

The History of the Great Lakes Environmental Research Laboratory

Significant scientific accomplishments are listed in green.

1974

GLERL, established on April 25, 1974 in Ann Arbor, MI, was formed by combining the staff of the International Field Year for the Great Lakes (IFYGL) Project Office in Rockville, MD with the Limnology and Computer Divisions of the Lake Survey Center in Detroit, MI. Dr. Eugene Aubert, Director.



1975

GLERL organized into four research groups:
- Physical Limnology and Meteorology
- Chemistry and Biology
- Lake Hydrology
- Special Projects

GLERL Library formed.
Acquired the 65-foot Research Vessel *SHENEHON* from the US Army Corps of Engineers. Home port in Monroe, MI.



Hosted a workshop on priority Great Lakes Research initiatives: Deficiencies included knowledge of nearshore process including physical, chemical, and biological components and exchange processes including lakes and land, lakes and atmosphere, and lakes and sediments. The nearshore was expected to be the most variable and have the greatest anthropogenic influences.

Developed a functional model of the fluctuations in major components in the Lake Ontario ecosystem – nutrients, pH, alkalinity, benthos biomass, phytoplankton, and zooplankton.

Developed a transient model of the flow of the Detroit River.

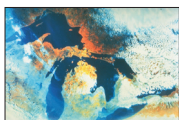
1976

Developed a technique for long range forecasting of percent of maximum ice cover.

Developed a four-level numerical hydrodynamic model of Lake Ontario.

Developed a water quality model of Maumee Bay and western Lake Erie and used to assist in tradeoff analysis of alternative water resources plans.

Developed and tested a phosphorus model to simulate the long-term variation of phosphorus concentration in the Great Lakes and to estimate phosphorus loads. The model supports the reductions specified by the water quality agreement for reduction in algal production for all lakes except Lake Erie.



1977

A model was developed to predict the effect of waste abatement programs and human development of the drainage basin on Great Lakes phosphorus levels. The model was used to prepare testimony for hearings by the State of Michigan on effects of a limitation of phosphorus in detergents on water quality of Lakes Erie, Michigan and Huron

A mathematical hydrologic response model was developed and used to simulate lake levels and flows that would have occurred naturally from 1860 to 1975 to test the effect of lake regulation at Sault Ste. Marie on water levels in the upper lakes.

A theoretical model was developed to simulate the intensity of storm surges on Lake Erie caused by lake-wide wind forcing.



1978

A numerical circulation model was successfully used to simulate the transport of mirex in Lake Ontario based on probable sources in the Niagara River and Oswego River.

A dynamic storm surge model of Lake Erie was developed at GLERL and tested by the National Weather Service.

Phytoplankton nutrient experiments indicated that primary productivity, chlorophyll production, and phytoplankton growth rates are coupled with variations in phosphorus turnover rates, silica concentrations, and silica to phosphorus ratios.



1979

Multilayer ecological models were applied to study the vertical structure of physical, chemical, and biological properties in Lake Ontario. Examined ecosystem response to variations in winds and water temperature.

The GLERL total phosphorus management model was used to estimate loading restriction necessary to meet water quality goals in the Great Lakes. These estimates were used by the International Joint Commission to determine phosphorus loading criteria for the Great Lakes Water Quality Agreement.

A two-dimensional cross-sectional model of water circulation was coupled to a chemical and ecological model of Lake Ontario, and the spring regime was simulated. The model reproduced the observed large gradients of many chemical and ecological variables.

A Great Lakes spill model was developed to determine the movement of oil and hazardous material spills. The model successfully predicted the drift of the abandoned ship Labrador in April.

GLERL begins to study cycling of toxics in the Great Lakes focusing on PAH and PCB.

Great Lakes precipitation from 1900 to 1979 was completed. A change occurred in the mid 1930's, increasing the average annual precipitation by 8% and the standard deviation by 40%. This has a major impact on Great Lakes basin supplies and water levels.

