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GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY

ANNUAL REPORT FY 1975

Dr. Eugene J. Aubert, Director

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Research Laboratories

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PREFACE

The Great Lakes Environmental Research Laboratory (GLERL) was established on April 24, 1974, to provide a focus for NOAA's environmental research in the Great Lakes region. GLERL was formed by combining the staff of the International Field Year for the Great Lakes (IFYGL) Project Office, Rockville, Maryland, with the Limnology and Computer Divisions, Lake Survey Center, Detroit, Michigan. The Ann Arbor, Michigan, Laboratory was opened in August 1974.

GLERL's mission is to conduct research directed toward an understanding of the environmental processes in the Great Lakes and their watersheds. Emphasis will be placed upon an interdisciplinary systems approach to the solving of problems in resource management and environmental services for that region. In support of this mission, the following central objectives have been established:

- To improve environmental information (e.g., statistical description, prediction, and simulation) concerning properties, processes, and phenomena of the Great Lakes and the Great Lakes watersheds;

- To develop improved environmental service tools, data, information, and consulting services to support the needs of users in government and private organizations; and

- To provide an environmental advisory service, as appropriate.

The scope of GLERL's research includes field, analytic, and laboratory investigations into the limnological, hydrological, meteorological, and limno-geological properties of the Lakes, their basins, and the atmosphere.

It is important periodically to assess the research program from the following points of view: (1) research management - strengthening the research program; (2) coordination - exchanging information with interdependent research agencies and encouraging cooperative activities; and (3) advisory service - informing potential users of available information and capability to support their needs and encouraging potential users to make their needs known.

This report will review the major GLERL research accomplishments of FY 75 and highlight the research plans for FY 76 and beyond.

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SUMMARY AND OVERVIEW

GLERL accomplishments for FY 75 fall into several categories: organizational, scientific, and participatory. The major problem was that of building a new organization, including establishment of the present research program, program development to define GLERL research goals and objectives, recruitment of the authorized staff with the required capabilities, and development of the facilities and administrative support services required by the research program. The staff and management organization are given in Appendix I. Note that Administrative Services and Computer Systems are organized within the Office of the Director and the scientific and engineering staff are organized into four groups: Physical Limnology and Meteorology, Chemistry and Biology, Lake Hydrology, and Environmental Systems Engineering. A total of 72 staff were on board as of June 30, 1975.

The scientific program has evolved from those of the IFYGL Project Office and the Limnology Division of the Lake Survey Center. This program is described most fully in the *GLERL Technical Plan*, a document which defines the FY 75 objectives, approach, and expected products for each of the 10 programs (or projects) described in this report; GLERL scientists participated in the development and critique of that document.

Several of the GLERL facilities (described in Appendix V) were developed during FY 75 to support the research program. The Ann Arbor, Michigan, offices and labs, and the Marine Facility at Monroe, Michigan, were opened and dedicated in late 1974. The Marine Instrumentation, Chemistry, and Biology Labs and the Computer Facility have all been set up since then and are now operational in Ann Arbor.

In order to develop future goals and objectives, GLERL hosted a workshop in October 1974 on priority Great Lakes environmental research initiatives, attended by 60 scientists working directly in Great Lakes research or in a government agency supporting that research. They identified the future Great Lakes environmental research required to provide a satisfactory state-of-the-art in environmental simulation and prediction and thereby to provide the basis for decisions on the future management of Great Lakes activities. Great Lakes environmental research accomplishments in IFYGL and in other research programs were reviewed, and deficiencies in the state-of-knowledge and needs for future research were identified and discussed. It was agreed that the state-of-knowledge is deficient in the physical, chemical, and biological processes of the nearshore region in the Great Lakes and in the exchange processes between lake and land, lake and atmosphere, lake and sediments, and nearshore and offshore. This coastal zone is a region of maximum natural variability and in addition is the region of maximum pressure on the Lakes from man's activities.

In order to develop a more coherent problem-oriented research program and to supplement in-house research capabilities, GLERL supports research

grants and contracts with private institutions and other agencies (Appendix II). This combination of in-house and contract research allows a significantly greater capability to be brought to bear on the research problems of the Great Lakes.

Significant FY 75 research accomplishments are as follows:

- Analysis of summer and fall current measurements in the Straits of Mackinac, indicating strong oscillatory modes of the individual basins of Michigan and Huron and of the combined system with a strong seasonal dependence in the vertical structure.

- Satisfactory deployment and retrieval of 65 current meters to study the winter circulation (November 1974 - May 1975) of Lake Huron [in collaboration with the Canada Centre for Inland Waters (CCIW) and in support of the International Joint Commission (IJC) Upper Lakes Reference].

- Development of a functional model which simulates fluctuations in major components of the Lake Ontario ecosystem, e.g., several nutrients, pH, alkalinity, benthos biomass, four phytoplankton types, and five zooplankton types.

- Studies on the feeding of carnivorous zooplankton (underway with laboratory cultures).

- Development and utilization of a transient model which simulates the flow of the Detroit River (in support of the Corps of Engineers Lake Erie Wastewater Management Study and the IJC Water Quality studies).

During FY 75, 54 papers were published by GLERL staff and contractors (Appendix III), and 27 papers were presented by GLERL staff at scientific meetings (Appendix IV).

NOAA is the U.S. lead agency for IFYGL, and the U.S. IFYGL Project Office is a part of GLERL. Results from this joint United States-Canadian multi-agency experimental field study of Lake Ontario and the Ontario basin continue to be documented. *IFYGL Bulletin No. 15* lists 26 official IFYGL publications, including 15 quarterly bulletins; a 4-volume *IFYGL Technical Plan;* 5 technical manuals; an overview report, "Two Nations, One Lake", and the *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union.* In addition, the current IFYGL bibliography now lists 204 other publications. Significant accomplishments to date are voluminous. A selection of highlights includes:

- A data archive in excess of 100 million pieces of data.

- An improved description of the thermal variations of Lake Ontario, including the seasonal, meteorological cyclone, and inertial scales.

- Identification of a major feature of the lake - that of intermittences - closely related to atmosphere-lake exchange processes.

- Identification of an intense and highly variable coastal current.

- Improved theoretical numerical circulation models.

- An improved description of the temporal and spatial variations in phytoplankton.

- Improved water quality and aquatic ecology numerical models.

IFYGL will terminate in late 1977 with the completion of eight international Summary Scientific Reports and a wrap-up workshop to synthesize and critique this major United States-Canadian project.

In addition to IFYGL, GLERL has significant involvement in other international and interagency environmental activities in the Great Lakes region. Environmental information developed by GLERL is now being used to support decisions pertaining to Great Lakes activities such as water quality, water resource planning, and navigation. As members of boards, committees, and work groups and as principal investigators on research studies, GLERL staff members participate in IJC activities to further the Great Lakes Water Quality Agreement. GLERL staff members also participate in the activities of the Great Lakes Basin Commission (GLBC) as the Department of Commerce Commissioner and Alternate Commissioner, as members of committees and work groups, and as principal investigators on research studies. Finally, GLERL cooperates with the three NOAA Great Lakes Sea Grant institutions and the International Coordinating Committee for Great Lakes Hydraulics and Hydrology and participates in the Winter Navigation Program to demonstrate the practicability of extending the navigation season on the Great Lakes-St. Lawrence Seaway System.

GLERL received and processed requests from over 100 sources for data and reports on IFYGL. These requests were in addition to the regular IFYGL distribution of over 450 institutions and individuals and came from a wide range of users, including university libraries, scientists in universities and government agencies, engineering and research companies, environmental groups (such as the Sierra Club), regional planning groups, high school science departments, interested citizens, etc. Products other than IFYGL data and reports were distributed upon request to 52 user groups covering a broad spectrum from universities and government agencies through private organizations and individual citizens. The products included reports, data, referral to information sources, presentations to civic groups, and the services of GLERL scientists on advisory boards or committees of various U.S. and international organizations.

GLERL participates for the Department of Commerce and the NOAA Offices of Ecology and Environmental Conservation in the review and critique of Draft Environmental Impact Statements (DEIS's) pertinent to the Great Lakes or the Great Lakes basin. In FY 75, some 65 DEIS's were reviewed.

The identification of emphasis for future GLERL research comes from international, interagency, and NOAA involvements, cooperation with potential users, and an awareness on the part of the scientific staff of the research state-of-knowledge and available environmental information. GLERL plans for FY 76 and beyond are:

- To consolidate, strengthen, and carry out the evolving technical plans of the programs (or projects) described in this report.

- To complete IFYGL satisfactorily in late 1977.

- To continue program development to further define future initiatives in Great Lakes environmental research in order to continue to provide the precise environmental information required for the decision process regarding Great Lakes resource plans, management, and environmental services.

Future research initiatives which have been identified to date include the development of research plans and Program Memoranda on:

- Great Lakes nearshore processes and properties - improved environmental information to support planning and management decisions of various activities (e.g., waste and water quality management, water supply management, power generation, fisheries management, recreation, and shipping) which utilize and impact the Great Lakes coastal zone.

- Engineering models of the Great Lakes environment - useful environmental engineering models to simulate and predict the Great Lakes limnology and hydrology to support decisions on water resources planning and management.

- Wind waves, run-up, flooding, and erosion - improved climatology and prediction to support Great Lakes resource management decisions on land use, shoreline protection, recreation, and shipping.

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

Conceived as part of the International Hydrological Decade (1965-1974), IFYGL is a joint United States-Canadian program of environmental and water resources research focusing on Lake Ontario and the Ontario basin. Approximately 1,000 individuals from the United States and Canada are participating in IFYGL, some of the U.S. participants representing 8 U.S. federal and New York State departments and independent agencies. An estimated $35 million will have been spent on IFYGL by the time it terminates in 1977.

