

# LAKE ERIE LITERACY: Essential Principles and Fundamental Concepts for Lake Erie Learning

Each principle is supported by fundamental concepts comparable to those in the Ocean Literacy Principles and the Great Lake Literacy Principles.

## 1 LAKE ERIE, ONE OF THE FIVE GREAT LAKES, IS A BODY OF FRESH WATER WITH MANY FEATURES.

- A.** Lake Erie is a prominent physical feature of North America and an internationally shared resource forming part of the political boundary between the United States and Canada.
- B.** Lake Erie is the shallowest, warmest and most biologically productive of the Great Lakes. Lake Erie contains three basins, each with distinctive features, circulation and ecology, along with many harbors, bays and embayments.
- C.** While smallest by volume, Lake Erie is an integral part of the Great Lakes, the world's largest supply of fresh surface water. Lake Erie's shore and watershed include the most southerly reaches of the Great Lakes ecosystem.
- D.** Lake Erie is connected to the other Great Lakes which together form a watershed that drains to the Atlantic Ocean. The upper Great Lakes (Superior, Huron and Michigan) drain down the Detroit River into Lake Erie. Lake Erie flows over the Niagara Falls into Lake Ontario, which flows through the St. Lawrence River into the Atlantic Ocean. Nutrients, dissolved gases, salts and minerals, sediments and pollutants from the upper Great Lakes and their watersheds are transported down rivers and through wetlands into Lake Erie.
- E.** Lake Erie is an integral part of the Midwestern United States' and Canada's (or North American) water cycle and is connected to the region's watersheds and hydrologic cycle. Changes in the hydrologic cycle affect the quality, quantity and movement of water.



- F.** Water currents circulate within Lake Erie and are powered by energy from the sun, wind, waves and differences in water density. The shape of the lakebed and its geographic orientation, the direction of the prevailing winds, the shore and the human-made structures along the shore influence the paths of circulation.
- G.** Lake level is the height of Lake Erie relative to sea level as measured using the International Great Lakes Datum. Lake level changes are caused by basin-wide variations in precipitation, evaporation, runoff, snow melt, changes in the levels of the upper Great Lakes, wind and waves, as well as water withdrawals. Tides are not discernable in Lake Erie, a wind-driven lake whose southwest to northeast orientation parallels the prevailing winds. This orientation combined with the shallowness of the lake makes Lake Erie especially prone to seiches or wind set-up.
- H.** Lake Erie stratifies in the summer and in winter under ice cover, forming distinct layers based on water density differences due to temperature variations. Turnover occurs in the spring and fall when weather minimizes temperature differences and the layers mix. Turnover is the main way that oxygen-deficient and nutrient-poor water in the deeper areas of the lake can be mixed with oxygen-abundant and nutrient-rich surface water.
- I.** Although Lake Erie is large, it is finite and its resources are limited.

## 2 NATURAL FORCES FORMED AND CONTINUE TO SHAPE LAKE ERIE AND ITS WATERSHED.

- A.** Many of the geological features underlying Lake Erie and its watershed originated when shallow tropical salt water seas covered the region. Large salt deposits below the lakebed are remnants of these seas. Many of the rocks now exposed on land were deposited or shaped during the advance and retreat of glaciers that carved the bed of Lake Erie.
- B.** During the Ice Age, mile-thick sheets of ice covered what is now Lake Erie and northern Ohio multiple times depressing the crust with their weight. Since the glaciers retreated (more than 10,000 years ago), Earth's crust has been adjusting upward in a process of isostatic rebound that continues today.
- C.** Lake level changes influence the physical features of Lake Erie's coast. Lake water levels vary over periods ranging from hours to millennia. Ancient beach ridges found in the watershed miles from the current water's edge mark previous lake shores. The difference between the yearly low and high water levels averages 1 to 2 feet.
- D.** Erosion—the wearing away of rock, soil and other earth material—occurs in coastal areas as wind, waves, river flow and currents in Lake Erie move sediments.
- E.** Sediments are a product of erosion and consist of fragments of animals, plants, rocks and minerals. Sediments are classified by grain sizes, from silt and clay to sand, cobbles and boulders. Sediments are seasonally redistributed by waves and coastal currents, nourishing beaches and coastal wetlands.
- F.** Beaches, barrier beaches and coastal wetlands protect upland areas by reducing the impact of storm waves and wind tides. Waves breaking on the beach area and wetland plants reduce wave height and energy.



