CHAPTER II

ASSESSMENT OF RESOURCE POTENTIALS

CHPATER II

ASSESSMENT OF RESOURCE POTENTIALS

2.1 AGRICULTURE

2.1.1 Current Agricultural Production

Cropping in Egypt is controlled by the Government partly by taking note of regional characteristics. In Aswan Governorate, production of wheat, groundnut, lentil, onion, sesame and date are made compulsory, while planting of rice is discouraged. In addition, planting of sugarcane, the major cash crop in the Governorate, is controlled by sugar factories. As shown in Table 2-1-1, the planted area in Aswan totaled 128,628 feddans in 1977, of which well over 40% was planted to sugarcane, 18% to wheat (winter crop) and 29% to coarse grains (maize, sorghum and barley, summer crops). Beans, vegetables and other crops accounted for a mere 10%, although it must be pointed out that these crops are often intercropped with major crops and such areas are not counted.

As clearly seen from the table, the yields of annual crops grown in the Governorate are generally distinctly lower than the national averages. Exceptions are sugarcane which is on a par with the national average, and lentil and onion which are higher. Garlic and sesame are not too outdistanced by the national figures. The major reasons of lower yields are due to the following factors.

- inadequate land preparation; shallow ploughing is done to a depth of only 7 - 12 cm and levelling is inadequate

- no use of improved varieties, especially of sorghum, maize and vegetables

- inadequate application of nitrogenous and phosphorus fertilizers

- generally low standards of farming practices, e.g., lack of timely weeding, uneven vegetative growth due to poor fertilizer distribution and poor drainage, etc.

- inadequate and poor extension services

Agriculture in Aswan Governorate is characterized by substantial shortfalls of supply in major foodstuffs. Wheat consumption totaled approximately 100,000 tons in 1977, but its local supply remained one-fourth of the demand. Coarse grains, although the actual consumption figure is not available, would probably be 30,000 - 40,000 tons short

Table 2-1-1 Agricultural Production in Egypt and Aswan

Crops	Unit of Production	Whole Egypt			Aswan Governorate		
		Production	Planted Area (fd.)	Yield/fd.	Production	Planted Area (fd.)	Yield/fd.
Wheat	ardab	12,887,152	1,380,612	9.33	160,576	23,486	6.84
Rice	ton	2,350,675	1,030,672	2.28	-	-	-
Maize	ardab	22,074,152	1,877,188	11.76	103,985	14,516	7.16
Sorghum	"	4,866,929	433,596	11.22	146,191	19,460	7.51
Barley	"	1,098,415	113,823	9.65	18,592	3,077	6.04
Sugarcane	ton	8,378,669	249,305	33.61	1,818,279	54,754	33.21
Cotton	Quintal	7,600,000	1,189,000	6.39	-	-	-
Soybean	ton	78,828	81,713	0.96	-	-	-
Broadbean	ardab	1,491,759	238,954	6.24	11,155	2,934	3.80
Lentil	"	98,069	35,504	2.76	71	22	3.23
Sesame	"	76,772	23,348	3.29	3,953	1,426	2.77
Groundnut	"	340,536	30,915	11.02	2,837	896	3.17
Okra	ton	64,531	10,180	6.34	1,390	449	3.10
Tomato	"	2,197,432	310,641	7.07	9,240	1,897	4.87
Onion	"	364,258	47,650	7.64	4,427	495	8.94
Potato	"	1,010,366	152,279	6.63	-	-	-
Pepper	"	155,946	23,641	6.60	1,721	372	4.63
Garlic	"	100,518	12,786	7.86	234	38	6.16
Melon	"	1,311,884	121,084	10.83	7,831	1,473	5.32
Watermelon	"	141,451	14,752	9.59	321	81	3.96
Orange	"	670,924	155,470	4.32	1,161	495	2.35
Lemon	"	46,296	11,172	4.14	640	186	3.44
Mango	"	57,198	25,492	2.25	665	390	1.71
Banana	"	126,927	12,509	10.15	1,081	96	11.26
Eggs	"	70,175	-	-	698	-	-
Milk	"	1,772,548	-	-	20,703	-	-
Poultry Meat	"	65,978	-	-	516	-	-
Beef	"	314,817	-	-	5,938	-	-

Source: Ministry of Agriculture.

of the demand. Rice is entirely imported from elsewhere in the country, because there is no local production. There seem to be shortages of beans and such vegetables as potato and tomato. Local demand for animal protein is also satisfied mainly by purchases from other governorates. In 1977, 10,500 heads of beef cattle were brought in from elsewhere, while the local supply was as low as 4,000 heads, or 30% of the demand. Local supply of poultry was estimated to number 440,000 and the demand was supplemented by 1,600,000 chickens brought in from Sohag. Only a few vegetables like okra and Jew's mallow

Table 2-1-2 Annual Demand and Supply of Major Crops in Aswan (1977)

(Unit: tons)

Crops	Local Supply	Actual Consumption 1/	Potential Per-capita Consumption (kg) 2/	Potential Consumption
Wheat	25,680	109,638	138	103,500
Rice	n.a.	7,491 3/	39 3/	29,250 3/
Maize/ Sorghum	35,024	n.a.	115	86,250
Sugarcane	1,818,279	10,760	20	15,000
Beans	1,729	901	9	6,750
Lentil	11	777	2	1,500
Sesame	474	30	1.5	1,125
Groundnut	213	n.a.	1	750
Tomato	9,240	n.a.	57	42,750
Potato	n.a.	11,970	24	18,000
Onion	4,427	n.a.	8	6,000
Garlic	234	n.a.	3	2,250
Mango	665 4/	900	2	2,500
Orange	1,160 4/	] 2,400	13	16,250
Lemon	640 4/		2	2,500
Watermelon	321	650	4	5,000

Notes: 1/ Local supply plus the tonnage distributed by Ministry of Supply.
2/ National averages.
3/ Milled.
4/ Calculated on the basis of the estimated yields per feddan of 4 tons for mango and 6 tons for citrus.

Sources: Ministries of Agriculture and of Supply.

(mulukia) appeared to be produced in excess in Aswan and shipped to Cairo or elsewhere. The demand and supply gap could be potentially much higher, if the total governorate consumption for each crop is estimated on the basis of the current national per capita consumption as shown in Table 2-1-2.

Another characteristic of agriculture in Aswan is the low level of farmers' income. According to the regional census of 1976, 34,557 farmers cultivated a total area of 87,419 feddans. The average size of land holding is 2.5 feddans which is substantially larger than in Qena (1.3 feddans) and Sohag (0.9 feddans). However, three-fourths of the farmers own less than 2 feddans as shown in Table 2-1-3. Even if double cropping is taken into account, a common farmer which manages 1 - 1.5 feddans is forced to produce more profitable crops like okra and Jew's mallow in what little land remains after the major part of the farm is planted to obligatory and price-controlled crops like wheat, lentil, groundnut, etc. This partly explains the afore-mentioned demand and supply gaps in major food crops in Aswan Governorate. The average value of farm production per feddan in Aswan is relatively high thanks to sugarcane, as will be shown later in this section, but the absolute scarcity of land available to individual farmers depresses their agricultural household income to about £E 200 per annum.

Table 2-1-3 Land Ownership in Aswan (1976)

Farm Size (fd.)	No. of Farms	%	Total Area (fd.)	%
Less than 1	18,119	52.4	16,025	18.3
1 - 2	7,889	22.8	14,188	16.2
2 - 3	3,778	10.9	9,367	10.7
3 - 4	2,216	6.4	6,982	8.0
4 - 5	1,092	3.2	4,826	5.5
5 - 10	982	2.8	6,768	7.7
10 - 20	318	0.9	4,768	5.5
20 - 50	122	0.4	4,221	4.8
50 and over	41	0.1	20,274	23.2
Total	34,557	100.0	87,419	100.0

Source: CAPMAS, Regional Census (Sohag, Qena, Aswan and Red Sea South) 1976, 1979.

2.1.2 Physical Potentials for Agricultural Development

(1) Soils

The soil conditions in some parts of the High Dam Lake area have been investigated and described in a series of publications since 1962. Among them, regional soil surveys and REGWA surveys are important because they covered extensive areas and were carried out systematically. However, the values of these works are somewhat limited by the poor topographic base maps and insufficient information on the relative and absolute elevation of land.

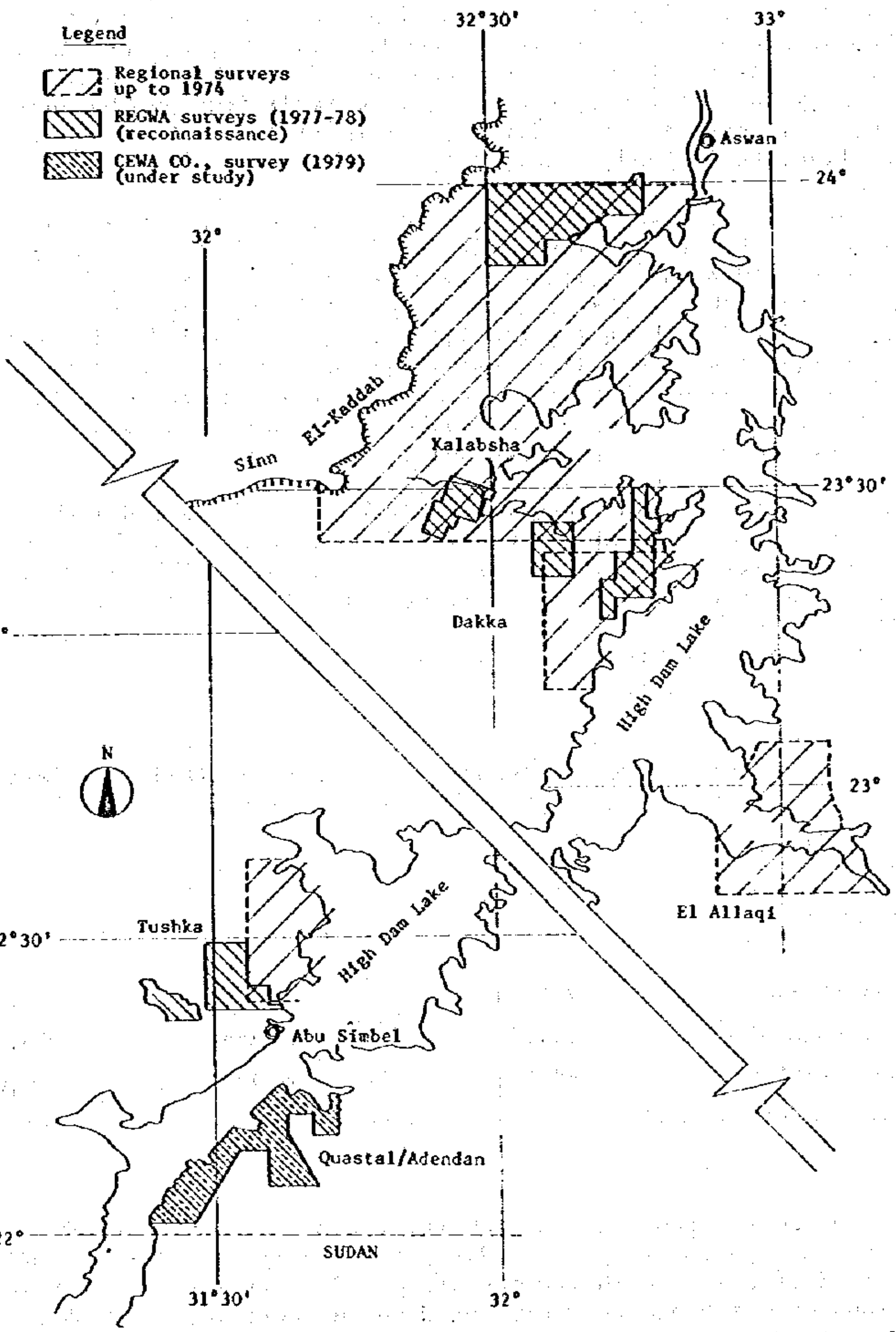
The regional soil surveys were undertaken by the Regional Planning of Aswan and the Desert Institute, Cairo, during 1972 to 1974 under the direction of Dr. M.A. Abdel Salam. These studies covered the Wadi Kurkur, Wadi Kalabsha, Tushka and Dakka and El Allaqi areas which were all considered to have a potential for agricultural development. Field investigations were carried out for reconnaissance and site observations were made with various densities ranging from one site every 10 to 20 km^2 to one site every 4 km^2. The areas covered by the soil survey are shown in Figure 2-1-1.

Subsequently, the selected areas in the Kurkur, Kalabsha and Tushka areas were re-surveyed by REGWA (General Company for Research & Ground Water) in cooperation with the Desert Institute during 1977 - 1978. Each area was surveyed for three different precision levels, i.e., reconnaissance, semi-detailed and detailed, as shown in Figure 2-1-1. The surveyed areas and profile densities were as follows.

	Reconnaissance	Semi-detailed	Detailed
Profile Density (nos/km^2)	1	4	16
Surveyed Areas (feddans)			
1. Wadi Kurkur	70,000	30,000	21,500
2. Wadi Kalabsha	71,000	30,000	15,000
3. Wadi Tushka	60,000	16,000	6,000

According to the studies mentioned above, the desert peneplain and desert pavement are the general landscape in the Project Area. Sandy soils derived from the weathered sandstone and conglomerates of bedrock, the outcrops of which are commonly found on the surface, are widely distributed in drainage channels and peneplains. The depth of sandy soils will vary according to the topographical conditions. Shallow

Figure 2-1-1 Areas Covered by Previous Soil Surveys



soils overlying bedrocks contain many gravels and fragments of rocks in the profile. These soils generally have a high water permeability, a low water holding capacity and low fertility. In Wadi Kurkur and Wadi Kalabsha, soils of finer texture and sufficient depth can be seen in alluvial terraces along wadis or in playas. These soils have high fertility and a high water holding capacity.

The reaction of the soils is neutral to alkaline, and in general, alkalinity is higher in clayey soils and lower in sandy soils. Most commonly found salts are bicarbonate and chloride but occasionally sulphate can be seen in areas where gypsum is deposited. The principal cations are sodium and calcium, but magnesium occasionally replaces calcium. Salts are generally concentrated in the surface layer. The dominant mineral in the silt and clay fractions is kaolinite with subdominant illite and montmorillonite.

The soils have been classified by the regional soil surveys1/ following the USDA system (1960) with some later revisions, commonly known as the Seventh Approximation. Subsequent REGWA surveys also followed the same system. The classification applicable to the High Dam Lake area is shown below.

Order	Suborder	Great Group	Subgroup	Type Location
Entisol	Psamment	Quartzipsamment	Typic	sand sheet; sand dune; drift sand in drainage ways.
			Lithic	shallow, sandy soil over sandstone on peneplain.
		Torripsamment	Typic	deep sandy loam soils on peneplain.
			Lythic	shallow sandy loam soil on peneplain.
	Orthent	Torriorthent	Typic	deep clay loam soils on wadi terraces
			Lithic	shallow clay loam over shales or gravel bedrocks
			Vertic	deep clay soils in playas (hatiyat)

Source: Hunting Technical Services Limited in association with Sir M. MacDonald and partners, the Agricultural Development Potential of Lake Nasser Region, Arab Republic of Egypt, April 1977.

1/ The Regional Planning of Aswan and the Desert Institute, Soils of Wadi Kurkur (1972), Soils of Wadi Kalabsha (1974), Soils of Tushka and El-Dakka Areas (1974) and Soils of El-Allaqi, Abdel Salam, M.A. et al.

In the High Dam Lake area, all soils are mineral soils with little or no development of normal horizons and consequently, classified in the Entisol order. On the suborder level, these soils are classified into either the Psamment or Orthent suborder.

Psamments are sandy soils and have a sandy texture down to a depth of 1 m, contain less than 35% of gravels or coarser fragments in all substrata and are not permanently waterlogged. Psamments are subdivided on the great group level by the amount of quartz in sand fractions. Quartzipsamments contain more than 95% of quartz and Torripsamments less than 95% in sand fractions. On the subgroup level, further subdivision by the depth of soils is made to distinguish typic (deep) and lithic (shallow). The dividing line is 50 cm.

Orthents are undeveloped soils which have a texture of loamy fine sand or finer in some horizon between 25 and 100 cm. They contain organic matters which decrease regularly with depth, reaching 0.35% or less within 100 cm depth, and are not permanently saturated with water. Orthents found in the Project Area are the Torriorthent great group characterized by a warm soil temperature and absence of moisture throughout the soils. Torriorthents are divided on the subgroup level into typic (deep), lithic (shallow) and vertic. Vertic Torriorthents are soils with a clayey texture and crack deep and wide for more than 240 days a year.

Based on the above soil classification, the area and distribution of each soil type in the Kurkur, Kalabsha and Tushka areas were estimated in the reconnaissance soil surveys by REGWA as shown in Table 2-1-4. As is seen in the table, about 80% of the soils in the surveyed areas are classified into three soil groups, i.e., Lithic Quartzipsamments (32%), Typic Quartzipsamments (31%) and Typic Torripsamments (17%). Hence, these three soil groups can be considered as the typical soils in the High Dam Lake area. The general characteristics of these soil groups are shown below.

Table 2-1-4 Distribution of Soil Groups

(Unit: feddans)

Soil Group	Kurkur	Kalabsha - Dakka	Kalabsha - Marawa	Tushka	Total	Composition (%)
Typic Quartzipsamments	1,500	19,500	9,500	18,500	48,500	30.9
Lithic Quartzipsamments	16,000	17,000	250	16,500	49,750	31.7
Typic Torripsamments	20,000	0	5,500	1,250	26,750	17.0
Lithic Torripsamments	6,000	0	0	3,400	9,400	6.0
Typic Torriorthents	15,000	1,600	0	0	16,600	10.6
Lithic Torriorthents	1,000	2,000	1,650	0	4,650	3.0
Vertic Torriorthents	0	760	500	0	1,260	0.8
Total	59,500	40,860	16,900	39,650	156,910	100.0

Source: REGWA, "Wadi Kurkur Reconnaissance Survey, 1977," "Wadi Kalabsha Reconnaissance Survey, 1978" and "Wadi Tushka Reconnaissance Survey, 1978" in Soil Studies of Lake Nasser Region.

Lithic Quartzipsamments: The soil profile is shallow and underlain by the Nubian sandstone on the peneplain. The soils are of sandy texture, single grain to massive in structure, but some surface layers have a weakly stratified structure. A relatively low to medium percentage of calcium carbonate is contained, ranging between 3.5% to 9% of soil components. Total soluble salts are very low to moderate, as indicated by the EC values ranging between 2.5 and 32.5 mmhos/cm. Dominant chemical components in the soil saturation extract are Na, Ca, Cl and SO_4 in that order. The alkalinity is moderately alkaline to alkaline.

Typic Quartzipsamments: This soil group is distributed on outwashed plains and peneplains. Soils are deep and sandy with a coarser texture than loamy fine sand and underlain by Nubian sandstone substrata. In some layers, the sandy matrix is intermixed with pebbles and/or gravels. The salinity level is mostly within the normal range. Predominant cations and anions in the soil saturation extract are Na, Ca, and Cl and/or SO_4. These soils are moderately alkaline to alkaline.

Typic Torripsamments: This soil group is found in low-lying topographic intrusions in the consolidated old terraces. The soil texture is loamy sand to sandy with more than 5% of weatherable minerals. The salinity level varies from low to moderately high according to the location of profiles. Lime is generally contained in the soils, and nodules and segregations of lime are found in some profiles. Ca, Mg, Cl and SO_4 are dominant chemical components of the soil saturation extract. The alkalinity ranges between neutral to moderately alkaline.

In summary, the predominant soil types in the Project Area have many limitations which constrain agricultural development: namely, generally shallow soil depth with low organic matter content, high surface infiltration, high permeability, low water holding capacity and susceptibility to erosion by wind and water.

