At present, pellets for trout and Tilapia are produced by a livestock feed company. The prices of pellets are 550-630 Kshs/70 kg for trout feed and 254.4 Kshs/70 kg for Tilapia pellet feed. Those pellets, however, are not very satisfactory in quality, and there is no organization or institution responsible for examining the quality and economy of artificial fish feeds in Kenya.

(4) Demand/supply balance

The potential demand for fish from the Region is 110,000 tons per year in 2005 as estimated above, including both regional and export demand. The yield from the lake seems most likely at 70,000 tons per year on sustainable basis as also determined above. The balance would have to be met by much increased production from aquaculture or import from other regions or both.

Increasing imports from other regions is not practical nor desirable. The yield from other lakes in the country, typically Turkana lake, is not very high, and importing sea fish would be costly. Besides, some export of fish from the Region is expected to meet the growing demand. The only way remaining is thus aquaculture.

In order to produce 40,000 tons, the balance between the total demand and the yield from the Lake, some 8,000 ha of water area, would be required, even if the highest productivity is assumed. Although by adopting the feeding culture method, irrigation canals and reservoirs as well as rivers can be used for aquaculture, the total area would be around 2,500 ha at maximum. Practically only less than half of this area can be actually used for the purpose. Besides, the production of 40,000 tons fish entirely by the feeding culture would require some 80,000 tons of good quality feed, which is difficult to obtain (Chapter 3, Report on Preparatory Study).

It is expected at best that some 18,000 tons of fish can be produced in 2005 by various forms of aquaculture in the Region as summarized below.

1) Irrigation canals and reservoirs: 1,000 ha, 5,000 tons (5 tons/ha)
2) Fish farms, inland: 500 ha, 2,500 tons (5 tons/ha)
3) Fish farms associated with fishery centers on the Lake shore: 1,000 ha, 8,000 tons (8 tons/ha)
   (see Section 3.4)
4) Backyard fish ponds by individual farmers 10,000 families (about 0.3% of total number of families in the Region) x 0.1 ha : 1,000 ha, 2,500 tons (2.5 tons/ha)

Thus the total fish production in the Region will be about 88,000 tons per year by 2005. This implies that about 80% of the potential demand may be satisfied. The expected demand and supply of fish in the year 2005 are illustrated in Figure 3.7.

3.3 Fisheries Development Plan

3.3.1 Objectives and strategy

(1) Objectives

Based on the examination of present conditions and demand/supply prospects, the following objectives are set for the fisheries development in the Region.

1) To meet fish protein requirement in the Region for better-balanced diet of the people;
2) To increase the value of fish in order to increase incomes of the fishermen; and
3) To satisfy increasing demand for fish export in order to contribute to the Region's development.

(2) Basic strategy

First, in order to meet the fish protein requirement in the Region, the demand/supply of fish has to be balanced to the extent possible. For this, aquaculture has to be much developed, in addition to sustaining the yield from the Lake.

Second, to increase the value of fish, the present situation of over-supply of fish around the Lake and lower prices of smoked and dried fish have to be rectified. Third, to warrant the export of fish to outer regions, marketing channels have to be improved.

Thus, the basic strategy for fisheries development in the Region is drawn out as follows:

1) To encourage aquaculture, especially with artificial fish feed;
2) To improve infrastructure necessary for expanding the markets for fish, such as transportation infrastructure, processing and cold storage facilities; and
3) To provide supporting services for marketing and pricing of fish, training and research especially related to aquaculture and processing, and credit facilities for fishermen.

3.3.2 Measures

(1) General

As described in Section 3.2, the major problem in fishery around the Lake is that as compared with the current fish production, storage, processing and transport facilities are not sufficient so that the over-supply tends to cause the fish prices to be suppressed and/or post harvest loss to increase.

In order to alleviate the problem, ice plants and cold stores should be provided at least in major fish landing areas, access roads serving fishery towns be improved, and processing factories be established. Especially filleting plants will be effective, as they will not only increase the value of fish, but also enable full utilization of fish resources by producing fish

meal and fish oil as by-products. These facilities may be more effectively located in a few selected fishery centers for systematic processing, marketing and other related activities.

In order to much increase fish production by aquaculture, high quality fish feed is indispensable. Usually protein content of some 30% is required, but the products from existing feed mills do not satisfy this condition. The provision of artificial fish feeds at reasonable prices will certainly stimulate the aquaculture by the local people.