## 3 LAKE ERIE INFLUENCES LOCAL AND REGIONAL WEATHER AND CLIMATE.

- A.** Lake Erie affects weather and climate by impacting the region's energy and water cycles. Changes in Lake Erie's water circulation, water temperatures and ice cover can produce changes in local weather.
- B.** Lake Erie warms by absorbing solar radiation. Lake temperatures are also affected locally by the temperature of inflowing rivers and the warm water discharge of power plants and other industries located along the shore. Lake Erie loses heat by evaporation and by warming the overlying air when the atmosphere is cool. After water vapor is released into the atmosphere, it condenses and forms precipitation, some of which falls within the Lake Erie basin.
- C.** Lake Erie modifies the local weather and climate because water temperatures change more slowly than air temperatures. Lake water absorbs heat in summer and releases heat during cooler months. This results in cooler springs, warmer falls, delayed frosts and lake effect snow.
- D.** Lake Erie has a significant influence on regional climate by absorbing, storing and moving heat and water. Lake effect precipitation can occur downwind when weather systems move over the lake and absorb moisture from Lake Erie.
- E.** Lake Erie is influenced by global climate change affecting North America and the world. The climate in the Great Lakes region is changing with warmer temperatures and more variable precipitation patterns. The observed patterns of temperature increases and precipitation changes are predicted to continue. Winters are likely to become wetter and summers drier, increasing the frequency of floods and droughts.



## 4 WATER MAKES EARTH HABITABLE; FRESH WATER SUSTAINS LIFE ON LAND.

- A.** Fresh water has unique properties. Its density and electrical conductivity (a measure of salinity) are lower than that of salt water.
- B.** Water is essential for life. All living processes occur in an aqueous environment.
- C.** All aquatic and terrestrial organisms in Lake Erie's watershed need a source of fresh water to survive.



## 5 LAKE ERIE SUPPORTS A BROAD DIVERSITY OF LIFE AND ECOSYSTEMS.

- A.** Life in Lake Erie ranges in size from the smallest blue-green bacteria, such as *Microcystis*, to the largest animal that still lives in the lake, lake sturgeon.
- B.** Lake Erie is the most biologically productive Great Lake. The most abundant life in Lake Erie are microorganisms. Phytoplankton are a type of microorganism that uses light to grow and reproduce. Phytoplankton are the primary producers in Lake Erie.
- C.** Lake Erie's watershed supports organisms from all taxonomic kingdoms.
- D.** The Lake Erie ecosystem provides many examples of life cycles, adaptations and important relationships among organisms, such as parasitism, symbiosis, predator-prey dynamics and energy transfer.
- E.** The Lake Erie ecosystem provides habitat for terrestrial and aquatic species. Lake Erie is multi-dimensional, offering vast living space and diverse habitats from the atmosphere to the shore, to the water surface and down through the water column into the lake bottom.
- F.** Lake Erie habitats are defined by environmental factors. As a result of interactions involving abiotic factors such as temperature, clarity, depth, oxygen, pH, light, nutrients, pressure, substrate type and circulation, life in the lake is not evenly distributed temporally or spatially. Abiotic factors within Lake Erie can change hourly, daily, seasonally or annually because of natural variation and human influences.
- G.** Abiotic conditions, prey availability and predation dynamics, influence the distribution and diversity of organisms from the surface to the bottom and from the nearshore to offshore.
- H.** Coastal wetlands, such as marshes and freshwater estuaries, provide important and productive nursery areas for many aquatic and terrestrial species which rely on these habitats for protective structure, hunting grounds, migration stops and raising offspring.
- I.** Life cycles, behaviors, habitats and the abundance of organisms in Lake Erie and its watershed have been altered by intentional and unintentional introduction of non-native organisms. Non-native species may have positive or negative impacts on the lake and its watershed.
- J.** Some threatened species thrive in specialized areas of the Lake Erie ecosystem.

