1-1-1960

THE NEBRASKA SANDHILL LAKES: THEIR CHARACTERISTICS AND FISHERIES MANAGEMENT PROBLEMS

D. B. McCarraher
Fisheries Biologist

THE NEBRASKA SANDHILL LAKES

THEIR CHARACTERISTICS AND FISHERIES MANAGEMENT PROBLEMS

by

D. B. McCarraher, Fisheries Biologist

Nebraska Game, Forestation and Parks Commission

Bassett, Nebraska

INTRODUCTION

A brief look at the map of Nebraska will readily point out the obvious fact that the sandhills comprise a considerable portion of the land area of the state. To be more precise, an area encompassing around 20,000 square miles or about one quarter of the total State area. This is indeed a vast prairie region long noted for its fine cattle and native hay crops. It is a region of vegetative dune sandhills, sandy basins and valleys, exposed ground water, spring seep lakes and marshes. Since much is already known concerning the land portion of the sandhills it is the intent of this paper to bring into focus the aquatic areas, namely the fertile, productive sandhill lakes.

Topographic evidence suggests that many of the present day lake basins within the same drainage valleys were at one time united into one vast body of water. Siltation, wind deflation, drought and man have all contributed towards the reduction of lake levels and total water acreage. Many of the lakes and marshes are intermittent and few maintain a permanent water pool during a series of dry years. Few lakes sustain fish life during the drought years.

A recent survey of the sandhill region revealed that around 1,640 lakes, ten acres and above in size, should be classified as sandhill lakes. These

NOTE: This paper is a contribution from Federal Aid to Fish Restoration Funds under Dingell-Johnson Project No. F-4-R, Job No. 2.

range in size from 10 to 2,300 surface acres and have a combined area of about 65,800 surface acres. This is an impressive water acreage figure, and one which should delight all anglers. However, since no one lake is exactly like another in regard to its chemical, physical and biological make-up, an explanation of these vital characteristics is important to understand why certain lakes provide good fishing while others support no fish life, or provide mediocre angling. In other words, we cannot expect all of the 1,640 lakes to be a fisherman's paradise. All too often the question is posed to us, "Why don't fish live in alkaline lakes?" The cowardly way out in answer to this question would be to reply that we don't know, and thus forestall further questions. However, we do have some answers to this question. There's a saying about a horn, suggesting that if one wants one blown, he had better do the blowing himself. To this end, we hope to give you some of the "whys" and "hows" now, and relate other facts later as we search for and find them in the future.

PHYSICAL CHARACTERISTICS OF THE LAKES

Perhaps the most basic of the three essential characteristics is the physical composition such as surface acres, depth, drainage pattern, shoreline development, water turbidity and bottom types.

In general, the sandhill lakes are shallow with saucer-type bottoms and closed drainage basins. In some, a natural drainage occurs usually from the west to the east. Man has increased the drainage of many by digging outlet ditches to speed up natural drainage.

The lakes are for the most part at ground water level, and thus fluctuate in depth during the wet and dry seasons of the years. The deepest known lake is Blue Lake, in Garden County, with a recorded maximum depth of 13.8 feet. Of the 1,640 lakes only about 10 lakes are known to have maximum depths exceeding 10.0 feet. This physical condition gives rise to the very apparent fact that the lakes are extremely shallow and, therefore, restricted to the production of warm water fish. The depth-water volume relationship is an important factor in the ability of an individual lake to sustain fish life during prolonged periods of ice-snow cover. If we were to grade the sandhill lakes according to the depth-water volume ratio, only about 22 percent could qualify as being free from periodic fish winter-kill conditions.

Water turbidity is a problem in carp or bullhead-infested lakes. Water turbidity becomes an important factor not only in limiting biological production, but is a considerable hinderance to angler harvest.

The bottom types of the sandhill lakes are directly related to fish winter-kill conditions. Sandy basins supporting little aquatic vegetation seldom experience winter-kill. Soft muck or silt basins with an abundance of aquatic plants suffer from periodic winter-kill. Thus, water-volume and the type of bottom are the two most important physical characteristics in relation to a long term fisheries.

CHEMICAL CHARACTERISTICS OF THE LAKES

The living world of alkaline lakes, whether in Patagonia where Darwin saw it, or in the sparsely settled lands of the sandhills, presents many interesting and challenging problems. The differences in chemical composition of our alkaline waters varies seasonally, and regionally, thus making any final classification difficult. As a provisional classification we have placed our alkaline to high alkaline lakes in the sulfate-bicarbonate group. By contrast the water of the Great Salt Lake, high in sodium and chloride salts, is often referred to as saline or satern.