(2) Projects

The general measured described above can be most effectively enforced by implementing them in a consistent and coherent way. For this purpose, development projects can be formulated as sets of mutually inter-related component projects. Thus the following two projects are presented:

1) Fishery complex project; and
2) Fishing town access improvement project.

Each of them will be described below.

Fishery complex project

The need for cold storage and processing as well as aquaculture can be most effectively met by providing a set of facilities at selected strategic locations (i.e. fishery centers), and connecting other fishing towns by a network of improved access roads. The fishery complex project will establish such fishery centers along the Lake shore, where marketing and research/training facilities, ice plants and cold stores will be provided to support both Lake fishery and aquaculture. Fishing ports may be upgraded, if necessary, and processing plants for fish meals and fillets will also be established at selected centers.

The research/training facilities may be combined with the operation of fish ponds, some of which may also serve for fingerlings production. Artificial feed plants will be established not only for these demonstration ponds but also for encouraging various forms of fish culture by individual farmers.

A typical arrangement of a fishery center will be as follows:

- Ice plant :	1 ton/day, 4 units
- Chillroom :	10 ton capacity
- Demonstration fish farm :	100 ha in total pond area
- Fish meals and fillet plant :	10 tons of fresh fish processed per day
- Research/training center :	1 manager, 3-6 staff members
- Artificial feed plant :	3 tons/hour production capacity

The fish meals and fillet plant of the capacity above would produce about 300 tons of fish meal per year. This can be combined with meat and bone meals of some 700 tons and mixed with agricultural residues in quantity about four times the total amount of the animal

wastes to produce about 5,000 tons per year of feed having about 30% protein content. The quality of feed is high enough to be applied directly to fish farming. It can also be used as high quality feed supplement to livestock. This possibility is further pursued in the preparatory study of animal feed industry project (Chapter 3, Report on Preparatory Study).

By the year 2005, six to ten such centers should be established. Candidate sites include Usenge and Asembo in Siaya district, Kisumu, and Kendu Bay, Homa Bay, Mbita and Karungu in South Nyanza district.

Of the total fish production by aquaculture, about 15,000 tons will be produced by the feeding culture and the remaining 3,000 tons by the manure culture. Some 30,000 tons of high quality artificial feed required for the feeding culture can be supplied from the animal feed industry project to be established, associated with the fishery centers (Chapter 3, Report on Preparatory Study).

Fishing town access improvement project

Smaller fishery towns/villages will be inter-connected with the centers by an improved network of access roads, to be complemented by boat services on th Lake where they are found more economical. A study should be conducted to find out which of all the class D or E roads should be improved, and which towns/villages would better be served by the boat services.

The following class C roads should also be improved in stages (Section 8.4, Sector Report).

- C 28 (Asembo - C 27 junction)
- C 26 (Oyugis - Kendu Bay)
- C 19 (Katito - Kendu Bay -Homa Bay - Mbita)

(3) Institutional measures

In order to further promote the fishery in the Region, reorganization and consolidation of fishermen's cooperatives will be essential for the following purposes.

1) To secure and maintain proper marketing channels;
2) To negotiate with traders from outside the Region and to offer stable and reasonable prices to fishermen for both fresh and processed fish;
3) To provide and manage improved facilities such as cold stores, workshops and processing plants; and
4) To provide credit facilities for fishermen and/or to make arrangements for such.

Existing 35 fishermen's cooperatives should be reorganized into a few consolidated ones so that these functions can be effectively fulfilled.

In association with the fishery centers, the following measures should be taken by LBDA in cooperation with the cooperatives.

1) More systematic study efforts on ecological aspect of Lake fishery with the view to sustaining fish resources;
2) Encouragement of commercial establishment and operation of fish farms with the development of artificial feed industry; and
3) Training of manpower for such fields as fish farming, artificial feed production and factory processing of fish.

Training courses may be established at Youth Polytechnic for the new technology, and joint programmes may be organized with the LBDA/fishermen's cooperative operated fishery centers.