Detailed information on the soil infiltration rate is available from the soil study reports prepared by REGWA during 1977 - 78. The test was carried out, under constant head of water using the double ring infiltrometer method, on the representative sites of each identified soil group in the Kurkur, Kalabsha, Tushka and Quastal/Adendan areas. The weighted averages of basic intake rates range from 48 to 73 mm/hr as shown on Table 2-1-5. This suggests the unsuitability of the surface irrigation method in the surveyed areas, because it would involve large water losses.

According to the same reports, the permeability coefficient was determined in the laboratory, under constant head of water, on disturbed soil samples taken from representative profiles of the Kalabsha and Quastal/Adendan areas. The average permeability coefficients measured for the Kalabsha and Quastal/Adendan areas are 4.5×10^{-4} cm/sec and 1.1×10^{-3} cm/sec, respectively. However, these values cannot be used for drainage planning, because they were obtained on disturbed and re-compacted samples. Based on the impressions on the field and information from the Desert Institute, the permeability coefficient for the above areas is estimated to be in the order of 10^{-3} - 5×10^{-2}.

Table 2-1-5 Physical Conditions of the Soil (detailed survey by REGWA)

Area	Soil Type 1/	Area (fds)	Basic Intake Rate (mm/hr)	Permeability 2/ Coefficient (cm/sec)	Available 3/ Water (mm/m)
Kurkur:	deep CL-C	4,950	31	-	-
	deep SL-SCL	1,460	28	-	-
	deep S over S	100	136	-	-
	deep S-SL	13,300	61	-	-
	deep S over CL-C	1,200	38	-	-
	deep S over SL-C	260	88	-	-
	deep S	2,700	27	-	-
	shallow SL	800	22	-	-
	weighted average		48		
Kalabsha:	(Marawa)				
	deep S-SL over SCL-C	400	28	5.0×10^{-4}	176
	deep SCL-C	1,050	48	7.9×10^{-4}	217
	deep SL	2,000	40	4.5×10^{-4}	147
	deep SCL over S-LS	600	72	-	-
	deep S-LS	3,200	98	4.2×10^{-4}	122
	moderately deep S-LS	1,500	24	3.0×10^{-4}	173
	shallow SL	1,250	22	3.0×10^{-4}	185
	shallow SCL-C	350	12	8.8×10^{-4}	241
	weighted average		55		
Tushka:	deep S over SL-CL	80	26	-	-
	deep SL	620	52	-	-
	deep S-LS	1,640	24	-	-
	moderately deep S-LS	1,660	109	-	-
	weighted average		64		
Quastal/Adendan:					
	deep SL over S	165	48	1.3×10^{-3}	-
	moderately deep S	170	98	9.3×10^{-4}	-
	weighted average		73		

Notes: 1/ C (Clay), L (Loam), S (Sand), SCL (Sandy Clay Loam), LS (Loamy Sand).

2/ Determined in the laboratory, under constant head of water, on disturbed soil samples taken from profiles.

3/ Moisture content in volume retained between 0.1 atm (field capacity) and 15 atm (permanent wilting point), (by REGWA).

The total available water stored in the soils is given by the soil water content at field capacity (0.1 - 0.3 atm) minus that at wilting point (15 atm). The test results for the Kalabsha area average 160 mm/m, ranging between 122 and 241 mm/m. However, all of this water is not readily available to planted crops. The depth of water readily available to crops is defined as p.Sa where Sa is the total available soil water and p is the fraction of the total available soil water which can be used by the crops. The value of p depends mainly on the kinds of crops and it ranges between about 0.6 and 0.2. Therefore, the total readily available water may be in the order of 100 - 30 mm/m. In other words, frequent application of water will be necessary to grow crops in the Project Area.

(2) Land Capability Classification

The aforementioned soil surveys classified land capabilities generally according to the system outlined by the U.S. Bureau of Reclamation. Some modifications were made to suit the local conditions, but they were not necessarily uniform among the surveys. In 1979, the Desert Institute prepared a new set of classification standards by partially modifying the U.S. Soil Survey Manual (1952) and reclassified land capabilities in the surveyed areas. The new classification standards are shown on Table 2-1-6.

Table 2-1-6 Standards of Land Capability Classification

Capability Class	Depth (cm)	Surface[1/] Soil Texture	Available[2/] Water (cm)	Permea-bility of Subsoil (cm/hr)	Slope (%)	Alkali-nity or Salinity
II	> 90	SL-SiCL	> 20.0	0.6 -12.5	2 >	None
III	> 90	LS-SiCL	12.5-20.0	0.6 -15.0	5 >	Slight
IV	50-90	FS-C	7.5-12.5	0.1 -15.0	9 >	Moderate
V	25-50	S-C	5.0- 7.5	0.05-15.0	16 >	Moderate
VI	25 >	Any	5.0 >	-	-	Severe

Notes: 1/ SL: Sandy Loam; SiCL: Silty Clay Loam;
LS: Loamy Sand; FS: Fine Sand; S: Medium Sand
2/ Available water in the root zone or upper 15 cm layer of the soil.

Source: M.A. Abdel Salam, S. El Demerdashe, A.A. Harga, A.A.M. Elson, M.S. Ismail and M.E. Bahr, Report on the Soils of the High Dam Lake Region, Jan. 1979.

The gist of the reclassification has to do with the evaluation of Land Class IV, which is normally considered too marginal for agricultural development. As shown on the table, the minimum soil depth of Land Class IV is 50 cm and this land class is often found over the bedrocks of permeable sandstone according to the Desert Institute. This means that Land Class IV in the Project Area can be considered arable, on the condition that the water-saving sprinkler irrigation method is adopted. Therefore, approximately 260,000 feddans are judged arable in the areas covered by the aforementioned surveys as shown on Table 2-1-7.

Table 2-1-7 Reclassified Land Capabilities by Desert Institute

(Unit: feddans)

Land Class	Kurkur	Kalabsha	Dakka	Tushka	El Allaqi	Total
II	10,700	3,000	-	-	-	13,700
III	19,600	25,000	18,000	13,000	7,000	82,600
IV	100,000	22,000	15,000	15,000	13,000	165,000
V	110,000	3,000	61,000	89,000	78,000	341,000

Source: M.A. Abdel Salam, S. El Demerdashe et.al., ibid.

(3) Estimation of Arable Land Area

In order to evaluate the entire agricultural development potentials in the Project Area, the Study Team is obliged to make several bold assumptions. It is assumed that prospective irrigated agriculture depends on the surface water, i.e., High Dam Lake, due to the paucity of data on underground water resources as was discussed in Section 1.1 of Chapter I. Given the uncertain allocation of water from the Nile, and the limited land capability of Land Class IV, it is assumed that the less water-consuming sprinkler irrigation method be mostly adopted in the Project Area. The findings of the existing soil surveys inclusive of the new standards for land capability classification prepared by the Desert Institute are utilized not only as they are but also as the basis for extrapolating over the areas which have not been covered by these surveys.

In view of the water level fluctuation of the lake, the exploitable lakeshore area is divided into two categories; namely, the upland area in the altitudes from 183 to 210 m and the foreshore area below 183 m and above 175 m[1/]. The former area is above the tentatively estimated high water level in a flood year (see p.24) and below the economically justifiable maximum head for pumping water from the lake and can be provided with costly permanent structures for irrigation. The latter area is roughly above the high water level during a medium flow year (see Table 1-1-5 on p.23) and can be exploited for crop production, provided that the irrigation facilities are of a simpler type which can bear occasional submersion under water in a flood year, as will be described further in 4.1 of Chapter IV. The area below the altitude of 175 m is subject to the annual fluctuation of the water level in a medium flow year and it is inadvisable to practice irrigated agriculture there. What is traditionally known as drawdown agriculture might be practicable in this area, but what little is now available in the way of information indicates the instability of such an undertaking, as will be described later in this section.

(a) Upland Arable Land

According to Table 2-1-7, the arable land in five surveyed areas totals approximately 261,000 feddans, which, however, includes land below the high-water level of 183 m. When the low-lying land is excluded, the total arable land area reduces to 212,000 feddans, as shown in Table 2-1-8. In addition, an informed estimate over the Quastal/Adendan area is made available by the Desert Institute on the basis of the recently concluded reconnaissance soil survey. Thus, the upland arable land totals 232,000 feddans in gross, or 185,000 feddans in net terms. Location of each area is shown in Figure 2-1-2.

Concerning the areas which have not been subjected to any form of soil surveys, the total arable land area is roughly estimated in the following manners. First, sizable flat areas visibly devoid of rocky outcrops and extensive boulders are identified on the controlled mosaic aerophotographs (scale 1:100,000) prepared by the Ministry of Development and New Communities. Second, arable land areas at these identified sites are estimated by applying the ratio of the total gross arable land area (Land Classes II through IV) to the total surveyed area, which is approximately 33%. As shown in Table 2-1-9, the gross arable land area totals 150,000 feddans. Location of each area is shown in Figure 2-1-2.

(b) Foreshore Arable Land

With regard to the areas which are below 183 m and above 175 m along the shoreline, flat areas with a size of at least about 20 km^2 to enable the settlement of a community with a population of about 2,000 and over are identified on the maps of scale 1:25,000. Such areas are scattered at

---

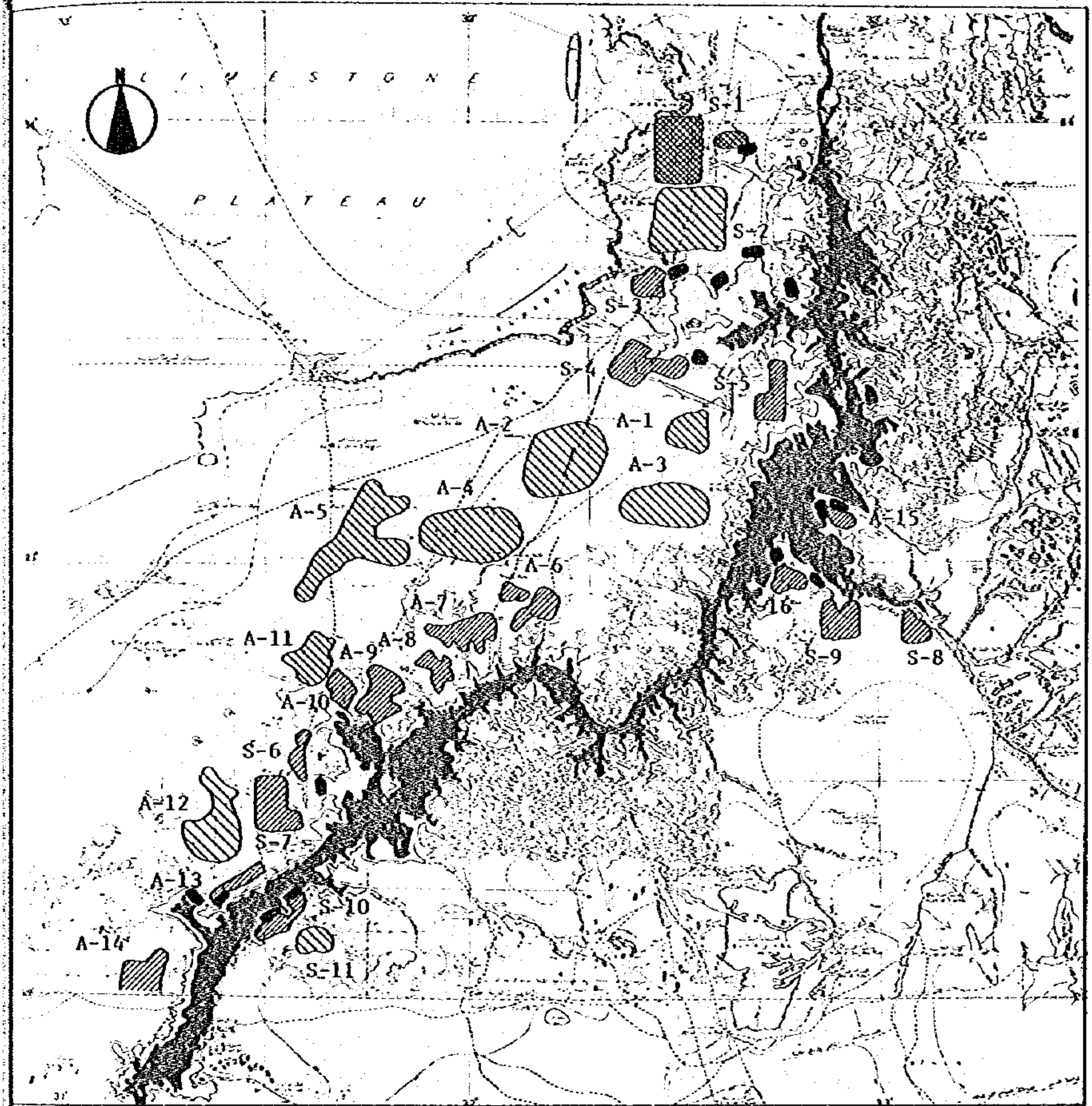
1/ It must be stressed that the indicated altitudes are tentatively determined for the purpose of planning from the available past records, and would have to be modified in all likelihood, once the operation rule of the High Dam be finalized, with the increased water utilization in the Sudan certainly taken into account among other things.

Table 2-1-8 Arable Land Identified from Previous Soil Studies

(Unit: feddans)

	Area	Regional Surveys 1/		REGWA Surveys 2/		Gross Arable Area			Net Arable Area
		A 3/	LA 3/	A	LA	A	LA	Total	
S-1 4/	Kurkur - 1	4,500	-	25,500	-	30,000	-	30,000	24,000
S-2	" - 2	-	83,000	-	7,000	-	90,000	90,000	72,000
S-3	Kalabsha - 1	4,900	1,300	-	-	4,900	1,300	6,500	5,000
S-4	" - 2	-	5,000	4,200	8,300	4,200	13,300	17,500	14,000
S-5	Dakka	-	-	1,500	21,500	1,500	21,500	23,000	18,300
S-6	Tushka - 1	8,000	-	-	-	8,000	-	8,000	6,400
S-7	" - 2	-	600	1,900	19,800	1,900	20,400	22,300	17,300
S-8	El Allaqi - 1	3,000	-	-	-	3,000	-	3,000	2,400
S-9	" - 2	-	12,000	-	-	-	12,000	12,000	9,600
S-10	Quastal/Adendan - 1	-	-	-	-	(10,000 by CEWA Co.)			8,000
S-11	" - 2	-	-	-	4,000	(10,000 by CEWA Co.)			8,000
	Total							232,000	185,000

Notes: 1/ Regional soil surveys conducted up to 1974.
2/ Soil surveys (reconnaissance, semi-detailed and detailed) by REGWA during 1977-78.
3/ A = Arable Land (Land Classes II and III).
LA = Limited Arable Land (Land Class IV).
4/ See Figure 2-1-2 for the location of the respective areas (S-1 - S-11).



INTEGRATED REGIONAL DEVELOPMENT PLAN OF THE HIGH DAM LAKE AREA

Figure 2-1-2

Selection of Potential Agricultural Development Areas

0 10 20 30 40 50 60 70 80 90 100(km)

(cross-hatched)	On-going project
(fine hatching)	Upland arable land areas selected for agricultural development
(coarse hatching)	Arable land areas rejected through economic evaluation
(black spot)	Foreshore agricultural areas
S-	Arable land areas identified from existing soil surveys
A-	Arable land areas identified on aerial photographs

some 15 locations, with an aggregate area of 280 km^2. Approximately one-third of this area, that is, 20,000 feddans in gross, is assumed to be arable.

(4) Potential Agricultural Development Areas

The arable land identified above is where agricultural development is technically possible. However, all of 402,000 feddans are not necessarily worth development efforts in economic terms. In fact, economic feasibility of irrigation is not very encouraging in the Project

Table 2-1-9 Areas Identified on Aerial Photographs

Site No.	Flat Area (fds)	Elevation (El. m)	Distance from Shoreline (km)	Arable Land Area Gross (fds)	Arable Land Area Net (fds)
1.	15,000	240.260	15	5,000	4,000
2.	70,000	300.310	45	23,000	18,400
3.	70,000	200.270	15	23,000	18,400
4.	70,000	280.300	35	23,000	18,400
5.	60,000	250.300	45	20,000	16,000
6.	9,000	190.250	8	3,000	2,400
7.	18,000	190.250	8	6,000	4,800
8.	9,000	200.250	5	3,000	2,400
9.	21,000	183.200	8	7,000	5,600
10.	10,000	183.200	5	3,000	2,400
11.	20,000	183.250	13	7,000	5,600
12.	38,000	250.280	20	13,000	10,400
13.	6,000	283.200	2	2,000	1,600
14.	20,000	190.230	10	7,000	5,600
15.	6,000	183.200	3	2,000	1,600
16.	9,000	183.250	4	3,000	2,400
Total	451,000			150,000	120,000

Notes: 1. Gross arable land = 1/3 of flat area.
2. Net arable land = 80% of gross area.
3. See Figure 2-1-2 for the location of the respective areas (A-1 through A-16).

Area, to say the least. The costs of irrigation facilities per unit of land depend upon the size of an irrigable area, on the one hand, and the distance from the shoreline, on the other. Especially the construction costs of water conveyance facilities (i.e., pumping stations and pipelines) would vary widely in the Project Area as will be discussed in Section 4.1 of Chapter IV. In this respect, flat lands found far away from the shoreline must be rejected, as long as irrigation water should be pumped up from the lake.

For the purpose of evaluating the arable lands identified around the lake in economic terms, relationships between the investment cost of sprinkler irrigation per feddan and the internal rate of return (IRR) are calculated for three cases, i.e., expected net benefits at £E 200, £E 250 and £E 300 per feddan, as shown in Figure 2-1-3. According to this figure, for example, if the investment cost is £E 2,000 per feddan with an expected net benefit of about £E 250 per feddan, the IRR will be 6 to 7%.

The financial IRR, which is internationally used to evaluate the degree of economic feasibility of a given development project, must be higher than 15% to attract private investment, or at least around 12% to justify investment in general. Considering the virtual absence of infrastructure in the Project Area and the overriding national needs to expand the habitable area and redistribute the rapidly growing population, the IRR to select "economically possible" agricultural development areas in the High Dam Lake area could be set at around 4%, which approximates the interest rate charged on soft loans by most international lending institutions.

As will be discussed in Section 4.1 of Chapter IV, an annual net benefit of £E 250 per feddan can be expected for upland agriculture. Based on this figure, the maximum investment cost to secure the IRR of 4% is calculated to be around £E 3,200 - 3,300 per feddan. In other words, the cost of £E 3,300 per feddan is regarded as a maximum allowable investment for upland agricultural development.

Concerning the upland areas identified as arable in the preceding section, it is estimated that 17 sites can be developed at the cost of £E 3,300 per feddan or less, as shown on Table 2-1-10. Of the total gross area of 138,000 feddans, the net irrigable area totals approximately 110,000 feddans, assuming that 80% of the gross area can be cultivated.

With regard to the foreshore areas, the total investment cost of furrow irrigation using movable pumps and pipelines (see 4.1.2. of Chapter IV) is estimated to be around £E 2,000 per feddan. Since the gross area of 20,000 feddans is considered arable as mentioned in the preceding section, the net irrigable area totals 16,000 feddans, or 80% of the gross area.

With regard to the extensive area at Kurkur (30,000 feddans in gross), the tender has been already announced and the terms of reference are now being prepared. Although the feasibility of the agricultural development in this area is expected to be very low due to the exceedingly high estimated investment cost, it is thought appropriate to include this area as an already on-going project.

