identified as "purists," or unequivocably opposed to state intervention in the market. However, those who developed the concept in the mid-19th century are recognized to have been more qualified in their positions. Specifically, they often provided lists of particular circumstances where the principle of laissez faire should be avoided in practice. These included instances when public services such as sanitation, transportation, education, and infrastructure need to be provided; the formation of monopolies should be prevented; and patent laws enforced.

The nature and extent of intervention and regulation the government should be allowed in order to address problems of environmental degradation, pollution, and resource depletion are also controversial issues. The controversy centers on the extent that state environmental policy should be regulatory in nature, and the degree that it should allow market forces to correct particular problems – the traditional laissez faire position. A third viewpoint is that government policies should play a significant role in regulating the broad framework of market interaction, while allowing market forces to correct the problems without direct regulatory intervention. One example of this approach is a system of tradeable pollution permits that allows companies to reduce emissions through the most cost-effective market-based mechanism.

LAKES AND PONDS

Standing waters are usually referred to as lakes, although some of the largest, such as the Caspian, are called seas, while the smallest may be called ponds. The water quality and biota of these waters are largely determined by the nature of the watershed. Most of the water entering a lake or pond is from surface runoff and rainfall on the water surface, although some have significant inflow of ground water. Consequently, human activities that affect the soil and vegetation of a drainage basin as well as air quality will largely determine the kinds and amounts of substances entering lakes. Lakes in regions where evaporation exceeds precipitation can have large concentrations of salt, e.g., Great Salt Lake. Lakes in rocky basins with little weathering have the very low mineral content of soft water. Lakes in forested areas may receive much organic material and therefore have darkly stained waters typical of bog lakes. Hence there is a broad spectrum of lakes from those that have soft water with few nutrients (oligotrophic), to hard-water, nutrient-rich, eutrophic lakes.

Water has unique characteristics. In addition to being a nearly universal solvent it makes life possible and governs the distribution of chemicals, temperature, movement of water, and the presence and abundance of biota. Fresh water has its greatest density at 4°C and becomes less dense above and below 4°C. Consequently in warm months cold, dense (hypolimnetic) waters occur in deeper areas of lakes and less dense, warm (epilimnetic) waters make up an upper layer. Furthermore, it is important that density decreases below 4°C, otherwise ice would form on the lake bottom rather than on the surface. Density differences between cold and warm water result in thermal stratification, which greatly reduces mixing and results in a seasonal cycle in temperate lakes. These lakes usually have two mixing periods, spring and fall. Mixing is limited by ice cover in winter since most mixing is wind-induced. As the ice cover disappears in spring, water temperature and density are relatively uniform from top to bottom and the lake mixes (spring turnover). The lake warms and vertical density differences occur. Wind energy becomes insufficient to mix the warm surface waters with the deeper colder waters and the lake becomes stratified during summer. Stratification persists until cooling in the fall reduces density differences enough to permit wind-generated mixing (fall turnover). Some large lakes that are ice free mix most of the year, as do shallow lakes and ponds unless they become ice covered. Even tropical lakes can stratify despite small vertical temperature gradients. Density differences for a few degrees' temperature change in warm water are much greater than density changes for several degrees in cold water. The relationship between temperature and density change is not linear.

Stratification can provide a refuge for cold-water species, such as trout, during the summer in the hypolimnion (the lower layer that is noncirculating and perpetually cold). Consequently a deep lake can have an assemblage of cold-water organisms as well as warm-water species. Stratification also results in gradients in concentrations of chemicals. For example, dissolved oxygen, essential for most life, enters the water at the lake surface and from photosynthesis of plants in the epilimnion (the warmer upper circulating layer). Respiration of organisms in the hypolimnion may deplete the dissolved oxygen. Thus dissolved oxygen will be plentiful in the epilimnion but may be exhausted in the hypolimnion.

The periods of mixing are critical for redistribution of nutrients essential for algal growth as well as for mixing oxygenated water into the depths. A few lakes are permanently stratified due to density differences associated with salts or humic material. These lakes never mix and are called meromictic.