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Table 3.1 Fish Catch by Year in Kenya

(Unit: metric ton)

	1974	1981	1982	1983	1984	1985
L.Victoria	17,175	38,179	60,958	77,327	71,854	88,589
L.Turkana	5,731	10,529	11,040	10,113	8,448	7,460
L. Baringo	122		401	352	297	653
L. Naivasha	39		411	692	320	245
Other Lakes	572	2,677#	499	473	398	96
Rivers	1,526		*268	*1,526	*2,172	*1,972
Fish Ponds			440	584	711	1,085
Total	25,165	51,385	74,017	91,068	84,200	99,764
Marine Products	3,416	5,967	7,116	5,798	6,069	5,777
Crustaceans				404	607	274
Total	3,416	5,967	7,116	6,202	6,676	6,051
Grand Total	28,581	57,352	81,133	97,270	90,876	105,815

Notes: #Total of other Lakes, Rivers and Ponds
* Other Areas

Source: Fisheries Statistical Tables,Kenya

Table 3.2 Annual Catch by Species from Lake Victoria and Percentage Composition

(a) Annual catches

(Unit: metric tons)

Species	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Alestes spp	1	14	2		35	23		4	2	4	1	
Bagrus spp	1,103	1,389	1,025	1,141	1,396	1,769	642	430	2,532	1,243	88	61
Barbus spp	127	283	182	183	199	417	421	292	682	100	53	113
Clarias spp	2,211	2,584	2,507	1,755	1,729	3,029	1,223	1,003	2,062	895	780	547
Engraulicypris spp	3,742	4,548	5,652	6,704	8,710	9,321	9,443	7,635	10,419	16,444	19,437	25,866
Haplochromis spp	6,013	4,620	6,368	5,378	6,621	6,599	3,636	916	2,546	612	41	6
Labeo spp	59	108	123	936	148	443	482	112	918	81	58	
Mormyrus spp	89	58	89	102	102	359	333	208	2,678	218	89	49
Nile Perch (Lates)	136	51	97	203	1,066	4,286	4,310	22,834	33,134	52,377	41,319	50,029
Protopterus	2,179	1,469	935	773	612	472	370	187	239	108	81	150
Shilbe spp	31	54	57	129	120	320	117	49	78	22	3	5
Syndontis spp	196	126	191	310	155	482	388	127	232	47	75	
T. esculenta	57	28	49	42	180	94	90	139	399	108	99	42
T. nilotica	411	202	421	465	972	962	1,184	1,858	2,581	2,516	6,136	7,573
Other tilapia	488	412	537	928	1,454	1,683	3,739	1,900	1,495	1,658	1,243	1,827
Mixed small fish	332	635	445	280	327	333	536	483	961	894	2,351	2,321
Total	17,175	16,581	18,680	19,329	23,826	30,592	26,914	38,177	60,958	77,327	71,854	88,589

(b) Percentage composition

Species	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Alestes spp	0.0	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Bagrus spp	6.4	8.4	5.5	5.9	5.9	5.8	2.4	1.1	4.2	1.6	0.1	0.1
Barbus spp	0.7	1.7	1.0	0.9	0.8	1.4	1.6	0.7	0.7	1.2	0.1	0.1
Clarias spp	12.9	15.6	13.4	9.1	7.3	9.9	4.5	2.6	3.4	1.5	1.1	0.6
Engraulicypris spp	21.8	27.4	30.3	34.7	36.5	30.5	35.1	20.0	16.6	21.3	27.0	29.2
Haplochromis spp	35.0	27.9	34.1	27.8	30.5	21.6	13.5	2.4	4.2	0.8	0.1	0.0
Labeo spp	0.3	0.7	0.7	4.8	0.6	1.4	1.8	0.3	1.5	0.1	0.1	0.1
Mormyrus spp	0.5	0.3	0.5	0.5	0.6	1.2	1.2	0.5	4.6	0.3	0.1	0.1
Nile Perch(Lates)	0.8	0.3	0.5	1.1	4.5	14.0	16.0	59.8	54.3	67.7	57.5	56.5
Protopterus	12.7	8.9	5.0	4.0	2.6	1.5	1.4	0.5	0.4	0.1	0.2	0.2
Shilbe spp	0.2	0.3	0.3	0.7	0.5	1.1	0.4	0.1	0.1	0.0	0.0	0.0
Syndontis spp	1.1	0.8	1.0	1.6	1.4	0.3	0.4	0.3	0.4	0.1	0.1	0.0
T. esculenta	0.3	0.2	0.3	0.2	0.8	0.3	0.3	0.3	0.7	0.1	0.1	0.0
T. nilotica	2.4	1.2	2.3	2.4	4.1	3.1	4.4	4.9	4.2	3.3	8.5	8.5
Other tilapia	2.8	2.5	2.9	4.8	6.1	5.5	13.9	4.9	2.5	2.1	1.7	2.1
Mixed small fish	1.9	3.8	2.4	1.4	1.4	1.1	2.0	1.1	1.5	1.2	3.2	2.6
Total	100	100	100	100	100	100	100	100	100	100	100	100

