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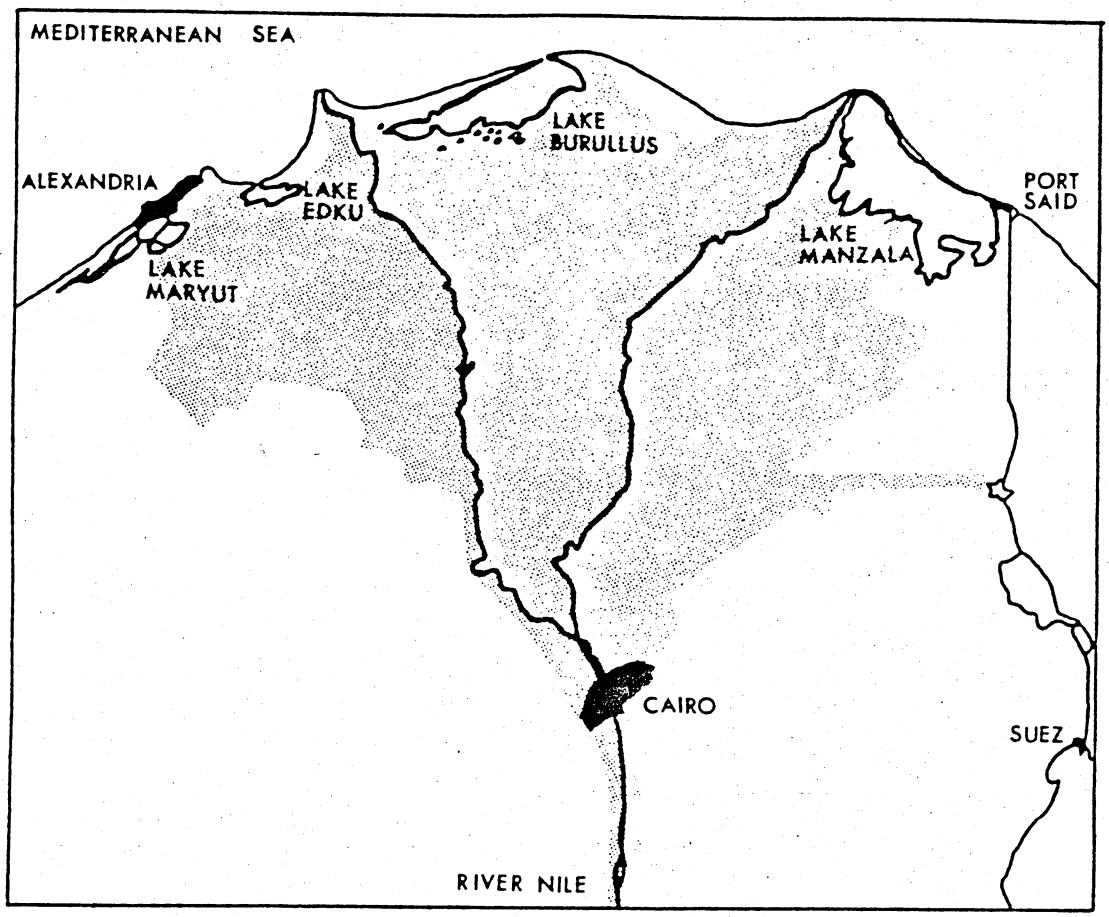
FISHERIES MANAGEMENT IN THE NORTHERN NILE DELTA LAKES OF EGYPT: THE CASE OF HOSHA

1. INTRODUCTION

On the Mediterranean coast of the River Nile delta there are four lakes (Figure 1). Lake Manzala is located on the eastern edge of the delta, extending from the Damietta branch of the Nile to Port Said. Lake Burullus is a long, thin lake in the mid-delta region, and Lakes Maryut and Edku are small lakes near Alexandria in the west. Three of these lakes - Manzala, Burullus and Edku - are lagoonal in nature, there being a lake - sea connection or "bougaz". Since 1892, the fourth lake, Lake Maryut, has served as a drainage basin (Aleem and Samaan, 1969) and is kept at three meters below sea level. The typical depths of these lakes ranges between 0.5 and 1.0 m, with very few areas being deeper than 1.5 m.

These lakes are sites of important fisheries in Egypt. The open water fishing areas of these lakes is currently 136,378 ha (Reid and Rowntree, 1982), or a little less than 6% of the 2,400,635 ha of arable land in Egypt (Parker and Coyle, 1981). The estimated fish yield in 1982 from open water fishing on these four lakes was 99,497 tons (Rowntree, Reid and Abou-Auf, 1983). An additional 30,000 tons of fish were reported by the Undersecretariate of Aquatic Resources as produced by primitive in-lake enclosures called "hosha". Producing about 60% of Egypt's inland fish catch, the value of the northern lakes fish catch in 1982 was about LE 155 million (US $1 = LE 0.83).