Each kind of lake has its particular assemblage of plants and animals. Oligotrophic lakes usually have a diverse biota, but relatively few organisms such as trout. Eutrophic lakes are usually rich in algae, large plants, and warm-water fishes. Saline lakes may have only a few species, e.g., brine shrimp. Bog lakes usually are very acid or alkaline and have few organisms other than insects. A diversity of habitats occur in a lake. Large plants, e.g., rushes and lilies, are found in the shallow areas. Submerged plants are farther offshore. The open surface waters provide a favorable habitat for some organisms, while others occur only in the deep waters. Organisms inhabiting the sedimentary environments of lakes and ponds make up the benthic (bottom) community of attached algae, bacteria, worms, clams, snails, insect larvae, and some crustaceans, e.g., crayfish. This community might include abundant populations of sponges, hydras, and other invertebrates. Organisms with limited locomotion that float in the water are the plankton, which includes many algae, rotifers, and crustaceans. Nekton consists of animals that are swimmers, primarily fish.

Human interactions with lakes have been both positive and negative. Lakes have played a prominent role in the dispersion of humans because they have provided transportation, water supply, and food. It is not happenstance that many of the world's large cities are on lake shores. Human activities often have led to major, even catastrophic, changes in lakes. The damming or diversion of tributaries can result in loss of certain fishes or even drying up of a lake. The Aral Sea, which was the world's fourth largest lake, has lost about 40% of its surface area due to diversion of tributaries.

Overfertilization of lakes from sewage, runoff from farms, and atmospheric inputs of nitrogen and phosphorus has resulted in eutrophication (nutrient enrichment). The rapid eutrophication of Lake Erie was especially alarming because it was assumed that such a large lake (9,930 square miles) could not easily be affected by human activity. "Clean" water benthos was replaced by pollution-tolerant forms, large algal blooms occurred, some fish disappeared, nutrients and other chemicals increased, and dissolved oxygen depletion occurred. Billions of dollars have been spent to limit nutrient inputs to lakes in North America and Europe. As a result, some lakes have shown reversal in eutrophication, e.g., Lake Erie and Lake Washington at Seattle.

The reversal of eutrophication in some lakes, restoration of viable fish populations in others, and lessened destruction of wetlands and shorelines give encouragement that lakes will continue to exist for the enjoyment and use of future generations of humans.

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For Further Reading: William Ashworth, *The Late Great Lakes* (1987); David G. Frey, *Limnology in North America* (1963); Robert G. Wetzel, *Limnology* (1983).

See also Algae; Dissolved Oxygen; Eutrophication; Glaciers; Oxygen; Plankton; Pollution, Water: Case Studies; Pollution, Water: Processes; Water.

LAND

Land is the solid part of the Earth's surface, also known as the lithosphere. It is created by a combination of abiotic and biotic processes. Physical phenomena including climate, geology, physiography, and hydrology sculpt the land through time. Human activities originate on, and are sustained by, the physical and biological properties of land. The human use of land has come to have economic, legal, and ethical consequences.

Geology affects the lay of the land strongly. Rock is a mineral material of consolidated or unconsolidated composition. It may originate from the cooling of molten liquid, as when volcanic lava cools to form basalt; from the deposition of layers of sediment; and from the metamorphosis of existing rocks that have been subjected to heat or pressure changes in the crust of the Earth.

Climate and geology together fix the physiography of land, that is, the physical conditions of the land surface. The soil of a desert differs from that of a tundra because of climate. Temperature, precipitation, and wind affect the fundamental structure of regions and localities. Physiography varies widely; the world is a myriad of peaks and depressions, ridges and valleys, rolling hills and flat plains, mesas and canyons, buttes and ranges.

This variation alters the flow of water at the surface and underground. Fluvial processes, in turn, reshape the land. Flooding, for example, from streams and rivers or from abnormally high tidal water or rising coastal water resulting from severe storms, hurricanes, or tsunamis can quickly change the character of land.

