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Introduction

Citizens of Oregon recognize the richness of water, land, fish, and wildlife in their state, as well as its natural scenic beauty and historic significance. They are proud of the reputation they have earned for the desire to maintain and improve the quality of these resources. Advances in the areas of land-use planning, pollution control, and the preservation of scenic waterways have been significant. Water is a vital part of the lives of Oregonians. Consequently, Oregon lakes comprise a large and important portion of their interest.

Within the state are more than 6,000 standing-water environments with a combined surface area greater than 500,000 acres (202,350 hectares). Included are more than 1,400 named lakes. In addition, there are hundreds of unnamed lakes, cattle ponds, farmponds, millponds, marshes and sloughs, some of considerable size. These water bodies range in size from less than 1 acre (0.4 hectares) to more than 90,000 acres (36,400 hectares) —Upper Klamath Lake and attached lakes. More than half of them lie in volcanic or glacial depressions near the broad summit of the Cascade Range, and nearly 100 lakes are clustered in the Wallowa Mountains of northeast Oregon. Many more lie in depressions between sand dunes on the Oregon coast within three miles of the ocean. Crater Lake is the deepest lake in the United States (1,932 feet, 590 meters) and contains 14 million acre-feet (17,262 cubic hectometers) of water. Other large, deep, natural lakes in Oregon include Waldo Lake (420 feet, 128 meters), Odell Lake (282 feet, 86 meters), and Wallowa Lake (299 feet, 91 meters). There are ten Fish Lakes, a fact which suggests the most common use of lakes in Oregon. There are also ten Clear Lakes and eleven Blue Lakes, names that indicate the generally high quality of water in Oregon lakes, and there are thirteen Lost Lakes, all of which have obviously been found.

Figure 1-1. Dexter Lake is one of 13 multi-purpose water resource projects built and operated by the U.S. Army Corps of Engineers in the Willamette Valley. In combination with Lookout Point Lake and dam immediately upstream, it was completed in 1954 and provides flood control, hydroelectric power generation, and summer recreation. *(Photo credit: U.S. Army Corps of Engineers)*

Oregon also has over 60 reservoirs of more than 5,000 acre-feet (6.2 cubic hectometers) capacity. The largest reservoir is Owyhee Lake in southeast Oregon, with a capacity exceeding 1,000,000 acre-feet (1,200 cubic hectometers). Many of the larger reservoirs were constructed by the U. S. Bureau of Reclamation (Department of Interior) to irrigate agricultural land in drier parts of the state. A group of thirteen large reservoirs in the Willamette Valley, built and operated by the U.S. Army Corps of Engineers, and two more in the Rogue River Basin provide those areas with flood protection, navigation, power, recreation, and other benefits (Figure 1-1). Throughout the state are hundreds of smaller single-purpose reservoirs, most of them built by local irrigation companies.

Lakes and Water Use

Lakes form a vital part of the total water resource system in Oregon and are utilized for a wide variety of economic purposes. Most of the reservoirs were built at least in part to store irrigation waters. Likewise, many of the natural lakes have had control structures built at their outlets to release stored waters for downstream irrigation. Nearly 6,000,000 acre-feet (7,400 cubic hectometers) of water irrigate over 2,000,000 acres (810,000 hectares) of land in Oregon to produce a variety of agricultural crops, and many more acres are potentially irrigable. Although much of this water is developed from ground water supplies, the majority comes from surface water diversions, for which lakes and reservoirs serve as sources. Irrigation is the largest consumptive use of water in the state. Other important consumptive uses in Oregon are for industrial purposes (e.g., wood products, food processing, dairy products, etc.) and for domestic supplies. Several public water systems in Oregon draw from lakes and reservoirs.

Non-consumptive uses of water in Oregon lakes include hydropower generation, maintenance of fish habitat, navigation, and recreation. Recreational use is of particular concern, because it is of immediate interest to the majority of Oregon citizens (Figure 1-2). The economy in certain regions of the state depends largely on water-based recreation. Over the last three decades, recreational use of Oregon lakes and reservoirs has increased at an astonishing rate. This tremendous growth in water-based recreation has its origins in several factors: economic prosperity and the consequent acquisition of recreational vehicles and boats by many people; the growing number of retired people; shortened work weeks and increased leisure time available; increased tourism;

population growth within the state itself; and the recent construction of large reservoirs near urban centers. Moreover, construction of new roads and the improvement of old ones has eased access to lakes and reservoirs.