Figure 1 Map showing the location of Lakes Maryut, Edku, Burullus and Manzala in the River Nile delta. Arable land is shaded.



These fisheries, historically the domain of open lake fishermen using a variety of traditional and more modern net and trap fishing methods, have experienced in recent years a vast increase in the number of hosha operations. Hosha is a method of fish capture which, though mainly illegal, is widely practiced, especially in Lakes Manzala and Burullus. Typically, dykes are constructed out into the lake from shallow vegetated lake shore margins to enclose an area of 1 - 5 ha or more. The dykes are usually constructed from lake bottom silts reinforced with reeds and dead vegetation. Fish swim into the gaps in the dykes and are harvested when the gaps are closed and the water pumped out. Hosha fish harvesting frequency varies from 2 to 20 or more times a year. Holding time for the fish is inversely proportional to the standing stock of fish in the adjacent lake waters. Furthermore, hosha is often used in land reclamation as an intermediate stage between lake and land, being particularly useful for leaching saline soils. Most hosha are built out from lake margins, but many are now found inside the lake or extended out from the islands within the lake. The spread of hosha has generated both many conflicts with open lake fishermen and many debates on the impact of hosha on the northern lake fisheries.

The increasing role of hosha in the minimally regulated northern lakes fisheries presents numerous fisheries management problems. This paper reviews the history and development of these lakes and their fisheries, exploring the prospects for and the dangers of continued hosha expansion and indicating the necessity of incorporating hosha management within a full fisheries management program.

2. THE NORTHERN DELTA LAKES AND THEIR FISHERIES

2.1 The impact of recent changes in the water regime

As the proximate reservoirs of Nile water before it flows into the Mediterranean Sea, these lakes are the sites of the last Egyptian uses of the water. This offers opportunities for sewage and waste processing as well as for fish production, but the quantities and qualities of water available to the lakes' fisheries are determined by up-stream uses, and not by the requirements of the productive activities within these lakes.

Prior to the construction of the Aswan High Dam, the River Nile discharged into the sea some 89,297 x 10^6 m^3/annum (Holeman, 1968). Much of this flowed into and through the northern delta lakes, flushing out saline water, wastes, flora and fauna accumulated since the previous flood period. Regulation of this flow by the dam has resulted in irrigation water being available year round; however, it has substantially decreased annual flows into lower Egypt. Measured in 1979, the annual discharge to the sea was 26,635 x 10^6 m^3 (Mancy, 1980), of which 73% was drainage water. Most of this drainage water flows to the sea via the four northern lakes.

This shift in the water regime of these lakes, from one largely marine in character (with periodic flushing by the annual floods), to one largely characterized by steady inflows of brackish irrigation water, brought significant changes in the lakes' environment. Immediately, this brought about a change in the fish species composition in the lakes, from one with a significant marine fish and crustacean component to one overwhelmingly dominated by fresh water Tilapia and Sarotherodon species (hereafter referred to jointly as "tilapia"). This species change was encouraged by the effect the altered water regime had on increasing the amount of aquatic vegetation throughout the lakes, thus providing protective areas for spawning and fish fry. In Lake Manzala there was now also a longer retention time of the eutrophic urban wastewaters from

Cairo, an environment in which tilapia have responded favorably to intensive fishing practices and have come to dominate the fishery.

2.2 Lake Manzala

Lake Manzala lies at the north-easternmost extremity of the Nile delta, between the Damietta branch of the Nile and Port Said. The bougaz is at Gamil, about 10 km west of Port Said. Freshwater inflows from canals account for only 2.4% of the total annual inflow of $6,627 \times 10^{6}\ m^{3}$. The rest of the flow is from agricultural drainage water and urban wastewater, mainly from the Hadous (49%), Bahr El-Baqar (25%) and Sirw (13%) drains, all of which flow into the southern El-Genki region of the lake. Water flows are impeded by the many islands which have effectively compartmentalized the lake into distinct areas.

Lake Manzala, with 69,922 ha of open lake, is the largest and most productive of the northern lakes, comprising some 51% of the total open lake areas and producing in 1982 some 59,000 tons of fish. This is about 59% of the total northern lakes open fishing yields and about 40% of Egypt's inland fish catch in 1982. Fishing intensity and fish production have both more than doubled over the past 20 years.

The most striking change in the Lake Manzala fish catch following the construction of the Aswan High Dam has been the change in the proportion if tilapia from 62% in the early 1960's to 83% of the yield by 1968, after which the proportion remained fairly steady. Catfish species and eels remained at about 5% and 6% respectively, of the total catch (Table 1), seemingly unaffected by the changes. Mullet and crustaceans, which represented 15% and 11% of the catch prior to the High Dam, were reduced to 7% and 1% respectively. The proportion of other fishes, which are mainly higher valued marine species, also declined from 8% to 1%.