Figure 2-1-3 Investment Cost - Financial IRR Relationships in High Dam Lake Area (50 years)

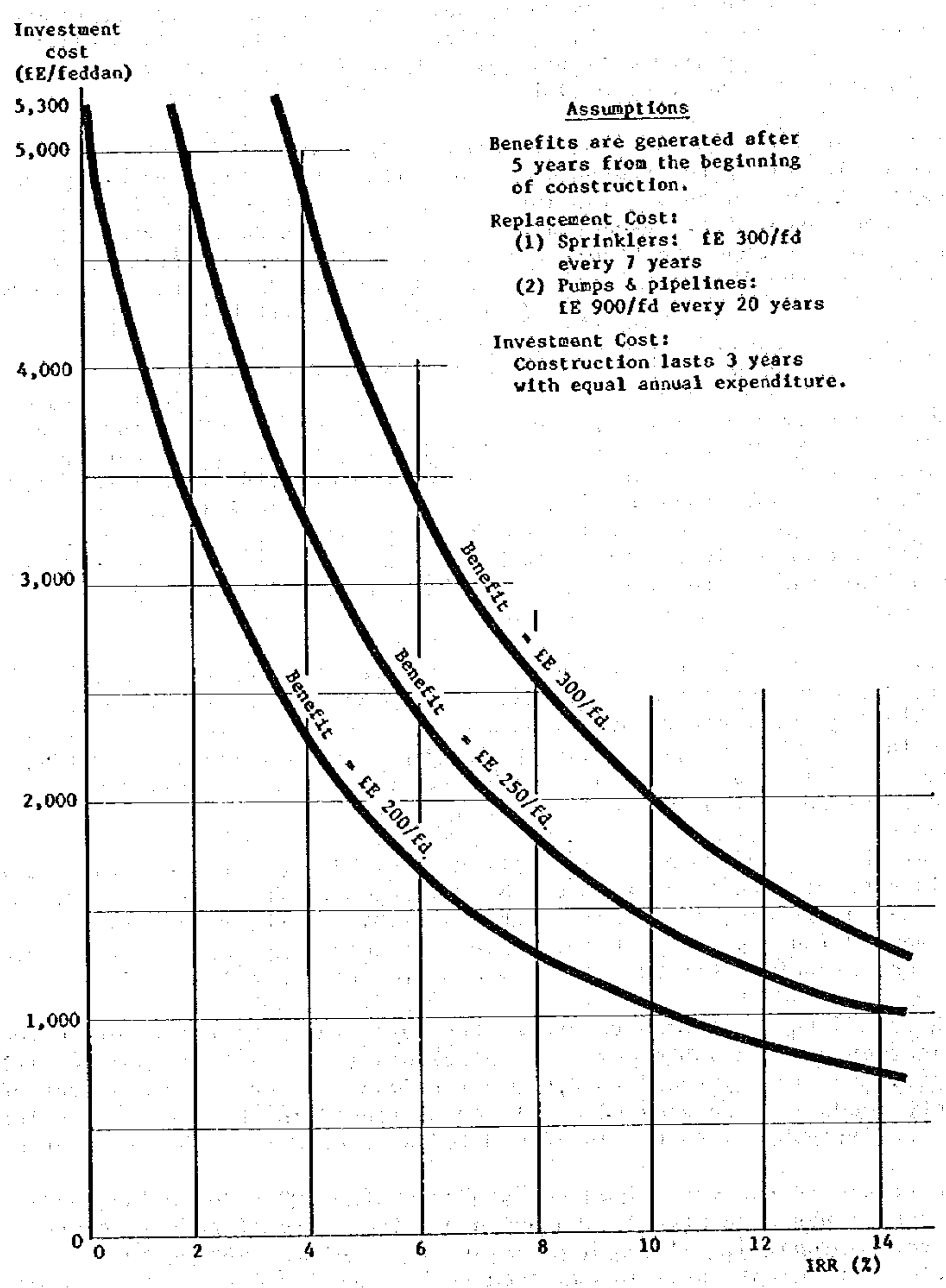


Table 2-1-10 Potential Areas for Agricultural Development

Area	Gross Area (fds.)	Net Area (fds.)	Cost per Feddan (£E)	Total Cost (£E mil.)
I. Upland areas identified by previous soil surveys				
1. Kalabsha - 1	6,200	5,000	2,500	12.5
2. Kalabsha - 2	17,500	14,000	2,400	33.6
3. Dakka	23,000	18,300	3,000	54.9
4. Tushka	8,000	6,400	2,400	15.36
5. Abu Simbel	22,300	17,400	3,100	53.94
6. Quastal/Adendan	10,000	8,000	2,400	19.2
7. El Allaqi - 1	3,000	2,400	2,500	6.0
8. El Allaqi - 2	12,000	9,600	2,600	24.96
II. Upland areas identified on aerophotographs				
1. Tomas/Affia - 1	3,000	2,400	3,100	7.44
2. Tomas/Affia - 2	6,000	4,800	3,000	14.4
3. Tomas/Affia - 3	3,000	2,400	2,500	6.0
4. Tushka - 1	7,000	5,700	3,000	17.1
5. Tushka - 2	3,000	2,400	2,500	6.0
6. Abu Simbel	2,000	1,600	2,100	3.36
7. Ballana	7,000	5,600	3,100	17.36
8. El Allaqi - 1	2,000	1,600	2,300	3.68
9. El Allaqi - 2	3,000	2,400	2,400	5.76
Sub-total	138,000	110,000		301.7
III. Foreshore agricultural areas				
	20,000	16,000	2,000	32.0
IV. On-going projects				
Kurkur Project	30,000	24,000	5,500	132.0
Grand Total	188,000	150,000		465.7

Accordingly, the potential agricultural development areas in the Project Area total 188,000 feddans in gross and 150,000 feddans in net terms as shown on Table 2-1-10. The locations of these selected areas are shown in Figure 2-1-2.

2.1.3 Selection of Suitable Crops

(1) Agronomic Potentials

(a) Abu Simbel Experiments

Agronomic studies are very scarce in the Project Area. The only well-documented data available concerns the field experiments conducted at a pilot farm in Abu Simbel for a year from 1972 to 1973 as part of the UNDP-financed multi-disciplinary project. Although the operation of the pilot farm has continued to this day, the documentation after 1973 has been extremely inadequate.

The Abu Simbel pilot farm is an irregular long narrow strip covering an area of about 60 feddans with an elevation between 180 and 192 m, and surrounded on three sides by small rocky hills of Nubian sandstone. The soils are sand to sandy loam and with variable depth (50 - 150 cm). The soils are neutral in reaction, high in lime content and low in organic matter. Due to the coarse texture, the soil infiltration rate is high and the water holding capacity low. Furrow irrigation is adopted at a spacing of about 5 m, while no drainage system is provided. Water is lifted by a diesel-powered pump from the lake and conveyed by a pipeline of about 3 km long.

Field experiments were started in October 1972 on wheat, barley, chickpea, lentil, fenugreek, pea and lupin. Trials were carried out to test seed rates, planting dates, crop varieties, fertilizer application and irrigation interval. The following observations were made after the trials.

(i) Wheat should be sown in mid-November, at a seed rate of 40 - 60 kg per feddan, dressed with at least 60 kg N and 30 kg P_2O_5 per feddan, and irrigated every five days. The variety Giza 155 provided the best yields among those locally available.

(ii) Barley should be sown before mid-November. It should be fertilized at the rate of 20 kg N and 10 kg P_2O_5 per feddan and irrigated every five days. The Giza varieties 119 and 120 gave the highest yields.

(iii) Chickpea may be sown any time during November and responds to phosphate applications up to 60 kg P_2O_5 per feddan. Irrigation interval needs to be five days for the first month, thereafter every seven days. Giza 1 is the best variety.

(iv) Peas may be sown at any time during November. A phosphate application of at least 30 kg P_2O_5 per feddan is essential to obtain reasonable yields (700 kg per feddan) and irrigation every five days.

(v) Results for lentil, lupin and fenugreek were not good in the large field trials, although the reasons for this poor performance were not given. Highest yields of vegetative growth were obtained at phosphate application of 30 kg P_2O_5 per feddan, although pod-setting or seed-setting was generally poor. Experiments in small observation plots produced better yields, but nitrogen was applied at the rate of 10 kg N per feddan.

(iv) Lucerne and vegetables (cabbage, watermelon, cucumber, squash) yielded well in small plots.

According to the UNDP Technical Report, yields obtained at the pilot farm were generally higher than the averages of Aswan Governorate and Egypt as a whole as shown below. The studies confirmed that local climatic conditions are restrictive and winter crops should be planted early in November so that harvest may be completed by the end of March. No data was collected on the quantities of water applied to each crop.

Table 2-1-11 Average Yields at Abu Simbel

(Unit: kg/feddan)

Crop	Pilot Farm	Aswan Governorate	Egypt
Wheat	1,700	900	1,170
Barley	2,400	1,080	1,000
Chickpea	1,600	660	700
Lentil	600	530	700
Lupin	900	675	580
Fenugreek	750	-	680
Lucerne	24,000	-	-

Source: UNDP Technical Report, 1974.

(b) Foreshore Trials

The immediate foreshore of the lake can be utilized for cultivation during the period while the shoreline gradually recedes, as long as soils have an adequate water holding capacity and the gradient is gentle (less than 2%). Foreshore trials have been intermittently carried out since 1970 in order to assess possibilities of such farming, known as drawdown agriculture.

At Khor Gindi situated about 9 km from Abu Simbel, several crops were planted in December 1972 to assess their relative performance in the drawdown zone, which is sandy in texture with a slope of 0.2%. It was observed that crops such as broadbean, lentil, wheat and so on could grow for only two to two-and-a-half months without supplementary irrigation under the lake recession rate of 50 cm/month. During February 1973, young seedlings (20 - 30 days old) of watermelon, cucumber and wild cucumber (atta) were transplanted on the shore, and all of them grew adequately till the end of April and produed fair-sized fruits.

Drawdown trials were also carried out in Khor Kalabsha (1970) and El Allaqi (1974). Winter crops like wheat, barley, lentil, chickpea and lupin did not grow well despite some fertilizer application, due to the rapid recession of the shoreline, the shallow soils with low water holding capacity, late planting, etc., while summer crops of various vegetables and cereals planted in January mostly failed due to the poor germination caused by lack of water and severe sandstorms.

Judging from what little was available to the Study Team on the results of these trials, the poor vegetative growth of the planted crops indicates the insufficiency of available water in the soils. The Study Team had the opportunity to visit during the field trips in 1979 the pilot farm in Kalabsha and the temporary settlement of Nubians in Quastal/Adendan. The observation of their foreshore trials confirmed the Team's view that irrigation would be indispensable chiefly due to the physical properties of the mineral soils predominant in the Project Area. Subsoil moisture reserves, if any, during the time of shoreline recession might reduce the necessary frequency of irrigation but cannot by themselves support plant growth.

(c) Floating Rice

The possibility of growing floating rice in the drawdown zone which is seasonably submerged under water has been contemplated in Aswan and some trials have been reportedly conducted in Abu Simbel. In Southeast Asia, floating rice is generally cultivated during the monsoon season from April/May to September/October. In other words, the cropping season is the same as regular rice varieties. The yield of floating rice is determined by four factors, namely, the panicle number in the unit area, the average number of grains per head, the percentage of ripened grains and the thousand kernel weight. Among the four factors, the percentage of ripened grains is strongly affected by the weather conditions during the growing period from neck node differentiation to the beginning of the yellow-ripe stage (about 70 days). The low temperature below 17°C during young panicle formation and flowering, especially during meiosis, causes high sterility.

In the Project Area, the lowest and highest water levels of the lake occur in July and November, respectively, and the monthly minimum temperature at Aswan drops below 15°C during November to March. Consequently, the cropping season is very limited to avoid the adverse effect of low temperature during the growing period. There are two conceivable cropping alternatives. In one alternative, varieties which mature in 150 - 180 days are directly sown in July and harvested in November. Since the water level drops after sowing, the varieties must be drought-resistant and supplementary irrigation will be probably necessary during the early stage of seedling. Harvesting coincides with the period of high water and must be done on boat. The varieties which could be used for trials are as follows.

Country of Origin	Varieties
Thailand	Leb Mue Nahng III, Khao Nahng Nuey II, Pin Gaew 56, Khao Puang 32,
Vietnam	Cu La, Nang Tay Nho, Lua Lem, Chang Kong Khman, Kospongsath,
India	Duahlachi, Tundia, Jaisuria

The other alternative is to sow sometime during August - October so that it is possible to harvest in June or July when fields are out of water. In this case, it is necessary to use varieties with a longer maturing period and no photoperiodic sensitivity. However, such varieties are probably unavailable in Asian countries.

The most serious constraint against floating rice is that the high water level of the lake is unpredictable and the annual fluctuation varies from 4 to 7 m. If the water level rises more than 6 m after sowing, the available varieties of floating rice are unlikely to catch up with the speed of the rise. A considerable period of experimentation will be required to identify, or rather breed, appropriate varieties suited to local climatic conditions. Moreover, the cultivation of floating rice will involve an element of risk for small farmers and be hazardous environmentally, even if the experiments turn out to be successful. Therefore, floating rice is not recommendable in the Project Area.

(d) Cultivable Crops

Although the foregoing agronomic information is by no means adequate, several crops are judged to be cultivable in the Project Area. At Karga in the New Valley where climate is harsher than in the Project Area, the Study Team observed that wheat, broadbean, clover, onion and tomato were doing better than in the Project Area thanks to good farm management. On the bases of the experimental results in the Project Area and the New Valley, and information made available from Egyptian experts, a number of crops cultivable in the High Dam Lake area are selected, as shown on Table 2-1-12. Although the Abu Simbel experiments indicate that the yields per feddan can be as high as in the delta area, the Study Team thinks that farming in villages is unlikely to be as well-managed as in experimental stations. Considering the predominance of immature and less fertile soils in the Project Area, the crop yields per feddan would be around 70% of the average levels currently attained in the Governorate, even if the similar farming practices are followed in the Area.

(2) Market Prospects

Selection of appropriate crops to be grown in the Project Area must naturally take into account factors other than agronomic requirements. The first important factor is the water requirement of each crop. As already mentioned, the availability of Nile water to the Project Area is yet uncertain and the Area is unlikely to be especially favored in water allocation, considering the long-term national objective of opening up additional 2.8 million feddans of new lands by the year 2000. Under the circumstances, crops to be selected is better to be less water-consuming. In this respect, crops like sugarcane and rice are undesirable despite their respective higher profitability and/or large market. This must be stressed all the more, because the physical properties of the soils in the Project Area indicate large losses of water under the flood basin or furrow irrigation methods which are commonly used to grow these crops in Egypt.

Two other equally important and interrelated factors to be considered are marketability, or possibility of demand increases in the future, and profitability, or probability of higher income. As already mentioned in the beginning of this section, Aswan Governorate currently has substantial shortfalls of supply in major foodstuffs and considerably lower levels of consumption for major food crops than the national averages. This suggests that most food crops currently grown in Aswan on the whole have good market prospects. Especially, consumption of vegetables such as tomato, potato and garlic, and watermelon and other fruits, is likely to increase in parallel with rises in per-capita income not only in Aswan but in entire Egypt.

On the other hand, newly opened lands are usually handicapped by their lesser soil fertility, which means lower crop yields and a lower income per unit of planted farmland. To attract people and have them settle on new lands, more profitable crops must be selected to ensure a higher agricultural income to the settling farmers. Table 2-1-13 compares the

Table 2-1-12 Major Crops Cultivable in the Project Area

	Crops
Cereals:	wheat, barley, rice, sorghum, maize
Vegetables:	radish, dill, purslane, parsley, cucumber, peas*, onion* spinach, turnip, watermelon, muskmelon, tomato*, eggplant, okra, cabbage, cauliflower, lettuce, carrot, vegetable marrow
Leafy Vegetables:	fenugreek, water cress, Jew's mallow, safflower
Oil Seeds:	sesame, safflower, sunflower, peanut*, linseed, rape safflower, rocket cress
Forages:	berseem*, lucerne*, napier grass*
Forages (green):	maize, sorghum, cowpeas, oats, dolichos
Grain Legumes:	chick pea, lentil, broadbean*, lupin*, soybean, pigeon pea
Spices:	fenugreek*, fennel, cumin, caraway, coriander, chilli
Fruits:	date*, orange*, lemon, grapefruit, grape, mango, guava, fig, mandarine, apricot

Notes: Underlines indicate crops observed during the field trips in the Project Area and the New Valley and asterisks show crops which were growing well in the fields.

Table 2-1-13 Profitability of Major Crops (1977)

(Unit: £E)

Crops		Yields per Feddan	Gross Income per Feddan	Costs per Feddan	Net Income per Feddan
Wheat	Aswan	6.84 ardab	68	51	17
	Egypt	9.33 "	76	56	20
Beans	Aswan	3.80 ardab	67	52	15
	Egypt	6.24 "	102	65	37
Chickpea	Aswan 1/	4.7 ardab	182	81	101
	Egypt	4.7 "	178	91	87
Garlic	Aswan 2/	6.1 tons	487	155	332
	Egypt	7.9 "	306	105	201
Onion	Aswan 1/	9.0 tons	206	104	102
	Egypt	7.6 "	216	186	30
Sorghum	Aswan	7.5 ardab	78	52	26
	Egypt	11.2 "	110	74	36
Maize	Aswan	7.2 ardab	98	77	21
	Egypt	11.8 "	125	85	40
Sugarcane	Aswan	33.0 tons	280	165	115
	Egypt	33.0 "	276	187	89
Sesame	Aswan	2.8 ardab	71	53	18
	Egypt	3.3 "	89	62	27
Groundnut	Aswan 1/	5.0 ardab	88	60	28
	Egypt	11.0 "	186	96	90
Rice		2.8 tons	115	91	26
Cotton		6.39 quintal	220	134	86
Soybeans		0.96 ardab	118	91	27
Barley		9.65 "	70	61	9
Haricot		2.55 tons	195	86	109
Lentil		2.76 ardab	74	70	4
Cucumber		6.36 tons	208	99	109
Okra		6.34 "	380	140	240
Sweet Melon		9.13 "	183	148	35

Notes: 1/ Data supplied by the Dept. of Agriculture in Aswan.

2/ Data by the Dept. of Agriculture in Aswan for the year 1978.

Source: Ministry of Agriculture.

net income per feddan for each of the major crops grown in Aswan Governorate with the respective national average. The table also shows the profitability in terms of national averages alone of those crops for which levels of net income in the Governorate are not available for various reasons. It is seen from the table that vegetables such as okra, garlic, and to a lesser extent, onion, cucumber and chickpea are relatively advantageous in Aswan. Wheat and beans have lower profitability than other crops on the national level, and their performances in Aswan are even less. Although self-sufficiency in staple food crops like wheat and rice is very important from the national point of view, the new lands handicapped by immature soils should concentrate on cash crops which promise higher returns. In this respect, crops like Jew's mallow (mulukia) and pepper will be equally suitable.

Although any crop will readily find a local market in Aswan under the prevailing conditions, the market principle that prices will fall if production increases should be taken into consideration in order to aim at higher incomes for farmers. Among various vegetables and fruits already referred to, crops characterized by a lower price elasticity of demand should be selected. Judging from market conditions, potato and some green vegetables can expect constant increases in demand and relatively firm prices. Garlic, pepper, onion, sesame and groundnut are by nature more resistant to price fluctuations, because they are easier to stockpile and therefore can be sold outside the local markets, provided that proper marketing arrangements are organized. Groundnut and sesame, however, will have lesser marketability in Egypt, because the demand for vegetable oils is largely met by cotton seed oil.

Crops like okra and Jew's mallow present a different picture, because their markets are limited and increases in demand will not be large. Their price elasticity of demand is high and excess production will soon lead to the deterioration of their prices. However, farmers in Aswan Governorate, including the Project Area, can take advantage of the different harvesting season and sell them during the off-season at relatively high prices in major domestic markets like Cairo. The elasticity of demand is also high with respect to tomato. On the national level, the supply seems to be far below the demand, but in Aswan, the potential demand appears smaller than the other vegetables. In addition, there will be strong competition from neighboring governorates which currently supply their surpluses to Aswan. Therefore, tomato is more likely to face a sharp decrease in price when its production suddenly picks up. Under the circumstances, it will be necessary to establish a tomato processing industry in conjunction to secure a stable income to the farmers.