1980

GLERL initiated its sediment trap program to follow deposition of particles in Lake Michigan.

An improved method for computing lake-wide evaporation was developed, taking into account atmospheric stability and ice cover.

Mathematical models at GLERL have been used to support the Great Lakes Environmental Planning Study to appraise the effect of phosphorus availability in the Great Lakes eutrophication management.



1981

American Federation of Government Employees Local 3908 established.

GLERL zeroed out of FY1982 President's budget proposal, but is restored by Congress.

A conceptual model reflecting the state of knowledge of phosphorus cycling was completed. Nutrient release by zooplankton was identified as a major recycling mechanism of nutrient supply to algae.

A non-point source pollution model termed Water-Shed was developed to determine the most cost-effective pollution control strategy for use by the U.S. Soil Conservation Service and the U.S. Environmental Protection Agency.

In cooperation with NOAA's Office of Marine Pollution Assessment (OMPA), a model designed to estimate the equilibrium partitioning of synthetic organic compounds between dissolved and solid phase within and aquatic ecosystem based on solubility and vapor pressure of the compound was developed.

1982

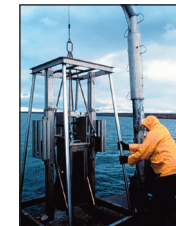
Research vessel operations transferred to Grand Haven, MI, effectively placing a priority on Lake Michigan research.

The toxic's cycling program calibrated a long-term near-equilibrium model for PCBs. Data hidden in the model suggested that the distribution of PCBs was shifting toward the more highly chlorinated compounds.

The interdependent tank-cascade model of basin runoff, which uses analytical solutions of climatological considerations relevant to large watersheds has been refined and applied to the Lake Ontario basin.

Laboratory studies of intact sediment cores indicated that significant quantities of nutrients were released from aerobic sediments promoting recycling of nutrients within the aquatic system.

A consumptive use study of Great Lakes water aided by estimates of a fivefold increase in consumptive use over the next 60 years suggests an average lake level drop of 21 cm for the unregulated lakes.



1983

VAX 11/780 mainframe computer online.

Complexation of toxic organics by natural organic matter was demonstrated for pore waters in Great Lakes sediments and the complexed toxic organics were found to have limited bioavailability.

The GLERL large basin runoff model was improved with regard to snowmelt and evapotranspiration. The calibration was improved, formalized, and encapsulated for semiautomatic use. A probabilistic outlook package for forecasting Lake Superior net basin supply was completed.

An improved spill model was made available to increase resolution, multiple spill capability, zoom, and conformance to the GLERL modeling system. This showed that 2.5 km resolution was nearly perfect.

A multi-year survey of the entire benthic community in nearshore Lake Michigan documented that miobenthos were responsible for about 50% of the respiration while only representing about 10% of the bioassess.



1984

Studies of primary production in Lake Superior demonstrate that abundant small cyanobacteria (bacteria-sized phytoplankton) account for one-half of the total primary production.

The 1983 Lake Michigan Ecosystem Experiment was completed. It was found that the transparency of the water column increased during the last year, suggesting that the quality of the water in the lake improved likely due to an increase in large cladocerans and a reduction in algae due to increased salmonid predation on alewife.

A wind generated wave prediction model was developed and tested with remarkable agreement with collected wave data. The software was given to the Great Lakes NWS forecast offices.

GLERL begins deployment of bottom-resting observatories to monitor sediment resuspension and transport to better understand the movement of particles that are so critical to nutrient and pollutant transport in the Great Lakes.



1985

The GLERL non steady-state mixing model for sediments was validated against the vertical distribution of lead in cores from high sedimentation areas of the Great Lakes.

Bacterial production was found to account for a significant portion of the total biomass production in the Great Lakes.