Table 1. Table showing the changes (as a percentage of the yield) in the species composition of Lake Manzala fish yields as a result of the construction of the Aswan High Dam.

Years	Tilapia	Mullet	Catfish	Eels	Crustacea	Others
1962-1965	61.6	14.5	4.8	0.8	10.5	7.9
S.D.*	6.0	1.6	0.7	0.1	3.4	1.6
1975-1979	83.4	7.4	5.6	1.1	1.1	1.4
S.D.	1.2	0.7	0.3	0.2	0.5	0.5

* Standard Deviation

2.3 Lake Burullus

Lake Burullus is in the mid-delta, between the Rosetta and Damietta branches of the Nile. It is a rather long (57 km), thin (14 km) lake with a bougaz at Burg El-Burullus at the extreme eastern end of the lake - sea boundary. All of the canals and drains that flow into this lake enter along its southern shore. Some freshwater from the Rosetta branch of the Nile flows into the lake through the Brimbal canal (4.3%), while the bulk of the water ($3,207 \times 10^6$ m^3/annum) is contributed by six agricultural drains (El-Sedfy and Libosvarsky, 1974).

This lake is the second largest of the four northern lakes. With 48,098 ha of open lake area, it comprises some 35% of the total northern lake open water area, but only produced 18% of the total northern lakes fish yields in 1982. Reasons for this relatively poor yield probably include the fact that this lake receives very little nutrient rich urban wastewater.

Table 2. Table showing the changes (as a percentage of the yield) in the species composition of Lake Burullus fish yields as a result of the construction of the Aswan High Dam.

Years	Tilapia	Mullet	Catfish	Eels	Crustacea	Others
1962-1965	42.4	26.1	3.6	3.3	17.9	6.8
S.D.	3.8	4.2	0.6	0.5	6.9	1.6
1975-1979	62.2	20.2	9.2	5.9	0.0	2.9
S.D.	2.4	2.6	0.6	1.1	0.0	2.1

Having a wide lake - sea connection (400-500 m wide), Lake Burullus remains the lake with the most marine environment. Despite this, however, since the completion of the Aswan High Dam in 1965, there has been a very significant increase in the proportion of tilapia caught in Lake Burullus (Table 2). The pre-dam catch represented some 42% of the total yield, but this increased to 62%. Catfish species have gone from 4% to 9% of the catch, while eels have increased from 3% to 6%. The proportion of mullet has remained relatively stable, at about one quarter of the catch. Crustaceans (crabs and shrimps), which formerly accounted for 18% of the catch, no longer are caught in sufficient quantities to appear in the official statistics.

2.4 Lake Edku

Lake Edku is located between the Rosetta branch of the River Nile and Alexandria. Lake water flows out into Abu-Qir Bay at El-Maadiya, a town at the north western corner of the lake. Water flow is generally from east to west, resulting from drain water being delivered from the Berzik and Edku drains. Inflow into the lake is estimated at 2,062 x 10^6 m^3/annum (Saad, 1976).

Lake Edku accounts for 8.5% of the total northern lakes open water areas, but produced only 6% of the total fish yields in 1982. The productivity of this small lake (11,537 ha of open water area) is constrained by the growth of water reeds and other aquatic vegetation, rendering 50% to 80% of its area, depending on the season, inaccessible to fishermen.

Table 3. Table showing the changes (as a percentage of the yield) in the species composition of Lake Edku fish yields as a result of the construction of the Aswan High Dam.

Years	Tilapia	Mullet	Catfish	Eels	Crustacea	Others
1962-1965	68.5	10.4	5.0	11.1	3.9	1.2
S.D.	3.2	2.5	1.1	0.9	2.5	0.4
1975-1979	82.4	5.6	3.0	9.2	0.0	0.0
S.D.	3.9	0.7	1.2	1.9	0.0	0.0

The catch of tilapia from this lake has increased from 69% to 82% since the Aswan High Dam came into operation (Table 3). Eels have remained relatively stable at about 10% of the catch. Yields for mullet have gone down from 10% of the total catch to 6% and catfish have remained at about 4% of the catch. Crustaceans and other marine species, formerly a small component of the total yield, are no longer caught in sufficient quantities to appear in the official statistics.

2.5 Lake Maryut

Lake Maryut is a long, thin lake lying in a NE-SW orientation with its northern portion dissected into a number of compartments by the Mersha Matruh causeway, the Nubaria canal, the Umum drain, and the Cairo-Alexandria desert road. The long extension of the lake to the southwest of the Mersha Matruh causeway is saline to hypersaline, and only two of the four segments in the northwest portion of the lake support this lake's fishery. These are the two portions northeast of the Umum drain, closest to Alexandria. Agricultural drainage water flows to Lake Maryut from the Umum, Qalaa and a few minor drains, while urban wastewater is discharged through three sewer outfalls on Kabbary Road and $11,315 \times 10^6$ m^3/annum from the Industries Pumpstation (Camp, Dresser, and McKee, 1977). There is little information available on the volumes of the other flows.

