LAKE NASSER, ITS FISH, AND ITS FISHERIES

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Abstract. Lake Nasser, behind the High Dam at Asswan on the Nile River in upper Egypt, began to fill in 1964. Presently about three-fourths full, the 300 km. long lake has a surface area of about 3800 km.^{2}. There are indications that the level of the lake may tend to fluctuate 5 to 10 m. annually around its present stage which may be maintained more or less indefinitely. The lake is basically rich, and local Nile River fish species have established themselves well in all major habitat zones except, because of summertime thermal stratification and hypolimmion stagnation, the deeper water.

The principal fishes in general magnitude of abundance are tilapia (very largely *T. nilotica*), tigerfish (*Hydrocynus forskali*), three species of *Alestes*, cyprinids, and siluroids.

The commercial fishery now takes about 7100 metric tons of fish, mostly of tilapia, *Alestes*, cyprinids, siluroids, and Nile perch. It is primarily a rowboat, shoreline, gill net, and trammel net fishery, thus the large stocks of tigerfish and *Alestes* in the open waters are largely unexploited. Nearly all tilapia and Nile perch are sold fresh while other species are usually marketed in a salted condition.

Full development of the fishery shall require more open water fishing, in larger than conventional boats, and with some modifications of existing gear and methods. There is a need for improved processing, holding, handling, and shipping methods.

INTRODUCTION

Lake Nasser is one of the larger African man-made lakes. It was formed by the Asswan High Dam which is located just above the First Cataract on the Nile River at Asswan in upper Egypt. The Dam formed a 450 km. long reservoir which extends southward 150 km. beyond the Egyptian-Sudanese boundary about to the Second Cataract. The 300 km. section in Egypt is known as Lake Nasser; that part in the Sudan is called Lake Nubia.

The dam first blocked the river in May 1964, and all work on the dam and its auxiliary facilities was completed early in 1971. At present Lake Nasser is about three-fourths full from a surface area standpoint, but a substantial commercial fishery already has been developed on it. This paper is a general description and assessment of the lake, its fish fauna, and its commercial fishery, and it is based on work carried out by a Food and Agriculture Organization of the United Nations research program that has been in operation on the lake since 1968.

Formation, Morphology, and Climate of the Lake

Lake Nasser has been filling at an annual net mean rate of about 6 m. However, the filling rate is declining and it is possible that the lake may stabilize and fluctuate around the 3/4-full level (about 170 m. above sea level) more or less indefinitely. Maximum annual water level fluctuations have been as high as 17 m. The dam completely held back the 1964 Nile River (summertime) flood and all floods since then. The reservoir has a maximum storage capacity of about twice the normal total annual discharge of the river, its only source of water.

The lake generally is long, narrow, and moderately deep. At present its surface area is about 3800 $km.^2$. Its mean width is about 14 km. and its mean depth about 22 m. The shoreline is fairly irregular and now about 6000 km. long.

The area flooded includes the old river bed and valley (along with some farm land and many old Nubian villages), the lower stretches of the dry washes (khors) that lead into the valley, and considerable expanses of low, sandy and rocky desert. Very little vegetation except for several hundred thousand palm trees along the old river bank was inundated. A very large proportion of the total bottom area is composed of sand and rock.

The reservoir is in an extremely hot and dry area between the Eastern and Western Deserts of Upper Egypt. Summertime air temperatures exceed 48^{o} C. in the shade, but in wintertime they drop to near 0^{o} C. Maximum mean air temperatures in the Asswan area are about 42^{o} C. in June and 23^{o} C. in January. Mean relative humidities range from 24 percent in June to 45 percent in December. Annual rainfall is in terms of 2 or 3 mm.