In the case of fruits, the potential domestic markets are sufficiently large, and moreover, there are greater export prospects. As long as the size of market is concerned, citrus and mango are promising, and the production of date palm, the major traditional cash crop in Southern Egypt, may work as well. It must be reminded that the markets for fruits, especially export markets, are highly competitive, and well-organized marketing and merchandizing will be inevitably required in order to edge into the markets.

Lastly, it is necessary to consider whether selected crops are technically acceptable to farmers in terms of production and marketing requirements. In the well-controlled situations like experimental stations, practically any crop can grow well. To expect likewise among the farmers is entirely a different matter. This criterion means, in other words, that selected crops are better to be conventional in the sense that farmers are generally well-acquainted with associated farming techniques and that there are already established marketing outlets. From another viewpoint, this means that those crops which are entirely new to the farmers and to the country should be refrained at least from early introduction. Although crops such as spices, flowers, industrial crops used for dyestuffs and pharmaceutical products, etc. have steadily increasing demands in international as well as domestic markets, they must be tested carefully in experimental stations before introduction. Moreover, these crops generally require effective quality control to compete in the international markets, which are often oligarchic. In other words, production and marketing of these crops must be well and centrally organized, which would be a formidable task by itself for small-holder agriculture in Egypt.

Table 2-1-14 Evaluation of Suitable Crops

	Water-saving	Marketability	Profitability	Technical Acceptability in Production and Marketing
Rice	C	A	B	A
Wheat	B	A	C	A
Maize	B	A	C	A
Sorghum	B	A	C	A
Sugarcane	C	B	A	B
Cotton	B	B	A	B
Soybean	A	B	B	B
Beans	A	B	B	A
Lentil	A	B	B	A
Sesame	B	B	B	B
Groundnut	B	B	B	A
Okra	B	A	A	B
Onion	B	A	B	A
Tomato	B	A	A	B
Potato	B	A	B	B
Sweet Potato	B	A	B	A
Chickpea	A	A	B	A
Haricot	A	B	B	A
Pepper	B	B	B	B
Cucumber	B	A	A	B
Jew's Mallow	A	A	A	B
Garlic	B	A	A	B
Orange	C	A	A	A
Lemon	C	A	A	A
Mango	C	A	A	A
Watermelon	B	A	B	A

A: Good B: Fair C: Bad

Taking all things into consideration, the conventional crops grown in Egypt can be evaluated for possible adoption in the Project Area, as shown on Table 2-1-14. Vegetables like garlic, potato, tomato, onion and okra and fruits like watermelon, citrus and mango are suitable, while cereals like rice, wheat and coarse grains are not suitable either for its higher water requirement or for its lower profitability.

2.2 FISHERY

2.2.1 Present Conditions of Production

(1) Production Trends

Lake fisheries grew rapidly in the last decade as the lake surface steadily expanded. As shown in Table 2-2-1, the total production of fresh and salted fish increased by 8.5 times from 2,662 tons in 1968 to 22,575 tons in 1978. The Tilapia accounted for 89 - 95% of the fresh fish production throughout the period, while the Nile perch (Lates niloticus) making up a mere 4 - 6% (Table 2-2-2). Two species of the Genus Tilapia are found in High Dam Lake. The Tilapia nilotica grows faster, reaching 50 cm in total length and 3 kg in weight in 4 years, while the Tilapia galilaea reaches only 30 cm and 1.3 kg during the same period. The growth of both species seems faster in High Dam Lake than in other lakes, as long as the available data is concerned (Table 2-2-3), and this is probably related to the high level of the primary production (the presence of phyto-plankton) in the lake as reported by Dr. A-F Abdel-Latif[1/] The Tilapia nilotica used to account for most of the tilapia catches, but their share has now sharply declined. The Study Team estimates that the Tilapia nilotica would have been 10 - 30% of the total tilapia production in the last few years. Of the salted fish, the Genus characinidae, mainly the Hydrocynus and Alestes, accounts for 60 - 70% of the total production, with the Genus Cyprinidae (chiefly the Labeo) making up most of the rest.

As shown in Table 2-2-1, the proportion of fresh fish in the total annual production remained at about 60% through 1972, but increased to 70 - 80% after that year. The salted fish merely trebled in the last decade, while the fresh fish production expanded 15.6 times. The rapid growth of lake fishery was, in other words, brought by the increased catches of fresh fish, and notably by the increase of the tilapia which accounts for approximately 90% of the total fresh fish production. The production of fresh fish is mostly in the northern half of High Dam Lake, accounting for roughly three-fourths of the total production. The production of salted fish is equally shared by the northern and southern halves of the lake.

As seen from Figure 2-2-1, the fresh fish production in the lake peaks during the period from March to May, when approximately 40% of the annual output is landed. The period of March to May coincides with the spawning season of Tilapia nilotica which accounts, together with Tilapia galilaea, for most of the fresh fish catches. This has serious implications for the future, as will be discussed in Chapter IV. The production of salted fish is relatively even, with the months of April through October keeping roughly the same level of output, though from December through February the landing appreciably declines.

1/ Aboul-Fotouh Abdel-Latif, Fisheries of Lake Nasser, UNDP/FAO Research Project at Aswan Regional Planning, 1974.

Table 2-2-1 Fishery Production in High Dam Lake (1968 - 1978)

Year	Fresh Fish		Salted Fish		Total
	tons	%	tons	%	
1968	1,152	43.3	1,510	56.7	2,662
1969	2,803	50.0	1,869	40.0	4,672
1970	3,325	59.2	2,293	40.8	5,618
1971	4,248	63.3	2,468	36.7	6,716
1972	5,304	63.6	3,040	36.4	8,344
1973	8,028	76.4	2,574	23.6	10,502
1974	8,018	67.5	3,866	32.6	11,884
1975	10,384	70.9	4,242	29.1	14,636
1976	11,097	70.7	4,600 1/	29.3	15,697
1977	12,272	66.3	6,228 1/	33.7	18,500
1978	18,000	79.7	4,575 1/	20.3	22,575

Note: 1/ A balance of the total minus the production of fresh fish.

Source: High Dam Lake Development Authority (HDLDA).

Table 2-2-2 Composition of Fresh Fish Production (1973 - 1977)

Year	Tilapia spp.	Lates niloticus	Bagrus bauad	Labeo spp.	Hetero-branchus spp.
1973	7,179 (89.4)	388 (4.8)	162 (2.0)	212 (2.7)	87 (1.0)
1974	7,244 (90.4)	490 (6.1)	127 (1.6)	83 (1.0)	74 (0.9)
1975	9,660 (93.0)	525 (5.1)	121 (1.7)	4 (0.03)	74 (0.7)
1976	10,519 (94.8)	446 (4.0)	75 (0.7)	-	57 (0.5)
1977	11,204 (91.3)	564 (4.6)	66 (0.5)	362 (2.9)	76 (0.6)

Source: HDLDA.

Table 2-2-3 Body Length and Growth Parameters of Tilapia

(Unit: mm)

Species	Lake	Year and Source	Age 1	2	3	4	5	6	Parameters[1/] Limited Length ℓ_∞ (mm)	Growth Coefficient κ
Tilapia nilotica	High Dam Lake	1974 Azim	260	378	455	508	-	-	650	0.371
	Lake Mariut	1970 El Zarka	284	212	292	327	376	-	445	0.430
	Lake Mariut	1957 Jensen	92	205	257	288	-	-	315	0.493
Tilapia galilaea	High Dam Lake	1974 Azim	237	305	342	388	-	-	520	0.248
	Lake Mariut	1957 Jensen	83	216	253	277	281	298	305	0.911
	Lake Tiberias	1959 Ben-Tuvia	138	227	274	315	325	341	365	0.546
	Lake Chad	1964 Beache	132	223	270	304	314	-	345	0.583

Note: 1/ Calculated by the Bertalanffy's growth equation:

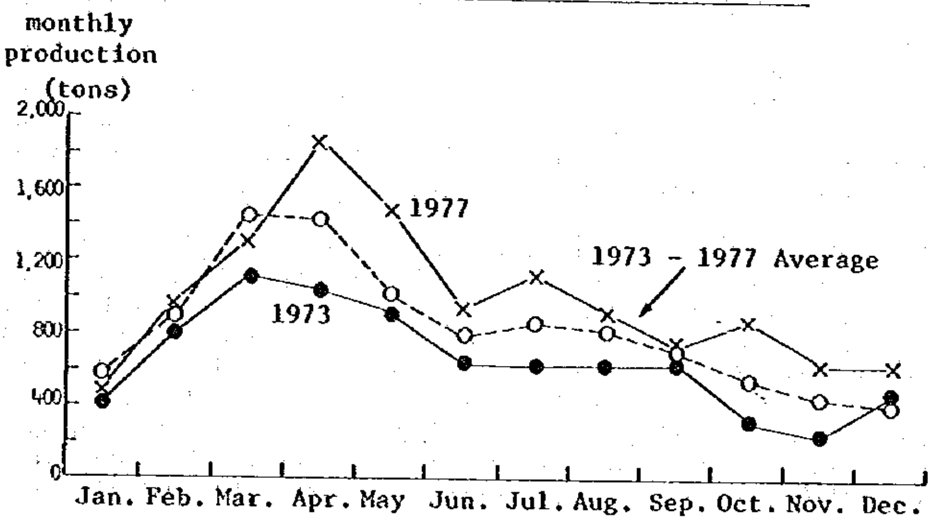
$$\ell(t) = \ell_\infty(1 - e^{-\kappa t})$$

Source: Except for the growth parameters, the table is reproduced from Limnology of Lake Nasser-Nubia prepared by E. M. Fead, c1978. The known original sources are:

M. E. Azim, Biological Studies on Tilapia niloticus L. and Tilapia galilae Art. in Lake Nasser, M. Sc. Thesis, University of Alexandria, 1974.
S. El-Zarka, A. H. Shahen and A. A. El-Aleem, Reproduction of Tilapia nilotica L., Institute of Oceanogr. and Fish., 1970.
A. Ben-Tuvia, The Biology of the Cichlid Fishes of Lake Tiberias and Huleh, Bull. Res. Counc. of Israel 8-B, 1959.

The current annual catch per fishing boat is around 10 tons. During the peak period in the spring, the landing per boat increases to 1 ton per month. Supposing that fishing boats operate 20 days a month on average, the daily catch per boat amounts to 50 kg.

Figure 2-2-1 Monthly Fresh Fish Production



(2) Technology

(a) Fishing Method and Gear

The fishing nets currently in use in High Dam Lake are classified into five types as follows:

i) Trammel nets (locally called duk)
ii) Bottom gill-nets (kabok)
iii) Beach seines (gorrafa)
iv) Long lines (sinndr)
v) Floating gill-nets (sakarota)

Approximately four-fifths of the tilapia catches are made with trammel nets, and bottom gill-nets, beach seines and long lines are employed to fish the remaining fifth. Floating gill-nets are chiefly used to catch pelagic Alestes and Hydrocynus species. In other words, trammel nets and floating gill-nets are the major types of fishing gear employed in High Dam Lake. Because the Study Team did not encounter the use of bottom gill-nets, beach seines and long lines during the surveys conducted over the lake in January-February and July, these types of fishing gear are presumably employed only at restricted places.

The trammel nets are made of light gray multi-filament nylon twines. The inner net uses 6 - 9 twines of 210 deniers, and has the stretched mesh size of 12 - 13 cm and the width of 20 meshes. The outer net uses approximately 9 twines, and has the stretched mesh size of 36 - 40 cm and the width of 4 meshes, or 1.2 - 1.5 m. A strip is 20 m in length and from 5 to 9 strips are normally joined to use for fishing. Buoy and sinker lines are of polyethylene and 6 mm in diameter. Buoys are round and made of synthetic materials and lead plates are used as sinkers.

Fishing takes place during the night. A trammel net is set in shallow waters of 1 - 3 m in depth paralleling the shoreline and the tilapia is driven into the nets by noises made on the boat or water surface. 7 - 9 castings are usually done per night.

Floating gill-nets are also made of light gray multi-filament nylon, using about 6 twines and have a mesh size of approximately 6 cm. The nets are 4 - 5 m wide and 1,000 - 3,000 m long and attached with round synthetic buoys and lead plates. Two flag buoys (normally empty 18-liter cans) are fixed at selected spots during the day and the ends of the net are tied to them in the evening. The net is lifted early next morning. Floating gill-nets are chiefly used in the southern half of the lake and, in most cases, set at right angles to the shoreline. Sometimes they are casted at 500 m intervals and obstruct the movement of ships in narrow parts of the lake.

(b) <u>Fishing Boats</u>

Fishing boats used in High Dam Lake are flat-bottomed and round-bottomed types, both of which are wooden rowing boats. Flat-bottomed boats are 5.9 m in length and 1.2 m at the widest middle and operated by a crew of two persons. Round-bottomed boats are 5.1 m long and 2 m at the widest middle and usually operated by a crew of four persons. The former are mostly employed in the northern half of the lake for trammel-net fishing, while the latter are chiefly used for floating-gill net fishing in the southern part of the lake. A half of the crew row the boat and the other half handle the net while in operation.

The number of fishing boats currently in operation is not accurately known, but the High Dam Lake Development Authority (HDLDA) gives a rough estimate of 2,000 (composition by type unknown), all owned by the members of the Fishermen's Cooperative Society of Aswan (FCSA). The number is expected to increase substantially in the near future, because a Nubian fishermen's cooperative has recently been formed with a number of their boats already moored at the West Harbor waiting for the official permission. Fishermen are currently expressing their wish to attach outboard engines to their boats and the number of boats so powered has been increasing gradually. The FCSA plans to purchase 100 additional outboard engines (10 HP) by the end of 1979. The introduction of outboard engines is primarily to reduce the time of travel back to the harbor after hauling catches.

Besides rowing boats, a fleet of 69 wooden carrier boats are employed over the lake to carry the hauls to the West Harbor (Table 2-2-4). The fish holding capacity of these boats ranges from 3 to 65 tons and 39 of them belong to the HDLDA, the rest being owned by the FCSA. In addition, the HDLDA owns two 200-ton barges (non-powered) and two tug boats specially to transport salted fish. Currently, two each of 30-ton wooden carrier boats, 70-ton steel carrier boats, 200-ton barges and tug boats are under construction for the HDLDA.

Table 2-2-4 Carrier Boats in Operation (Aug. 1979)

	H D L D A			F C S A		
	Capacity 1/ (tons)	Number	Total (tons)	Capacity 1/ (tons)	Number	Total (tons)
Fresh Fish						
	7	12	84	6	5	30
	55	2	110	15	5	75
	65	2	130	18	5	90
	3	2 2/	6	25	15	375
	20	15 2/	300			
	30	6 2/	180			
	Total	39	810		30	570
Salted Fish						
	230	1	230			
	200	1	200			
	200	2 3/	400			

Notes: 1/ The fish holding capacity per boat. In Aswan, the size of a carrier boat is expressed in tons of fish it can hold.

2/ Newly constructed boats.

3/ Under construction.

Source: HDLDA

Carrier boats are out of operation for two months of the year for maintenance and repair and when in operation 25% of the fleet are moored at the West Harbor and other appropriate places to meet emergency cases. Each boat is deployed 3 times a month. The utilization of the holding capacity of carrier boats during 10 months of the year is roughly as follows:

3 months of peak hauling	100%
4 months of moderate hauling	65%
3 months of low hauling	50%

A 30-ton (= fish hold capacity) carrier boat, therefore, annually transports 639 tons of fish catches; 3 (months) x 3 (times per month) x 30 (capacity) x (100 ÷ 100) + 4 x 3 x 30 x (65 ÷ 100) + 3 x 3 x 30 x (50 ÷ 100) = 639. As shown on Table 2-2-4, the total fish holding capacity of carrier boats amounts to 1,380 tons, of which 75%, or 1,035 tons, are available at any time during 10 months of operation. The annual transportation capacity of the fleet therefore comes to about 22,000 tons. When the carrier boats for salted fish and those currently under construction are added, the annual transportation capacity is estimated to total approximately 30,000 tons.

(c) Fishermen

The number of fishermen working in the lake are not accurately known. An FAO expert estimated them to be around 3,400 in 1970 on the basis of the sample survey. The number apparently increased gradually since then and the HDLDA gives a rough estimate of 7,000 for 1979. Of the total, approximately 1,700 persons are boat owners. The practicing fishermen therefore come to 5,300 persons. In addition, the HDLDA employs 450 workers to handle various matters connected to lake fisheries.

Virtually no fishermen is permanently settled at the moment around the lake except in Aswan City and its vicinity. Most of them come from rural areas of Sohag and Qena Governorates and are largely small farmers or agricultural laborers in their home lands. They are roughly grouped according to the places of their origin, such as the Gehna and the Balliana from Sohag and the Gaziret Matera from Qena and other smaller groups.1/ The organization of fishing operation centers on the members

---

1/ Bernard van Heck, Resettlement of the Lake Nasser Fishermen, UNDP/FAO Financed Lake Nasser Development Centre Project, June 1970.
Aboul-Fotouh Abdel-Latif, Towards Settlement of Lake Nasser Fishermen, Aswan Regional Planning, 1973.
Sherif Mahmoud El-Hakim and Nirvana Ahmed Khadr, "Special Report B: The Development of Fishing Activities on Lake Nasser", in Socio-Economic Studies: Final Annual Report 1977, The Egyptian Academy of Scientific Research and Technology, Lake Nasser and River Nile Project, 1978.

of the Fishermen's Cooperative Society of Aswan (FCSA), who exclusively consist of the owners of fishing boats and gears. The management of the fishing operation varies from more "familiaristic and cooperativistic" to more "monopolistic and capitalitic", but arraga fishermen who actually labor in the lake leaving their families behind generally suffer from harsh living conditions and low wages.

The fishing operation normally starts around 7 o'clock in the evening and continues till 5 o'clock next morning. The hauls are brought back to temporary camps set up on the shore or tiny islands where fishermen take rest during the day and wait for carrier boats to pick up their catches. Fishermen's camps are extremely poorly furnished. There is nothing but a miserable shelter of about 10 m² constructed with some sticks and stones and covered by pieces of cloth. In fear of poisonous snakes, scorpions and jackals, many camps are built on tiny islands and where established on the shore, fishermen prefer to sleep cramped in their rowing boats. Daily necessities like food, fuel and clothing are brought to the camps by carrier boats, but fishermen usually suffer from the extreme shortage of fresh vegetables and meat in their diet.

Majority of the fishermen appear to be in their forties or younger, and school-age children are often found among them. According to the fishermen interviewed at one of the camps in Khor El Ramla, which is near the West Harbor, the married fishermen usually keep the cycle of 30 days of work in the lake and 20 days at home in their villages. However, those working in distant camps cannot usually afford such luxury and it is reported that not a few have to remain at their camps for as long as 2 years in a row.

According to the FAO/UNDP survey conducted by B. van Heck in 1970, there were 153 camps distributed at 37 fishing grounds which were respectively alloted to various groups of fishermen from the same villages or working under the same boat owners. Five of the fishing grounds at El Allaqi, Salaya, Korosko, Tushka and Abu Simbel had more than eight camps, while the others had one to six camps. The fishing boats at the time numbered 984, and were operated by 3,441 fishermen. The number of fishermen per camp ranged from 4 to 46 and averaged 22, while the number of boats ranged 1 - 26, or 6.4 on average, per camp. The number of camps in 1979 is not known, but considering the present numbers of boats and fishermen in the lake which are double the numbers in 1970, they might total more than 300.

The Fishermen's Cooperative Society of Aswan is composed of some 1,700 owners of fishing boats and gears and managed by an elected council of nine leading members and a chairman. More than 5,000 fishermen actually operating in the lake have no representation in the decision-making of the FCSA and are deprived of the means to improve their miserable working conditions.