The semi-automatic software package to predict water supplies to Lake Superior was installed on the U. S. Army Corps of Engineers (Detroit District) mainframe computer for use in forecasting Great Lakes water levels for the International Joint Commission. A similar package was developed for Lake Champlain and provided to the National Weather Service.

The Pathfinder Trajectory Prediction Model was used several times by the U.S. Coast Guard and the NOAA Hazardous Materials Response Team to predict the movement of spills.

GLERL participates in the multi agency Upper Great Lakes Connecting Channels Study. GLERL provides a phosphorus mass balance model for Lake St. Clair.



1986

Dr. Eugene Aubert retires as GLERL director in June 1986.

Dr. Frank Quinn serves as acting director from June to November.

Dr. Alfred Beeton becomes GLERL's new Director November 1986.



Extensive resuspension of contaminated sediments was found in all the Great Lakes, and calculations indicate that sediment recycling is a major process controlling the long-term concentration of organic contaminants.

Model simulations to evaluate the influence of gradients of both phosphorus load and alewife abundance indicate that summer plankton composition and water clarity are controlled largely by predation, and thus, top-of-the-food-web management practices can cascade down to affect water quality.

1987

GLERL moves into a new building in January 1987, consolidating facilities from two buildings on Washtenaw Ave. and the Marine Instrumentation Lab on Felch St. in Ann Arbor.



A first generation optimization model that takes uncertainty into consideration was applied to strategies for management of phosphorus loading to the Great Lakes.

GLERL developed a PC-based computer program to assist in planning for storm surges on the Great Lakes in response to requests from the Department of Natural Resources of Michigan and Ohio, the Army Corps of Engineers, and several Sea Grant Programs.



1988

Four critical research needs identified as: Natural Hazards, Global Climate Change, Pollutant Effects, and Fisheries Oceanography.

GLERL approved by NRC for resident research associateship program in November.

A new theory was proposed to explain concentration-variable selection of different food types by zooplankton and other predators. The paradigm was developed from microcinematographic observations.

A contaminant fate and transport model for Lake St. Clair was used to predict the extent of cross-boundary (US-Canada) movement of a generic contaminant under various loading scenarios.

A lake evaporation model was calibrated for Lakes Superior, Huron, St. Clair, and Ontario against daily surface temperature data derived from NOAA satellite coverage.

Models of rainfall and runoff, overlake precipitation, heat storage, and lake evaporation were combined with operational regulation plans and models to estimate Great Lakes water levels.

1989

GLERL reorganized to create the Physical Science Division, the Biogeochemical Science Division, a combined Marine Instrumentation Lab, and a Computer Information Systems Group. The Administrative office and the Publications Unit remain under the Director's Office.

GLERL library receives a unique, self contained Bibliofile Intelligent Catalog station from NOAA Headquarters library for access to NOAA libraries catalog database.

The Cooperative Institute for Limnology and Ecosystems Research (CILER) established. Agreement signed by Univ. of Michigan and Michigan State Univ. Presidents and NOAA Administrator. Dr. Russell Moll becomes CILER's first director.

Initial studies employing the use of body residue as a dose metric for the toxicity of PAHs showed that *Diporeia* requires 6 $\mu\text{mol g}^{-1}$ to produce 50% mortality as the molar sum of the PAH showing molar additivity and consistency with a non-polar narcotic mechanism of toxic action.

A long-term fate model for contaminants in Lake St. Clair sediments was completed.

Studies of the distributed costs for selected contaminated sites demonstrated that the costs to government and for damage to natural resources varied between 30 and 50% of the total cost of damage at sites such as New Bedford Harbor, MA, James River, VA, and Hudson River, NY and could range from tens of millions of dollars to over a billion dollars depending on the site.

1990

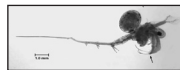
GLERL becomes the NOAA CoastWatch node for the Great Lakes.

GLERL assumes ownership of the former Coast Guard base at Muskegon, MI and establishes the GLERL Muskegon Facility. The site includes three buildings and research vessel dockage. The R/V Shenehon home port relocates from Grand Haven to Muskegon.