Lake Maryut's open water area was reduced by about half between the early 1950's and 1981, shrinking to 6,820 ha of open water area, or about 5% of the total for the northern lakes. The fishery, actually engaged in about 2,500 ha in the northwestern end of the lake, produced about 17% of the 1982 fish yields. Lake Maryut's high productivity is due to the nutrient inputs from Alexandria's wastewaters, which however are also endangering the fishery due to pollution and excessive eutrophication.

The changes in the composition of the fish catch in this lake do not follow those in the other three lakes (Table 4) since this lake was little affected by the construction of the Aswan High Dam. Instead of an increase in the proportion of tilapia in the catch, there has been a decrease from 97% to 77% of the catch. It appears that increasing salinities from evaporation together with increasing eutrophication and frequent anoxic conditions are responsible for the changed composition of the fish catch. Catfish, eels and mullet, which constitute the rest of this fishery, have all shown increases in their proportion of the yield. Catfish have shown a major increase, from 2% to 17%, while eels and mullet have each increased from 0.6% to 3%.

Table 4. Table showing the changes (as a percentage of the yield) in the species composition of Lake Maryut fish yields as a result of the construction of the Aswan High Dam.

Years	Tilapia	Mullet	Catfish	Eels	Crustacea	Others
1962-1965	97.2	0.6	1.7	0.6	0.0	0.0
S.D.	0.2	0.1	0.4	0.1	0.0	0.0
1975-1979	77.2	2.7	16.8	3.2	0.0	0.0
S.D.	4.5	1.3	2.0	2.0	0.0	0.0

The total yields from Lake Maryut have roughly doubled since pre-dam days, in the official survey statistics as well as in the projections from the 1982 survey, thus there has been an absolute increase in the tonnage of tilapia despite its falling proportion of the catch. The other fishes caught have also increased greatly in tonnage over the time span considered.

3. THE RISE OF HOSHA IN A PERIOD OF NON-REGULATION

Open water fishermen have always been intolerant of hosha, and in 1960, it was declared illegal. Despite its illegality, there continued to be a slow increase in the number of hosha operations in Lakes Manzala and Burullus, particularly near drain outlets along their southern shores. During the hostilities of 1967 which continued until 1973, the army occupied much of the area near these lakes and were unable to do other than provide minimal policing of fisheries activities. The numerous islands in Lake Manzala were illegally, but nevertheless, rapidly, settled during this period, and since 1970, there has been appreciable growth in the area of island and lake shore utilized by hosha operators. In Lake Manzala most of the hosha are on the perimeter of these islands and along the eastern and southern shores. The hosha in Lake Burullus are located primarily along the southern shore of that lake. There is little hosha activity on the other two lakes.

During the early 1960's a number of new and revised fisheries regulations were promulgated by the Egyptian government. These detailed the licensing of fishing boats, fishermen, legal net sizes and fishing methods, and prescribed lakeside locations for the sale of fish, those lakeside communities which may engage in fishing, and those areas where fishing is permitted. Virtually none of these regulations were enforced during the period of hostilities, giving rise to vast increases in the numbers of unlicensed fishermen, fishing with illegal techniques, and fishing in illegal locations. The expansion of hosha was only one among many examples of the expansion of unlawful activities. Squatters occupied the islands and shores of the lakes. Open battles, including gun battles, broke out in the lakes among warring groups of fishermen, hosha operators, and squatters on the islands.

3.1 The Decline of the Traditional Regulatory Mechanisms

Concommitant with the decline of governmental regulation was a decline in the ability of the traditional fisheries management techniques to maintain an orderly fishery. Historically, the river, canal, and lake waters of Egypt have been available to all who desired to fish them. However, in practice this apparent free access has been limited by informal arrangements among fishermen dividing up the lakes into "private plots." While there have always been some areas where anyone can fish, most of the productive areas are divided up and the rights to fishing in those areas claimed by families by tradition and are passed on to heirs. Due to this, fishing intensity was historically regulated to a certain extent by the limited ability of the individual families to vary their fishing effort in their own fishing areas.

Tradition rather than law protected the rights of the fishermen to their plots. Thus, when newcomers encroached on traditional family plots or when farmers extended hosha into the lakes from its margins, the traditional fisherman was left without recourse, particularly during the period of almost total non-regulation.

3.2 Efforts at a New Fisheries Management Regime

The consequences of the period of non-management became apparent, and by the late 1970's the government instituted additional regulations for fisheries management. In 1978, new regulations, aimed at controlling hosha, allowed some experimental licensing of hosha operators, provided that the mode of operation was changed from one of pure capture to that of a modified fish farm. Additional incentives included specialist help and financial aid from the government. There were still restrictions on locating hosha near the bougaz, near drain and canal outlets, in the lake proper, and within 200 m of an adjoining hosha. The hosha licensing authority, however, was given to the governorates, and few hosha have thus far been licensed.