Source: Fisheries Statistical Bulletin-Kenya

Table 3.3 Beach Value and Consumer Prices of Fish by Main Species

(a) Beach value by main species in 1985

Species	Ksh/Kg
Tilapia esculenta	6.5
Tilapia nilotica	6.4
Nile perch	1.8
Other Tilapia	5.0
Engrulicypris	1.4

Average Value	Ksh/Kg
Fresh Fish	3.0
Processed Fish	1.6

(b) Consumer's prices

Place	Date	Species	Forms	Price (Ksh/Kg)
Kisumu City Market	28/Jun./1986	Tilapia	Fresh, Whole	18.0-20.0
		Tilapia	Smoked	14.0*
		Engrulicypris	Dried	9.0*
Nairobi City Market & Shops	7/Jun./1986	Tilapia	Fresh,Whole	25.0
		Tilapia	Fillet,Frozen	45.0-66.0
		Nile Perch	Fresh without head and guts	20.0-25.0
		Nile Perch	Fresh,Fillet	30.0
		Nile Perch	Frozen, Fillet	36.0
		Black Bass	Fresh,Whole	30.0
		Rainbow Trout	Fresh,whole	100.0

Note: * Value in 1984

Table 3.4 Status of Fish Ponds in LBDA Region

Location	Number of Pond	Total Area (square meters)	Average Area (square meters)	Average Crop (tons/ha)
Kisumu	164	30,601	187	
South Nyanza	420	56,432	134	
Siaya	253	41,538	164	
Kisii	2,227	169,149	76	
Nyanza Province (Sub-total)	3,064	297,720	97	1.6
Kakamega	913	156,578	171	
Bungoma	502	85,275	169	
Busia	363	47,971	132	
Western Province (Sub-total)	1,778	289,824	163	0.7
Lake Basin (Total)	4,842	587,544	121	1.2

Source: LBDA/0.8/4/2 1986

Table 3.5 Fish Catch Per Canoe and Per Fisherman in Lake Victoria

Year	Annual Catch (tons)	Number of Canoes	Catch per Canoe(tons)	Number of Fishermen	Catch per Fisherman (tons)
1971	14,918	*4,320	3.453	*16,900	0.256
1972	15,989				
1973	16,797				
1974	17,175	3,400	5.051		
1975	16,581	3,400	4.877		
1976	18,680	3,920	4.765	18,000	1.038
1977	19,332	3,920	4.932		
1978	23,856	4,000	5.964		
1979	30,592	4,000	7.648		
1980	26,914	4,000	6.728	18,000	1.495
1981	45,667	5,000	9.133	19,500	2.342
		**8,500	5.373	**31,000	1.473

Notes: * Survey by Butcher and Colaris (1975)
** Nordic Survey by Hansen (1981)

Source: Coche and Balarin,1982

Table 3.6 Exotic Fish Species Introduced into Kenya

Species	Date	Place	Origin
Lates niloticus	1959/62	Luwala Dam and L. Victoria	Uganda(L.Alverto)
Salmo trutta	1921	Highlands Streams	United Kingdom
Salmo gairdneri	1910	Mt. Kenya	South Africa
Cyprinus carpio*	1969	Sagana Station	
Common Carp			Japan
Mirror Carp			Israel(via Uganda)
Ctenopharyngodon idella	1969	Sagana Station	Japan
Micropterus salmoides	1929	L. Naivasha	U.S.A.
Tucanare ocellaris	1974*	Segana Station	U.S.A.(Hawaii)
Macrobrachium rosenbergii	1981	Bamburi Farm	Mauritius
T. aurea	1977/78	Bamburi Farm	Israel
T. galilaea	1978	Bamburi Farm	Israel
T. andersonii	1980	Bamburi Farm	Botsuwana
T. macrochir	1980	Bamburi Farm	Botsuwana