The central objective of IFYGL is to strengthen knowledge of Lake Ontario and the Ontario basin in order to provide a scientific basis for improved Great Lakes management activities related to water quality and quantity and environmentally sensitive operations. Examples of such activities are the provisions of municipal, industrial, and rural water supplies; protection of water quality; fish resource management; optimization of commercial and recreational navigation; control of water levels and flows; provision of hydropower; shore use and erosion control; and warnings of hazardous and destructive conditions.

National Committees of the International Hydrological Decade in the United States and Canada established an International Steering Committee for IFYGL. This committee undertook broad planning and establishment of policy. Policy implementation and continued coordination is the responsibility of the Joint Management Team, made up of the Canadian Management Team and the United States IFYGL Project Office in GLERL. Coordination efforts are supported by seven scientific panels concerned with the terrestrial water balance, energy budget, atmospheric water balance, evaporation synthesis, boundary layer, water movement, and biology and chemistry. Data management coordination takes place between individuals in the United States and Canada identified by the Joint Management Team.

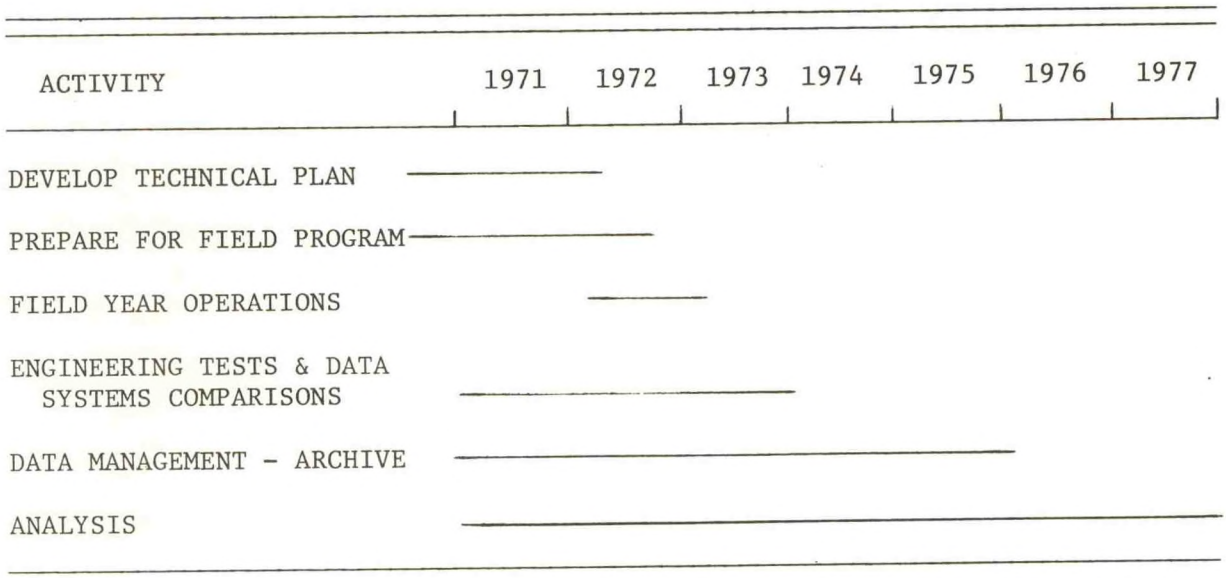
An intensive data acquisition program was mounted on and around Lake Ontario from April 1, 1972, through March 31, 1973. Data acquisition platforms included ships, buoys, towers, aircraft, rawinsonde stations, radar, and a wide variety of on-shore installations. In excess of 100 million observations, including physical, chemical, and biological parameters, were collected in the lake, atmosphere, and basin.

A comprehensive international system has been established to process, archive, and disseminate the data gathered in the field. It is centered around two IFYGL Data Centers, one at CCIW in Burlington, Ontario, and the other at the National Climatic Center in Asheville, North Carolina.

The U.S. schedule, shown below, indicates the phasing of six major activities over a 7-year period. The schedule for field operations was agreed upon in April 1971 by R. M. White, NOAA, and R. F. Shaw, Environment Canada. Not reflected in the schedule is the fact that the planning began

in 1966. The *IFYGL Technical Plan*, a four-volume compendium issued in April 1972, was the result of years of work by the Steering Committee, the scientific panels and subcommittees, and the two McMaster University workshops and the Washington, D.C., workshop; this was brought to fruition by the Joint Management Team.

U.S. IFYGL Schedule



The major components of IFYGL include seven projects, planned by the panels, the objectives of which are described below:

Terrestrial Water Balance

Determine the contribution of each of several factors affecting water balance relationships to provide improved understanding of these factors for better management of water supply and estimate the seasonal cycle of lake evaporation.

Atmospheric Water Balance

Determine the magnitude of the terms in the atmospheric water balance equation and their contribution to the hydrologic cycle of Lake Ontario and estimate the variation of lake evaporation in the fall.

Lake Heat Balance

Determine the three-dimensional thermal structure of Lake Ontario and its variation with time; compute the seasonal cycle of terms in the lake heat balance, including evaporation.

Lake Chemistry and Biology

Determine the materials balance, i.e., the inflow, storage, and outflow of certain key chemicals in Lake Ontario; determine the chemical and biological status and processes, e.g., conditions and their variability in time and space, both in the lake and in shore areas.

Water Movement

Determine the characteristics of large-scale water motion and the processes responsible for natural distribution and variability and develop diagnostic and simulation models of lake and coastal circulation and diffusion, internal waves, and surface waves.

Atmospheric Boundary Layer

Determine air-water interface fluxes of heat, moisture, and momentum; describe response of boundary layer structure to variations of surface conditions; provide data for parameterization and simulation models.

Evaporation Synthesis

Determine the best estimate of lake evaporation based upon estimates from the budget projects and from observations.

Highlights of specific scientific results to date include the following:

- The terrestrial water balance indicates that Field Year evaporation was only 6 percent of the Niagara River inflow and that the level of Lake Ontario was raised 68 cm; the seasonal variation of evaporation shows a maximum in the fall, 13 times the spring minimum value.

- The analysis of direct measurements of the turbulent eddy flux of moisture during an episode of extreme cold, strong northwesterly flow over the warm lake in October indicates an upward latent heat flux which varied from 100 to 300 $JM^{-2}S^{-1}$ from the upwind to the downwind side of the lake.

- The energy balance study indicates that the main process heating Lake Ontario in the spring is the net radiation, and the main process cooling the lake in the fall is the latent heat of evaporation.

- The analysis of current measurements from buoys and towers in Lake Ontario indicates that, in addition to the seasonal scale, two variability maxima occur at the surface layers corresponding to the scale of inertial oscillations (approximately 17 hr) and the longer period meteorological cyclone scales. For water temperature measurements, four variability maxima occur when a thermocline is present: at the cyclone and diurnal frequency at the lake surface and at the cyclone and inertial frequency at the thermocline. In mid-lake, the current motions predominate in inertial circles; in the nearshore region, the current motions predominate parallel to the coastline.

- A major feature of the lake are intermittences, which show up in the currents and water temperatures, associated with the response to forces from the atmosphere, primarily through the surface wind stress. Storms provide the major force on the lake surface, and the lake responds in an intermittent manner by (1) generating inertial oscillations which decay with time, (2) generating surface waves which intensify the vertical mixing process, and (3) generating coastal or nearshore currents.

- An intense and highly variable coastal jet phenomena occurs in a zone 5 to 10 km out from the shore with the flow essentially parallel to the coastline and with speed maxima approaching 1 m s^{-1}.

- Phytoplankton observation studies identified 40 individual species in 4 major assemblages, i.e., diatoms, microflagellates, green algae, and blue-green algae; spatial and seasonal variations are noted in the dominance and succession.

- A variety of numerical models are under development to simulate the annual cycle in Lake Ontario of chemical and biological variables. Useful water quality models have been developed; aquatic ecology models are in an early stage.

- Theoretical numerical models of the currents, water temperatures, and levels are being developed and tested to simulate the lake-scale circulation; results to date are encouraging.

- Fishery studies identify the dominant species in Lake Ontario as alewife, white perch, and smelt from a total of 63 species captured.

The U.S. analysis activity is progressing and will continue until 1977. The IFYGL data collection is being used to calculate the large-scale budgets; to define the natural distribution and variability of the physical, chemical, and biological properties in the lake and basin; and to develop models of interactive processes.

Several models to describe and predict processes occurring in Lake Ontario are under development or test and evaluation. The aim of IFYGL is to develop an information base and models useful in determining the environmental impact of various alternatives for developing the resources of the Great Lakes.

Plans call for the publication of eight IFYGL Summary Scientific reports in 1977, one for each of the project (or panel) areas and one overall summary prepared jointly by the United States and Canadian Co-Chairmen of the IFYGL Joint Management Team.

RESEARCH PROGRAMS

Water Circulation, Transport, and Diffusion

Tasks involved in this program are designed to develop climatological information on the spatial and temporal distribution of such physical lake variables as currents, temperatures, etc., and to establish the interdependence of these variables on causative meteorological and hydrological variables. User activities, such as waste, water supply, and fishery management, power generation, etc., require such information, and the understanding and prediction of chemical and biological properties presupposes an understanding of the processes of transport and diffusion.

Several interrelated approaches are used to attack these problems. Data must be collected through field experiments and then analyzed, and the processes involved must be studied and simulated by numerical models. Finally, the models must be verified with data.

Another task analyzed currents recorded in the Straits of Mackinac during the summer and fall of 1973. On a long-term average there is a net inflow of about 2,000 $m^3 s^{-1}$ into Lake Huron from Lake Michigan. The transport in the straits exhibits strong oscillations with magnitudes sometimes reaching as high as 50,000 to 80,000 $m^3 s^{-1}$. The vertical structure of the transports is seasonally dependent. During the stratified season, transports in the upper and lower layers are in opposite directions, with the eastern transport amounting to three times the net flow and the western transport amounting to two times the net flow. During the unstratified season, the transport is in the same direction from top to bottom. Oscillatory currents as high as 1 $m s^{-1}$ are recorded in the straits following the passage of a storm. Spectral analysis of currents shows oscillatory modes of the individual basins of Michigan and Huron, modes of a combined system, and strong lunar semi-diurnal tide components. Flow in the straits will be monitored

from October 1975 to May 1976 to better resolve some of the long period oscillations found in the previous analyses.