## 6 LAKE ERIE AND HUMANS IN ITS WATERSHEDS ARE INEXTRICABLY INTERCONNECTED.

- A.** Lake Erie affects many human lives. The lake supplies fresh water to more than 11 million people. It is a source of drinking water, transportation, and food as well as mineral and energy resources.
- B.** One-third of the Great Lakes population lives in Lake Erie's 30,140 square-mile watershed. Lake Erie's watershed is the most urbanized, has the highest population density, and its land is the most intensively farmed of all the Great Lakes.
- C.** Lake Erie is directly affected by the decisions and actions of people throughout its watershed, which includes parts of Michigan, Ohio, Indiana, Pennsylvania, New York, the Canadian province of Ontario, and tribal lands. Lake Erie is also impacted by the decisions of people living in the watersheds of the upper Great Lakes (Superior, Huron and Michigan) because water from these lakes and their watersheds flows into Lake Erie.
- D.** International treaties and agreements as well as local and national laws, regulations and resource management policies affect what is put into and taken out of Lake Erie. Coastal development and industrial or commercial activities throughout the watershed can lead to point and non-point source pollution. Humans have altered the biology of the lakes and the viability of species through harvesting, species introduction, habitat alteration, and nutrient and contaminant loading.
- E.** Lake Erie, its coast and watershed are impacted by land use decisions, water use decisions and natural hazards. Physical modifications (changes to beaches, shores and rivers) can exacerbate effects of erosion, storm surges and lake-level changes.
- F.** Eutrophication is a natural process by which freshwater lakes gradually become shallower, warmer and build up concentrations of plant nutrients as they age. Human activities in the watershed accelerate eutrophication which can lead to areas of oxygen depletion commonly referred to as "dead zones."
- G.** Coastal wetlands protect communities and the lake itself by storing flood waters, absorbing wave energy to reduce coastal erosion, and removing sediment and other pollutants from watershed streams and rivers. Lake Erie coastal wetlands have been degraded and eliminated by human activities that have compromised the ability of wetlands to perform their natural functions.
- H.** To ensure continued availability of Lake Erie assets, people must live in ways that sustain the lake. Individual and collective actions are needed to effectively conserve and manage lake resources for the benefit of all.

## 7 MUCH REMAINS TO BE LEARNED ABOUT LAKE ERIE.

- A.** Exploration and study of Lake Erie and its watershed are ongoing. Such exploration increases understanding of the role people play within the ecosystem.
- B.** Understanding Lake Erie is more than a matter of curiosity. Exploration, inquiry and monitoring supports protection of Lake Erie ecosystems, resources and processes.
- C.** Over time, the use of Lake Erie resources has changed significantly. The future sustainability of lake resources depends on our understanding of those resources and their potential and limitations.
- D.** New technologies and methods of observation are expanding our ability to explore Lake Erie. Freshwater scientists rely on new technologies to monitor conditions in the lake and provide information to policy makers and leaders in coastal communities.
- E.** Models help us understand the complexity of Lake Erie. Models can process and help visualize observations, describe interactions, expose information gaps and forecast future conditions.



- F.** Exploring, understanding and communicating about the Lake Erie ecosystem are interdisciplinary efforts. They require close collaboration among professionals in science, technology, engineering and math, as well as public outreach and education.

## 8 LAKE ERIE IS SOCIALLY, ECONOMICALLY AND ENVIRONMENTALLY SIGNIFICANT TO THE REGION AND NATION.

- A.** Lake Erie is a source of inspiration, recreation, rejuvenation, discovery and raw materials. It is also an important element in the heritage of many cultures and individuals.
- B.** Lake Erie, its tributaries and coastal wetlands have been significant to historical settlement and development. The lake's name and the names of many cities, counties, tributaries and landmarks along its shore have Native American or immigrant origins. As a freshwater resource, Lake Erie continues to play a role in the habitation of the area.
- C.** Lake Erie's moderating effects on climate influence the human culture, outdoor activities, agriculture and the health of adjacent coastal areas.
- D.** Waterborne commerce moves millions of tons of cargo annually through Lake Erie. Shipping is an economically efficient method of transporting raw materials, finished goods and agricultural products. However, shipping also transports non-native species, several of which may be detrimental to the Lake Erie ecosystem.

- E.** The economy is diverse around Lake Erie, with major sectors in industry, recreation and tourism, agriculture, commercial and sport fisheries, forestry and mining.
- F.** Lake Erie has been and continues to be dramatically degraded and challenged by human endeavors. Individual and collective efforts are being made to restore the lake and its resources. While restoration challenges still exist, Lake Erie is used as a representative model for environmental management and regional and international cooperation. Proper foresight and informed decision making will continue to make Lake Erie a model of environmental protection, restoration and innovation.