In the same year as the new fisheries regulations were established, a new unit was formed to police fishing activities on the lakes. The Water Area Police, formed from seconded army units, is administered by the Ministry of the Interior and the Ministry of Agriculture's Undersecretariate of Aquatic Resources. Methods used to deter hosha operators include dyke destruction, confiscation of pumping equipment, and imposition of fines. While the Water Area Police have gradually been increasing their presence on the lakes, the unruly state that existed in the late 1970's necessitated a slow, determined effort at improved enforcement. Thus, throughout the lakes illegal fishing techniques, unlicensed fishermen, and fishing in off-limit areas are common. Similarly, the bulk of hosha operators remain unlicensed and unregulated.

As this history has revealed, the northern lakes fisheries have undergone dramatic legal, social, political, topographical, hydrological, species composition, and other changes during the past 20 years. The period of the self-reglating traditional fishery is forever gone. On the other hand, the new fisheries management system is barely in place and has not yet firmly established its control or its policy direction.

4. THE EXTENT OF HOSHA IN THE NORTHERN LAKES

Hosha are widely used in the northern Nile delta lakes. Accordingly, adequate fisheries management must necessarily incorporate hosha management and regulation. Recognition of the extent of hosha and its impact on the lakes and the fisheries environment is the first step in dealing with the problem.

The Ministry of Agriculture estimates that hosha now occupy about 37,800 ha, most of them being located on Lake Manzala and the rest being on Lake Burullus. Lakes Manzala and Burullus have a total of 118,020 ha of open lake area, accounting for about 86.5% of all the northern lake open areas. Together they accounted for about 77% of the 1982 northern lakes fish yields. Since Lake Edku is quite small and Lake Maryut is, while highly productive, constantly threatened by urban pollution and encroachment, the future development of the fish wealth of Egypt is dependent on the success of management of the Lakes Manzala and Burullus fisheries.

The Lake Manzala Study (MacLaren, 1982) identified 14,918 ha of hosha in 1979-90. This included 7,140 ha of hosha in the western region of the lake, in 1458 operations of about 5 ha average size. A further 3,780 ha in 1,125 hosha with an average size of about 3.3 ha were observed between the town Matariya in the south and Port Said to the northeast. And 3,150 ha in 2,500 hosha of about 1.3 ha average size were found in the highly productive El-Genki region. It is not clear which, if any, and to what extent these operations have been licensed. Licensing is done at the governorate level where only the largest hosha tend to be issued a license.

On Lake Burullus in 1982 there were 171 licensed (i.e., presumably "modified" with fish culture practices) hosha operations occupying 12,689 ha. Of these, 45% were 1-42 ha in size, 28% were 42-84 ha, and a further 12% were 84-126 ha. The remaining 15% were of operations 126-420 ha in size. Interestingly, the Lake Burullus Area Development Study found that in addition to the 171 licensed hosha, there were an estimated 1,079 unlicensed or illegal hosha on Lake Burullus. Together the total estimated hosha area amounted to 17,522 ha, 38% more than officially licensed. While the officially licensed hosha averaged more than 74 ha in size, the unlicensed hosha averaged only 4.5 ha.

The areas of the open water portions of the lakes obtained from recent Landsat satellite images and estimates of the area occupied by hosha are set out in Table 5. In Lake Manzala hosha

Table 5. Hosha areas in Lake Manzala and Lake Burullus (in hectare)

	Lake Manzala	Lake Burullus
Area of Hosha	14,910 [1]	17,522 [2]
Open Water Area	69,922 [3]	60,698 [3]
Ratio Hosha:Open	21:100	36:100

Source: 1. Ifagraria, 1983.
2. MacLaren, 1982.
3. Reid and Rowntree, 1982.

operations from lake and island shorelines occupy an area nearly 1/5 the size of the open water area. For Lake Burullus the figure is over 1/3 of the open water lake area.

The extent of hosha intrusion into the lakes fisheries is widespread, and any fisheries management program for the northern Nile delta lakes must take proper cognizance of the role of hosha in the fisheries. There is much that could be done to improve the performance of hosha, particularly in terms of restricting them to particular locations and encouraging feeding and rearing practices. However, effective fisheries management necessitates extending the technical advice and admonitions to the thousands of hosha operators who are now illegal and outside the regulatory network.

5. HOSHA AS A PRELUDE TO LAND RECLAMATION

Given Egypt's relatively fixed arable land base and a population of 44 milllion (about 18 persons per cultivated hectare) that is increasing by about 1.1 million annually, Egypt has strong incentives to reclaim its deserts and its lakes for agricultural and urban uses. These lakes were subject to large scale government-sponsored reclamation schemes between the late 1950's and the early 1970's. In addition, private reclamation of these lakes has proved to be an attractive method of acquiring land for agricultural use. Public and private reclamations of the northern lakes between 1953-55 and 1981 reduced the total open water area by 26% (Reid and Rowntree, 1982).