In support of the IJC Upper Lake Reference and in collaboration with the CCIW, the winter circulation in Lake Huron is under investigation. Sixty-five current meters were deployed in Lake Huron from November 1974 to May 1975. This is the first intensive effort to measure lake-scale circulation through the winter. The data are being analyzed now; this will continue into FY 76.

One of the major tasks involved the observation of currents in Saginaw Bay (Lake Huron) during May - October 1974. Nine current meter moorings were supplemented with drogues. The final report (to EPA) will show that currents are driven in the direction of the wind in shallower parts of the bay with return flow down the middle (deeper) part. Winds predominated from the southeast and northwest. The bay water appeared to be stagnant in the southeast corner.

Studies in support of the IJC Upper Lakes Reference of old current data in Lakes Huron and Superior indicate one persistent counter-clockwise gyre over the central part of Lake Huron and another over most of Lake Superior with strong currents near Keeweenaw. In both lakes some of the periodic seiche motions and strong inertial motions were identified.

Studies on IFYGL continued both in-house and through contracts. Data from the buoys and towers were edited and provided on magnetic tape to all contractors. In-house work chiefly involved long-term, large-scale lake properties and contract work entailed nearshore, episodic properties. In an in-house study, monthly mean air and water temperatures, winds, and currents were calculated for Lake Ontario for all months of 1972. It was found that in July the mean air temperature pattern resembled the lake surface temperature pattern except in the northwestern part of the lake near Toronto. The prevailing winds were westerly at 3 m s^{-1}, resulting in warm water (> 19°C) on the south-central shore and cold water (≃ 16°C) on the northwest shore. Geostrophic calculations made for the monthly mean temperatures showed cyclonic flow at all depths and conformity with the observed currents. This cyclonic flow has currents moving to the west on the north shore and hence in the direction opposed to the prevailing winds. Thus far, no numerical models have been created that are capable of faithfully reproducing this feature, but under a contract, various processes are being examined further to resolve this problem. Other contract studies involve examination of the dynamics of coastal jets. This will seek to explain the reversal of flow in the coastal jets in terms of propogation of Kelvin waves and topographic waves around the basin. Work on analysis of IFYGL data will continue in FY 76.

Multi-level numerical models for the general circulation of the Lakes are currently being developed at GLERL. This effort will continue through FY 76, focusing attention first on Lake Ontario. Also, in 1976 a large field experiment consisting of at least 16 moorings will be launched in southern Lake Michigan to get some preliminary information on nearshore circulation.

Surface Waves and Oscillations

By using a combination of observations, analyses, theoretical studies, and formulation and verification of prediction models, the Surface Waves and Oscillations program develops climatological information on the distribution and variability of waves, wind setups, and seiches and improved methods of prediction. This is important because these environmental hazards have direct impact on commercial and sport fishing, beach erosion, flooding, boating, etc.

During the past year, the major effort was directed to detailed analyses of wave characteristics during storm episodes selected from IFYGL data. Results indicated that the growth and decay of total wave energy follow approximately the patterns of increasing and decreasing wind speeds. The temporal development of individual spectral components breaks down into three spectral ranges: a low frequency range most sensitive to wind, a high frequency range generally independent of time or wind stress, and an intermediate range possessing some of the properties of the other two. Efforts to model these empirical results quantitatively are currently in progress.

Periods and structures of Lake Michigan seiches were computed, taking into account the bathymetry and shape of the lake and the rotation of the Earth. The oscillations comprise those dominant in the main basin of Lake Michigan and those dominant in Green Bay. The periods and structures of several gravitational modes were compared with those obtained from spectral analyses of water levels, and the agreement was good.

A comprehensive wave measurement program is planned for initiation in FY 76 with installation of a research tower, including four wave staffs, and four wave riders across southern Lake Michigan. Direction wave characteristics and basic micrometeorological data will be recorded. The program will yield important wave properties, such as directional wave characteristics, effects of fetch, and duration, etc.

Other plans include a continuation of the studies on the free oscillations of Lake Huron and a new task to examine the storm surge problem.

Lake Ontario Energy Budget (IFYGL)

The energy budget technique is fundamental to the understanding of the interrelationships among a water body, the atmosphere, and the surrounding area. It thus provides input to forecasts of water balance, evaporation, ice formation and decay, and heat dissipation. The study of evaporation was a major theme of IFYGL and the energy budget technique was selected as one of the basic approaches.

This investigation will define the general and specific properties of the energy budget of a large dimictic lake and evaluate all budget terms for Lake Ontario by analyzing data collected during field investigations conducted from April 1972 to April 1973.

During FY 75, the analysis of net radiation over Lake Ontario was completed and verified with available observations. A numerical model was used to compute the radiation budget and weekly averaged radiation fluxes.

In relation to heat advection for Lake Ontario, a frequency distribution was prepared of daily average water temperatures for principal tributaries. Changes in heat storage in 4 of a total of 40 cells were computed. Time-related advection of heat was then determined. Discrepancies between shipboard and buoy heat storage estimates occur during unstable periods and relate more to station density than to observing frequency.

Also developed was a numerical lakeshore ice-formation model that computes water and sub-bottom temperatures in a two-dimensional plane normal to the shore. In addition, it computes the location of freezing and melting points as well as release or absorption of latent heat.

Within the next year, analysis and evaluation of each of the energy budget terms will be completed, and daily averages will be estimated for each. Inputs from various scientists working on IFYGL will then be synthesized into an energy budget of Lake Ontario, and a scientific report to evaluate each item will be prepared.

Modeling of Great Lakes Ecosystems

A great many of the problems identified in the Great Lakes in recent years are closely related to the ecology of the Lakes. This program, therefore, is aimed at the development of a series of models, at several levels of complexity, to realistically simulate the fluctuations in amounts of carbon in ecologically meaningful components of the Great Lakes ecosystems. Once components are identified and interrelationships are defined, data already collected, especially the IFYGL data base, will be used to test, tune, and verify the models. In the process, research areas requiring further effort will be identified.

Already, a functioning model has been developed which simulates the fluctuations in the major components of the Lake Ontario ecosystem. This includes simulation of concentrations of several nutrients, pH, and alkalinity, as well as biomass of benthos, four types of phytoplankton, and five types of zooplankton. The development of the model has already revealed several vital areas where our knowledge is inadequate, e.g., phytoplankton succession, and towards which future efforts should be directed.

Plans include refinement of this model. For example, four kinds of fish will be added. Also the lake has been subdivided, and a submodel, developed to simulate hydrodynamic flow between these subdivisions, will be integrated into the ecological model so that the three-dimensional flow of material can be simulated. The model will then be adapted to simulate the cycling of a toxic substance and the effect of such a substance on the various living components of the Lake Ontario ecosystem.

Planktonic Succession

Attempts at modeling the ecology of the Great Lakes have so far been limited to including all the phytoplankton species under one or occasionally a couple of groupings; the same approach has been used for the zooplankton. However, modeling at such a gross level can not simulate a number of the processes of immediate practical concern. For example, different types of algae may vary greatly in their potential to clog water intakes and to cause taste and odor problems and different types of plankton vary greatly in their potential to serve as food to higher levels in the food chain. Thus, treating all types alike obscures many of the processes and allows simulation of only the least complex relationships. This project attempts to describe the process of succession of the plankton in the Great Lakes by developing a model of the process and determining the controlling mechanisms.

Nutrient competition and zooplankton grazing are two major factors controlling phytoplankton succession. In FY 75 the research has concentrated on the development of research plans, the identification of experiments, and the development of methods and laboratory facilities for these studies. Laboratory studies, some using radioactive tracers and autoradiographic techniques, have been planned to determine the rates of nutrient uptake under various conditions. Zooplankton grazing studies are also planned to use various foods to determine food selectivity under a variety of conditions. Studies on feeding of carnivorous zooplankton have already been initiated.

Further studies, including the investigation of zooplankton reproductive and growth rates, will be conducted in an attempt to increase our knowledge of their population dynamics and the way in which this affects succession. Full-scale field studies will be initiated in the spring of 1976. Laboratory studies on the nutrient uptake and feeding of herbivorous zooplankton will be initiated in late 1975 or early 1976.

Natural Distribution and Variability of Lake Properties

Great amounts of data have been collected from the Great Lakes specifying the levels of certain properties at various places and times. Many of the data sets have not been analyzed at all, while others have only been analyzed in a cursory fashion. This program will use these data to describe the distribution in space and time of selected limnological variables in the Great Lakes. This would aid the design of a monitoring system to detect long-term environmental trends by providing a basis for identifying where, when, and how often to monitor conditions in order to obtain a representative view of the trend of conditions in each lake.

Data collected during IFYGL have already been used to describe the variations during the Field Year in limnological conditions in the vicinity of Oswego Harbor. In addition, data estimating the flow of materials through the St. Clair-Detroit River system have been collected and will

be the basis of a report to the IJC. A carbon budget was calculated for Lake Ontario and forms the basis for determining the major sources and sinks of the element. An intercomparison has been accomplished of chemical measurements made during IFYGL by several groups; it reveals that substantial biases exist in that data set.

Plans for FY 76 include spectral analyses of chlorophyll and oxygen data from IFYGL to determine the important scales of variability for these parameters and a field study will be initiated to gather data for spectral analysis of other important parameters. Further studies of the dynamics of carbon will also be conducted, this time emphasizing gas-water exchange. Finally, data collected in previous years will be used to describe the limnological conditions in selected areas of the Great Lakes.