GLERL initiated a new program on non-indigenous species to address the recent invasion of the zooplankton *Bythotrephes cederstroemi* and the zebra mussel (*Dreissena polymorpha*).

Biomass estimates of the benthic macroinvertebrate community in Lake Michigan showed that estimates were a function of depth and substrate and that the amphipod *Diporeia* was clearly the dominant form and provided a significant connection between the benthic community and the pelagic food web.



1991

GLERL receives the first of five yearly add-ons by Congress to conduct invasive species research.

A multi agency program to examine the impact of the zebra mussel in the Great Lakes was initiated with a study on the impact in Saginaw Bay.

A carbon budget was developed for *Diporeia* showing the importance of the spring diatom bloom for biomass production of this important benthic organism.

The CoastWatch program calibrated the satellite-derived water surface temperature data against water temperature from NOAA weather buoys.



1992

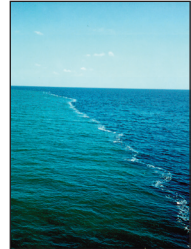
GLERL connected to the internet.

GLERL hires a full-time safety and environmental compliance officer.

A conceptual lake-averaged thermodynamics ice cover model was linked with GLERL's lake evaporation model and calibrated using observed ice data for Lakes Erie, Superior, Michigan, Huron, and Ontario.

Routine operation of the Great Lakes Forecasting System in cooperation with Ohio State University provides wind, wave, and temperature forecasts for Lake Erie as the prototype.

Dated core studies from the Gulf of Mexico confirmed enhanced coastal production in recent sediments demonstrating that nutrient enrichment of the Gulf of Mexico is a relatively recent phenomena.



1993

GLERL's Lake Michigan Field Station in Muskegon, MI officially established. Building modifications and renovations were completed to include scientific laboratories, offices, and storage.

GLERL is designated the Great Lakes Research Office by NOAA Administrator John Knass.

In contrast to the spring when zebra mussels remove phytoplankton from the water column, the filtering activity of the mussels declines when the bluegreen alga *Microcystis* was dominant.

The model for lake ice and lake evaporation was completed and was used to simulate the lake-averaged ice cover climatology for each Great Lake.

Remarkable internal waves were found in Lake Champlain as a large internal seiche with wave heights as high as 30-40 m.

GLERL provided sediment transport analysis for Green Bay to the U.S. EPA's Green Bay Mass Balance Program, demonstrating that the horizontal transport of suspended sediment was not adequate to remove all the tributary input to southern part of the bay.

1994

Thunder Bay, Lake Huron is designated as a Marine Sanctuary, and is administratively housed at GLERL.

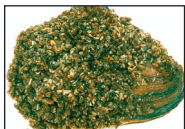
First GLERL website online in June.

GLERL senior research scientist relocated to Muskegon facility to establish a remote research outpost on Lake Michigan

The Great Lakes Coastal Forecasting System was expanded to provide Lake Erie nowcasts four times a day to support the U.S. Environmental Protection Agency.

A survey of native mussels in Lake St. Clair indicated that the native population had been decimated by the encroachment of the zebra mussel, and that native mussels will be completely eliminated from the lake within a few years.

A sediment chronology and history was established for metal and organic contamination of Lake George, a receptor site on the St. Marys River chronicling the pollution of the lake during WWII.



1995

Muskegon facility officially named the Lake Michigan Field Station.

GLERL is zeroed out of FY1996 House appropriations bill. Last minute amendment restores the lab's full funding. GLERL union holds letter writing campaign to help restore funding.

The Great Lakes Water Resources Forecasting System was developed and coupled with NOAA's extended climate predictions to produce outlooks that can now extend out to 30 days or more.