Some Limnological Conditions

The annual Nile River flood, whose effects formerly were strongly felt all along the river in Egypt, occurs from about June to October, but its main physical characteristics are now lost before it reaches the lower end of Lake Nasser. The flood keeps the water in the upper third of the lake turbid from about July to January, but the water discharged at the dam is always clear. Depending on location in the lake, season, and the amount of plankton present, observed Secchi disk transparencies have been from 20 to 400 cm. Since the main flood flow is down the old river channel, the principal changes in transparency toward the upper ends of the longer khors are due to changes in plankton concentration.

Surface water temperatures range from about 16 to 32^{o} C. Summertime maximum water temperatures are well below maximum air temperature at the same time. Below 5 m., the water temperature is always between about 17 and 28^{o} C. During the December-April overturn period, temperatures tend to be nearly uniform at about 18^{o} C., from top to bottom. Thermal stratification develops about May.

During the winter circulation period, the entire water column is fairly well-oxygenated, but after thermal stratification sets in, dissolved oxygen concentrations drop to zero or nearly so below the metaliminion. During stratification, only surface waters, down to a depth of around 10 m., are well-oxygenated.

There are virtually no higher aquatic plants in the lake. The only vegetation around the lake develops in a narrow strip at the annual high water mark and it is flooded out by the next year's high water.

The Fishes

Thirty-six species of fish are known from the lake, but it is likely that about 57 are present, based on fishes known from the river in Upper Egypt and in Lower Sudan. The fish fauna of the Lower Nile River is considerably less rich than that of the upper river.

Numerically, the most abundant open-water species are the tigerfish (*Hydrocynus forskali*), three species of *Alestes* (*A. baremose*, *A. dentex*, and *A. nurse*), the pelagic siluroid, *Eutropius niloticus*, and a small cyprinid, *Chelaethiops bibie*. From a weight standpoint, *Labeo coubie* and the Nile perch (*Lates niloticus*) are important also. Toward the lower end of the lake tigerfish appear to be much more abundant than *Alestes*. The reverse is true toward the upper end. *Alestes baremose* and *A. dentex* comprised about 12 and 74 percent of the total experimental catch by weight of all open-water fish from the lower and upper ends, respectively. Tigerfish made up about 65 and 16 percent, respectively.

During the winter circulation period, tigerfish *A. baremose*, and *A. dentex* are fairly well scattered vertically, down to 20-30 m. During the summer stagnation period they probably are restricted almost entirely to the upper 10-15 m., in or above the metalimnion. Dense aggregations of any open-water species have not often been observed.

The main plankton-feeders in open water are three species of *Alestes*, *E. niloticus*, three species of *Labeo*, and two small cyprinids, *C. bibie* and *Barilius niloticus*. The tigerfish is the main predator, but in the spring and early summer during its spawning period the Nile perch also is important.

The inshore fish fauna is more complex than the open water community, but only a few species dominate it also. Numerically, the principal species are *Tilapia nilotica*, two small cyprinids, *C. bibie* and *B. niloticus*, tigerfish, and Nile perch.

The smaller species of siluroids are not concentrated anywhere, but discrete pockets of some of those that attain large size, particularly *Clarias lazera*, are seen during the summer stagnation period. Juvenile *T. nilotica* school densely along shore in shallow water as do adults at the surface over deeper water, except in mid-winter.

While little direct evidence has been gathered to demonstrate it, there must be considerable movement of fish from deeper water upward and toward the shore during development of stagnation in late spring. Increased commercial catches per unit of effort in the spring may be one indication of this.

The Commercial Fishery

The commercial fishery on the lake is still similar to the old Nile River fishery from which the lake fishery was derived. The boats and gear are mainly those still traditional of the existing river fishery.

There are presently about 3,500 fisherman using perhaps 1,200 unpowered rowboats on the lake. The fisherman operate in village and family groups out of about 150 shoreline bases in 39 designated fishing areas. The boats, of two main types, are designed for quiet, inshore waters. Gill and trammel nets are the main kinds of gear used, but longlines, beach seines, and cast nets are also used. All gear is fished primarily alongshore, but when water conditions are favorable gill nets are set in the open waters of the khors and to some extent in the main lake channel.