Hydrologic Properties

An understanding of lake hydrology is fundamental for water resource studies of the Great Lakes, including regulation of lake levels and shore protection. Numerical models must be developed to predict and simulate water flow through the Great Lakes system, and a hydrologic data base of sufficient quality for both scientific and water resource studies of the Great Lakes must be developed. This will form the basis for a Great Lakes water levels and flows advisory service serving those who use or study the Great Lakes.

In FY 75, particular emphasis was given to lake precipitation, lake evaporation, beginning-of-month water levels, and water levels and flows simulation. For example, a study of land-lake precipitation relationships for northern Lake Michigan has been completed. This is a tool for quantifing overlake precipitation from perimeter measurements.

Overland precipitation has been quantified for the Lake Ontario land basin by using Thiessen polygon networks and National Weather Service observations. For FY 76 the emphasis will be on the development of an automated Thiessen polygon procedure to compute overland precipitation for each of the Great Lakes' land basins.

The current goal of evaporation research is to determine accurate values of water loss from the Great Lakes due to evaporation. During the past year a comprehensive evaporation study has been completed to determine Lake Erie evaporation by the water budget, mass-transfer, and energy budget procedures. In FY 76 these techniques will be transferred to Lake Superior where evaporation will be determined by the mass transfer and water balance procedures.

Great Lakes beginning-of-month levels and monthly rates of change in storage are being computed for each of the Great Lakes and Lake St. Clair. Reports for Lakes Superior and Michigan have been completed and the final four publications in the series are scheduled for completion in FY 76.

Hydrologic response and hydraulic transient models are being used for specific problems involving Great Lakes water quantity and quality studies, such as determination of connecting channel flows and pollution studies of the Lakes. Of particular interest in FY 75 has been the use of Detroit River transient models to provide flow input for the computation of pollution loadings as part of the Corps of Engineers' Lake Erie Waste Water Management Study and for water quality studies undertaken by the IJC. For FY 76 the emphasis will be on the development of a hydraulic transient model for the St. Clair River to be used in water resource studies of the upper Great Lakes. In addition, a study will be undertaken to determine the effects of water temperature changes on the volume of the Great Lakes.

Lake Ice

The amount, type, and extent of ice on the Great Lakes is of interest to all those who use the Lakes in winter, but especially to those who navigate them. The Lake Ice program was created to develop improved climatological information on the formation, growth, and decay of the Great Lakes ice cover; to develop numerical models and techniques to simulate and forecast the freeze-up, breakup, areal extent, and thickness of the Great Lakes ice cover; and to define the natural distribution and variability of the physical and chemical characteristics of the Great Lakes ice cover. These ice data, information, and techniques will not only increase scientific knowledge of the Great Lakes, but also provide the basis for a lake ice advisory service.

During the past year, data on the extent, type, and distribution of the Great Lakes ice cover were collected. The techniques used included visual aerial reconnaissance, satellite imagery, and side-looking airborne radar. In addition, weekly charts depicting ice-cover concentration and distribution were generated for each of the Lakes. At the end of the ice season a report documenting the growth and decay of the ice cover was published. Next year, the task will continue, but with emphasis on remote sensing.

The need for Great Lakes ice forecasts increased with the advent of the Winter Navigation Season Extension Program. During the past year, a technique to predict the freeze-up of the St. Lawrence River at Massena, New York, has been finalized; this will be operational in the coming year. Operational ice forecasts were also developed and implemented during the last year for the Little Rapids Cut area of the St. Marys River. During FY 76 the emphasis will be on the development of techniques for forecasting ice breakup on the St. Lawrence River.

Ice thickness, crystallographic, and chemical data are obtained by the collection of ice samples from bays, harbors, and connecting channels of the Great Lakes. These data are analyzed in the ice laboratory to provide tabulations of the orientation of the c-axis (optic axis) of ice crystals, photography of ice crystals for shape and size studies, and tabulations of various chemical concentrations in the ice and in the water below the ice.

A systematic procedure was developed in the 1969 winter and used and improved in subsequent winters to the present. The physical characteristics of lake ice will be emphasized in the coming year.

Also in support of the Winter Navigation Program, data on water temperatures are being collected at selected locations around the Lakes and in the St. Marys and St. Clair Rivers. The Lake Superior autumn temperature decline is being monitored by the use of ships of opportunity and an expendable bathythermograph system. The ice thickness measuring network has been augmented for this task. The collected data are supporting navigation operations as well as serving as input for ice forecasting studies. The Winter Navigation Program will be completed in FY 76.

Environmental Engineering Models and Applications

Accurate environmental information is a prerequisite for effective Great Lakes resource planning and management. In its absence, the decision-maker must rely on economic, social, and political considerations or on intuition. Thus, decisions affecting the environment have often been made without the benefit of current scientific knowledge. The goal of this project is to develop and test improved simulation and prediction models and other tools for user applications and to develop a basis for rational decisions for the development and utilization of Great Lakes resources.

A mathematical model of Maumee Bay in Western Lake Erie is under development to simulate the transport and diffusion of water quality parameters due to inflow from the Maumee River system. This task supports the GLBC's Maumee River Basin Level B Study, a multi-agency activity intended to examine the pros and cons of alternative futures for the Maumee Basin. The study includes problems concerning erosion and sediment control, land use and management, conservation of recreational resources, and the relationship of water quality in the basin to that in Maumee Bay and Lake Erie. Results to date are encouraging. Future plans include the completion of this model and the simulation of Maumee Bay water quality as it is subjected to the loads from the Maumee River associated with alternate basin strategies.

A phosphorus model is under development to simulate the long-term phosphorus budgets for the Great Lakes for the 19th and 20th centuries. The waste loads to each lake were related to demographic information. Future plans include further testing of the model and its application to the prediction of phosphorus concentrations in the Great Lakes to the year 2000. These plans include an examination of the water quality objectives contained in the Water Quality Agreement between the United States and Canada.

An atlas of Lake Ontario physical properties is being developed to depict the physical environment observed during IFYGL and to present this information in forms useful for engineering, design, and research purposes. Participants in IFYGL are preparing descriptions using tables, graphs, and maps of the lake currents, water temperature, water levels, waves, air temperature, humidity, wind, tributary flows, precipitation, and lake ice. Work on this atlas will continue in FY 76.

Environmental Information Services

The GLERL mission includes development of environmental information on the Great Lakes to improve understanding and to provide improved environmental service tools, data, information, and consulting services to support user needs in various levels of government, institutions, and private organizations. The value of GLERL products depends on their applicability to the solution of Great Lakes environmental problems because research products must be understood and correctly applied in order to solve problems. Products that are misunderstood or misused will foster a lack of confidence on the part of the Great Lakes community.

Since every scientist cannot be in contact with every potential user, an advisory service is needed to provide a channel through which a dialogue with specific users can be developed. Individuals who require environmental information for problem solving must be identified and interactions established. This will provide guidance to GLERL in developing short- and long-range program objectives to satisfy the maximum number of most urgent needs.

Once the advisory service is created, an information system of value to Great Lakes resource managers and planners in their decision-making role will be developed, that is, information will be provided in a form useful to the Great Lakes community, and services for the application and interpretation of environmental information will be supplied.

Sources of information on user requirements will include, but not be limited to, the NOAA Marine Advisory Service, the GLBC, local Sea Grant institutions, the Great Lakes States, Great Lakes Commission, Federal Energy Office, Federal Power Commission, Army Corps of Engineers, Department of Interior, U.S. Coast Guard, and IJC Water Quality and Research Advisory Boards.

An environmental information service must have a product inventory. The initial efforts in this program are therefore being directed towards determining the user needs and defining the products that GLERL has the capability to provide. The first year of the program has involved user contacts through membership and participation on various commissions and boards, an environmental research priorities workshop, addresses to various public and government units, interactions with the regional and national levels of the Sea Grant Advisory Service, and supply of products and services on an individual basis.

Plans for FY 76 are for surveying potential users and updating user requirements to reflect emerging problems and to assist in long-range program development. In addition, the GLERL products inventory is to be substantially increased to cover an increasing spectrum of user needs.

INTERNATIONAL AND INTERAGENCY ACTIVITIES

To a large extent, the managers of Great Lakes resources are government agencies at various levels: international, federal, state, regional, and local. Since GLERL's mission is to solve problems in resource management and to provide environmental services for the Great Lakes region, GLERL, in order to identify resource problems for research investigation and to participate in their solution, must actively participate in those international and interagency organizations which influence Great Lakes resource planning and management. Thus, although a broad survey of environmental needs provided an initial basis for the GLERL problem-oriented research program, additional information on current and projected user needs must be obtained through participation on various boards and commissions, joint participation in interagency programs, and direct interaction with potential users. Participation, directed towards items that parallel NOAA mission responsibilities, requires close evaluation to avoid overcommitment of the available resources of the Laboratory.

GLERL participates in the activities of the IJC under the provisions of the Canada-United States Great Lakes Water Quality Agreement signed in April 1972 through the Research Advisory Board, the Water Quality Board, and the Upper Lakes Reference. The Research Advisory Board reviews research activities concerned with and applicable to the quality of water in the Great Lakes System, makes recommendations to the IJC concerning research needs and provides scientific advice on specific problems referred to the board by both the IJC and the Great Lakes Water Quality Board. GLERL participates in the Research Advisory Board activities through membership on the board, chairing the Research Needs Committee, and membership on the Standing Committee for Scientific Bases for Water Quality Criteria. GLERL participates in Water Quality Board activities through membership on the Federal Support Committee to the Chairman, Water Quality Board, and through membership on the Data Quality Assurance Committee. In addition to Board and Committee participation, GLERL is actively involved in the IJC Reference to study the pollution problems of Lakes Superior and Huron. Participation in this international, multi-agency, multi-state, and provincial program includes work group membership and specific tasks related to net transport of pollutants from Lake Michigan into Lake Huron (conducted with the EPA and the University of Michigan), lake-wide circulation of Lakes Superior and Huron using EPA data and coordinated with the CCIW, winter circulation in southern Lake Huron in conjunction with the EPA and the CCIW, and the transport of pollutants through Saginaw Bay (conducted with the EPA).