Lying atop the lithosphere, soils provide the interface between abiotic and biotic elements. Their properties result from the integrated effect of climate and living matter acting upon parent material over periods of time. Each soil can be described in terms of a profile, defined as a sequence of layers or horizons from the surface downward to rock or other underlying material. These layers include: organic horizons, which form above the mineral soil from litter derived from dead plants and animals; eluvial horizons, which are characterized by leaching; illuvial horizons, which are the zone of maximum accumulation of materials including iron, aluminum oxides, and silicate clays; un-

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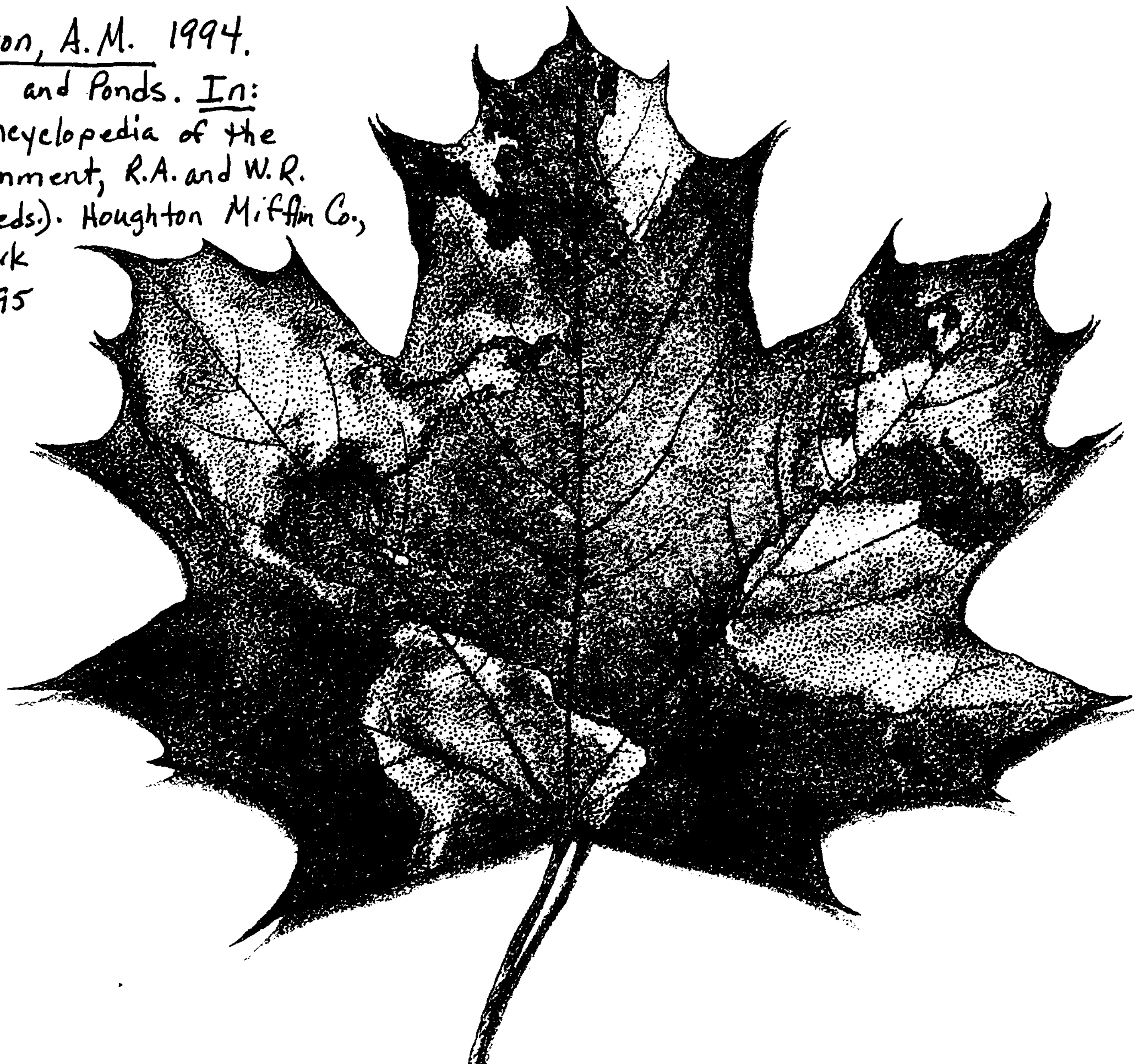

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