Note: collected by auther
Source: A.G.Coche and J.D.Balarin,1982

Table 3.7 Agricultural By-products and Food Ingredients for Tilapia

Item	Availability	Quantity (kg)	Price (Ksh.)	Price (Ksh/kg)	% Crude Protein	Remarks
Maize meal	++	24	76.4	3.18	12	For human consumption
Maize germ	++	50	43	0.86	12	Used for oil
Extr. maize germ	++	50	40	0.8	12.5	18% oil
High prot. maize germ cake	-	-	-	0.82	15	Limited available from CPC
Maize bran	++	70	42	0.6	8	
Wheat flour	++	90	412.35	4.58	14	For human consumption
Wheat bran	++	45	39.5	0.87	17	In high demand
Wheat pollard	+	70	63.7	0.91	16	In high demand
Fine wheatbran	+/-	50	36.6	0.73		Only in Nairobi
Broad bran	-	25	36.6	1.46		Only in Nairobi
Wheat germ I	+/-	35	66.25	1.86		
Wheat germ II	+/-	70	119.5	1.71		
Crushed wheat	+/-	90	317.6	3.53	14	
Cond. wheat		90	236.1	2.62		
Chick wheat		90	66.3	0.74		Broken wheat
Beans mixed	+	90	150	1.67	25	For human consumption
Rice bran	Produced but not commercially available yet					
Sunflower seed	++	40	65	1.63	40	
Sunflower oil cake	++	1000	2450	2.45	32	
Groundnut cake	-	1000	2100	2.1	40	Problems with aflatoxins
Rape seed cake	+	1000	1800	1.8	34	Contains glucosides toxic to fish in high quantities
Cotton seed cake	+/-	75	150	2	30-40	From Uganda
Fish meal						
Danish herring	+	45	450	10	69-72	Imported
Indian	+	45	461.7	10.26	52-60	Imported
Blood meal	-	38	304	8	78-84	From KMC
Meat and bonetary meal	+/-	50	325	6.5	43-52	From KMC
Soy-bean meal	-	-	-	6.7	45	Imported from India
Brewers yeast	++	40	120	3	42	Powder(16% moisture)
Fodder yeast	++					From AFC Muhoroni
Brewers waste	++	1000	40	0.04		Wet(20% moisture)
Premix vitamins and minerals	++			70.3		Imported

Notes: ++=readily, += good, +/-= reasonable, -= poor
Source: Nobert Zonneveld,1985