2.2.2 Offshore Fishery Resource Potentials

(1) Findings by Echo-sounder Probe

In response to the request of the HDLDA, the Study Team conducted the echo-sounder probe in the off-shore of the lake reaching more than 5 m in depth. The survey was conducted twice, from January 16 to February 21 and from July 8 to August 8 of 1979, and covered the center lines of the main channel from Aswan to Abu Simbel and of major khors (inlets) at El Ramla, Brame, Kalabsha, El Allaqi, Tushka and Abo Askar. During the July-August period, however, Khors El Ramla, Brame and Kalabsha were not surveyed due to the limited time available to the Study Team. The probe was conducted during the day, because navigation was impossible during the night.

In conjunction with the echo-sounding, the transparency and surface temperature were measured at selected places (30 stations during the winter and 13 stations during the summer of which 9 roughly correspond with the places measured during the winter). The results are shown in Figure 2-2-2. Figure 2-2-3 compares the vertical distribution of water temperature and dissolved oxygen as measured at an offshore place near Adama during the summer (near Station 32 in Figure 2-2-10).

The echo-sounder used for the survey is a Model NJA-550A manufactured by Nihon Musen, Inc. (frequency 50 kHz, power output 100 W, and beam angle 33°). The range of depth coverage was set at 0 - 50 m and the sensitivity and discrimination of the lake bed were adjusted at Dial 2. Figure 2-2-4 shows a sample of the echo-sounder readings during the January-February survey. Black convex-dots near the surface and bottom show fish, large fish in the sample sheet, considering the size of the recorded dots.

The estimation of total fish stock requires the application of the probability theory to the echo-sounder readings and its accuracy primarily depends on the extensiveness of coverage by the echo-sounder probe. Due to the limited time available for the survey, however, the Study Team could not collect sufficient data to enable such accurate estimation. Therefore, the Team calculated the density per kilometer of offshore fish distribution in the formula shown below and compare density figures in various surveyed areas of the lake. The number of fish recorded per unit of time is read from the echo-sounder recordings and converted to the fish distribution density per kilometer, adjusting by the speed of the survey boat. For example, 67 fish are recorded during 7 minutes from 14:26 to 14:33 on Figure 2-2-4 and, given the speed of the survey boat at 2 m per second, the fish distribution at Khor Brame is roughly estimated to be 80 fish per kilometer as follows.

$$\frac{67}{7 \times 60 \times 2 \times 10^3} = 80$$

The species of the recorded fish are probably composed of largely <u>kalb-samak</u> (<u>Hydrocynus forskali</u> or tiger fish in English) and <u>samoos</u> (<u>Lates</u>

Figure 2-2-2 Transparency and Surface Temperature (Winter and Summer)

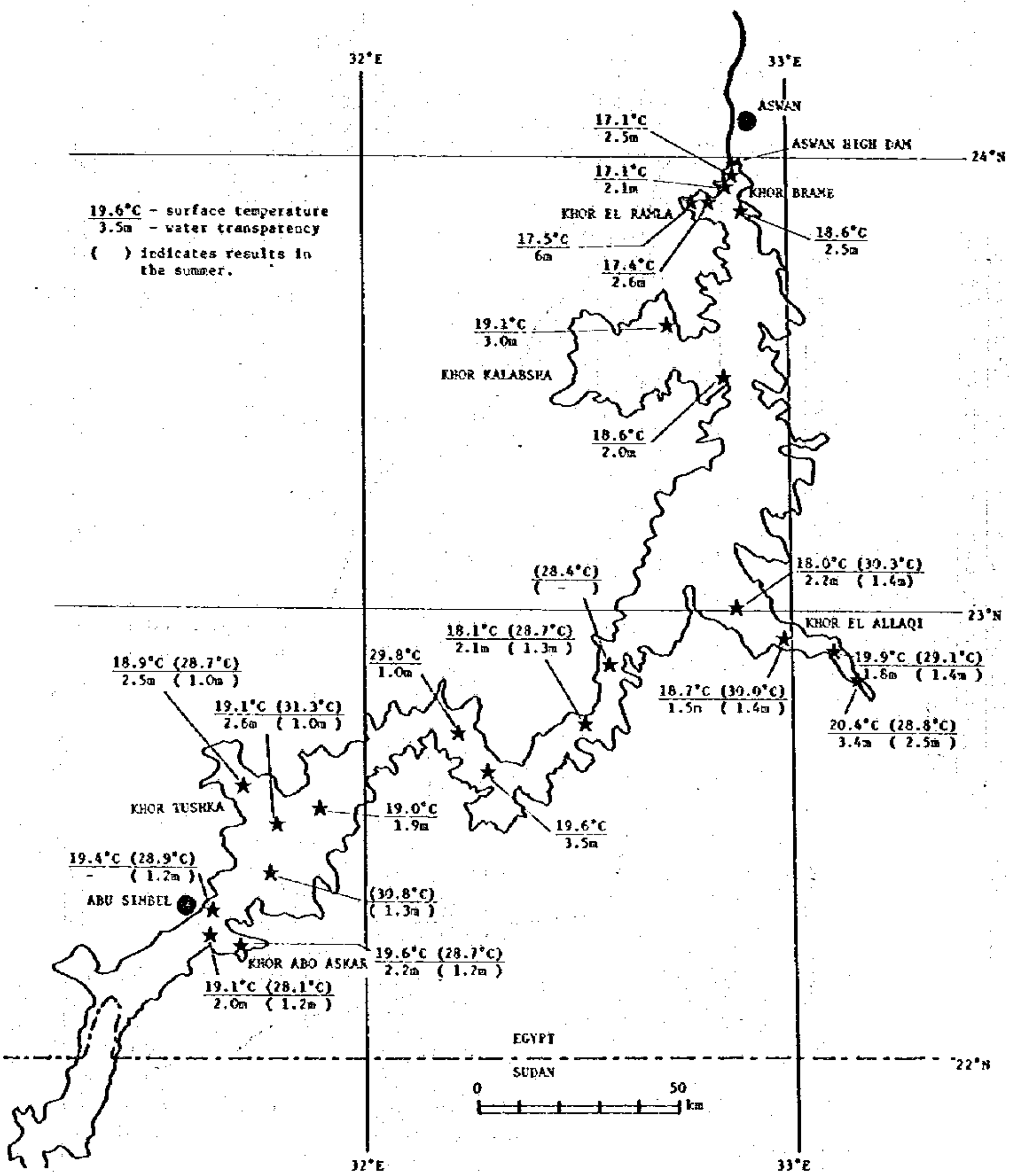


Figure 2-2-3 Vertical Distribution of Water Temperature and Dissolved Oxygen at Offshore of Amada (Summer)

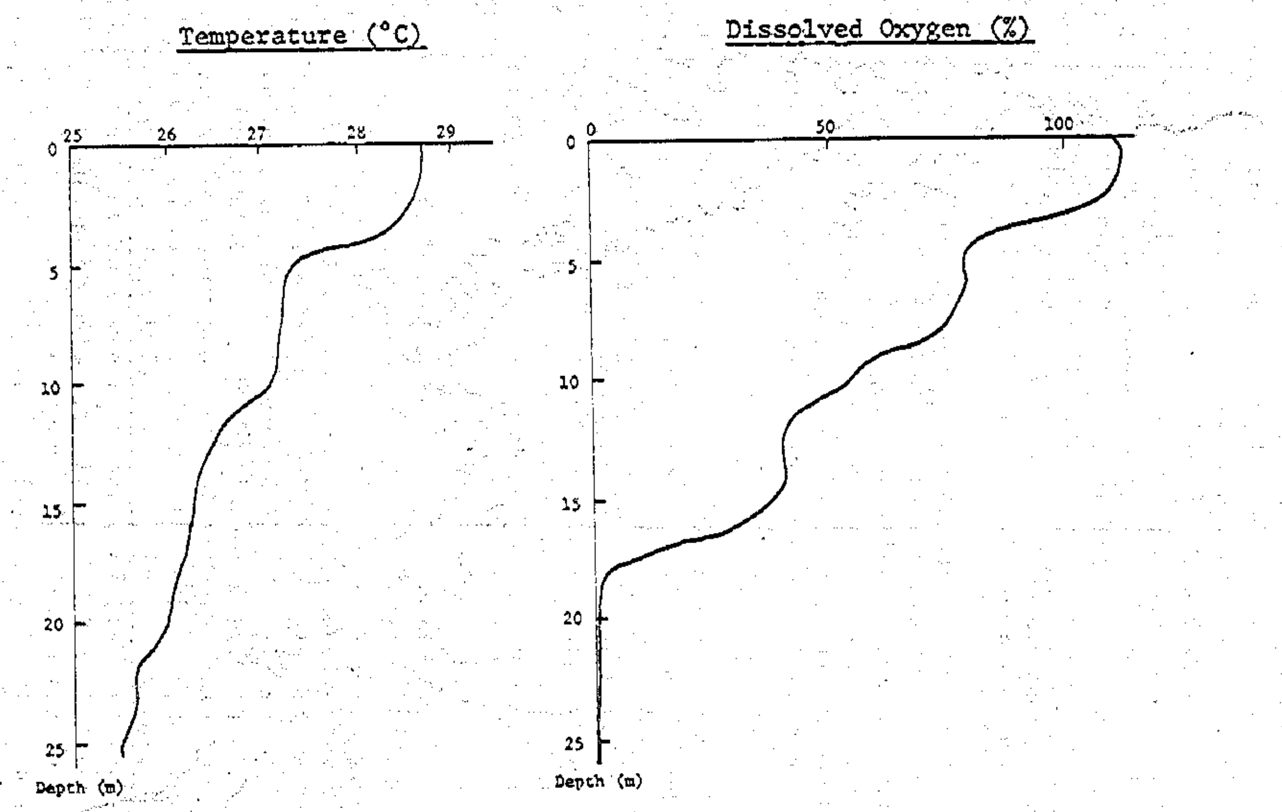
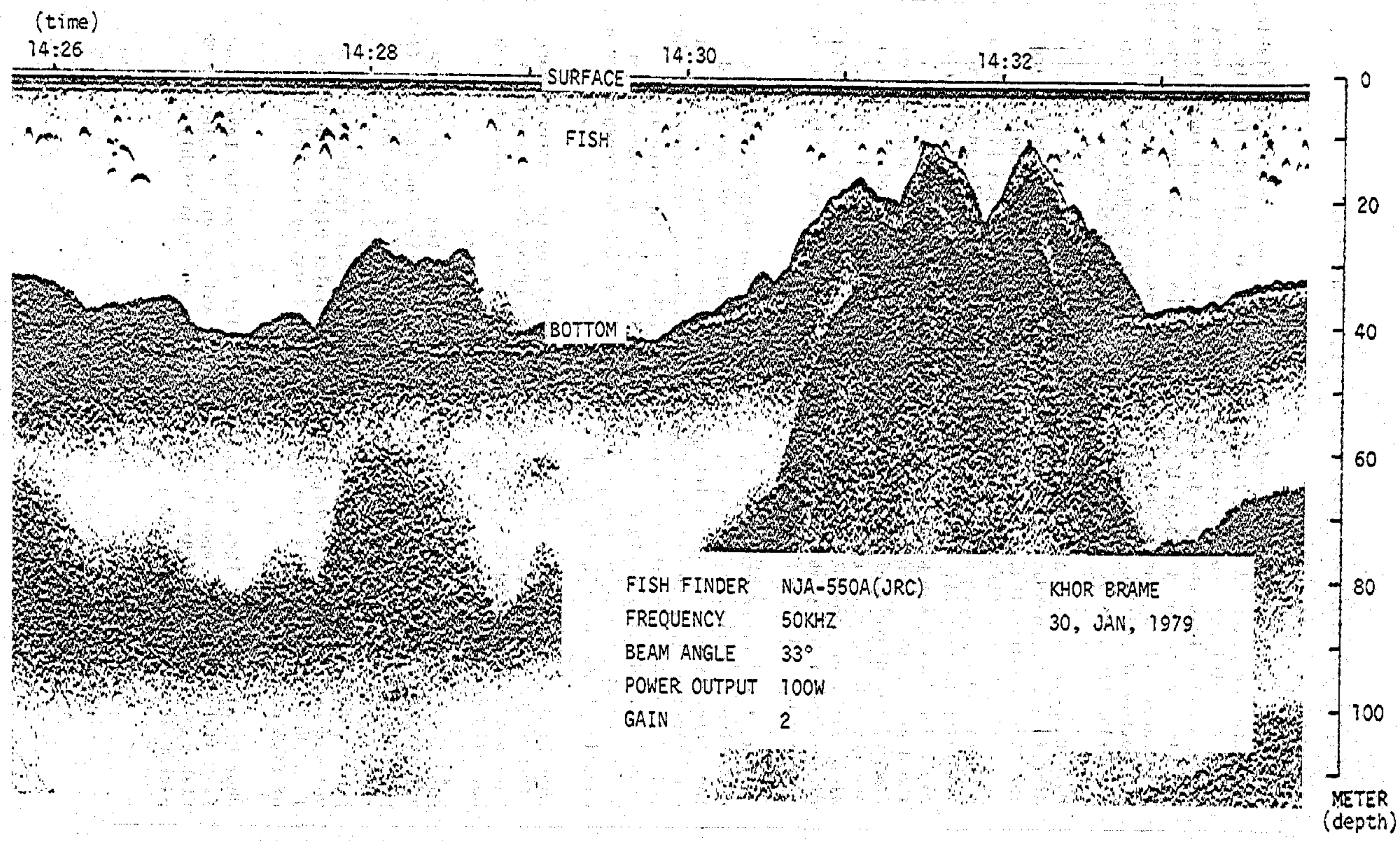


Figure 2-2-4 Sample Echo-sounder Reading



niloticus, or Nile perch), considering the hauls of experimental fishing conducted at selected spots during the survey. The tilapia locally known as bolti were not recorded, because their normal habitat is near the shoreline less than 3 m in depth. It is reported that the tilapia usually move to the depth of 10 m during the hot summer when the surface temperature rises considerably, but in such cases they stay too close to the bottom of the lake to be picked up on the echo-sounder recording. The major findings of the survey are briefly shown below.

Main Channel Between Aswan and Abu Simbel: Fish were found to be distributed throughout the main channel in winter and summer (Figure 2-2-5). The distribution was especially dense in the channel off Khor Kalabsha (22 fish per kilometer in winter and 55 per kilometer in summer) and the area between Tushka and Abu Simbel (25/km in winter and 12/km in summer). It was observed that the vertical distribution was wider during the winter, reaching the depth of 50 m at maximum. The depth of 15 - 35 m had the highest density of fish. During the summer, the distribution was concentrated in the depth of 8 - 12 m, and the echo-sounder readings indicated the occasional existence of small fish, or possibly fry. The concentration in the shallower depth of narrower range presumably has to do with the vertical variations of temperature and amount of dissolved oxygen.

Khor Ramla: The khor was surveyed only during the winter. The distribution of fish was relatively dense, especially at the mouth and the narrowest part of the inlet where the maximum density was 39 fish per kilometer (Figure 2-2-6). The fish distribution was scarce at the end of the khor, and there was no fish recording in the area less than 5 m in depth, partly due to the sensitivity of the echo-sounder. The water at the end of Khor Ramla is generally high in transparency and aquatic plants are clearly visible (Figure 2-2-2).

Khor Brame: Khor Brame is a long and deep inlet on the eastern shore of the lake. The survey during the winter found an abundant distribution of fish in the khor, with the maximum density reaching 80 fish per kilometer.

Khor Kalabsha: The khor was surveyed only during the winter (Figure 2-2-7) and found to be most abundant in fish distribution (23 - 71 fish per kilometer). The experimental fishing conducted in the inlet had the largest hauls. The fish were often recorded as forming small shoals, the occurrence which was not found elsewhere in the lake. As was the case with Khor Ramla, the end of the inlet with the depth of less than 5 m was highly transparent and there was no recorded trace of fish distribution.

Khor El Allaqi: The khor is the longest inlet in High Dam Lake. The fish distribution was sparse both in winter and summer, ranging 1 - 8 fish per kilometer (Figure 2-2-8). The water was also highly transparent at the end of the khor.

Figure 2-2-5a Distribution of Fish along the Main Channel (Winter)

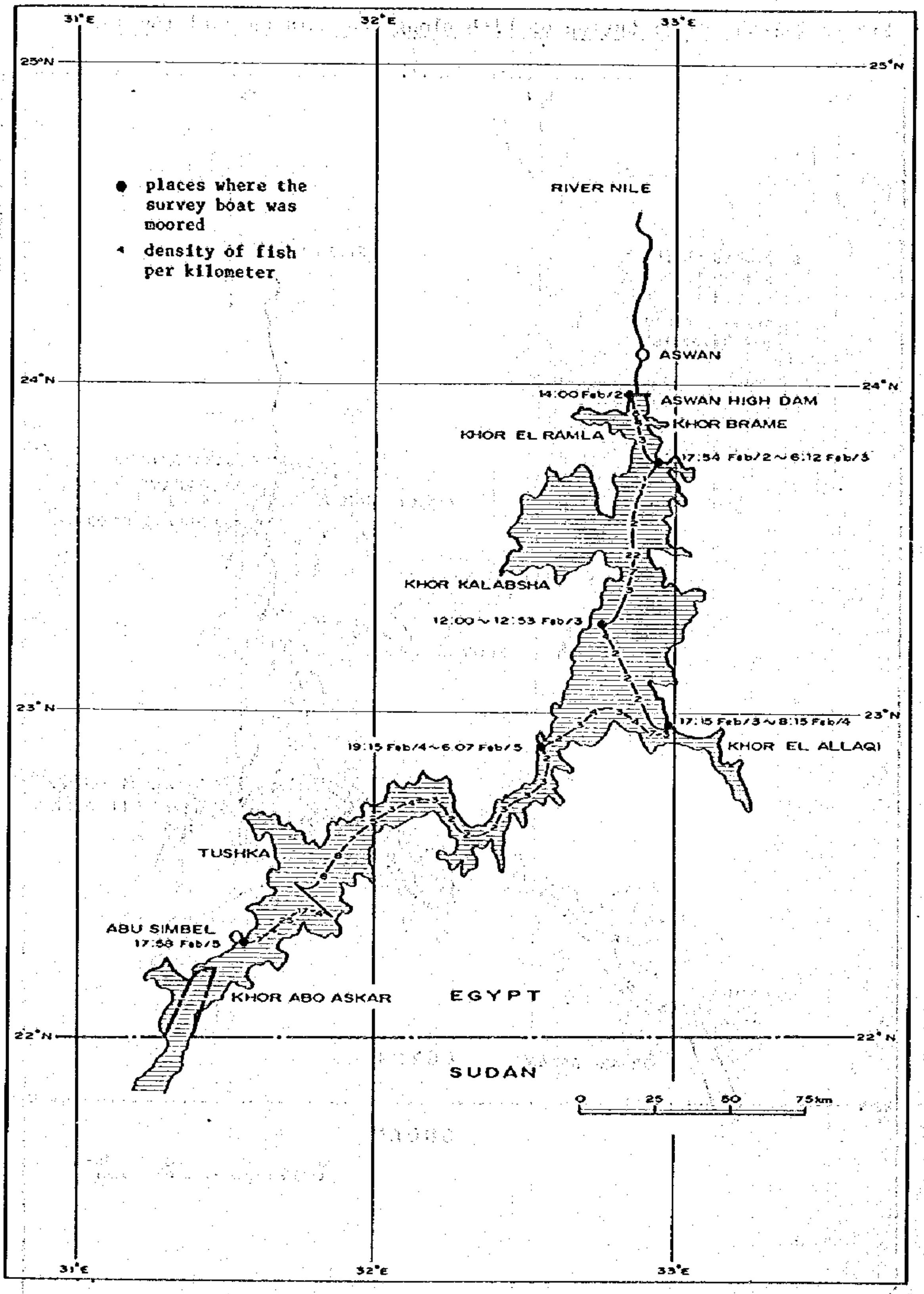


Figure 2-2-5b Distribution of Fish along the Main Channel (Summer)