Farming near these lakes historically has been hampered by the extensive, lowlying marshes extending inland from the southern lake shores. Schemes for the reclamation of parts of both the marshlands and lakes are still troubled by the poor quality alkaline soils and the upward flow of high salinity groundwater due to seawater intrusion which occurs some distance (up to 50 km) south of all four delta lakes (Farid, Hefny, and Amer, 1979). All the same, there has been extensive private reclamation of marshland and lake bed along the banks of drains which provide suitable sources of irrigation water.

Hosha located near the outlets into the lakes of agricultural drain water have been used to leach land prior to agricultural use. The water source for flooding the impoundments has been fresh to brackish, and although the soils are not good and the groundwater saline, it has provided an attractive, inexpensive albeit illegal manner in which to obtain further land holdings. This has been particularly true in the southern portion of Lake Manzala, where extensive reclamation has occurred using the nutrient rich Bahr El-Baqar drain water for both leaching and subsequent crop irrigation. When the open lake is taken for hosha or reclaimed for agricultural uses, the area of the lake available for fish breeding, rearing, and harvesting is reduced, the traditional open water fishing areas to which families lay claim are reduced, and the rights of tenants to the reclaimed land are usually uncertain.

The extensive hosha areas, amounting to almost 1/5 of Lake Manzala's open water area and more than 1/3 of Lake Burullus's open water areas, were not all formerly open water areas. These areas also include those hosha which have been established on former marsh land and thus were unavailable to open water fishermen. However, these figures do not reveal the extensive area of lake shore that has already been reclaimed for agricultural production. Table 6 shows that between 1973 and

1981, 16% of open water from Lake Manzala, or 12,919 ha, was lost to hosha and/or reclamation. In Lake Burullus during the same period there was an 8% reduction in lake size which translates into a decrease of 4,330 ha.

Table 6. Reductions in open water areas in Lake Manzala and Lake Burullus between 1973 and 1981. (in hectare)

	Lake Manzala		Lake Burullus	
	Area	% Reduction	Area	% Reduction
1973	82,841	---	52,429	---
1981	69,922	16 %	48,098	8 %

Source: Reid and Rowntree, 1982.

Hosha thus cannot be viewed simply as a fishing technique. It is commonly used as an intermediate stage in the land reclamation process which is rapidly reducing the open water areas of the lakes. Hosha regulation is a necessary component of a proper fisheries management program for the northern lakes. In particular, the management scheme will need to outline acceptable hosha operating guidelines so as to prevent the gradual reclamation process and to limit the expansion of unwarranted or improper hosha. Policies directed at stabilizing the open lake margins by recognizing existing hosha, along with encouraging the construction of more permanent dykes, will be required to preserve the fisheries.

6. HOSHA FISH YIELDS

Northern lakes fish yields have increased dramatically in recent years, and hosha have become a sizeable component of the total yields. Table 7 shows the general contribution of hosha to the total fish yields in Lakes Manzala (for 1980) and Burullus (for 1982). The contribution is substantial. Hosha occupied

Table 7. Hosha and open water fishing yields in Lake Manzala (1980) and Lake Burullus (1982)

	Area[1] (ha)	Yield (tons)	Yield/Unit Area (tons/ha)
Lake Manzala			
Hosha	14,910	22,570[2]	1.514
Open Water	69,922	40,760[2]	0.583
Hosha/Total, %	17.6 %	35.6 %	---
Lake Burullus			
Hosha	17,522	17,000[3]	0.970
Open Water	48,098	26,015[3]	0.541
Hosha/Total, %	26.7 %	39.5 %	---

Source: 1) Reid and Rowntree, 1982.
2) MacLaren, 1982.
3) Ifagraria, 1983.

17.6% of the total (hosha and open) area in 1980 and produced 35.6% of the total Lake Manzala fish yields. In Lake Burullus in 1982 hosha produced 39.5% of the total fish yields on 26.7% of the total water area. Thus, hosha currently produce about 35-40% of the Lakes Manzala and Burullus fish yields.

It can also be seen in Table 7 that hosha yields per ha are much higher than yields per ha from open lake fishing. On the average Lake Manzala hosha produce more than 2.5 times the yield per ha produced in the open lake, 1.514 tons per ha as compared to Ø.583 tons per ha. However, there is great diversity within the lake. In the most productive southern EL-Genki region of Lake Manzala open fishery yields are 2.533 tons/ha; hosha in this region increase the per ha yields to 4.762 tons/ha, which is about 1.9 times greater than the open fishery yields. By contrast, in the relatively unproductive western region of Lake Manzala the open fishery yields (Ø.1Ø7 tons/ha) are increased by about 4.5 times on a per ha basis by hosha (Ø.476 tons/ha). In the eastern region hosha yields (1.9Ø5 tons/ha) are 5.1 times greater than those of the open fishery (Ø.371 tons/ha) (MacLaren, 1982). Hosha yields exceed open fishery yields in the productive southern region by a smaller portion than they do in the less productive eastern and western regions. This suggests that there is less of a rearing component to hosha in the south, a point to which we shall return.

