasingly acute stage. Degradation of our water routes has many other effects aside from reducing the quality of our water to a

gations regarding marine research. Because of the equipment, experience, and expertise gathered during five years and the substantial personnel commitment involved, it is believed that the FWI is in a unique position to function in a more comprehensive capacity for freshwater systems. If such a status is realized, even more can be done to imple-

level unfit for man's use. It can damage or eliminate desirable aquatic and terrestrial wildlife, foster undesirable plant and animal growth, favor development of human and animal pests, provide a reservoir for transmissible pathogenic organisms, and generate putrid water unusable for any purpose. There still exist, however, many unanswered questions and several unrealized issues regarding the pollution process and the alternatives available to man for arresting and subsequently reversing it.

It is extremely important to note that many of the very fundamental scientific and technical data necessary for complete understanding of water supply and pollution problems have not yet been fully defined. The completed studies and the ongoing research program of the FWI provide the basis for developing alterations, revisions, and progressive improvements in the aforementioned models at any time to accommodate any freshwater system and to obtain useful recommendations for managing these systems.

Evidence continues to accumulate which favors a worthwhile quality of life that necessitates serious consideration of man's impact on the earth's resources. It is to this end that the multidisciplinary activities of the FWI have been directed. The research proceeds and is designed toward understanding our natural systems and applying the results of these efforts in arresting or reversing their despoliation. It is our intent to develop the knowledge and experience at Lake George, a relatively simple system, to a level that will allow the opportunity to address the more complex systems. We firmly believe it very difficult, if not virtually impossible, to understand complex systems unless one is able to cope with simpler ones.

The belief in this approach extends itself to include the education and exposure to today's student. By appreciating the advantages of multidisciplinary team research, they will undoubtedly benefit and improve its performance beyond our present endeavors.

The potential impact which the studies at the FWI will have toward preserving man's freshwater resources parallels those investi-

ment these research endeavors to solve the pollution problems of our nation's fresh waters.

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