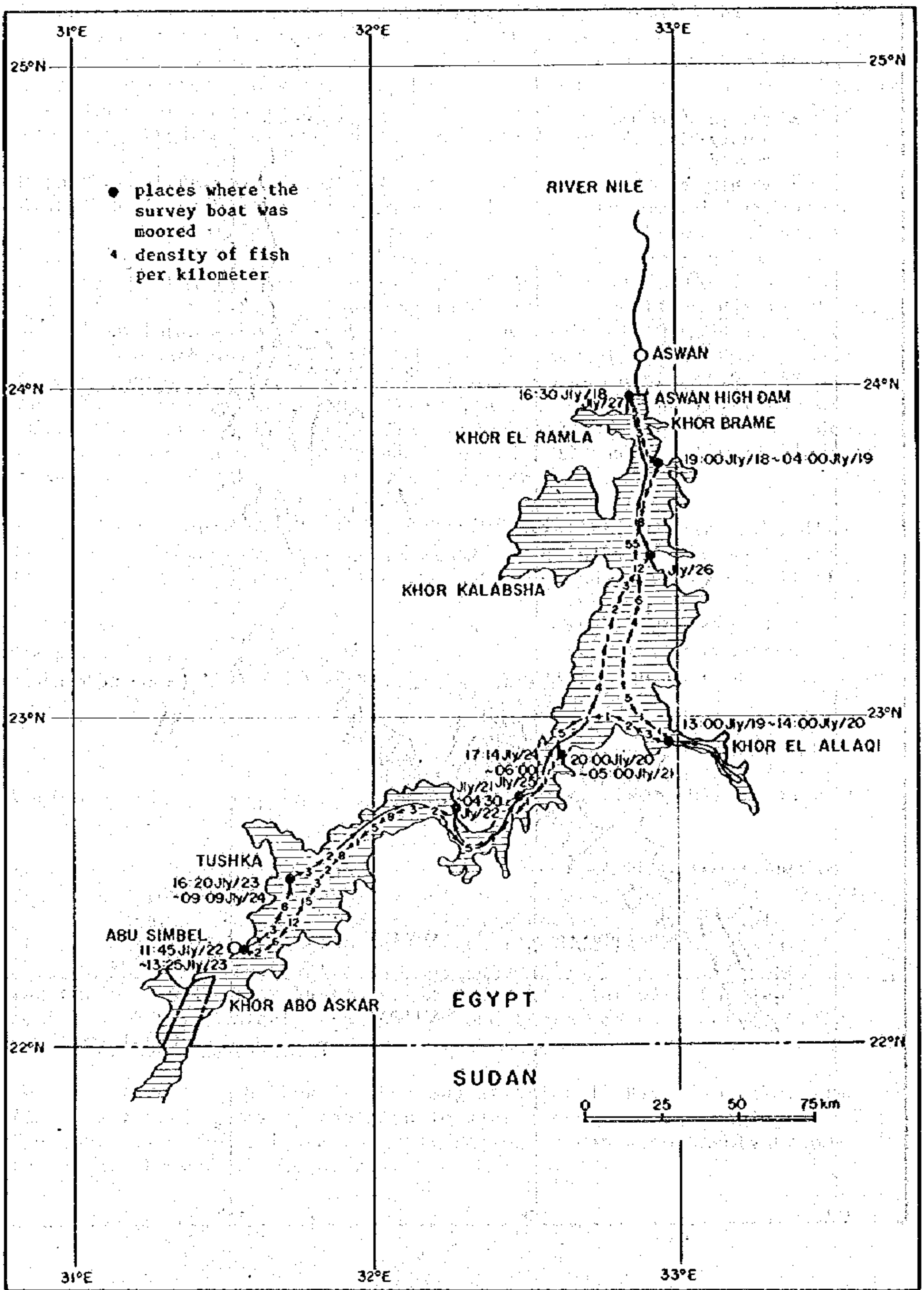


Figure 2-2-6 Distribution of Fish at Khor Ramla (Winter)

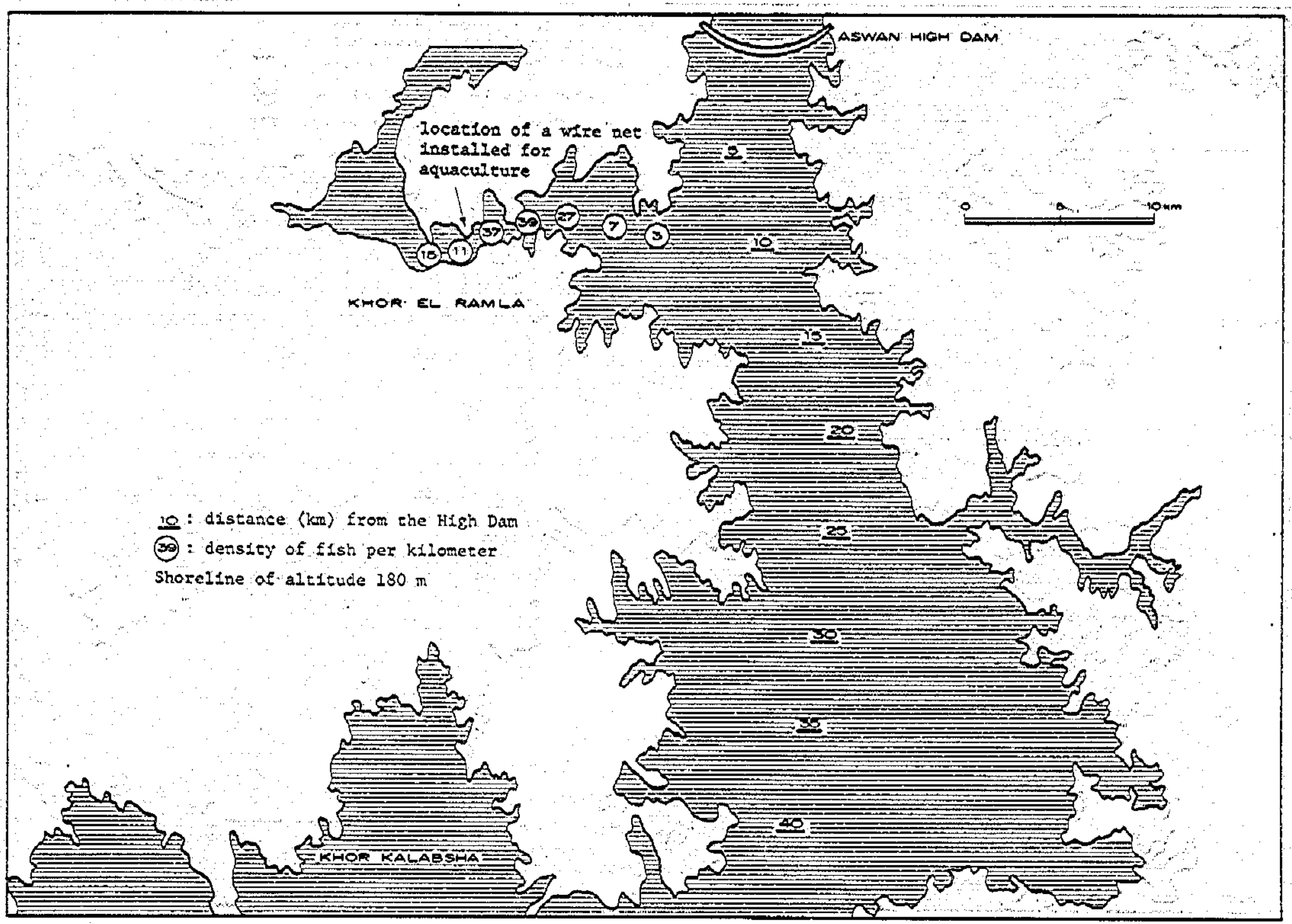


Figure 2-2-7 Distribution of Fish at Khor Kalabsha (Winter)

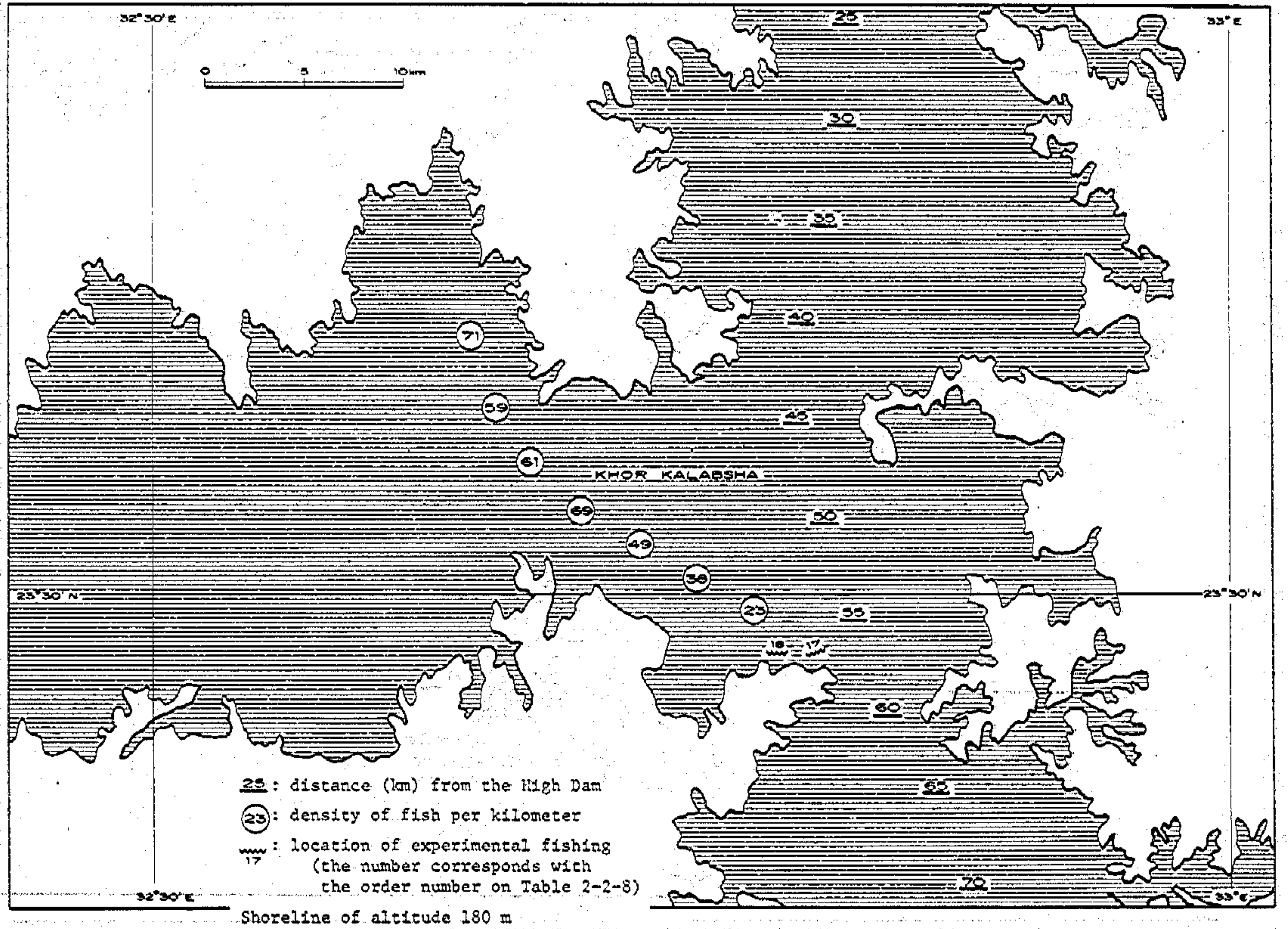
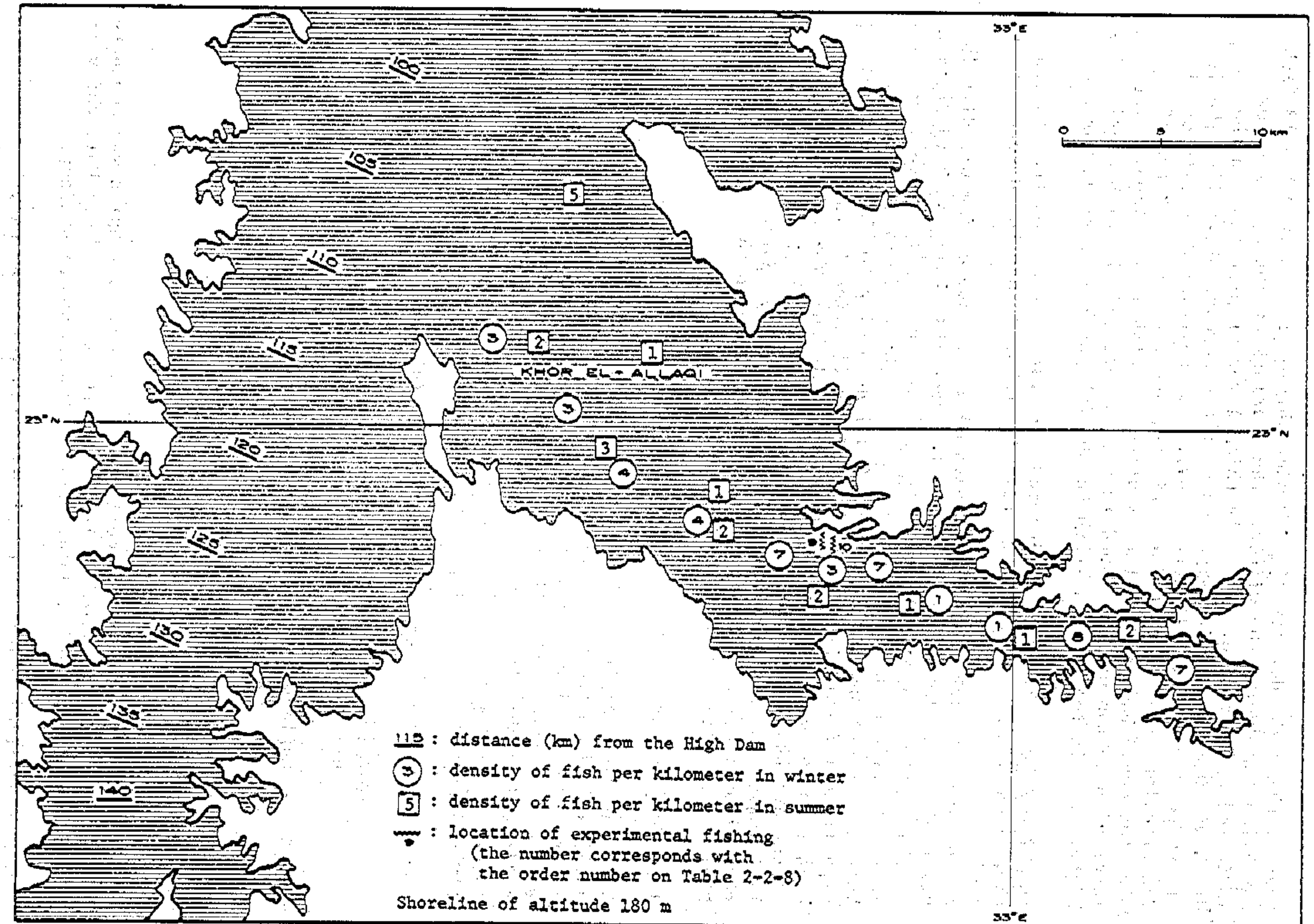


Figure 2-2-8 Distribution of Fish at Khor El Allaqi (Winter and Summer)



Khor Tushka: The density of fish distribution ranged from 5 - 13 fish per kilometer during the winter. The readings of the echo-sounder indicated an extensive, extremely thick layer of plankton in the depth of 20 - 27 m, which appeared on the recording sheet like shoals of numerous small fish (Figure 2-2-9). The calculated density of fish distribution might be an under-estimate, because the thickness of plankton could have masked the existence of fish in the layer. The layer of plankton was not found in the summer, and the fish density was higher than in the winter, reaching 38 fish per kilometer at maximum.

Khor Abo Askar: The khor is located a little upstream on the eastern shore opposite Abu Simbel. The fish distribution was found to be sparse.

In summary, the echo-soundings indicated an extensive offshore distribution of fish, almost all of which are presumably kalb-samak (Hydrocynus forskali, tiger fish) and samoos (Lates niloticus, Nile perch), with the latter comprizing a much smaller fraction (the ratio of occurrences between the two species is roughly 9 : 1 according to the results of experimental fishing). The density of distribution is found to be higher in the offshores of the khors, notably Khor Kalabsha in the winter and Khor Tushka in the summer, but excluding Khors Abo Askar and El Allaqi. The distribution of fish is generally sparse along the main channel of the lake, except in those areas close to the mouths of the khors where fish are found to be abundant.

(2) Surface Distribution of Zoo-plankton 1/

The number of samples collected was 20 in the winter (January - February, 1979) and 11 in the summer (July, 1979), and their location is shown in Figure 2-2-10. 140 liters of surface water was taken in a pail at each station and after being filtered through the net of 0.1 mm mesh, the collected plankton was immediately fixed by formalin to be taken back to Japan for identification. The results on zoo-plankton only are presented here. 2/

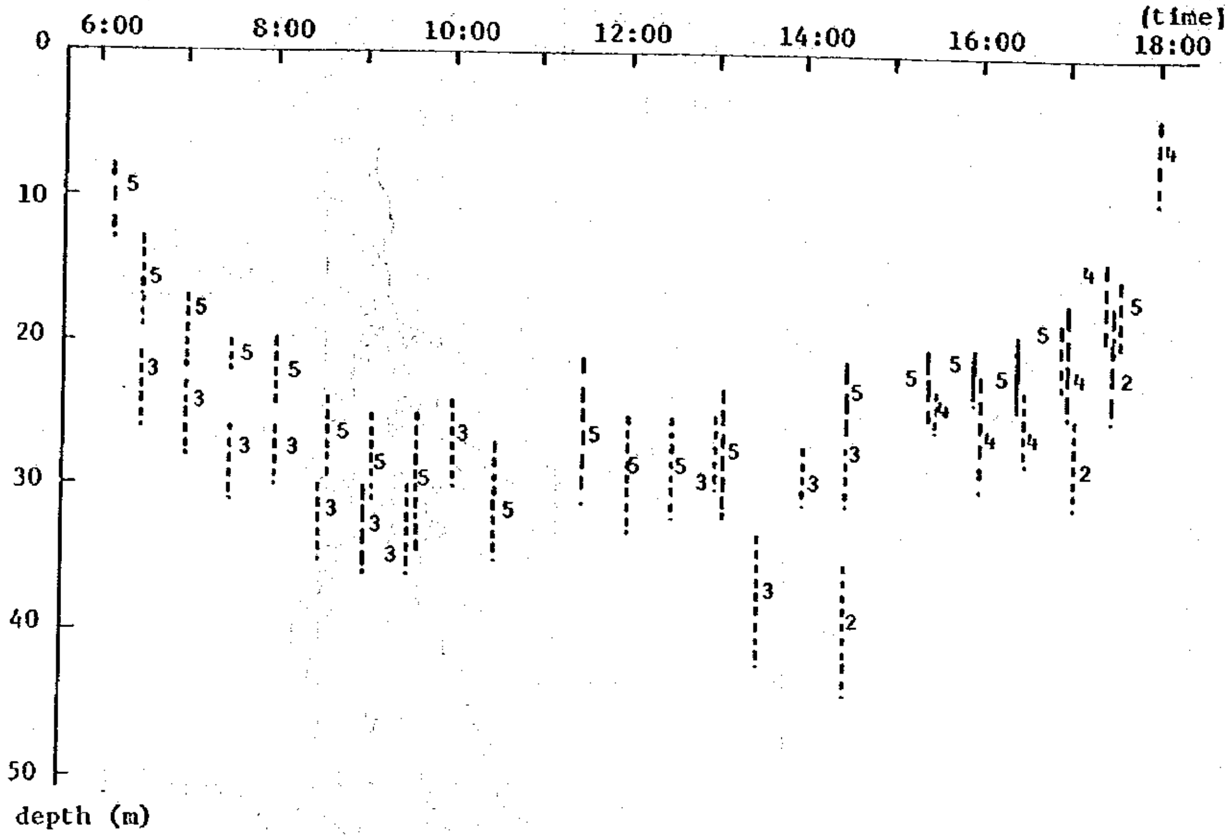
The identified species are summarized as follows:

PROTOZOA
- Dinoflagellida
  - Ceratium hirundinella O. F. Müller**
- Euglenoida
  - Volvox sp.*

1/ Identification of the collected zoo-plankton samples was conducted by Dr. Masaaki Murano, Associate Professor of Tokyo University of Fisheries, and Mr. Jotaro Urabe, Undergraduate student.