Virtually all fish are landed at the High Dam, after being collected from the fishing bases in powered, and in some cases, refrigerated carrier boats. During the winter when the total daily catch is low, there is an excess carrier boat capacity which could easily be diverted to open-water fishing.

The government-reported annual landings of fish increased about 80 percent yearly from 1965 to 1969, but the 6,033 metric ton total catch in 1970 was only 46.6 percent greater than that of 1969. Fresh fish made up 56 percent of the 1970 landings. The remainder was of salted fish, whose actual weights were multiplied by 1.5 to convert them into fresh fish terms in reporting total landings. The actual catch of fish in 1970 is estimated to have been nearer 7,100 tons than the reported landings figure for several reasons, including that an average of perhaps 10 percent of the fish caught spoil before they can be collected by the carrier boats.

Since the reported landings are not accurate with respect to species composition, a randomized sampling program was carried out to estimate composition. Based on a sampling period in each of the years, 1970 and 1971, the percentage composition by weight of the landings of fresh fish is about as follows:

Tilapia nilotica	60.8
Lates niloticus	10.2
Clarias lazera	8.6
Bagrus docmac	5.8
B. bayad	3.1
Labeo coubie	3.0
Synodontis serratus	2.5
Labeo horie	1.5
Synodontis schall	1.2

Accurate information on the composition of the salted fish landings is not available. Almost all species caught are sometimes salted, but Alestes spp., Labeo spp., and small siluroids make up the great bulk of the landings.

Stock Assessment

All stocks are believed to be underexploited, particularly those of tigerfish and to a lesser extent those of Alestes spp., all of which are abundant in the open waters which are not yet much fished. T. nilotica is abundant all along the shoreline and it is the species landed in greatest quantities. Since the percentage it constituted of the total landings dropped from 45 to 38 between 1969 and 1970, an analysis of its commercial catch curves was made. A considerable change in the stock between the beginning of the fishery (in 1965-66) and the present (1970-71) is indicated. The peak in the 1965-66 curve was at a (total) fish length between 26 and 30 cm., and in 1970-71 it was at about 45 cm. Another sign of good condition of the stock is that there has been no appreciable change in the proportion of older (i.e., longer) fish in the landings over the last three years.

The landings of Nile perch have increased more rapidly than those of other species, but the mean length and average maximum size of fish in the landings have increased also.

Lake Nasser appears to be one of the basically most productive large bodies of water in Africa, and other conditions indicate a large fish production potential for it. However, because of summer stagnation of the hypolimnion, the production of fish, and that of most other animals as well, must be restricted to surface waters from about June to October, and the indirect effects of stagnation on overall fish production may extend through the rest of the year.

The yield of fish in 1970 amounted to about 7,100 metric tons, or about 28 kg/ha. If the same rate of yield is maintained when the lake reaches the point of being about 3/4-full (say at 4000 km.^{2}) from a surface area standpoint, the total annual yield would be about 12,000 tons. It is believed however that the present yield rate could easily be doubled (to say 60 kg/ha) and maintained, or that an annual sustained yield of around 25,000 tons is easily possible. With improved ecological conditions and a full lake, a potential yield of 30,000 to 40,000 tons would not seem unreasonable.

Fishery Development

Based mainly on experimental catch-per-unit-of-effort data, it was estimated that the 1970 catch of tigerfish and Alestes spp. alone could have been increased by 3000 tons by fully exploiting the open waters of the lake and by taking more of the available tigerfish alongshore, with gill nets alone. For adequate expansion of this fishery, only minor modifications of existing gear and methods would be necessary but powered and larger and safer boats would be required. The existing inshore fishery is based on reasonably efficient gear and methods for most species, but existing fishing boats are unsatisfactory for winter fishing conditions and the sleeping quarters that most are used for. Thus, it is believed that the principal need for full development of the fishery is for boats suitable for open-water and winter fishing, but improved carrier boat services and better fish processing, holding and shipping facilities and methods are also needed.