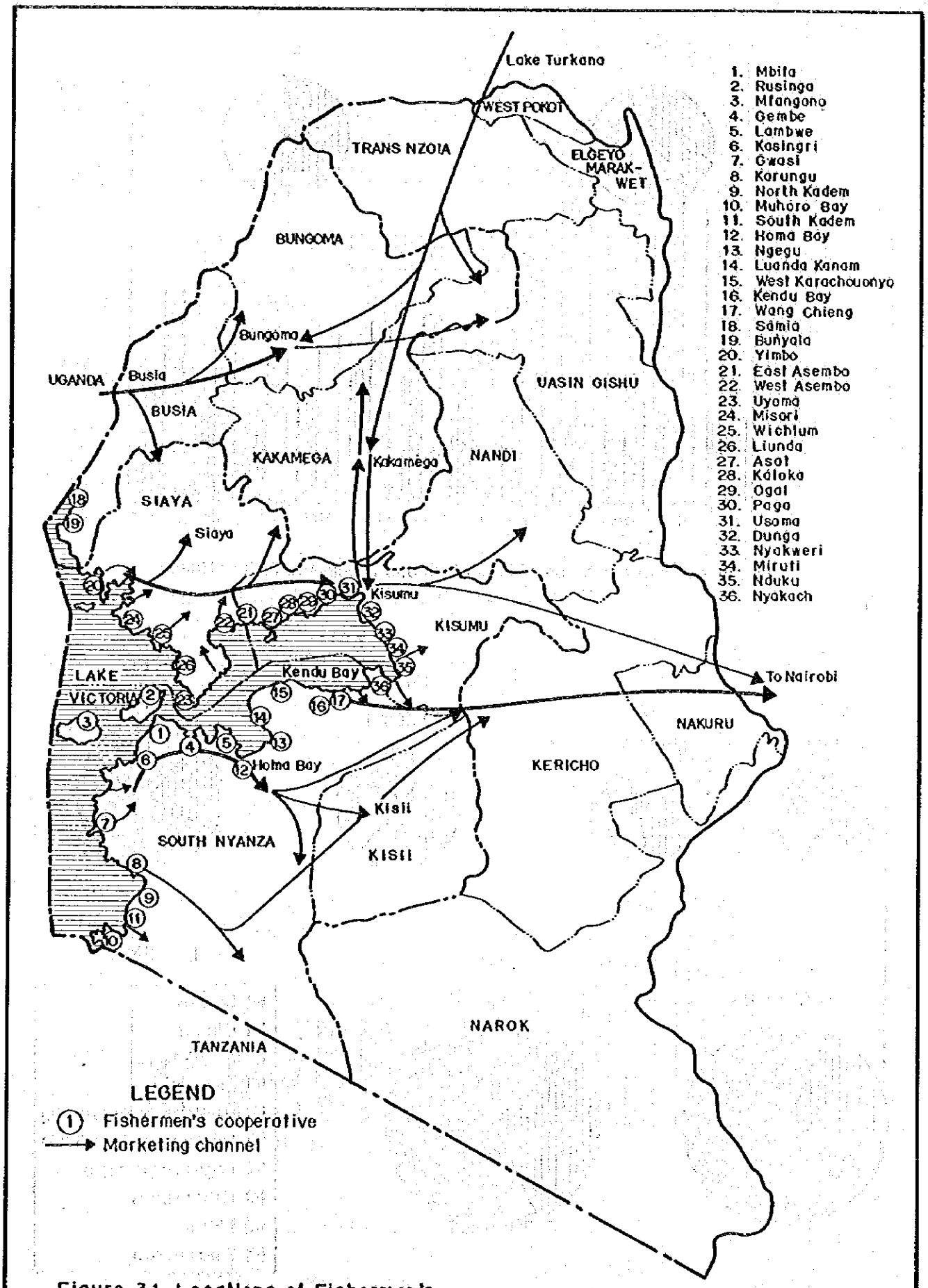

Figure 3.1 Locations of Fishermen's Cooperatives and Main Marketing Channels of Fish

REPUBLIC OF KENYA LAKE BASIN DEVELOPMENT AUTHORITY
THE STUDY OF INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE LAKE BASIN DEVELOPMENT AREA
JAPAN INTERNATIONAL COOPERATION AGENCY