The conclusion of the 1990-1993 Saginaw Bay study of the impact of the zebra mussel invasion demonstrated a dramatic shift in the routing of energy and nutrients through the food chain. There was also evidence that zebra mussels encourage growth of harmful blue-green algae.

Sediment trap studies in Saginaw Bay demonstrated that zebra mussels are increasing the amount of resuspendable sediments even in the deeper parts of the bay.



1996

Dr. Alfred Beeton retires from GLERL to become Acting Chief Scientist for NOAA in April 1996

Dr. Peter Landrum serves as Acting Director.

GLERL Partnership Agreement signed between GLERL Management and GLERL Union.

GLERL receives the R/V Halcyon from the Corps of Engineers in October. In November, the Halcyon sinks at the dock in Muskegon while being winterized. It is later sold to the private sector.

GLERL Website Hits = 175,329

A Lake St. Clair circulation model was produced to better predict macrophyte deposits on shore to help predict beach closings.

A new Lake Michigan bathymetry map with a 10 m contour interval was produced.

A nearshore model of circulation and water discharges from Milwaukee Harbor showed that the water intake should be moved to prevent an outbreak of *Cryptosporidium*.

Combined models of large-basin rainfall-runoff and large-lake thermodynamics and heat storage into the Great Lakes Water Resources Forecasting System is used by the US Army Corps of Engineers, the National Weather Service, Ontario Hydro, the New York Power Authority, and NOAA's Midwestern Climate Center.

GLERL and the Midwest Climate Center investigate changes in climate variability using data for climates that actually exist to the south and west of the Great Lakes and that resemble some of the earlier 2xCO₂ general circulation model scenarios.

1997

Dr. Stephen Brandt becomes the new director of GLERL.

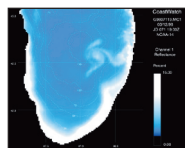


Official retirement of the VAX mainframe computer.

GLERL contributes to an evaluation of the state-of-the-art testing methods for sediment toxicity as part of the U.S. EPA program Assessment and Remediation of Contaminated Sediments.

The risk in operational decisions was quantified using the Great Lakes probabilistic water level forecasting model.

A major interagency, international, and interdisciplinary program on the impact of winter-spring storms on southern Lake Michigan was begun. GLERL has overall leadership of this Episodic Events (EEGLE) program which includes over 40 investigators from 16 institutions and lasts for more than 6 years. The major storms resuspend very large amounts of sediments and associated contaminants in all of the Great Lakes.



1998

GLERL reorganized into one science division and one scientific support division, plus Marine Instrumentation Lab, Computer, Administrative, and Information Services teams.

GLERL, CILER, and Michigan Sea Grant co-host the first National Ocean Sciences Bowl Midwest Regional Competition for high school student teams.

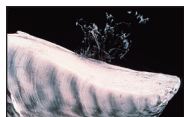
The Cooperative Institute for Climate and Ocean Research (CICOR) established between NOAA and Woods Hole Oceanographic Institute.

GLERL Library upgraded to an online card catalog.

First GLERL webcam installed at Lake Michigan Field Station in Muskegon, MI.

Winter severity and ice cover were found to be significantly lower for winters following a strong warm EL Nino event relative to the average of other winters in a 1950-1994 period.

Declines in benthic productivity were observed. The decline in oligochaetes and fingernail clams was thought to be due to phosphorous abatement. The decline in the amphipod *Diporeia* was thought to be due to the influence of the zebra mussel. The average *Diporeia* decline in southern Lake Michigan was 82%.



A modular middle Great Lakes hydrologic routing model, MIDLAKES, was developed and coordinated between the US and Canada for use in binational Great Lakes studies and operational regulation and forecasting of lake hydrology.

The updated bathymetry for Lake Erie was completed, and maps were produced.

1999

Seven nearshore water intake sites (Bay City, MI; Green Bay, WI; Sault Ste. Marie, MI; St. Joseph, MI; Sandusky Bay, OH; Put-In-Bay, OH; and Erie, PA) in the Great Lakes were chosen, and regression analysis showed a warming trend at five of the seven sites.

