NOAA Great Lakes Environmental Research Laboratory
2012 Strategic Plan

Appendix C: Logic Models

Note: The logic models on the following pages are planning tools that were used to aid the development of the strategic plan. They contain additional information supplemental to the main text of the plan.

GLERL Top-Level Logic Model								
							Long-Term Outcomes	
Objective	**Theme**	**Resources**	**Activities**	**Outputs**	**Short-Term Outcomes**	**Mid-Term Outcomes**	**Community and Societal Outcomes**	**Organizational Outcomes**
GLERL and partners build a research to operations approach to deliver: 1 or more validated ecosystem forecasts to the Great Lakes user community by 2014; 2 or more by 2016; 3 or more by 2018	Observing Systems and Advanced Technology (OSAT)	Remote sensing observation, buoys, cabled systems, sensors, vessels, and personnel	Deploy optical and acoustic products; deploy observation platforms, vessels, and sensors; design, schedule, and cost observational systems; transition system components to operations on 5 Great Lakes	Year-round ecosystem observation systems, web-based decision support systems, technology transfer, reports, peer-reviewed publicatons, and scientific presentations	OSAT scientists and partners design and operate observing systems to collect information on key ecosystem variables for forecasting efforts	Observing systems support ecosystem forecasting efforts year-round and in all Great Lakes	Real-time data and ecosystem forecasts supported by observing systems are used by Great Lakes managers and other stakeholders to improve management and protect human health and property	GLERL is thought leader for community of practice to develop ecosystem forecasts in the large lakes of the world
	Ecosystem Dynamics (EcoDyn)	Personnel, ship support, equipment, base funds, existing ecological knowledge	Carry out core monitoring program and conduct process experiments that focus on variables/processes of most importance to modelers and Great Lakes stakeholders	Database, reports, peer-reviewed publicatons, and scientific presentations	Researchers design monitoring programs and experiments to improve understanding of critical environmental variables and ecological processes in the Great Lakes	Great Lakes managers and other stakeholders use information to inform decision-making; Modelers have access to and use information for ecosystem modeling and forecasting	Great Lakes managers and other stakeholders use enhanced ecosystem understanding for better management and stewardship of resources	
	Ecological Modeling and Forecasting	Data from observations and ecosystem dynamics groups, models, personnel, equipment	Develop and test models of ecosystem processes at spatial and temporal scales of most interest to Great Lakes stakeholders; Develop Integrated Ecological Modeling Framework by linking physical and ecological modeling and forecasting systems	Web-based tools, technology transfer, reports, peer-reviewed publicatons, and scientific presentations	Great Lakes stakeholders are aware of GLERL ecosystem models and forecasts and understand their measures of accuracy and skill	Great Lakes stakeholders use new data, tools, and forecasts to improve decision-making processes	Ecosytem models and forecasts are used by managers and stakeholders to enhance Great Lakes ecosystem services	
	Information Services and Cooperative Programs	Personnel, research results and predictions, communications infrastructure, strategic internal and external partners, stakeholder input	Seek strategic partnerships, personnel, and funding; convey research results and forecasts using tailored approaches; solicit feedback from stakeholders and partners; coordinate GLERL engagement in regional and national research, management, social science, and education activities	Print, web-based, and oral communication products tailored to targeted stakeholder groups, educational resources, outreach activities, needs assessment results	The public and other stakeholders are aware of GLERL's predictive research and forecast capabilities including uncertainty principles; researchers deliver forecasts most relevant to target audiences	A diverse group of stakeholders uses forecasts to inform decision-making; social science is integrated into research planning	The public is more Great Lakes-literate; Great Lakes stakeholders and the public are resilient in the face of ecosystem change	