The GLBC was established under the Water Resources Planning Act of 1965 as the principal agency for coordination of federal, state, interstate, local, and non-governmental plans for the development of water and related land resources in the Great Lakes basin and was given responsibility for development of a comprehensive coordinated joint plan. GLERL provides to the GLBC, the Department of Commerce Commissioner and an Alternate Commissioner who interact at the policy level and critique reports and recommendations. GLERL is also represented on the Plan and Program Formulation Committee which

is charged with development of a Comprehensive Coordinated Joint Plan for management and utilization of the Great Lakes and water related land resources and on the Standing Committee on Coastal Zone Management with a goal to coordinate state and federal support to the NOAA Coastal Zone Management Program in the Great Lakes.

GLERL is participating in the GLBC sponsored Maumee River Basin Level B Study, a multi-state and agency program under the authorization of the Water Resources Planning Act of 1965 and under the Water Quality Amendments Act of 1972, designed to provide a baseline and develop short- and long-range management goals and alternatives for resource development in the basin and adjacent portion of Lake Erie. GLERL is developing a baseline for Maumee Bay and through application of computer simulation is assessing the impact of alternative management strategies on the bay and western Lake Erie.

GLERL has also been directing preparation of a basic resource appendix on the Limnology of Lakes and Embayments as a part of the Level A Framework Study being developed by the GLBC.

The three top priority items that the GLBC has submitted to the Water Resources Council for authorization are a Level B Study of the Fox-Wolfe River Basin, Wisconsin (similar in principal to the Maumee Level B Study), a Regional Water and Energy Study relating to power needs and impacts in the Great Lakes basin, and a Great Lakes Environmental Planning Study, which includes a comprehensive limnological systems analysis to be used as a basic tool in assessing alternative management strategies. GLERL has been identified as a potential participant in all these programs, but the level will depend first on approval, then on GLERL mission interest and capabilities applicable to the problems.

The NOAA Sea Grant Program is directed toward developing and improving the management of marine and aquatic resources. A major part of the program is public interaction through the Sea Grant Advisory Service. There are three Great Lakes Sea Grant Institutions: University of Wisconsin, State University of New York/Cornell, and University of Michigan. GLERL mission objectives supplement those of Sea Grant: GLERL provides environmental research support to the Great Lakes Sea Grant institutions, where appropriate. To this end, GLERL participates in site visits, coordinates program plans, provides support and services, and interacts with and participates in the Advisory Service.

Because much of the Great Lakes data is used internationally, Canadian and United States users of hydraulic and hydrologic data formed a Coordinating Committee in 1953. The objectives of this committee are to reach agreement upon hydraulic and hydrologic data and related physical data concerning the Great Lakes; to assist agencies in pursuing studies requiring international data; to provide basic data to anyone with a recognized need; to reach agreement on methods and procedures for measuring, collecting, and storing pertinent data; and to publish coordinated data. GLERL participates on the River Flow Subcommittee with a charge to coordinate tributary stream inflow

to the Great Lakes system, to coordinate studies of flow in the connecting channels and the St. Lawrence River, and to establish procedures for updating and disseminating river flow data.

Commercial shipping interests have long desired to extend the navigation season on the Great Lakes. Congress authorized a Winter Navigation Program under the River and Harbor Act of 1970 aimed at demonstrating the practicability of extending the navigation season on the Great Lakes-St. Lawrence Seaway system. The Secretary of Army, acting through the Chief of Engineers, was directed to carry out the program in cooperation with the Departments of Transport, Interior, and Commerce and the EPA. GLERL chairs the Ice Information Work Group, has membership on the Winter Navigation Working Committee, and represents NOAA on the Environmental Evaluation Work Group. Data is provided by the Laboratory on the physical and structural character of lake ice; on ice formation, growth, and decay; and on the effects of winter navigation on shore properties. In addition, marine environmental service is provided to shippers during the extended season. A report will be submitted to Congress in December 1976.

APPENDIX I

GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY

STAFF AND ORGANIZATION

JUNE 30, 1975

Name	Position Title	Grade	Code
OFFICE OF DIRECTOR			
Aubert, Dr. Eugene J.	Director	16/8	FTP
Hill, Rosa Lee	Secretary (Stenographer)	6/10	FTP
Administrative Services Group			
Bramlet, Robert H.	Head	13/6	FTP
Pelto, Carol L.	Clerk-Typist	4/4	FTP
Loegel, Lawana J.	Administrative Assistant	7/7	FTP
Sparks, Eric S.	Maintenance	5/1	FTT (WG)
Publications			
Kelley, Jeanne M.	Writer-Editor	7/1	FTP
Hanks, M. Ann	Clerk-Typist	4/5	FTP
Library			
Carrick, Barbara J.	Librarian	9/1	PTP
Computer Systems			
Rodante, Frank C.	Head	13/3	FTP
Del Proposto, Donato J.	Computer Specialist	12/2	FTP
Hodson, Alan W.	Computer Systems Analyst	11/10	FTP
Holt, Deborah J.	Computer Programmer	5/4	FTP
Maxey, Vernon K.	Computer Systems Analyst	11/4	FTP
Harrison, Shirley A.	Key Punch Operator	2/1	PTT
PHYSICAL LIMNOLOGY AND METEOROLOGY GROUP			
Rao, Dr. Desiraju B.	Head	14/4	FTP
Hein, Marlene A.	Clerk-Stenographer	4/1	FTT
Albert, Jordan C.	Physical Scientist	5/1	WAE
Bermick, Stephen	Physical Scientist	5/1	FTP
Danek, Larry J.	Physical Scientist	9/1	FTT
Doughty, Blondell C.	Research Physical Scientist	11/8	FTP
Dungan, J. Edward	Physical Science Technician	10/5	FTP
Grumblatt, John L.	Research Physical Scientist	12/6	FTP
Heikes, Brian G.	Physical Science Aid	4/1	WAE
Heinmiller, Paul A.	Physical Science Aid	4/1	WAE
Huang, Dr. Joseph C. K.	Physical Oceanographer	13/4	FTP
Kessenich, Timothy A.	Research Physical Scientist	LTJG	CO

Liu, Paul C.	Physical Scientist	12/6	FTP
Miller, Gerald S.	Physical Scientist	12/3	FTP
Ottenbaker, David T.	Physical Science Aid	2/1	WAE
Pickett, Dr. Robert L.	Physical Oceanographer	14/3	FTP
Saylor, Dr. James H.	Physical Scientist	14/4	FTP
Sloss, Dr. Peter W.	Physical Scientist	11/2	FTP
Winkler, Dennis M.	Physical Science Technician	2/1	WAE

Marine Instrumentation Lab - Field Operations

Soo, H. K.	Head	13/1	FTP
Weinstein, Stuart D.	Electronics Technician	4/1	WAE

CHEMISTRY AND BIOLOGY GROUP

Robertson, Dr. Andrew	Head	15/2	FTP
Grasso, Jean O.	Secretary (Typing)	5/5	FTP
Bell, Gerald L.	Research Physical Scientist	12/6	FTP
Chambers, Richard L.	Research Physical Scientist	11/1	FTP
Eadie, Dr. Brian J.	Chemical Oceanographer	13/1	FTP
Endres, Julianne	Biological Technician	4/1	WAE
Lee, William R.	Physical Science Technician	4/1	WAE
Manor, James P.	Physical Scientist	7/1	WAE
Nalepa, Thomas F.	Aquatic Ecologist	11/1	FTP
Rheaume, Paul H.	Biological Technician	4/1	FTT
Scavia, Donald	Environmental Systems Modeler	9/1	FTP
Tarapchak, Dr. Stephen J.	Biological Oceanographer	12/1	FTP
Vanderploeg, Dr. Henry A.	Biological Oceanographer	13/2	FTP

Water Chemistry Lab

Malczyk, John M.	Head	9/6	FTP
Bobovski, Joseph	Physical Science Technician	4/1	PTT
Langston, Albert L.	Physical Science Technician	7/4	FTP

LAKE HYDROLOGY GROUP

Quinn, Dr. Frank H.	Head	14/2	FTP
*Lawton, Barbara J.	Clerk-Typist	4/10	FTP
Assel, Raymond A.	Research Physical Scientist	12/1	FTP
Bolsenga, Stanley J.	Research Physical Scientist	12/7	FTP
Derecki, Jan A.	Research Physical Scientist	12/9	FTP
Gales, John E.	Physical Science Technician	7/5	FTP
Hagman, Brenda B.	Physical Science Aid	4/1	WAE
Hagman, John C.	Physical Scientist	7/1	WAE
Kelley, Raymond N.	Research Physical Scientist	9/8	FTP

Lebeis, Mark P.	Physical Science Aid	4/1	WAE
Leshkevich, George N.	Physical Science Technician	5/2	FTP
Norton, David C.	Research Physical Scientist	11/3	FTP
Rogers, Jeffery C.	Research Physical Scientist	9/1	FTP
Santek, David A.	Physical Science Aid	4/1	WAE

ENVIRONMENTAL SYSTEMS ENGINEERING GROUP

Pinsak, Dr. Arthur P.	Head	14/5	FTP
*Lawton, Barbara J.	Clerk-Typist	4/10	
Chapra, Steven C.	General Physical Scientist	12/2	FTP
Hendershot, Phillip	Physical Science Aid	4/1	WAE
Jenkins, C. Fred	Physical Scientist	14/7	FTP
Landay, Beth Diane	Physical Science Aid	4/1	WAE
Simonson, Jonathan H.	Physical Scientist	7/1	WAE

*Indicates names listed more than once.