Lake Burullus is a more homogeneous water body and yields an average Ø.97Ø tons/ha by hosha and Ø.541 tons/ha in the open lake fishery (Ifagraria, 1983). Hosha yields on a per ha basis still exceed open fishery yields by about 8Ø%.

7. IMPACT OF HOSHA ON TOTAL FISH YIELDS

While it is clear that hosha produces a large and rapidly increasing portion of the total northern lakes fish yields, an important question for designing fisheries management policies concerns the impact of hosha on total or potential sustainable yields. The data are too fragmentary to determine the full impact of hosha on total lakes and open fishery yields. Too many changes have occurred at the same time--the spread of hosha, the long period of fishery non-regulation, a dramatic increase in numbers of fishermen and fishing effort, and improvements in gear and fishing methods. However, the above data showing the much higher yields per unit area of hosha over open fishing (Table 7) are somewhat misleading. Some sizeable portion of the hosha yields originated within the open lake, while some portion of the yields are correctly attributable to fish production within the enclosures. The more frequent the hosha are pumped and harvested (and the less feeding of hosha fish), the greater is the proportion of hosha yields that is properly attributable to the open fishery.

Table 8 shows the proportion of hosha yield produced inside and outside of the enclosures. Hosha are pumped on Lake Manzala when the standing stock reaches about 240 kg/ha and on Lake Burullus when the standing stock reaches about 480 kg/ha. The

Table 8. Origin of hosha yield in Lake Manzala and Lake Burullus

	Total Hosha Yield According to Origin			
	Hosha		Open Fishery	
	Tons	%	Tons	%
Lake Manzala[1]				
Southern Region	750	5	12,750	95
Eastern Region	450	7	5,699	93
Western Region	525	18	2,384	82
Lake Burullus[2]	1,954	11.5	15,046	88.5

Source: 1) MacLaren, 1982.
2) Calculated from Ifagraria, 1983, data.

exploitation rate (yield/standing stock) reflects the regional variations in fish population density and ease of catch. Assuming that the average standing stock at the time of harvest is close to the mean seasonal standing stock in the hosha, the product of exploitation rate and the standing stock gives a rough estimate of annual fish production in hosha (MacLaren, 1982).

Thus Table 8 reveals that most of the fish yield from hosha actually originates in the open fishery. Furthermore, these results are consistent with what is known about hosha harvesting practices. In the productive southern region of Lake Manzala hosha are pumped and harvested as often as once a week in the May to October period. Thus, most of the hosha yield, about 95%, originates in the open fishery. In the less productive lake areas, where standing stocks are lower, the hosha are harvested more typically on a once a month basis and even as seldom as twice a year. In the eastern region of Lake Manzala the open fishery still generates about 93% of the hosha yields, but this proportion falls to 82% of the hosha yields in the western region which is the least biologically productive region.

In Lake Burullus, where hosha are harvested on the average about 10 times a year or less, about 11.5% of the hosha yields originate within the enclosures, while the remaining 88.5% of the yields actually originate in the open fishery.

The general conclusion from the analysis of these data is that hosha at the present time is primarily a pure harvest technique. This reaffirms the necessity of increasing fisheries management efforts to encourage the introduction of fish culture practices, longer hosha retention periods, more feeding, selective stocking, and so forth. Currently, hosha is competing with the open fishery for the same fish population.

8. THE PROMISE AND CHALLENGE OF HOSHA

Assessing the future contribution of hosha activities in the northern delta lakes fisheries is a complex task because the positive and negative features involve such different dimensions. The promise of hosha is in the potential expansion of employment opportunities and fish yields offered by the use of this indigeneous low cost, low technology fish farming technique that combines fish capture and fish culture aspects. The challenges posed by hosha concern first the difficulties of regulating and managing these activities so widespread in such inaccessible areas and second the complexities of assuring an equitable impact of hosha on the whole fishing community.

There seems to be common agreement that hosha fish yields could increase by at least 2.5 times with the introduction of supplementary feeding and stocking as well as selective harvesting (Ifagraria, 1983; MacLaren, 1982). The generalization of such improvements throughout the lakes would, then, increase total fish yields by about 60%. There are already some examples of such "hosha fish farmers" who have increased their yields over the typical yields by 2.5 times, have doubled the proportion of high valued fish harvested, and have received an increase in the average price per kg of about 30%. It is not known whether these results can be generalized to the whole fishery.