Observing Systems and Advanced Technology						
Objectives	**Resources**	**Activities**	**Outputs**	**Short-Term Outcomes**	**Mid-Term Outcomes**	**Long-Term Outcomes**
By 2014, develop remote sensing products supporting scientific understanding of primary productivity and ice formation	Scientists and researchers at GLERL/Cooperative Institute for Limnology and Ecocsystem Research (CILER)	Evaluate satellite (MODIS and MERIS) freshwater algae estimation algorithms; evaluate ice thickness estimation tools; CoastWatch operation	Chlorophyll/primary production imagery and maps; ice thickness and ice classification	Commercial shippers and water intake and beach managers have information to support decisions; image products provided to researchers for warnings and forecast model validation	Managers, researchers, treatment plant operators, and commercial shippers use observations to make improved decisions	Improved management and stewardship of Great Lakes ecosystem; protection of human health and property
By 2015, six operational Realtime Environmental Coastal Observation Network (ReCON) ecosystem observation buoys support decision-making by water intake and beach managers	Buoys, sensors, vessels, MIL, and field personnel	Deploy buoys for ecosystem, hypoxia, rip current, and HABs observations	Real-time, web-based ecosystem observations supporting hypoxia, HABs and rip current warnings	Modelers, researchers, and decision-makers are aware of and use data from ReCON buoys in evaluation phase	Water intake and beach managers make informed decisions using data from operational ReCON buoys; buoys provide input to research, models, decision support tools, and forecasts	Drinking water, beach, and resource managers make improved decisions that enhance Great Lakes ecosystem services using GLERL observations and forecast models
By 2016, new scientific research vessel supporting GLERL science priorities is operational	Vessel operations personnel and GLERL/CILER researchers	Determine new vessel user requirements, determine design criteria, and implement vessel design contracts	Scientific and vessel requirements and design criteria	Vessel group is aware of GLERL science needs and priorities	GLERL research is conducted aboard a research vessel designed to meet science needs with maximum efficiency	Operational research vessel meets NOAA needs for ecosystem understanding and ecosystem forecast validation
By 2016, Autonomous Underwater Vehicle (AUV) routinely collects ecosystem data year-round, contributing to decision-support systems	Sensors, vessels, Marine Instrumentation Laboratory (MIL), and field personnel	Deploy and evaluate AUVs	Spatially important, year-round ecosystem observations supporting research products and scientific understanding	Capability to achieve under ice observations is demonstrated	AUVs are routinely deployed in winter and provide input to research, models, and forecasts	Drinking water, beach, and resource managers make improved, year-round decisions that enhance Great Lakes ecosystem services using GLERL observations and forecast models
By 2020, decision-support system addressing ecosystem understanding, drinking water and beach health in Areas of Concern (AOCs) is operational on five Great Lakes	GLERL/CILER researchers, users, and industry partners	Implement necessary observations, forecast models, database content and web display; educate users	Web-based decision-support tools, educational materials	Observations and forecasting tools for Lake Erie, Muskegon, and Saginaw Bay inform current and future remedial actions, and provide warnings on phosphorous loads, hypoxia and harmful algal blooms	Operational decision support tools, warnings, and forecats for Lake Erie, Muskegon, Saginaw Bay and Green Bay enhance understanding of ecosystems and improve decision-making by stakeholders	Communities are fully aware of causes of AOC-related impacts through real-time observations and forecasts and have begun restoration

Ecosystem Dynamics						
Objectives	**Resources**	**Activities**	**Outputs**	**Short-Term Outcomes**	**Mid-Term Outcomes**	**Long-Term Outcomes**
By end of 2012, define core set of measurements of most interest to resource managers and modelers for long-term research (LTR) at three stations	Personnel, ship support, upgraded shipboard sampling equipment	Conduct field studies and hold quarterly meetings to evaluate different designs	Physical and biological observation and process studies, project write up, study design	Modelers and observations groups are aware of LTR program for joint development	Modelers, observations group, and LTR researchers coordinate activities to maximize efficiency and usefulness of LTR for ecosystem models and forecasts	LTR supports decision-making that results in better management of Great Lakes resources and protection of ecosystem services, and is a model to other LTR programs
By 2015, provide modelers with information on mussel impacts for models that inform management of water quality and fisheries	Personnel, ship support, upgraded shipboard sampling equipment	Carry out core monitoring program, spatial field studies, and mussel process/impact studies	Peer-reviewed publications, accessible database, NOAA technical memoranda, and public presentations on current and past state of ecosystem; information on mussel abundance, process rates, and impacts	Managers and modelers are aware of the state of Lakes Michigan and Huron. Modelers improve scenario and ecological forecasting models by adding dreissenid processes	Modelers improve scenario and ecological forecasting models by adding dreissenid processes	Managers make improved decisions that enhance water quality, fisheries, and other ecosystem services in lakes Michigan and Huron
By 2015, develop fuller understanding of harmful algal bloom (HAB) mechanisms to enhance HAB forecasting	Personnel, ship support, upgraded shipboard sampling equipment, HAB ecologist hire	Carry out core monitoring program and targeted process research , analyze samples, organize data	Contributions to HAB bulletin for Lake Erie; publications, technical memoranda, and presentations on bloom mechanisms	Increased mechanistic understanding of bloom dynamics allows modelers to begin developing conceptual models	Modelers build mechanistic models of bloom dynamics and scenario models to predict blooms under various nutrient loading and weather scenarios	Management and stewardship of ecosystem services is enhanced in Lake Erie; human health is protected
By 2022, have long-term observations of core variables in Lake Michigan and Huron and an understanding of most factors driving the changes.	Personnel, ship support, upgraded shipboard sampling equipment	Carry out core monitoring and process research program, analyze samples, organize data	Database, reports, peer-reviewed publicatons, and scientific presentations	Great Lakes managers and other stakeholders have a better understanding of Lake Michigan and Lake Huron ecosystem dynamics	Great Lakes stakeholders recognize GLERL as the primary provider of Lake Michigan and Huron information and request data	Management and stewardship of Lake Michigan and Lake Huron ecosystem services is improved through understanding of effects of stressors gained in LTR
Provide current status of plankton and benthos communities within one year of collection of data	Personnel, including expanded support staff, laboratory equipment	Carry out core monitoring program, analyze samples, organize data	Publications, technical memoranda, and public presentations	Stakeholders are aware of current status of the Lake Michigan ecosystem	Great Lakes managers and stakeholders use the data to make informed management decisions	Management and stewardship of Lake Michigan and Lake Huron ecosystem services is improved by coupling current information with scenario models