GLERL identified the extirpation of native unionid mussels in Lake St. Clair due to the invasion and spread of zebra mussels.

The planktonic ecosystem structure across all five Great Lakes was evaluated and was found to be limited by phosphorous limitations and zebra mussel competition such that the lower lakes are becoming similar to the upper lakes.

GLERL determined that PCBs do not take a direct route on particles from the water column to the sediment, rather a large portion of the PCBs recycle off the particles, particularly the lower molecular weight compounds.

2000

GLERL Website Hits = 440,572
Apparent tumors in zooplankton in the Great Lakes were identified as ellobiospid parasites.

GLERL developed a probabilistic model and the associated graphic user interface for predicting Great Lakes water levels based on the NOAA climatology forecasts.

The updated bathymetry for Lake Ontario was completed, and the map was published.

GLERL established several near-lake real-time meteorological stations to improve lake circulation modeling and to provide data to the public via the Internet.



2001

GLERL Website Hits = 710,118

GLERL partners with Sea Grant to hire a Great Lakes Extension Agent located at GLERL to increase GLERL outreach capacity and responsiveness to constituent needs.

GLERL Library web site goes live on the Internet.

Ships entering the Great Lakes with no ballast on board but containing residual non-pumpable ballast were demonstrated to have a variety of species of invertebrates living in the water and sediment creating a source of invaders to the Great Lakes.

GLERL demonstrates that the decline in *Diporeia* in Lake Michigan has a significant impact on two species of forage fish: bloater, and alewife.

The declines in benthos in Lake Ontario and Lake Huron were found to be similar to that observed in Lake Michigan and appear to result from zebra mussel food competition.

Lake Michigan is invaded by two new benthic species, the amphipod *Echinogammarus ischnus* and the mussel *Dreissena bugensis*.



2002

GLERL Website Hits = 862,717

Acquired the 80-foot Research Vessel *LAURENTIAN* from the University of Michigan.



Assessed the frequency and variability of coastal resuspension events in Lake Michigan using ADCP acoustic backscatter.

Report on estimates of the Lagrangian time and space scales associated with coastal circulation in southern Lake Michigan.

Develop and test computer model of Lake Michigan hydrodynamics and sediment transport.

Report changes in the structure and function of the Lake Michigan food web due to invasion by zebra mussels.

Publish analysis of Great Lakes ice cover for a 28 winter period (1973-2000) on the Internet.

Evaluate the impact of declining food resources on Great Lakes fishes.

Complete and report on classifying and mapping Great Lakes ice cover using satellite synthetic aperture radar data.

Complete first year of biological surveys of no-ballast-on-board (NOBOB) vessel ballast tanks in the Great Lakes.

Complete assessment of changes in the benthic macroinvertebrate community in Saginaw Bay, Lake Huron relative to trophic state and invasive species.

2003

GLERL Website Hits = 1,150,261

NOAA announces the formation of a National Center for Research on Aquatic Invasive Species to be housed at GLERL.

Cynthia Sellinger becomes the first official Deputy Director of GLERL.

Redesign of GLERL programmatic structure to focus on Ecosystem Forecasting.

Digital telephone system online in March.

Observatory platform (buoy) deployed in Lake Erie as initial prototype for the Great Lakes Observation Network.

Apply GLERL's Large Basin Runoff Model in a distributed-parameter fashion for the Kalamazoo River Basin and calibrate and adjust the model to account for difference in soil characteristics.

Implement routine distribution of GLERL Coastal Forecasting System wave forecasts to NWS offices via NOAAPORT or other communications systems.

A prototype buoy with wireless internet connection deployed and tested in Lake Erie and Lake Huron measuring oxygen, currents, chlorophyll and turbidity.

Model the disruption of food webs by invasive species with implications to fish populations.