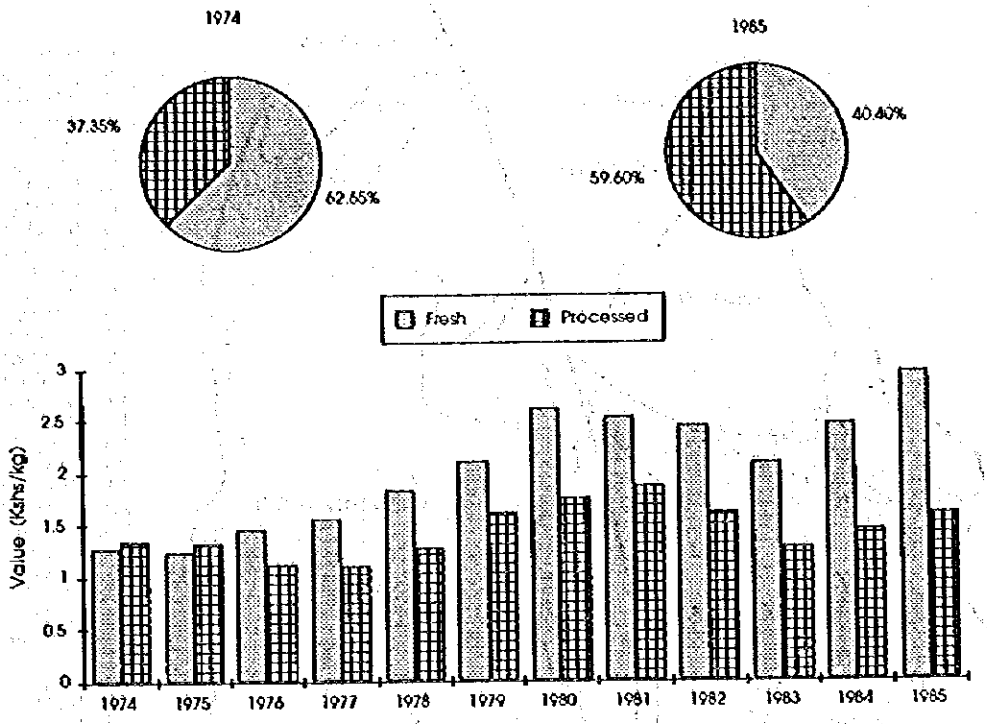

Figure 3.2 Average Value of Fresh Fish and Processed Fish at Beach

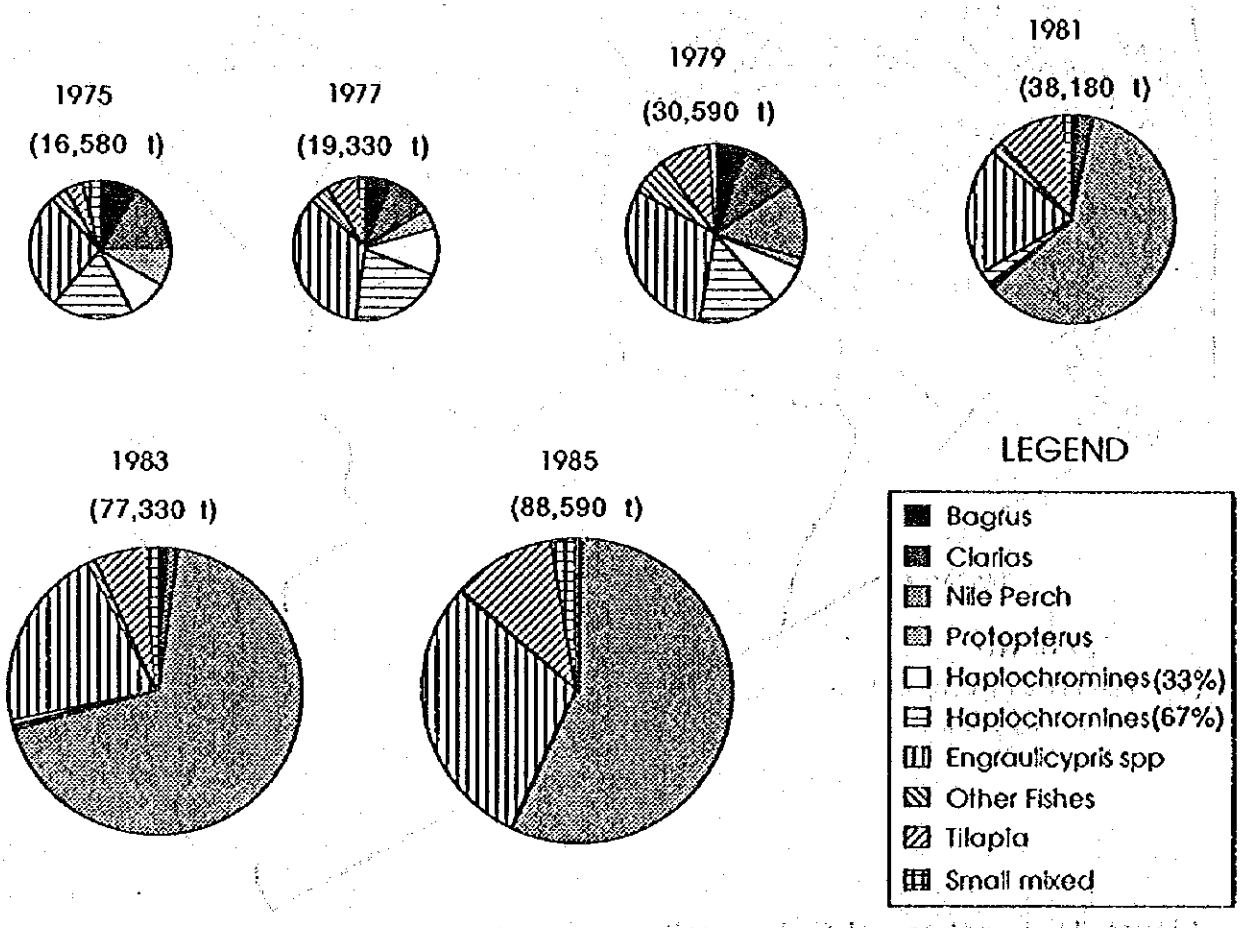

Figure 3.3 Annual Change of Catches by Spieces and Shares between Predators and Non-predators