APPOINTMENTS CODE:

FTP:	Full Time Permanent
FTT:	Full Time Temporary
FTT (G):	Full Time Temporary (G Appointment)
PTP:	Part Time Permanent
PTT:	Part Time Temporary
WAE:	When Actually Employed (Q Appointment - Student)
CO:	Commissioned Officer, NOAA Corps
WG:	Wage Grade
T:	Term Appointment

SUMMARY TABLE

	FTP	FTT	PTP	PTT	WAE	CO	TOTALS
Office of Director	12	1	1	1	0	0	15
Physical Limnology & Meteorology	12	2	0	0	6	1	21
Chemistry & Biology	11	1	0	1	3	0	16
Lake Hydrology	10	0	0	0	4	0	14
Environmental Systems Engineering	3	0	0	0	3	0	6
TOTALS	48	4	1	2	16	1	72

APPENDIX II
GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY
CONTRACTS AND GRANTS
FY 1975

GRANT OR CONTRACT NO.	TITLE	PRINCIPAL INVESTIGATOR	INSTITUTION	TERM	
				FROM	TO
2-35286	Snow Observation Network	Sykes	State Univ. of New York, Buffalo	11/17/71	8/15/74
2-35307	Lake Ontario Temperature Transects	Mortimer	Univ. of Wisconsin (Milwaukee)	1/1/72	12/31/75
3-35468	Whole Basin Inertial Oscillations	Mortimer	Univ. of Wisconsin (Milwaukee)	6/30/73	6/30/76
2-35353 Task I	Basin Precipitation - Land and Lake	Wilson	The Center for the Environment and Man, Inc.	1/1/72	9/30/74
Task II	Net Radiation	Atwater		1/1/72	10/31/74
3-35163	Nearshore Ice Formation, Growth and Decay	Pavlak	General Electric	8/30/72	9/31/74
3-35142	Coastal Circulation in the Great Lakes	Csanady	Woods Hole	9/1/72	11/15/74
04-4-158-25	Mesoscale Disturbances	Estoque	Univ. of Miami	3/73	6/30/75
04-4-022-33	Dispersion of Pollutants	Houghton	Univ. of Wisconsin (Madison)	6/1/74	11/30/75
4-35481	Climatology Circulation Patterns	Scott	SUNY Albany	6/30/74	12/31/75
04-4-022-32	Phytoplankton Associations in Lk Ontario	Stoermer	Univ. of Michigan	6/15/74	6/14/76

CONTRACTS AND GRANTS (continued)

GRANT OR CONTRACT NO.	TITLE	PRINCIPAL INVESTIGATOR	INSTITUTION	TERM	
				FROM	TO
04-4-022-37	Data Integration and Modeling of Coastal Lk. O.	Birchfield	Northwestern	6/1/74	5/31/76
----	Current Instr. Study	Kalvaitis	NOIC/NOS/NOAA	8/1/74	2/1/75
03-5-022-3	Ecological Model	Chen	Tetra Tech	8/1/74	8/31/75
03-5-022-17	Completion of IFYGL PCP Program	Wilson	CEM	10/1/74	5/31/76
03-5-022-36	DEIS	Bajorunas	----	1/1/75	12/31/75
01-5-022-190	GL Institutions	Prosser	GLBC	7/2/74	7/26/75
04-5-022-13	Studies of Ice Growth	Sydor	Univ. of Minnesota	10/15/74	10/14/75
03-5-022-26	Coastal Circulation	Csanady	Woods Hole	11/16/74	11/15/75
04-5-022-21	Copepod Life History	Sweeney	SUNY Buffalo	4/1/75	9/30/76
03-5-022-45	Nearshore Ice (Phase 3)	Dilley	General Electric	3/31/75	3/30/76
----	Satellite Ecology	Strong	NESS/NOAA	1/30/75	6/30/75
03-5-022-65	Reanalysis of Drogue Study Data	Okubo	SUNY Stony Brook	6/1/75	12/31/75
03-5-022-57	Circulation in Lake Ontario	Bennett	MIT	6/1/75	5/31/76
04-5-022-23	Mesoscale Disturbances	Estoque	Univ. of Miami	6/1/75	5/31/76
----	Atmospheric Budgets	Rasmussen	CEDDA/EDS/NOAA	7/1/74	6/30/76

CONTRACTS AND GRANTS (continued)

GRANT OR CONTRACT NO.	TITLE	PRINCIPAL INVESTIGATOR	INSTITUTION	TERM	
				FROM	TO
----	Boundary Layer Synthesis	Almazan	CEDDA/EDS/NOAA	7/1/74	6/30/75
----	Four-Dimensional Analysis	Grayson	NWS/NOAA	1/30/75	6/30/75

APPENDIX III A

GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY

PUBLICATIONS

FY 1975

Assel, R. A., "Great Lakes Ice Cover, Winter 1973-74," *NOAA Technical Report ERL 325-GLERL 1*, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Boulder, Colorado, July 1974, 52 pp.

Aubert, E. J., "IFYGL: Scientific Overview," in: *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union*, National Oceanic and Atmospheric Administration, Rockville, Maryland, August 1974, pp. 8-21.

Bennett, E. B.[2], and J. H. Saylor, "IFYGL Water Movement Program - A Post Field Work Review," in: *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union*, National Oceanic and Atmospheric Administration, Rockville, Maryland, August 1974, pp. 102-128.

Braster, R. E.[2], S. C. Chapra, G. A. Nossa[2], "A Computer Program for the Steady-State Water Quality Simulation of a Stream Network," *Documentation for SNSIM1/2*, Environmental Protection Agency, New York, New York, February 1975, 54 pp.

Chapra, S. C., and G. A. Nossa[2], "A Computer Program for the Modeling of Water Quality Parameters in Steady-State Multi-Dimensional Natural Aquatic Systems," *Documentation for HAR03*, Environmental Protection Agency, New York, New York, October 1974, 94 pp.

Gehrs, C. W.[2], and A. Robertson, "Use of Life Tables in Analyzing the Dynamics of Copepod Populations," *Ecology*, Vol. 56, 1975, pp. 665-672.

Huang, J. C. K., "Effective Cloudiness Derived from Ocean Buoy Data, *Journal of Applied Meteorology*, Vol. 14, 1975, pp. 240-246.

Huang, J. C. K., "Ocean/Atmosphere Dynamically Coupled Model for Climatic Study," in: *Monograph IV*, Department of Transportation, Climatic Impact Assessment Program, 1974, pp. (6-210)-(6-216).

Ischinger, L. S.[2], and T. F. Nalepa, "Freshwater Macroinvertebrates," *Journal Water Pollution Control Federation*, Vol. 47, 1975, pp. 1520-1538.

Liu, P. C., "Duration-Limited Wave Spectra in Lake Ontario during the 1972 Hurricane Agnes," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, pp. 435-444.

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[1]No longer affiliated with this Laboratory.

[2]Not affiliated with this Laboratory.

Liu, P. C., and R. J. Robbins[2], "Wave Data Analysis at GLERL," in: *Proceedings of International Symposium on Ocean Wave Measurements and Analysis*, Vol. 1, American Society of Civil Engineers, New York, New York, 1974, pp. 64-73.

Nalepa, T. F., and L. S. Ischinger[2], "Sediment Oxygen Demand Studies on the Androscoggin, Presumpscot, and Penobscot Rivers, Maine, May and July 1974," *Report to Region I, EPA, and State of Maine*, Environmental Protection Agency, National Field Investigations Center, Cincinnati, Ohio, 1974, 15 pp.

Nalepa, T. F., and L. S. Ischinger[2], "Sediment Oxygen Demand Studies on the Chowan River, North Carolina, December 1974," *Report to State of North Carolina*, Environmental Protection Agency, National Field Investigation Center, Cincinnati, Ohio, 1974, 8 pp.

Norton, D. C., "Lake Ontario Basin: Overland Precipitation, 1972-73," *NOAA Technical Memorandum ERL GLERL 1*, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Boulder, Colorado, March 1975, 12 pp.

Park, R. A.[2], D. Scavia, and N. H. Clesceri[2], "CLEANER the Lake George Model," in: *Ecological Modeling in a Management Framework*, ed. C. S. Russell, Resources for the Future, Inc., Washington, D.C., 1975, 394 pp.

Park, R. A.[2], R. U. O'Neill[2], J. A. Bloomfield[2], H. H. Shugart[2], R. S. Booth[2], R. A. Goldstein[2], J. B. Mankin[2], J. F. Kounce[2], D. Scavia, M. S. Adams[2], L. S. Clesceri[2], E. M. Colon[2], E. H. Dettmann[2], J. A. Hoppes[2], D. D. Huff[2], S. Kutz[2], J. F. Kitchell[2], R. C. Kohberger[2], E. J. Larow[2], D. C. McNaught[2], J. L. Peterson[2], J. E. Titus[2], P. R. Weiler[2], J. W. Wilkerson[2], and C. S. Zahorcak[2], "A Generalized Model for Simulating Lake Ecosystems," *Simulation*, Vol. 23, 1974, pp. 33-50.

Pickett, R. L., "Comparison of July Currents from Adjacent United States and Canadian Buoys," *IFYGL Bulletin 11*, July 1974, pp. 107-110.

Pickett, R. L., "Editing Procedures for Analysis of Buoy and Tower Data," *IFYGL Bulletin 11*, July 1974, pp. 105-106.

Pickett, R. L., and S. Bermick, "Comparison of Airborne Radiation Thermometer and Buoy Temperature Measurements," *IFYGL Bulletin 14*, June 1975, 76 pp.

Pinsak, A. P., "Federal Agency Programs: Commerce - NOAA," in: *Proceedings of the Recession Rate Workshop*, Great Lakes Basin Commission, Ann Arbor, Michigan, 1975, pp. 55-63.