Integrated Physical and Ecological Modeling and Forecasting								
	Resources*							
Objectives	**Models**	**Data**	**General**	**Activities**	**Outputs**	**Short-Term Outcomes**	**Mid-Term Outcomes**	**Long-Term Outcomes**
By 2014, provide an improved analysis tool and high spatial resolution numerican models for operational coastal forecasting in the Great Lakes to maintain safe navigation and enhanced recreational opportunities	POMGL, FVCOM, GDWM, GLIM	NOS CO-OPS water level gauges, NCDC weather station dat, in-situ physical data	Personnel, scientific partnerships, computer resources	Develop and test new models for coastal forecasting	Outreach materials, journal articles, operational models, web-based decision-support tools	Stakeholders are aware of and have access to improved operational coastal forecasts	Great Lakes stakeholders make informed decisions aided by improved operational coastal forecasts	Great Lakes stakeholders use forecasts to protect lives and property
By 2014, develop predictive models for algal blooms in Lake Erie, Saginaw Bay, and Green Bay, and for beach water quality at key swimming beaches in all five Great Lakes to protect human health	GLCFS, POMGL, FVCOM, trajectory prediction models, watershed pollutant fate and transport models	remote sensing, in-situ physical data, fecal indication bacteria measurements		Develop and test new models for algal blooms and beach water quality		Stakeholders are aware of and have access to improved algal bloom and beach water quality forecasts	Great Lakes stakeholders make informed decisions aided by improved algal bloom and beach water quality forecasts	Great Lakes resource managers and other stakeholders use forecasts to protect human health
By 2022, develop predictive models for large-scale water quantity and quality parameters such as water levels, ice, turbidity, stratification, and primary and secondary productivity on a seasonal basis to provide information to Great Lakes decision-makers	AHPS, FVCOM, Ecopath with Ecosim/Atlantis, Upper Trophic Level/Lower Trophic Level Ecological Models	NOS CO-OPS water level gauges, US Geological Survey stream gauge network, NOAA-GLERL temporary gauge monitoring network in ungauged basins, NCDC weather station data; ship surveys, long-term research (LTR) data		Develop and test models for large-scale water quantity and quality, including integrated ecological models		Stakeholders are aware of and have access to improved predictive models for water quantity and quality parameters	Great Lakes stakeholders make informed decisions aided by improved predictive models for water quantity and quality parameters	Great Lakes resource managers and other stakeholders use forecasts to improve management and stewardship of Great Lakes ecosystem services
By 2022, expand regional modeling efforts to predict the impacts of climate on physical and ecological conditions on a multi-decadal	CHARM, CWRF, AHPS, GLIM, FVCOM	LTR data, NARR, Great Lakes Ice Atlas		Develop and test regional atmospheric models, basin-scale hydrologic models, five-lake hydrodynamic model		Stakeholders are aware of and have access to improved regional climate impact models	Great Lakes stakeholders make informed adaptation decisions aided by improved regional climate impact models	Great Lakes communities use forecasts to better prepare for and adapt to changes in climate
As the above objectives are accomplished, develop a comprehensive integrated framework for ecological modeling and forecasting that results in better products and tools	All of the above	All of the above		Link existing or improved integrated physical-ecological modeling and forecasting systems described above		Stakeholders are aware of and have access to operational Integrated Ecological Modeling and Forecasting system	Great Lakes stakeholders and managers make informed decisions aided by integrated ecological models	Great Lakes resource managers and other stakeholders use forecasts to improve management and stewardship of Great Lakes ecosystem services

* Acronym definitions: AHPS = Advanced Hydrologic Prediction Service, CHARM = Coordinated Hydrologic and Atmospheric Research Model, CWRF = Climate and Weather Research and Forecasting Model, FVCOM = Finite Volume Community Ocean Model, GLCFS = Great Lakes Coastal Forecasting System, GDWM = GLERL Donelan Wave Model, GLIM = Great Lakes Ice Model, NARR = North American Regional Reanalysis, NCDC = National Climatic Data Center, NOS CO-OPS = National Ocean Service Center for Operational Oceanographic Products and Services, POMGL = Princeton Ocean Model Great Lakes