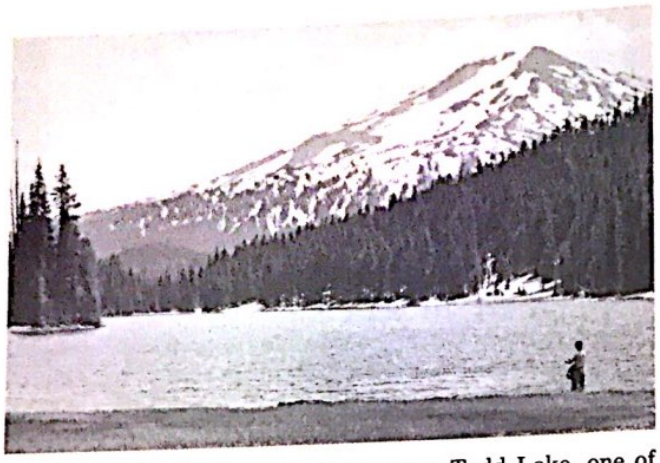

Figure 1-2. The South Sister looms over Todd Lake, one of many trout fishing lakes in the popular Central Oregon recreational area. *(Photo credit: Oregon State Highway Department)*

Water Quality in Oregon Lakes

Lakes and reservoirs have unique chemical, physical, biological, geological, and cultural attributes that are distinct from other freshwater aquatic environments such as rivers, streams, or wetlands. Their uniqueness results from their formation in depressions in the earth's surface; the characteristic reduction or absence of velocity of water and, thus, a longer residence time as compared to that of streams and rivers; and their ultimate destiny to become filled with sediment and to eventually support terrestrial life. Consequently, a lake acts as a sink for various pollutants generated from the surrounding drainage basin. It is, therefore, necessary to understand and describe the properties of lakes and their contributing drainage basins in order to best plan for the management of this resource.

A lake undisturbed by human activities undergoes a natural process of aging known as eutrophication. However, this process may be accelerated by introduction of nutrients to lake waters through improper land use and waste disposal practices. Land use practices on farm land, forests, and construction sites often result in the erosion of nutrient-rich soils into streams feeding lakes. Significant quantities of nutrients are also discharged by sewage treatment and certain industrial plants and by urban, pasture, and feedlot runoff.

For the most part, surface water in Oregon lakes is of excellent chemical and physical quality and low in mineral content. Hundreds of natural lakes in national forests and on Bureau of Land Management lands have high, inaccessible locations, or are accessible only by foot trail. Most of these lakes display little evidence of human effects on water quality. Many lakes which are more accessible also have good quality water. Nevertheless, as increased demands for recreation and development are placed on these lakes and their drainage basins, potential problems of water-quality deterioration develop. In Oregon, several lakes already show signs of deteriorating water quality. The Department of Environmental Quality has noted this trend through analysis of data from frequent field studies over the last twenty years by agency biologists. Although some lakes are suffering a loss of quality, in most cases the "degraded" water quality is still relatively high.

Oregon's lakes are a vital resource that must be protected, maintained, and enhanced to provide for present and future beneficial uses. Resource management agencies in Oregon are concerned with the water quality of lakes because their ecological conditions may promote or limit their many uses. Highly eutrophic lakes are characterized by dense algal blooms, floating mats of vegetation, and a murky appearance. Algae are found naturally in every body of water, but when stimulated by abundant nutrients, sunlight, and warm temperatures, they rapidly multiply to become a nuisance to recreational users while seriously affecting water quality for other uses. These plant nuisances may curtail or even eliminate recreational activities such as swimming, boating, and fishing; may impart taste and odor to water supplies; and may cause toxic conditions which adversely affect other aquatic life in the lakes. For example, when sufficient quantities of algae die, the decaying process may deplete dissolved oxygen sufficiently to kill fish and other aquatic life. Recreational use of lakes can also affect water quality. Power boats create waves that erode banks, contributing to sediment, nutrients, and muddy water; they also release mixtures of oil and gasoline and associated contaminants to the water. Removal of vegetation from shorelines to ease public access can also lead to erosion.

The need to protect and enhance water quality in lakes is a recognized national goal as stated in the Federal Clean Water Act of 1972. Section 314 of this Act initiated the Clean Lakes Program to address water-quality problems associated with the nation's lakes, especially those in and around urban areas having high recreational benefits. The program is administered nationally by the Environmental Protection Agency, which provides financial assistance to states and local sponsors to diagnose lake problems and to identify, evaluate, and implement restoration methods to protect and restore publicly owned freshwater lakes.

The Clean Lakes Program has two steps. Step one calls for the completion of a statewide inventory and classification of lakes according to trophic status. This step is the subject of this book. Step two calls for the start of individual restoration projects for high-priority lakes. In January of 1980, the Oregon Department of Environmental Quality was designated the lead state agency to coordinate the federal lakes program in Oregon. Six lakes were identified for study to determine their feasibility for restoration: Mirror Pond in Bend, Sturgeon Lake, Devils Lake (Lincoln County), Fern Ridge Lake, Upper Klamath Lake, and Blue Lake (Multnomah County).

Lake Survey and Classification

In order to detect any present or potential conditions of water-quality impairment, it is essential that existing conditions in Oregon's lakes be investigated and defined. This study was undertaken by Portland