2/ Identification of phyto-plankton is yet under way.

Figure 2-2-9 Daily Movement of Plankton Layer (Winter)

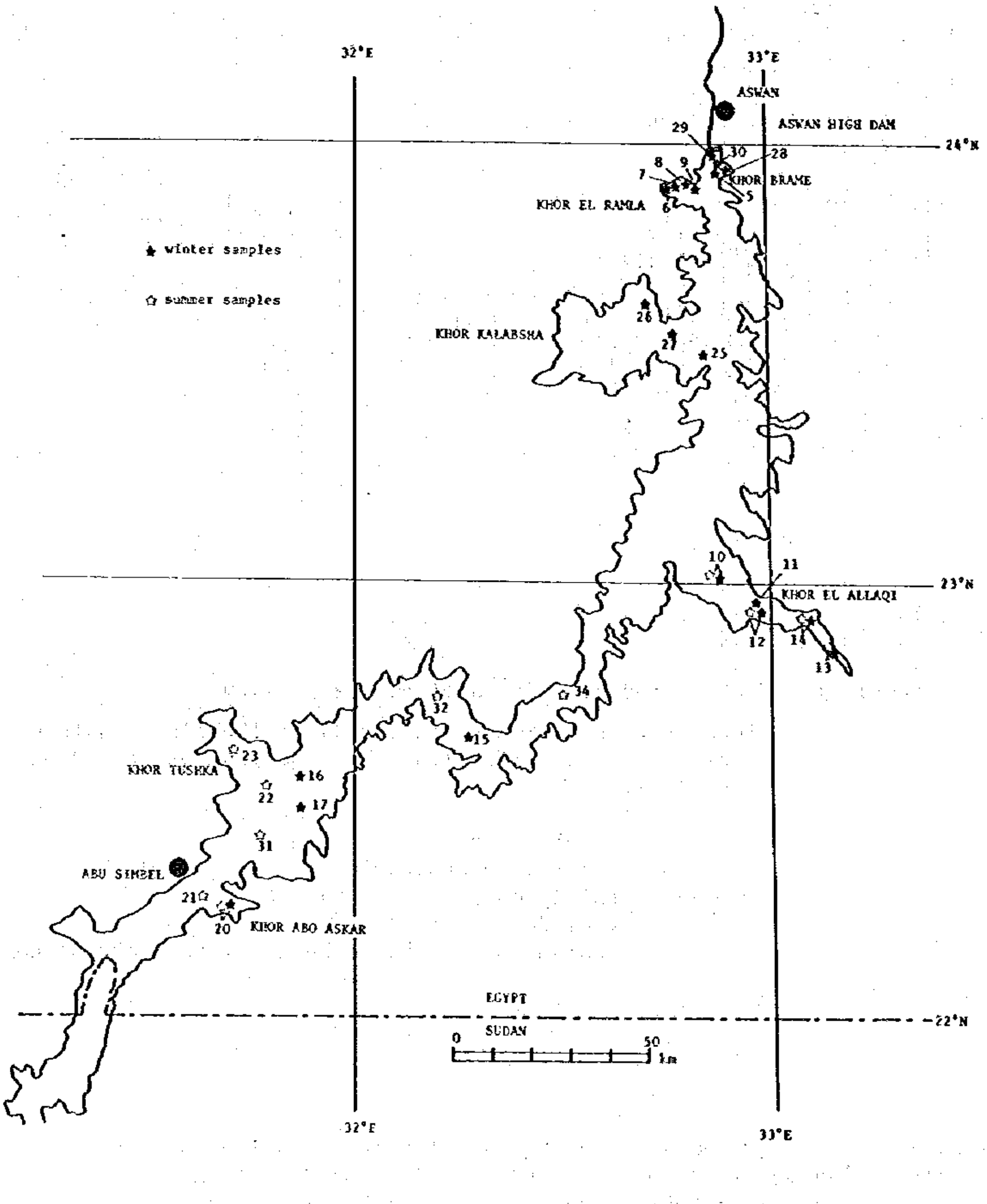


Notes: 1/ Numbers indicate dates of February, 1979.

2/ Lines show the relative thickness of the plankton layer as expressed as darkness on the echo-sounder recordings as follows:

- - - - - - Barely traceable
- - - - Clearly recognizable
— — — Fairly dark
— - — - Very dark
——— Equivalent to the darkness of the lake bottom

Figure 2-2-10 Sample Collection of Zoo-plankton



TROCHELMINTHES

Rotatoria

Trichocera sp.

Brachionus calyciflorus Palla

Brachionus quadridentatus Hermann*

Keratella sp.*

Platyias patulus (O. F. Müller)

Euchlanis sp.*

Lecane sp.*

Tetramastix sp.

ARTHROPODA

Crustacea

Cladocera

Diaphanosoma sp. (D. excism?)

Daphnia sp.

Ceriodaphnia sp.

Bosmina sp. (B. longirostris?)

Macrothrix sp.*

Alona sp.

Copepoda

Heliodiaptomus sp.

Mesocyclops sp. (M. leuckarti?)

Thermocyclops sp. (T. hyalinus?)

(* signifies occurrences only in winter;
** only in summer)

(a) Winter Samples

Zoo-plankton from the winter samples was identified to contain one protozoan, eight rotatorians, six cladocerans and three copepods (Table 2-2-5). The total density varies from 314 individuals/m³ at St.6 to as many as 628,300/m³ at St.15, averaging 97,470/m³. The distribution is generally thin near the High Dam and the average density of the samples taken at seven places (Sts. 5 - 8, 28, 29 and 30) is 14,031/m³, which is only one-seventh of the average of all stations. This corresponds with the relatively high transparency of water in the area. The main channel in the southern half of the lake (Sts. 15 - 20) has extremely high densities, chiefly due to the abundant presence of the Volvox species. In Khor El Allaqi, the density is substantially high in the middle part, but low at the end of the Khor corresponding to the high trnasparency of water there.

Protozoa: Only one species of Vovlox is identified from the samples taken at Sts. 15, 16, 17 and 20, but the occurrences of this species are enormous, accounting for 45.6% of the total occurrences of the entire species sampled from the lake.

Rotatoria: The occurrences of the eight identified species are generally few. Brachionus calciflorus has the largest occurrences among them, with its highest density at 12,429 individuals/m³ near the end of Khor Kalabsha (St. 26) and averaging 1,295/m³ over the lake. The occurrences of this species make up 1.3% of the total.

Table 2-2-5a Surface Occurrences of Zoo-plankton by Species (Winter)

(Unit: No. of individuals/m^3)

	St. 5	St. 6	St. 7	St. 8	St. 9	St.10	St.11	St.12	St.13	St.14	St.15
Volvox sp.											547,857
Trichocera sp.			7								
Brachionus calyciflorus	21	7	7			71					307
B. quadridentatus											
Keratella sp.							143		164		
Platyias patulus											
Enchlanis sp.											
Lecane sp.											
Tetramastix sp.											
Diaphanosoma sp.	236	29	800	3,500	10,714	357	18,714	17,143	664	4,857	8,664
Daphnia sp.	29	7	121	500	536	71	286	143	164	1,429	5,571
Ceriodaphnia sp.	71		179	7,071	1,071	714	2,714	1,857		429	2,471
Bosmina sp.	893	179	621	7,500	49,500	3,286	4,429	5,857	2,000	2,000	307
Macrothrix sp.											
Alona sp.										143	
eggs of Cladocera			429	536	321	857	5,143	857			1,857
Heliodiaptomus sp.	121	7	21	714	1,500	500	17,143	5,858	329	1,857	31,872
Mesocyclops sp.	43		36	500	1,071	71	4,571	1,143	664	1,000	307
Thermocyclops sp.	36	7			107	143	10,857	14,857	164	143	929
copepodite of Cyclopoida	864	43	243	1,286	2,143	3,000	55,000	49,143	4,000	16,429	10,829
nauplius	814	36	700	1,429	1,929	8,786	16,429	3,286	2,329	1,571	17,329
unidentified						71	1,000		164		
Total	3,128	314	3,493	23,036	68,893	17,928	136,429	100,143	10,643	29,857	628,300

(Unit: No. of individuals/m^3)

	St.16	St.17	St.20	St.25	St.26	St.27	St.28	St.29	St.30	Mean	%
Volvox sp.	60,186	12,143	265,664							44,293	45.6
Trichocera sp.										0	0.0
Brachionus calyciflorus	7,236	5,000	329	379	12,429			114		1,295	1.3
B. quadridentatus					214					11	0.0
Keratella sp.			329	93				114	114	48	0.0
Platyias patulus					429					21	0.0
Enchlanis sp.					214					11	0.0
Lecane sp.									114	6	0.0
Tetramastix sp.				186						9	0.0
Diaphanosoma sp.	1,521		9,664	471	54,214	1,307	3,286	714	471	6,866	7.0
Daphnia sp.	1,900		146,000	93		357	429	357	114	7,905	8.1
Ceriodaphnia sp.	379		18,664	1,043	214	357	4,286	593	236	2,117	2.2
Bosmina sp.	900		22,000	3,429		11,543	13,143	4,643	2,971	6,760	6.9
Macrothrix sp.						114				6	0.0
Alona sp.										7	0.0
eggs of Cladocera	1,143		24,000	857		829	857	1,071		1,938	2.0
Heliodiaptomus sp.	6,286		50,000	2,093	214	1,778	1,142	2,022	714	6,209	6.4
Mesocyclops sp.	379		2,664		1,286	1,307			829	794	0.8
Thermocyclops sp.			9,664	1,143	643	829	571	1,071	114	2,064	2.1
copepodite of Cyclopoida	8,186	9,521	17,000	11,614	19,929	6,786	6,143	6,664	8,329	11,858	12.2
nauplius	8,000	236	10,329	5,429	4,071	13,093	2,857	2,021	2,143	5,141	5.3
unidentified			329	93		236				111	0.1
Total	96,115	26,901	576,636	26,923	93,856	38,535	32,714	19,385	16,150	97,470	100.0

Table 2-2-5b Surface Occurrences of Zoo-plankton by Species (Summer)

(Unit: No. of individuals/m^3)

	St.34	St.10	St.12	St.13	St.14	St.32	St.31	St.20	St.21	St.22	St.23	Mean	%
Ceratium hirundinella					114							10	0.0
Trichocera sp.				143			286					39	0.1
Brachionus calyciflorus	429	2,186		143		829	2,000	2,379	4,329	5,000	3,571	1,897	4.7
Platyias sp.			592	714	4,000			357				515	1.3
Tetramastix sp.							286					26	0.1
Diaphanosoma sp.	10,714	1,429	12,379	4,429	11,571	2,164	18,285	26,900	23,164	7,329	9,757	11,647	28.7
Daphnia sp.	143											13	0.0
Ceriodaphnia sp.	143						286		164			54	0.1
Bosmina sp.	143			143			93	357	329			97	0.2
Alona sp.								114				10	0.0
eggs of Cladocera			357		357		286					91	0.2
Heliodiaptomus sp.	2,286	93					2,850	471	1,329	329		669	1.7
Mesocyclops sp.	2,571	186	1,664		114		757	593	2,664		471	820	2.0
Thermocyclops sp.	2,286	286	236				571	357	164			355	0.9
copepodite of Cyclopoida	19,143	15,236	7,379	2,571	13,429	5,829	51,807	9,757	79,500	14,664	8,807	20,738	51.3
nauplius	4,000	757	3,686	2,700	13,857	500	7,043	1,071	3,286	164	471	3,412	8.4
unidentified				1,143				236				125	0.3
Total	41,858	20,173	26,293	11,986	43,442	9,322	84,550	42,592	114,929	27,486	23,077	40,518	100.0

Cladocera: The aggregate occurrences of the six identified species account for 24.2% of the total. The Diaphanosoma sp. (possibly D. excisum), Daphnia sp. and Bosmina sp. (possibly B. longirostris) have roughly the same average density (respectively 6,866 individuals/m³, 7,905/m³ and 6,760/m³), but show recognizable concentration in different localities; Diaphnosoma in Khor El Allaqi, Daphnia in Khor Abo Askar and Bosmina near the High Dam. The fourth identified species which belongs to Ceriodaphnia accounts for 2.2% of the total occurrences of the entire species and is mainly found in Khor Abo Askar. The occurrences of the remaining two species, Macrothrix and Alona, are rare.

Copepoda: The three identified species, i.e, Heliodiaptomus sp. of Diaptomidae and Mesocyclops sp. (possibly M. leuckarti) and Thermocyclops sp. (possibly T. hyalinus) of Cyclopidae, account for 39.4% of the total occurrences of the entire species. The highest density of Heliodiaptomus sp. is found in Khor Abo Askar (50,000/m³ at St.20), followed by the middle part of the lake (31,872/m³ at St.15). The distribution of this species is distinctly fewer near the High Dam. The two species of Cyclopidae, the exact identification of which is difficult with regard to those in the copepodite stage in the samples, are found abundant in Khor El Allaqi, with their aggregate density reaching 70,428 individuals/m³ at St.11, while their distribution is few near the High Dam. Judging by the distribution of the adult individuals, Thermocyclops sp. appears more abundant than Mesocyclops sp.

(b) Summer Samples

The summer samples contained one protozoan, four rotatorians, five cladocerans and three copepods. The total density varies from 9,322 individuals/m³ at St.32 to 114,929/m³ at St.21, averaging 40,519/m³. The occurrences appear to be more even than in the winter, although it is not conclusive due to the much smaller number of stations at which samples were taken in the summer. The end of Khor El Allaqi (St.13) has smaller occurrences of zoo-plankton organisms and the higher transparency of water compared with the other sampled stations nearby and elsewhere. The unidentified species numbering 1,143/m³ at this station resembles none of the zoo-plankton species normally recorded to occur in fresh water lakes and is likely to be temporary issues from some non-planktonic species. On the whole, the sample from St.13 suggests the existence of an aquatic environment which is somewhat different from the main body of the lake.

Protozoa: Only Ceratium hirundinella is identified and its occurrences are very few.

Rotatoria: Four species are identified, among which Brachionus calyciflorus is predominant at the average density of 1,897 individuals/m³. Occurrences of the other three species are generally few, with the presence of Platyias sp. being barely notable.

Cladocera: Diaphanosoma sp. averages 11,647/m³, the density only second to cyclopoid copepods, and accounts for 28.7% of the total occurrences of the entire species identified. Other species such as Daphnia sp., Bosmina sp. and Alona sp. have very limited occurrences, respectively making up less than 1% of the total occurrences.

Copepoda: Two species of cyclopoid copepods, Mesocyclops sp. and Thermocyclops sp. (excluding those in the nauplius stage) have the aggregate average density of 21,913 individuals/m³, and account for 54.2% of the total occurrences. Judging by the occurrence of adult individuals, Mesocyclops sp. appears to be more abundant than Thermocyclops sp. Another Copepoda, i.e., Heliodiaptomus sp., has much fewer occurrences (669/m³) and comprises only 1.7% of the total occurrences of the entire species.

(c) Seasonal Comparison

The number and composition of the occurrences show great differences by season, with the surface water temperature risen from about 19°C in winter to 29°C in summer. The total occurrences of the entire species less than halves in summer (40,518/m³) compared with winter (97,470/m³). This large difference is mostly due to the enormous propagation of Volvox sp. of Protozoa during the winter in the southern main channel of the lake. If the occurrences of this species are excluded, the average density in the winter comes down to 53,177 individuals/m³, which is only 13% higher than the figure in the summer.

Rotatoria: The number of identified species in the summer is smaller by half than in the winter but the occurrences are larger. Brachionus calyciflorus has the highest occurrences in both seasons and is probably the predominant species among Rotatoria in the lake. The other species remain insignificant in occurrence in both seasons, except Platyias sp. which shows some notable increase in the summer.

Cladocera: The number of species in the summer is smaller by only one but the total occurrences drop to less than 50% of the winter figure. During the winter, three species of Diaphanosoma, Daphnia and Bosmina have roughly similar numbers of occurrences ranging between 6,800 - 7,900 individuals/m³, with fairly sizable occurrences (2,000/m³) of Ceriodaphnia sp. as well. In the summer, Diaphanosoma sp. has the overwhelming predominance of 11,647/m³, and the rest of the species have occurrences less than 100/m³.

Copepoda: The species are the same and their total occurrences do not vary much in both seasons. However, Heliodiaptomus sp. which has the occurrences of 6,209/m³ in the winter decreases to mere 669/m³ in the summer. Cyclopoida species obviously propagate throughout the year, but their propagation seems enhanced in the winter when the water temperature is lower by about 10°C, as seen from the occurrences of nauplius larvae which are 5,141/m³ in the winter and 3,412/m³ in the summer.

(2) Findings by Experimental Fishing

Together with the echo-sounder probe, experimental fishing was conducted at selected off-shore spots more than 10 m in depth over High Dam Lake in the winter (January 28 to February 14) and the summer (July 19 - 28) of 1979. To identify appropriate types of fishing gear and method, the four types of fishing nets were employed: namely, floating gill-nets, midwater gill-nets, bottom gill-nets, trammel nets and pots. Specifications of these nets are shown in Tables 2-2-6 and 2-2-7 separately for the winter and summer. As seen from these tables, the nets used during the winter were made of monofilament nylon twines, but the ones used during the summer were of multi-filament nylon twines. The change was thought appropriate because multi-filament nets are commonly used by lake fishermen, but to enable the seasonal comparison of the density of fish distribution, mono-filament floating gill-nets (8 cm stretched mesh size only) and trammel nets were used together. Figure 2-2-11 shows the location of experimental fishing conducted over the lake.

(a) Hauls by Location

Tables 2-2-8 and 2-2-9 show hauls of experimental fishing by location of casting. The majority of the catches were kalb-samak (Hydrocynus forskali) numbering 632 in the winter and 165 in the summer, followed by samoos (Lates niloticus) totalling 69 and 43, respectively. Kalb-samak were relatively abundant in Khors Kalabsha, El Allaqi and Brame and few in El Maharraka. During the summer, they were relatively abundant in Khor Tushka and few in El Allaqi, though it must be noted that Khors El Ramla, Kalabsha, Brame and Abo Askar were not fished during the summer survey due to the limitation of time available. The number of Tilapia nilotica in the hauls was small both in the winter and summer respectively at 6 and 10, because the nets were set in areas more than 10 m in depth where this species does not normally inhabit.

Other species hauled during the survey were as follows. January-February: docmac (Bagrus docmac) 14 fish, lebeo (Labeo horie) 7, zammar (Synodontis serratus) 6, Raya (Alestes dentex) 5, boweza (Mormyrus Kannume) 5, shelpa (Schilbe mystus) 3, korker (Synodontis schall) 2, bolti (Tilapia galilaea) 2, benni (Barbus bynni) 1, sardina (Alestes nurse) 1, and fohaka (Tetrodon fahaka) 1.
July: korker 18, boweza 16, lebeo 14, bolti (Tilapia galilaea) 1, and zammar 1.