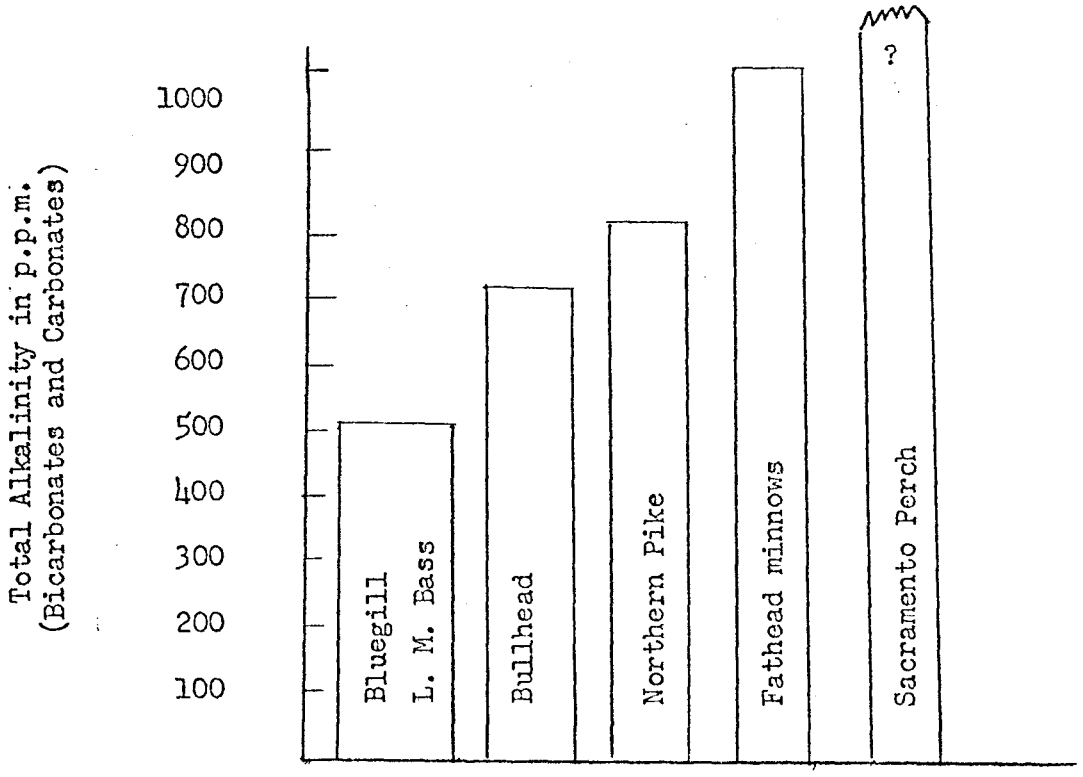
The relationship between chemical characteristics of alkaline waters and the general occurrence of fish populations and other biological forms of life has been demonstrated by several research investigators. This direct relationship is perhaps the most important and yet least understood by anglers and naturalists. If we were to place our finger on one single factor which most influences the fish and fishing of the lakes we should say water chemistry. To be specific, a toxic salt called sodium bicarbonate is the culprit in limiting fish production in most sandhill lakes. This salt often occurs in concentrations from 50 to 50,000 parts per million in Nebraska waters. The concentration of bicarbonates is a function of temperature, pH and other dissolved solids, especially the carbonate ion.

Through careful experimentations in research laboratories, fisheries biologists have determined that most fresh water fish can survive in bicarbonate waters up to 500 p.p.m. Several species can tolerate bicarbonate levels to around 1,000 p.p.m.

An alkaline sandhill lake has its own characteristic animal and plant life that have become adapted to wide ranges of salt content in their habitat. Fresh water kills some salt-water fish by saturating their body with water, similar to drowning. Some fresh-water fish, on the other hand, are fatally effected by alkaline water which dehydrates or dries them out.

Figure 1 will show the importance between total alkalinity and survival of several fish species in the sandhill lakes. Current experiments with several fish species may alter our knowledge of this relationship in the future. The suggested tolerance levels are relative and should not be considered absolute.

Figure 1. Relationship Between Total Alkalinity and Fish Survival



A good many fish have been literally dumped down the drain in the past years by indiscriminate stocking of alkaline lakes not chemically adapted for fish life. We hope that this wasteful practice can be halted now that our basic knowledge of alkaline lakes ecology and chemistry has been demonstrated to be of value in fisheries management. In referring back to Figure 1., it is easy to see why the largemouth bass is not especially suitable for introduction into lakes having total alkalinity readings in excess of around 500 p.p.m. The northern pike appears to have a wider salt tolerance range, and thus lends itself to introductions into a greater number of alkaline lakes.

The number of sandhill lakes that were found to be non-supporting for fish life because of high alkalinity values probably does not exceed 540 lakes (33 percent). These lakes are located primarily in Garden, Morrill and Sheridan Counties. The lakes in Arthur, Brown, Cherry, Grant, Holt, Hooker, Logan, McPherson and Rock Counties are for the most part light alkaline where dissolved salts do not impede fish production. Thus, a knowledge of water chemistry helps to predict the conditions suitable for a given fish population.