The Lake Manzala Study developed a hosha "enhancement" budget which would yield an annual net economic return to the operator of about LE 298/ha, with the rate of return to the enhancement (feeding, stocking, etc.) being greater than that to the operator's initial investment. However, the cost of the enhancement, LE 210/ha, represents roughly a doubling of the cost of constructing and operating existing hosha. Improved hosha management will need to take account of the costs to the operators of hosha enhancement.

The fishermen usually see hosha as a negative factor, focussing on the competition for the same stock of fish and the competition for fishing areas. Further, fishermen believe that hosha reduces the production potential of the lake, primarily because it harvests all age cohorts. Some hosha, particularly in the tilapia grounds of Lake Manzala's southern region, produce tons of small fish (less than 6 cm) which are sold for chicken feed production; the proportion of small fish in the hosha harvest ranges from 15% to 30%.

The long standing arguments against hosha that it reduces important inshore breeding grounds and that it indiscriminately harvests fish of all sizes and thus (harmfully) removes juveniles from the potential breeding population may have had some validity prior to the construction of the Aswan High Dam. However, the change to a more freshwater environment has weakened both criticisms. First, the new water regime has resulted in aquatic vegetation and the accompanying tilapia breeding areas spreading throughout the lakes. Thus the preservation of these inshore areas is now less important. Furthermore, the spread of aquatic vegetation has rendered much of the shallow shoreline unsuitable for open water fishing gears. Second, the change, especially in the southern portions of these lakes, to a higher yielding fishery much dominated by tilapia means that increased fishing pressure and thinning of juveniles may help diminish the problems of over-recruitment of tilapia. It has been shown (MacLaren, 1980) that in the El-Genki region of Lake Manzala stock levels are very high but growth rates appear low, indicating that over-recruitment is already a problem. In addition, it is likely that hosha's periodic drying of the bottom sediments will stimulate the recycling of nutrients, thus contributing to the overall productivity of the fisheries. This has been confirmed by many reports of algal blooms in newly flooded hosha.

One of the challenges posed by hosha concerns the problems of policy development and enforcement. Unfortunately, most of the efforts at lakes development and fisheries management has focussed so far on improving the yields of the high valued marine species which have declined in numbers in the lakes, and on the expansion of large scale fish farms. All the while, the private sector has been rapidly introducing to these fisheries an indigeneous fish capture technique that potentially has many of the advantages of fish farm production. Neglecting the small scale low technology hosha will undermine future fisheries developments, possibly sacrificing greater fish production than will be generated by the expansion of high technology fish farms. Even with fisheries management policies that incorporate important hosha regulatory elements, however, there remains the practical problem of locating, licensing, advising, monitoring, and imposing fines or constraints on the thousands of widely dispersed and often inaccessible hosha operators.

Hosha also raises many of the socio-economic and political problems encountered in other lagoonal and estuarine fisheries throughout the developing countries, such as conflicts between traditional fishermen and newcomers with new technologies (Kapetsky, 1981). Many allusions have been made above to the distributional and equity problems of the introduction of hosha. Even if the hosha are properly managed so as to maximize over-all sustainable lakes' fish yields, there is no assurance that the yields and incomes of the open water fishermen will not deteriorate. Hosha and fishermen will continue to compete for the same resources to some extent. However, the more serious social problem is that hosha do displace fishermen, that displaced fishermen do not tend to become hosha operators, and traditional property rights to family fishing plots are being usurped. This, indeed, is the source of the conflict that has led to private battles on the lakes.

While the fisheries have always permitted free and open access in principle, until recently, the practice has been to protect those who have traditionally fished on the lakes. Recent experience, however, has been one of newcomers encroaching on the space of the traditional fishermen. Since the hosha are generally illegal and unlicensed, they pay neither taxes nor rent, having an additional financial advantage over the traditional fishermen.

Successful regulation and managing of hosha in the context of overall fisheries management will require the cooperation of the open water fishing community. They will have to become convinced of hosha's valid contribution, of the permanence of hosha, and of the stabilizing influence of positive regulation of hosha. Most importantly, some method of sharing the gains of hosha fishing with the open lake fishermen will need to be found. Since most fishermen belong to cooperatives, encouraging cooperative hosha developments may provide one avenue of sharing the fisheries' productivity equitably.

The promise of hosha will remain only a promise in the absence of a thorough-going fisheries management policy that successfully meets the challenges of balancing the diversity of interests in the northern lakes fisheries.

9. CONCLUSIONS

All of the evidence suggests that hosha are very widespread in Lakes Manzala and Burullus, that hosha are expanding rapidly in the lakes, and that hosha are currently used primarily as a fish capture technique. The dangers that continued rapid expansion of unregulated hosha pose for the future viability of the fisheries are serious. However, a well-designed fisheries management policy could develop a fishery more highly productive than that already existing in these northern Nile delta lakes.

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