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[1]No longer affiliated with this Laboratory.

[2]Not affiliated with this Laboratory.

Pinsak, A. P., "Physical Characteristics," *Limnology of Lakes and Embayments*, the Great Lakes Basin Commission, Ann Arbor, Michigan, 1975, 103 pp.

Pinsak, A. P., (editor), *Proceedings of Workshop on Great Lakes Environmental Research Initiatives*, Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan, April 1975, 196 pp.

Pinsak, A. P., and T. L. Meyer[1], "Baseline Reference for Maumee Bay," in: *Interior Report*, Maumee River Basin Level B Study, The Great Lakes Basin Commission, Ann Arbor, Michigan, 1975, 40 pp.

Pinsak, A. P., and G. K. Rogers[2], "Energy Balance of Lake Ontario," in: *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union*, National Oceanic and Atmospheric Administration, Rockville, Maryland, August 1974, pp. 86-101.

Quinn, F. H., "Lake Michigan Beginning-of-Month Water Levels and Changes in Storage," *NOAA Technical Report ERL 326-GLERL 2*, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Boulder, Colorado, March 1975, 32 pp.

Rao, D. B., "Transient Response of Shallow Enclosed Basins Using the Method of Normal Modes," *Scientific Series No. 38*, Canada Centre for Inland Waters, Inland Waters Directorate, Burlington, Ontario, 1974, 26 pp.

Robertson, A., "A New Species of Diaptomus (Copepoda, Calonoida) from Oklahoma and Texas," *American Midland Naturalist*, Vol. 93, 1975, pp. 206-214.

Robertson, A., "U.S. IFYGL Shipboard Data Acquisition System," *IFYGL Technical Manual Series, No. 5*, National Oceanic and Atmospheric Administration, Rockville, Maryland, March 1974, 40 pp.

Robertson, A., "Zooplankton," in: *Encyclopedia of Environmental Sciences*, McGraw-Hill Book Co., New York, New York, 1974, pp. 700-701.

Robertson, A., F. C. Elder[2], and T. T. Davies[2], "IFYGL Chemical Intercomparisons," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, pp. 682-696.

Robertson, A., C. W. Gehrs[2], B. D. Hardin[2], and G. W. Hunt[2], "Culturing and Ecology of Diaptomus clavipes and Cyclops vernalis," *Ecological Research Series, EPA-660/3-74-006*, Environmental Protection Agency, Washington, D.C., 1974, 226 pp.

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[1]No longer affiliated with this Laboratory.

[2]Not affiliated with this Laboratory.

Rooney, J. P.[2], and S. C. Chapra, "Water Quality Analysis of the Raritan Bay System," report prepared for the Water Programs Branch, Environmental Programs Division, Environmental Protection Agency - Region II, Environmental Protection Agency, New York, New York, December 1974, 62 pp.

Sacketts, W. M.[2], C. W. Poag[2], and B. J. Eadie, "Kerogen Recycling in the Ross Sea, Antarctica," *Science*, Vol. 185, 1974, pp. 1045-1047.

Saylor, J. H., "Nearshore Bottom Stability in Relation to Changing Lake Levels," in: *Proceedings, Technical Conference on Lake Michigan Shoreland Planning*, Chicago, Illinois, 1974, pp. 42-55.

Scavia, D., "Implementation of a Pelagic Ecosystem Model for Lakes," *Eastern Desciduous Forest Biome - IBP Report* #74-4, International Biological Program, Troy, New York, 1974, 65 pp.

Scavia, D., J. A. Bloomfield[2], J. S. Fisher[2], J. A. Nagy[2], and R. A. Park[2], "Software for a Generalized Model for Simulating Ecosystems," *Simulation*, Vol. 23, 1974, pp. 51-56.

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[2]Not affiliated with this Laboratory.

APPENDIX III B

GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY

CONTRACTORS' PUBLICATIONS

FY 1975

Atwater, M. A., "The Radiation Budget of Lake Ontario (IFYGL)," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, pp. 250-258.

Atwater, M. A., and J. T. Ball, "Cloud Cover and the Radiation Budget Over Lake Ontario During IFYGL," *Final Report*, Volumes I and II, IFYGL Contract No. 2-35353, October 1974, 178 pp.

Ball, J. T., "Cloud Analysis and Diagnosis Over Lake Ontario and Vicinity (IFYGL)," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, pp. 704-712.

Bean, B. R., C. B. Emmanuel, R. O. Gilmer, and R. E. McGavin, "Spatial and Temporal Variations of the Turbulent Fluxes of Heat, Momentum, and Water Vapor Over Lake Ontario During IFYGL," *NOAA Technical Report ERL 313-WMPO 5*, National Oceanic and Atmospheric Administration, Boulder, Colorado, February 1975, 57 pp.

Bennett, J. R., "On the Dynamics of Wind-Driven Lake Currents," *Journal of Physical Oceanography*, Vol. 4, 1974, pp. 400-414.

Ching, J. K. S., "A Study of Lake-Land Breeze Circulation Over Lake Ontario From IFYGL Buoy Observations (IFYGL)," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, pp. 259-268.

Csanady, G. T., "Hydrodynamics of Large Lakes," *Annual Review of Fluid Mechanics*, Vol. 7, 1975, pp. 357-385.

Csanady, G. T., "Lateral Momentum Flux in Boundary Currents," *Woods Hole Oceanographic Institution Contribution* No. 3409, Woods Hole, Massachusetts, 1974, 29 pp.

Csanady, G. T., "Spring Thermocline Behavior in Lake Ontario During IFYGL," *Journal of Physical Oceanography*, Vol. 4, 1974, pp. 425-445.

Csanady, G. T., "Topographic Waves in Lake Ontario," *Woods Hole Oceanographic Institution Contribution* No. 3543, Woods Hole, Massachusetts, 1975, 23 pp.

Csanady, G. T., and J. T. Scott, "Baroclinic Coastal Jets in Lake Ontario During IFYGL," *Journal of Physical Oceanography*, Vol. 4, 1974, pp. 524-541.

Dilley, J. F., and A. Pavlak, "Analysis of Lake Shore Ice Formation, Growth, and Decay," *IFYGL Phase 2 Final Report*, NOAA Contract No. 3-35163, General Electric Company, Ocean Sciences Laboratory, 1974, 100 pp.

Foreman, J., "IFYGL Physical Data Collection System: Intercomparison Data," *NOAA Technical Memorandum EDS CEDDA-3*, U.S. Department of Commerce, Washington, D.C., May 1975, 7 pp.

Jalickee, J. B., J. K. S. Ching, and J. A. Almazan, "Objective Analysis of IFYGL Surface Meteorological Data (IFYGL)," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, pp. 733-750.

Kalvaitis, A. N., "An Analysis of Current Speed Errors from the 1972 IFYGL Lake Ontario Intercomparison Station," *Technical Report*, National Oceanographic Instrumentation Center, National Ocean Survey, National Oceanic and Atmospheric Administration, Washington, D.C., June 1975, 60 pp.

Mortimer, C. H., and D. L. Cutchin, "The Internal Wave Response of the Lake Ontario Thermocline to the Passage of a Storm, 9-10 August 1972," *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union*, National Oceanic and Atmospheric Administration, Rockville, Maryland, August 1974, pp. 129-145.

Rasmusson, E. M., and J. A. McCulloch, "The IFYGL Lake Meteorology Program," in: *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union*, National Oceanic and Atmospheric Administration, Rockville, Maryland, August 1974, pp. 56-69.

Stoermer, E. F., and A. L. Schaedel, "Data Analysis-Intensive Study of Lake-Wide Changes in Spring Phytoplankton Assemblages," *Final Report*, IFYGL/NOAA Grant 04-3-158-72, University of Michigan, Ann Arbor, Michigan, January 1975, 67 pp.

Strong, A. E., "Great Lakes Temperature Maps by Satellite (IFYGL)," in: *Proceedings, Seventeenth Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Michigan, 1974, 321-333.

Strong, A. E., J. L. Hart, and J. A. Prichard, "Utilizing NOAA Satellite Data for the Development of Great Lakes Temperature Maps," *Final Report*, U.S. IFYGL Task No. 61, National Satellite Service, National Oceanic and Atmospheric Administration, 1975, 23 pp.

Wilson, J. W., and D. M. Pollock, "Rainfall Measurements During Hurricane Agnes," in: *Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union*, National Oceanic and Atmospheric Administration, Rockville, Maryland, August 1974, pp. 40-55.

Wilson, J. W., and D. M. Pollock, "Rainfall Measurements During Hurricane Agnes Using Three Overlapping Radars," *Journal of Applied Meteorology*, Vol. 13, 1974, pp. 835-844.

APPENDIX IV

GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY

PRESENTATIONS

FY 1975

Adams, C. E., Jr.[1], "Winter Thermal Structure of Lake Superior," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Assel, R. A., "Great Lakes Ice Thickness Prediction," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Aubert, E. J., "International Field Year for the Great Lakes (IFYGL)," paper presented at the American Association for the Advancement of Science (AAAS) Annual Meeting held in New York, New York, January 26-31, 1975.

Bell, G. L., "Diffusion at Oswego Harbor, New York," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Derecki, J. A., "Multiple Estimates of Lake Erie Evaporation," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Eadie, B. J., and A. Robertson, "An IFYGL Carbon Budget for Lake Ontario," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Grumblatt, J. L., "Some Aspects of Lake Ontario Heat Advection," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Liu, P. C., "Duration-Limited Wave Spectra in Lake Ontario during the 1972 Hurricane Agnes," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Liu, P. C., and T. A. Kessenich, "IFYGL Ship Wave Observations vs Wave Measurements," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

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[1]No longer affiliated with this Laboratory.

[2]Not affiliated with this Laboratory.