BIOLOGICAL CHARACTERISTICS OF THE LAKES

Biological studies of the sandhill lakes during the past six years have, of necessity, been slanted towards fisheries possibilities and limitations. This brief report on biology is of a general nature partly because

of the mass of field data available, but chiefly in the hope that several groups of organisms will be discussed more thoroughly by special technical reports.

Full appreciation of the biology of our alkaline lakes must consider not only the fishery but vegetation, aquatic invertebrates and plankton (tiny plants and animals). It seems reasonable to also include that all the biological organisms are closely related to water chemistry and physical environment.

The aquatic plants become a nuisance to fishermen in those areas of soft muck bottoms, light alkalinity, and water depths of less than six feet. Alkalinity is probably, to a great extent, the explanation for the vast difference in the plants of lakes which are otherwise uniform in all other factors.

Aquatic plants also become an important contribution to the cause of fish winter-kill, a natural biological phenomena so common throughout the sandhill region. During late winter, under the ice-covered shallow lakes, these once lush green plants turn brown, decompose and slowly release a gas called carbon dioxide. This gas in certain quantities is highly toxic to fish life. The higher alkaline waters, often free of submergent plants, seldom experience fish winter kills.

Summer fish kills due to excessive blooms of blue-green algae (scum) have been recorded in several sandhill lakes. These fish kills have invariably occurred when the water was stagnant and quite warm (80 to 85° F.). Decomposing blue-green algae not only takes dissolved oxygen from the water, but may give

off highly toxic substances such as hydroxylamine and hydrogen sulphide. Algae toxicants have also been known to cause death or illness in cattle when drinking water from lakes fouled by blooming algae.

A discussion of aquatic invertebrates and their relationship to fish production and water chemistry would fill a sizeable book. It would seem that something must live almost anywhere, and small aquatic animals have been found in many substances that would poison man, including crude oil pools, sulphur spring and acid mine drainage. To be sure, some specialized invertebrates thrive in such mineral environments as our highly alkaline lakes. It must be confessed that much too little evidence is on hand, not only concerning alkaline sandhill lakes, but throughout the United States in regard to animal life of inland mineral waters. The scope of alkaline lakes research must be comprehensive and systematic; otherwise, an adequate biological inventory would be too fragmentary to be of value to the biologists.

We have left the subject of fish life to the last because, in summation, it is the final product of all the other lake characteristics combined. Without proper environment (physical, chemical, biological) fish life would be non-existent in our sandhill lakes. Indeed, from the limnologist point of view the fisheries segment is more or less an accepted "means to an end" through which basic research may be justified and condoned by the majority of the fee paying anglers.

Records of fish life in the sandhill lakes dates back only to around 1880; thus, we surmise that few records were maintained by the State prior to

that date. In glancing through U. S. Army Engineering Department records for the year 1855-57, only a brief mention is directed towards fish life in the sandhills. Since explorations by the engineers was along major streams few of the natural lakes were encountered. To the best of our knowledge, most of the lakes were devoid of fish life before the migration of white man to the region. The green sunfish and the fathead minnow appeared to have invaded a few lakes by 1860. The year 1920 found many of the more accessible lakes stocked with black crappie, black bullheads, yellow perch, green sunfish, largemouth bass, bluegill and tadpoles. For the next 20 years a multitude of fish life, of all sizes and species, were literally stocked without regard to physical, chemical or biological conditions. There were indeed "happy stocking" days. Fish conservation programs today are guided by the facts - the same as practiced in the field of medicine, engineering or agriculture. To obtain these facts the Nebraska Game Commission in 1954 set up an information seeking survey of the major sandhill lakes.

A good many lakes have been checked for fish life and fisheries potential. Results to date suggest that of the 1,640 sandhill lakes with a permanent water pool about 225 lakes, or only 14 percent of the total lakes, are suitable for a long-range sport fishery. The other were found to be either too shallow or too high in alkaline salts. A ray of hope exists that perhaps some day research will come up with a game fish which will survive in the deeper alkaline lakes, and thus furnish angling in lakes previously devoid of fish life.

The future of fish and fishing in the sandhills looks bright, once three limiting factors are remedied. The three causes for poor fishing at this time are: (1) lack of good public access to lakes; (2) dominance of rough fish population (carp) in many fine game fish potential lakes; (3) poor angling knowledge and techniques by a majority of fishermen.

Rough fish control is proceeding just as fast as money and the landowners' cooperation becomes available. Access roads and improved angling techniques are slow to progress, but some headway is being accomplished each year.

This article gives you a sample of the characteristics and problems that designate our sandhill lakes as unique water areas. Some of the problems are tough ones, it's true, but all of them are interesting. We are only starting on this new science of inland mineral waters. It is worth the work, for as recorded in the Compleat Angler, "God never did make a more calm, quiet, innocent recreation than angling".