(b) Hauls by Type of Fishing Nets

Tables 2-2-10 and 2-2-11 show hauls by type of fishing nets and by mesh size. In terms of the average catch per square meter of net per casting, floating gill-nets had better hauls of kalb-samak than bottom gill-nets during the period of January-February (Table 2-2-10), indicating that the species has a pelagic inclination during the winter. Kalb-samak caught by bottom gill-nets and trammel nets largely consisted of fish smaller than 30 cm in scaled body length, as shown on Figure 2-2-12. This tendency was more pronounced when these types of fishing nets were set at shallower waters (Table 2-2-8).

Table 2-2-6 Nets Used for Experimental Fishing (January-February)

	Twines (mono-filament nylon)	Mesh Size (cm)	Net Length (m)	Net Width (m)	Net Size per Strip (m²)	Hanging Rate (%)	No. of Strips Used
Floating Gill-nets	No. 8 (0.47 mm dia.)	5.0	50	8.7	435	50	1
	"	8.0	"	10.4	520	"	"
	10 (0.52 mm)	12.0	"	7.3	365	"	"
	14 (0.62 mm)	17.5	"	6.1	305	"	"
					Total 1,625		
Midwater Gill-nets (3 m hanging string)	8	5.0	50	8.7	435	"	1
	"	8.0	"	10.4	520	"	"
	10	12.0	"	7.3	365	"	"
	14	17.5	"	6.1	305	"	"
					Total 1,625		
Bottom Gill-nets	8	5.0	50	4.3	215	"	1
	"	8.0	"	6.9	345	"	"
	10	12.0	"	7.3	365	"	"
	14	17.5	"	6.1	305	"	"
					Total 1,230		
Trammel Nets							
Inner Net	3 (0.29 mm)	4.7				50	
			30	3.8	114		3
Outer Net	6 (0.40 mm)	30.3				33	
					Total 342		
Pots	Bottom diameter 72 cm, top diameter 52 cm, height 35 cm, opening diameter 10 cm, 10 units Hi-zex twines of 0.60 cm in diameter and stretched mesh size of 1.6 cm.						

Table 2-2-7 Nets Used for Experimental Fishing (July)

Twines		Mesh Size (cm)	Net Length (m)	Net Width (m)	Net Size per Strip (m^2)	Hanging (%)	No. of Strips Used
Floating Gill-nets	mono-filament:						
	No. 8	8.0	50	10.4	520	50	1
	multi-filament:						
	4 twines (0.41 mm dia.)	5.0	30	5	150	40	"
	"	6.0	"	"	"	"	"
	6 " (0.58 mm)	7.0	"	"	"	"	"
	"	8.0	"	"	"	"	"
	9 " (0.69 mm)	10.0	"	"	"	"	"
Trammel Nets	mono-filament:						
	Inner Net No. 3	4.7	30	3.8	114	50	2
	Outer Net No. 6	30.3				33	
	multi-filament:						
	Inner Net 6 twines	8.0	31	1.9	58.9	50	"
	Outer Net 9 "	39.0				30	
	Inner Net 4 "	12.0	"	"	"	50	"1/
	Outer Net 9 "	39.0				30	
	Inner Net 6 "	16.5	"	"	"	50	"
	Outer Net 9 "	39.0					

Note: 1/ One strip was stuck to the rocky outcrop in the lake bottom and seriously damaged at the first casting and its use was subsequently discontinued.

Figure 2-2-11 Location of Experimental Fishing

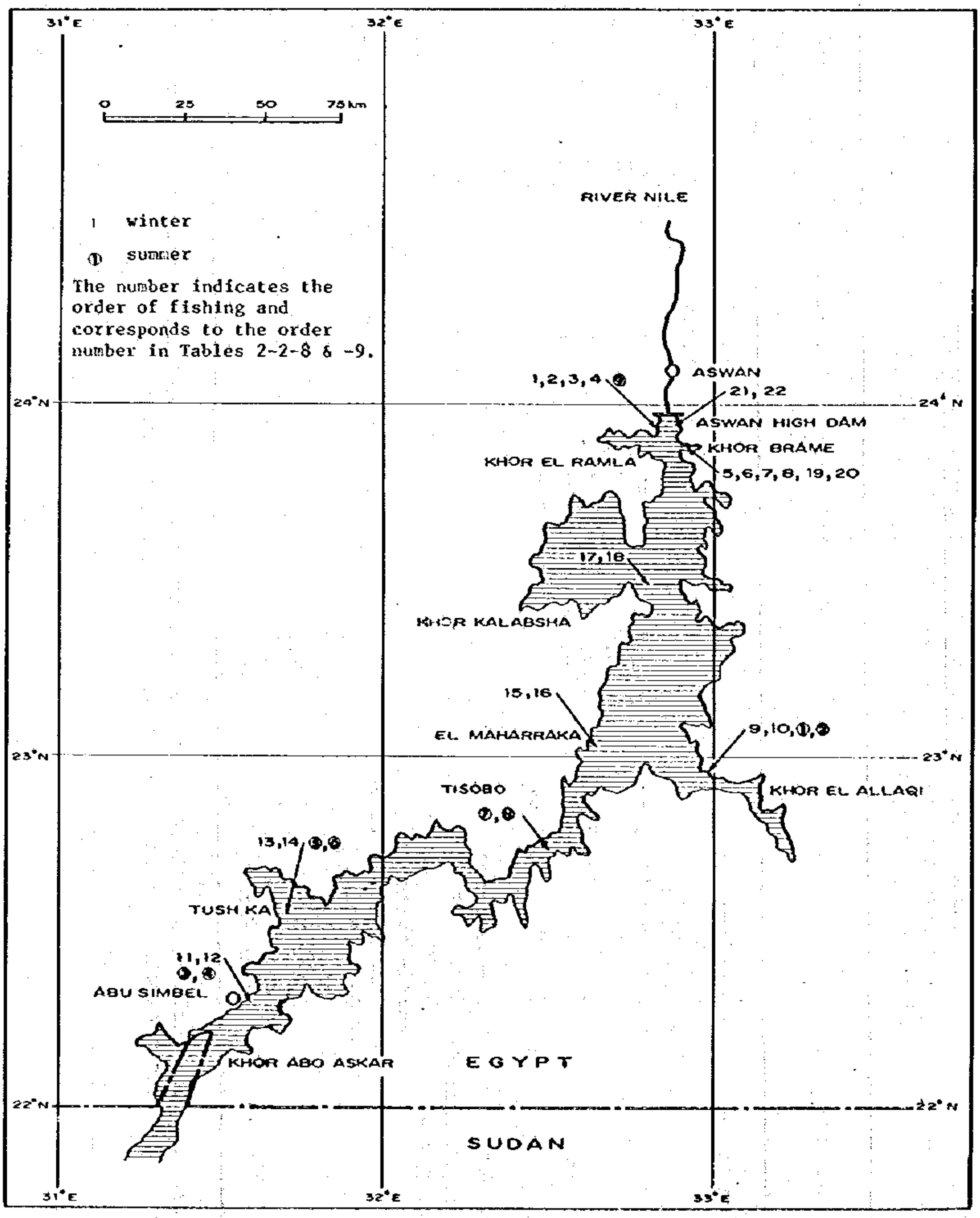


Table 2-2-8 Fish Hauls by Location (January-February)

Order No.1/	Dates of Setting and Lifting	Net Used	Location	Depth (m)	Number of Hauls by Major Species: Kalb-samk	Samoos	Bolti
1	Jan. 28 - 29	Floating Gill-nets	Asvan	30	29		
2	Jan. 29 - 29	"	"	15 - 20	No haul due to day-time casting		
3	Jan. 29 - 30	Bottom Gill-nets Trammel nets	"	16 - 18	13	7	3
4	"	Floating Gill-nets	"	30 - 50	26	1	
5	Jan. 31 - Feb. 1	Bottom Gill-nets Trammel nets	Khor Brame	12 - 30	1	11	
6	"	Floating Gill-nets	"	15	41		
7	Feb. 1 - 2	Bottom Gill-nets Trammel nets	"	10 - 15	14	6	2
8	"	Floating Gill-nets	"	20 - 40	49		
9	Feb. 3 - 4	"	Khor El Allaqi	30	77	2	
10	"	Bottom Gill-nets Trammel nets	"	30	1	1	
11	Feb. 6 - 7	Floating Gill-nets	Abu Simbel	20 - 40	10	1	
12	"	Bottom Gill-nets Trammel nets	"	30 - 40	9	3	
13	Feb. 7 - 8	Floating Gill-nets	Tushka	25	15		
14	"	Bottom Gill-nets Trammel nets	"	15	36		
15	Feb. 8 - 9	"	El Maharraka	12 - 20	3	17	
16	"	Floating Gill-nets	"	20	5	2	
17	Feb. 9 - 10	"	Khor Kalabsha	30	148	3	1
18	"	Bottom Gill-nets Trammel nets	"	10 - 14	36	10	
19	Feb. 12 - 13	Floating Gill-nets	Khor Brame	5 - 20	57	3	
20	"	Midwater Gill-nets	"	20 - 40	24		
21	Feb. 13 - 14	Floating Gill-nets	Asvan	20 - 70	28	1	
22	"	Midwater Gill-nets	"	15 - 70	10	1	
23	"	Pots	"	4 - 22			
				Total	632	69	6

Note: 1/ Corresponds with an uncircled number on Figure 2-2-11.

Table 2-2-9 <u>Fish Hauls by Location (July)</u>

Order No.[1/]	Dates of Setting and Lifting	Net Used	Location	Depth	Number of Hauls by Major Species		
				(m)	Kalb-samak	Samoos	Bolti
1	Jul. 19 - 20	Floating Gill nets	El Allaqi	35	13		
2	"	Bottom Gill-nets Trammel nets	"	5 - 35	0	0	0
3	Jul. 22 - 23	"	Abu Simbel	5 - 10	13	4	0
4	"	Floating Gill-nets	"	15 - 22	18	1	0
5	Jul. 23 - 24	Bottom Gill-nets Trammel nets	Tushka	15	71	10	0
6	"	Floating Gill-nets	"	25	12	4	0
7	Jul. 24 - 25	"	Tisobo	25 - 30	3	6	0
8	"	Bottom Gill-nets Trammel nets	"	5 - 7	9	17	10
9	Jul. 28 - 29	Floating Gill-nets	Aswan	25	26	1	0
				Total	165	43	10

Note: 1/ Corresponds with a circled number on Figure 2-2-11.

Table 2-2-10 Fish Hauls by Type of Nets and Mesh Size (January-February)

Fish Species	Mesh Size 5.0 cm	8.0 cm	12.0 cm	17.5 cm	Total
Floating Gill-nets (mono-filament nylon)					
Kalb-samak	129 (2.966)	333 (6.404)	23 (0.630)	0	485 (2.985)
Samoos	1 (0.023)	6 (0.115)	6 (0.164)	0	13 (0.080)
Bolti	0	0	0	1 (0.033)	1 (0.006)
Midwater Gill-nets (mono-filament nylon)					
Kalb-samak	8 (0.919)	26 (2.500)	0	0	34 (1.046)
Samoos	0	1 (0.096)	0	0	1 (0.031)
Bolti	0	0	0	0	0
Bottom Gill-nets (mono-filament nylon)					
Kalb-samak	33 (1.919)	11 (0.399)	2 (0.068)	0	46 (0.467)
Samoos	3 (0.174)	26 (0.942)	5 (0.171)	1 (0.041)	35 (0.356)
Bolti	0	0	0	1 (0.041)	1 (0.010)
Trammel Nets (mono-filament nylon)					
Kalb-samak					67 (2.449)
Samoos					20 (0.731)
Bolti					4 (0.146)

Note: Figures in parentheses indicate hauls per square meter of net per casting, but multiplied by 10^{-2}.

Table 2-2-11 Fish Hauls by Type of Nets and Mesh Size

(July)

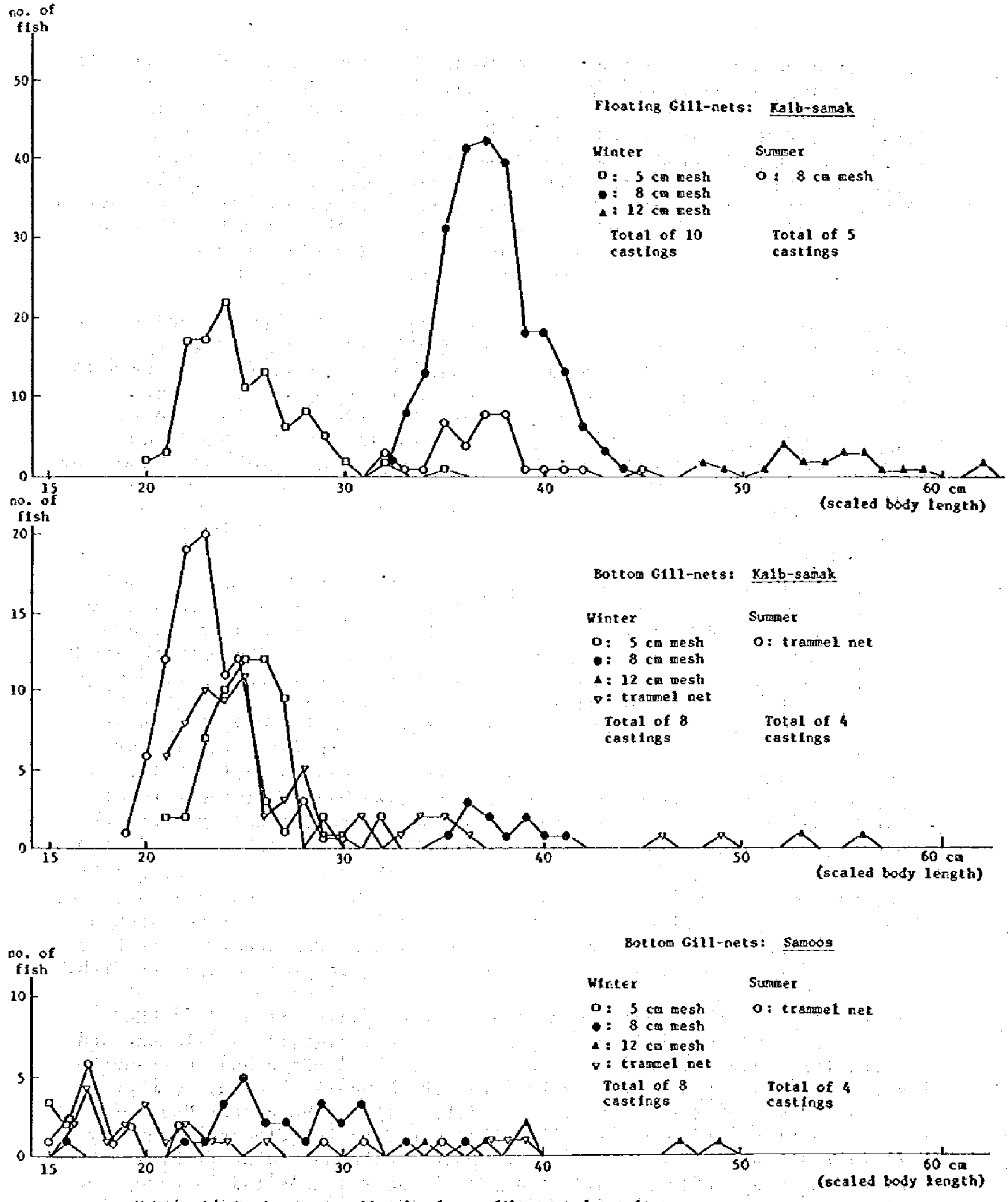
Fish Species	Mesh Size						
	Multi-filament Netting						Mono-filament Netting
Floating Gill-nets	5.0 cm	6.0 cm	7.0 cm	8.0 cm	10.0 cm	Total	
Kalb-samak	18 (2.400)	2 (0.267)	2 (0.267)	1 (0.133)	1 (0.133)	24 (0.640)	48 (1.846)
Samoos	0	0	0	0	0	0	9 (0.346)
Bolti	0	0	0	0	0	0	0
Trammel Nets	Inner Net Mesh Size (multi-filament nylon)1/						
	8.0 cm	12.0 cm	16.5 cm			Total	
Kalb-samak	1 (0.212)	0	0			1 (0.085)	
Samoos	6 (1.273)	6 (2.547)	1 (0.212)			13 (1.104)	
Bolti	4 (0.849)	2 (0.849)	4 (0.849)			10 (0.849)	
Trammel Nets	Inner Net Mesh Size (mono-filament nylon)2/						
		4.7 cm					
Kalb-samak		46 (5.044)					
Samoos		18 (1.974)					
Bolti		0					

Notes: 1/ The mesh size of the outer net is 39.0 cm.

2/ The mesh size of the outer net is 30.3 cm.

3/ Figures in parentheses indicate hauls per square meter of net per casting, but multiplied by 10^{-2}.

Figure 2-2-12 Catches by Mesh Size and Body Length



Notes: 1/ Used nets are all made of mono-filament nylon twines.
2/ Employed one strip for the floating and bottom gill-nets and three strips in the winter and two strips in the summer for the trammel net.
3/ The number of catches is adjusted by assuming the net width of 7.3 m.

The seasonal difference can be seen from the hauls by the floating gill-net of mono-filament netting with 8-cm mesh size. The average catch of kalb-samak per square meter of net was 6.404×10^{-2} for the winter and 1.846×10^{-2} for the summer (Tables 2-2-10 and 2-2-11). In other words, large-size fish have better hauls during the winter. Concerning mono-filament trammel nets, the average catch of this species was 2.449×10^{-2} for the winter and 5.044×10^{-2} for the summer. In contrast, the summer season has better hauls of small-size kalb-samak. As seen from Figure 2-2-12, the most frequent scaled body length was 23 - 25 cm in the winter and 22 - 23 cm in the summer.

With regard to samoos, hauls were larger by bottom gill-nets and trammel nets both in the winter and the summer (Tables 2-2-10 and 2-2-11), indicating the species' demersal inclination. According to the results of the mono-filament nets, the average catch per square meter per casting was 0.731×10^{-2} for the winter and 1.974×10^{-2} for the summer. The better hauls during the summer were also indicated by the mono-filament floating gill-net (8 cm mesh), e.g., 0.115×10^{-2} in the winter and 0.346×10^{-2} in the summer.

(c) Hauls by Mesh Size

Figure 2-2-12 shows catches of kalb-samak and samoos by mesh size and their distribution by scaled body length. The frequency by body length was adjusted by assuming the net width of 7.3 m. As seen from the figure, the mesh size of 8 cm had the largest total catch of kalb-samak among the floating gill-nets during the winter, with highest frequency occurring in the range of 36 - 38 cm in body length. The 5-cm mesh size had the highest frequency of catch in the scaled body length of about 24 cm, but the 12-cm mesh size had no discernible peak in frequency distribution. The 17.5-cm mesh size had no haul at all. Among the bottom gill-nets, the 5-cm mesh size had the largest total catch, and the hauls by the other sizes were very small. The trammel net was relatively wide-ranged in terms of the body length distribution of its catches. During the summer survey, the 8-cm-mesh floating gill-net had the highest frequency of catch in the body length of 35 - 38 cm, which corresponds with the results of the winter survey. The catches by the mono-filament trammel net had the highest frequency in the body length of 22 - 33 cm, and the summer on the whole yielded smaller fish.

As already mentioned, the 8-cm-mesh floating gill-nets used in the summer were of two different types of netting, e.g., mono-filament and multi-filament. As shown in Table 2-2-11, the average haul per square meter per casting was 1.846×10^{-2} for the mono-filament nylon type and 0.133×10^{-2} for multi-filament nylon type. The better haul of the mono-filament twines is probably due to its relative transparency (lesser visibility to the prey) and better hold on caught fish. Although superior in catching fish, the mono-filament twines have some disadvantages. The hard mono-filament twine makes the net bulky off the water and its handling on a small fishing boat is more hazardous. It is also apt to damage caught fish. Moreover, its superior effectiveness will have to be examined carefully from the viewpoint of fishery resource management.