Liu, P. C., and R. J. Robbins[2], "Wave Data Analysis at GLERL," paper presented at the International Symposium on Ocean Wave Measurement and Analysis held in New Orleans, Louisiana, September 9-11, 1974.

Nalepa, T. F., and N. A. Thomas[2], "Macrobenthos and Sediment Analysis of Lake Ontario, June and November 1972," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Pickett, R. L., and F. P. Richards[1], "Lake Ontario Mean Temperature and Currents in July 1972," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Pinsak, A. P., "Heat Storage in Lake Ontario," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Pinsak, A. P., and R. L. Chambers, "Material Transfer through the Straits of Mackinac," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Quinn, F. H., "Detroit River Flow Characteristics," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Rao, D. B., and D. J. Schwab, "Two Dimensional Free Oscillations of Natural Basins on a Rotating Earth: Applications to Lakes Ontario and Superior," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Robertson, A., "Plankton-Mediated Transport of Energy-Related Pollutants," paper presented at the Second ICMSE Conference on the Great Lakes held in Argonne, Illinois, March 25-27, 1975.

Robertson, A., and B. J. Eadie, "A Carbon Budget for Lake Ontario," paper presented at the Nineteenth Congress of the International Association of Limnology held in Winnipeg, Manitoba, August 22-29, 1974.

Robertson, A., F. C. Elder[2], and T. T. Davies[2], "Chemical Intercomparison Programs Conducted during IFYGL," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

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Rogers, J. C., "Forecasting St. Marys River Ice Problems at the Little Rapids Cut," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Rogers, J. C., "Investigation of Ocean-Atmosphere Teleconnections during the Climatic Fluctuation of the 1960's over North America," paper presented at the Climatology Conference and Workshop of the American Meteorological Society held in Asheville, North Carolina, October 8-11, 1974.

Rogers, J. C., "A Long-Range Forecasting Method of Freeze-Up Dates and Ice Extent on the Great Lakes," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Saylor, J. H., "Current Measurements with Drogues in Lake Ontario," paper presented at the Seventeenth Conference on Great Lakes Research held at McMaster University, Hamilton, Ontario, August 12-14, 1974.

Sloss, P. W., and J. H. Saylor, "Large-Scale Current measurements in Lake Huron," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Tarapchak, S. J., "Phytoplankton Distribution and Indicators of Trophic State in Minnesota Lakes," paper presented at the Thirty-Eighth Annual Meeting of the American Society of Limnology and Oceanography, Inc., held in Halifax, Nova Scotia, June 23-26, 1975.

Tarapchak, S. J., "Phytoplankton Diversity in the Great Lakes," paper presented at the Eighteenth Conference on Great Lakes Research held at the State University of New York at Albany, Albany, New York, May 20-23, 1975.

Vanderploeg, H. A., and J. R. Kercher[2], "Effects of Limnological Variables on Bioaccumulation Factors," paper presented at the Fifth International Congress of Radiation Research held in Seattle, Washington, July 14-20, 1974.

Vanderploeg, H. A., R. S. Booth[2], and F. H. Clark[2], "A Specific Activity and Concentration Model Applied to Cesium-137 Movement in a Eutrophic Lake," paper presented at the Fourth National Symposium on Radioecology held in Corvallis, Oregon, April 14, 1975.

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APPENDIX V

GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY

FACILITIES

June 30, 1975

GLERL leases two adjacent buildings in Ann Arbor, Michigan. The office of the Director and some of the other offices are at 2300 Washtenaw Avenue. This is a block-type building with 5,446 ft^2 of office and laboratory space on two levels. There is parking space for 25 cars. The second building is at 2320 Washtenaw Avenue. This is a block-type building with 7,224 ft^2 of office and laboratory space on two levels. Behind this building is space for another 25 cars.

In addition, GLERL occupies 3,500 ft^2 of space in a dockside warehouse (leased by the National Ocean Survey, Lake Survey Center) in Monroe, Michigan.

FIELD OBSERVING FACILITIES

The Marine Instrumentation Laboratory, is responsible for the planning, development, and maintenance of the Data Acquisition Systems employed by the various research projects.

Much of GLERL's field experiments are carried out on the *R/V Shenehon*, a converted T-boat, length - 65.5 ft, beam - 17.75 ft, and draft - 6.5 ft. The vessel has a 2,100 nautical mile range with a cruising speed of 9.5 knots and is fully complimented with navigational, communication, and depth sounding equipment. Presently, the forward electro-hydraulic winch carries 3,000 ft of 5/32-inch wire cable for hydrographic casts, limnological sampling, coring, and dredging, but it is capable of carrying a 10-conductor cable. The electric after-winch is equipped with 690 ft of 6-conductor cable for electronic bathythermograph and turbidity measurements. A 120 ft^2 air-conditioned laboratory with lake and potable water supplies is the primary work area for on-board biological and chemical analyses and also houses the 14-channel physical data logger for recording meteorological, oceanographic, and position information with output on ASCII coded punch paper tape.

A special plankton trap for grazing experiments, in-situ chemical sampling probes for $CaCO_3$ saturation experiments, and incubation chambers for culture and radioactive isotope uptake experiments are through prototype stages of development.

Two 21-ft aluminum outboard boats are used for shallow water experiments and to service current, wave, and air-sea interaction data acquisition systems.

The wave measurement program employs five Datawell Wave-Rider buoys

which transmit the water surface displacement signal over a range of 8-10 miles with receiver and analog tape recorders on shore. The air-sea interaction system consists of four staff relay-type wave gages supported on a tower in 20 m of water extending 10 m into the air with six channels of wind and temperature data telemetered to a shore recording station.

In our winter current studies, sixteen AMF Model 610B vector averaging current meters, each capable of recording 15 minutes averaged current vectors and temperatures for a duration of over 6 months were used in conjunction with 10 AMF Acoustic Releases and a Canadian designed subsurface float. One hundred percent recovery was obtained over the last deployment period; the network will be increased for FY 76 experiments.

Plans are to mount meteorological data sensors on buoy platforms built for the IFYGL project. Wind and temperature sensors from the IFYGL packages will be used with a micro processor controlled data logger under development by the Marine Instrumentation Laboratory.

Meteorological data at ice observation sites are recorded by the Towner 2000 portable meteorological data acquisition system which produces an ASCII coded punched paper tape with data on wind, temperature, radiation, and relative humidity. The lake temperature network consists of 14 Leupold-Stevens Model 7000 water temperature gages with output on 16 level 2-inch wide BCD coded punch paper tape, supplemented by four Bristol resistance thermometer analog recorders.

Future data reduction will be done by a DEC LAB 11/40 DATA ACQUISITION SYSTEM consisting of a PDP-11/40 CPU with 16 K memory, 2.4 megaword disks, a 9-track bi-phase 1/2-inch magnetic tape unit, 8 channel analog to digital converter, real-time clock, and electrostatic printer/plotter. It is hoped this can be implemented during FY 76.

LABORATORY OBSERVING FACILITIES

Chemistry Laboratory

The Chemistry Laboratory is used to measure chemical properties of the Great Lakes. Carbon concentrations are measured with a carbon analyzer; metal and major ion concentrations are determined with an atomic absorption spectrophotometer; and chlorophyll and nutrient concentrations are measured with a visible-UV spectrophotometer. Phosphate concentrations are also followed with an autoanalyzer. Recently, a gas chromotograph was acquired for measurement of volatile materials. Analytical balances at several levels of precision are available as are smaller pieces of standard chemical equipment and glassware.

Biology Laboratory

The Biology Laboratory is equipped to carry out a variety of experimental studies involving benthos, zooplankton, and phytoplankton. Studies measuring nutrient uptake with radioactive isotopes are conducted with the aid of a liquid scintillation counter, and the effects of zooplankton feeding on particle size distributions are monitored with a Coulter Counter. Controlled environment chambers allow the culturing of various kinds of plankton. An inverted microscope is used to obtain species counts for algae, and conventional microscopes are used to identify and count zooplankton and benthos.

Ice Laboratory

The Ice Laboratory is currently located in the Federal Building in Detroit. Included in the laboratory is a two-compartment cold room. The outer compartment, maintained at a temperature of -12°C, has an area of 180 ft^2 and serves as a working area. Equipment includes work benches, a band saw and microtome for ice sample preparation, and a universal stage fitted with a camera mount for studies of ice crystal size and orientation. The inner compartment, maintained at a temperature of -32°C, has an area of 60 ft^2 and is used for ice sample storage. The facility supports the ice crystallography analysis programs and is presently being used to analyze ice samples collected during the 1974-75 winter season. Future use of the laboratory will include studies of the physical properties of ice where artificial conditions can adequately represent the natural environment. Artificial simulation of ice growth and decay rates, strength tests of natural lake ice, and studies of the optical properties of ice are some of the projects which may be initiated, depending on available staff.

SUPPORT FACILITIES

Computer Systems

The GLERL Computer Systems staff contributes greatly to the success of the GLERL projects in the following activities: data management, analysis, modeling, and evaluation. The programming activities are accomplished via remote batch processing through a CDC-U200 communications terminal connected to a CDC 6600 computer located at the Environmental Research Laboratories in Boulder, Colorado.

Plans for FY 76 include the upgrading of the CDC-U200 terminal to improve card reading and printing time and to connect a Tektronix 4014 Graphical Display Terminal to the CDC 6600 computer in Boulder.

Library

GLERL has a small Library (400 ft^2) with a wide variety of periodicals,

reference materials, and bibliographies. A Librarian is available to help scientists find what they need in the GLERL library and to arrange for interlibrary loans through the many libraries available in the area and through Environmental Data Service facilities.

Publications

All GLERL scientific reports are edited and typed in the Publications Unit. One Magnetic Tape-Selectric Typewriter and one Magnetic Card II-Selectric Typewriter provide both print-ready hard copy and magnetic storage of GLERL reports.

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