REPUBLIC OF KENYA LAKE BASIN DEVELOPMENT AUTHORITY
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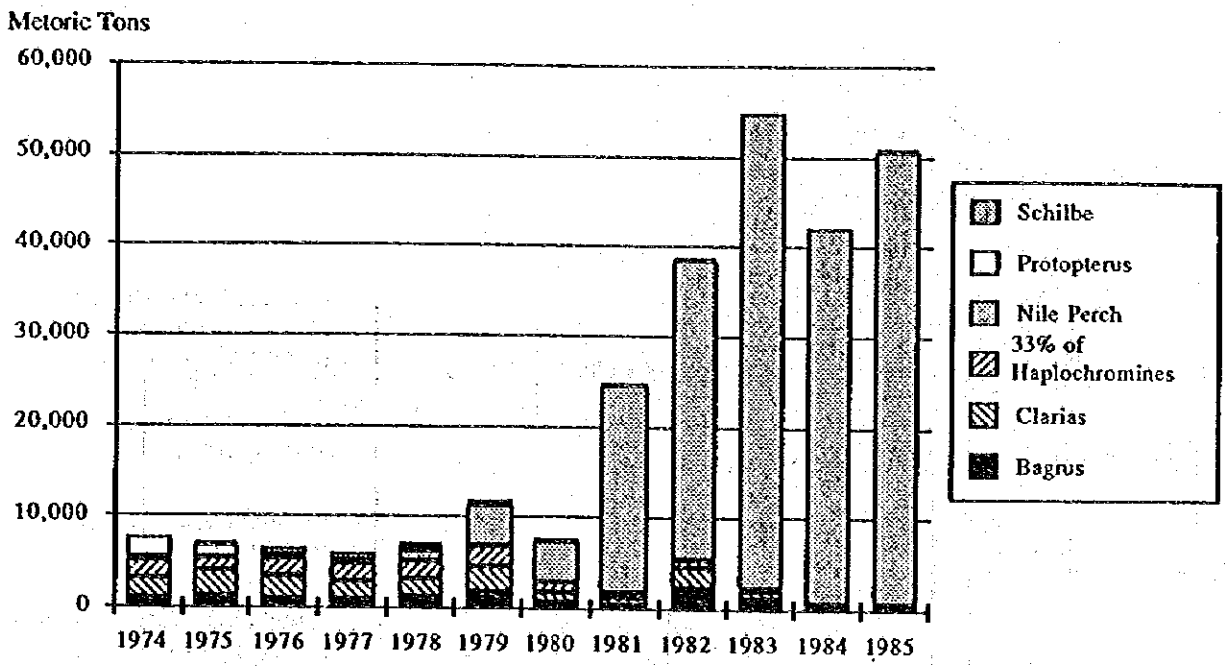

Figure 3.4 Change of Annual Catches by Preditors

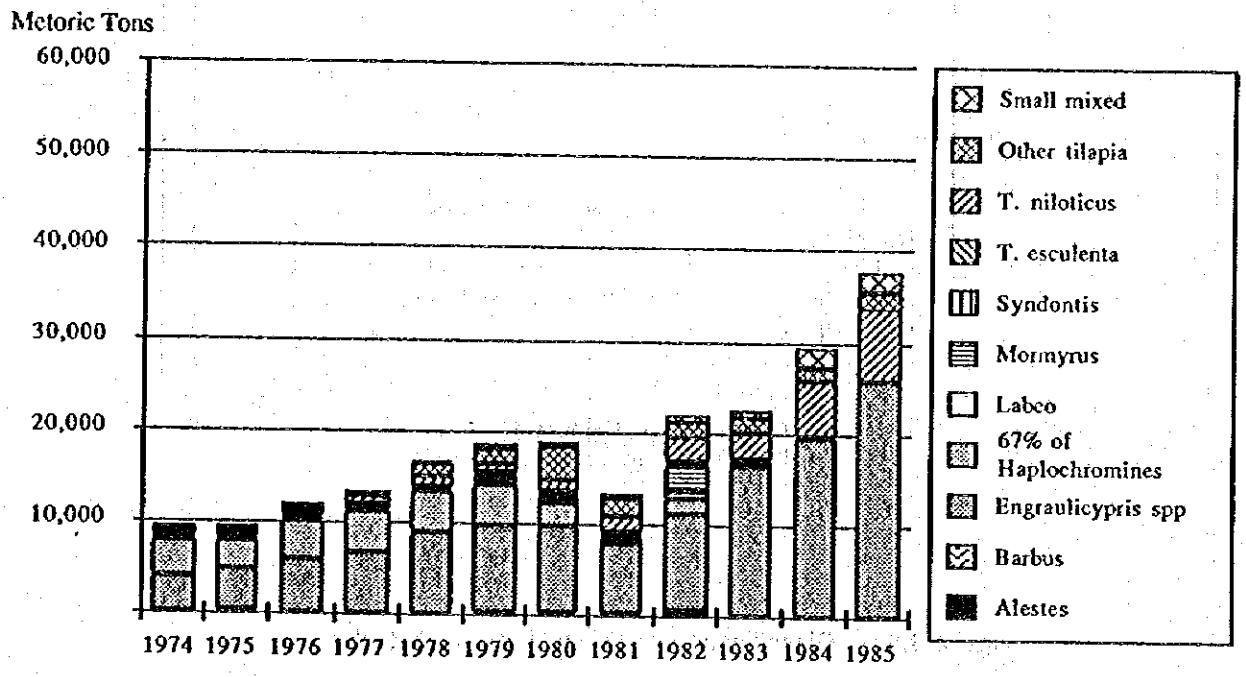

Figure 3.5 Change of Annual Catches by Non-Preditors

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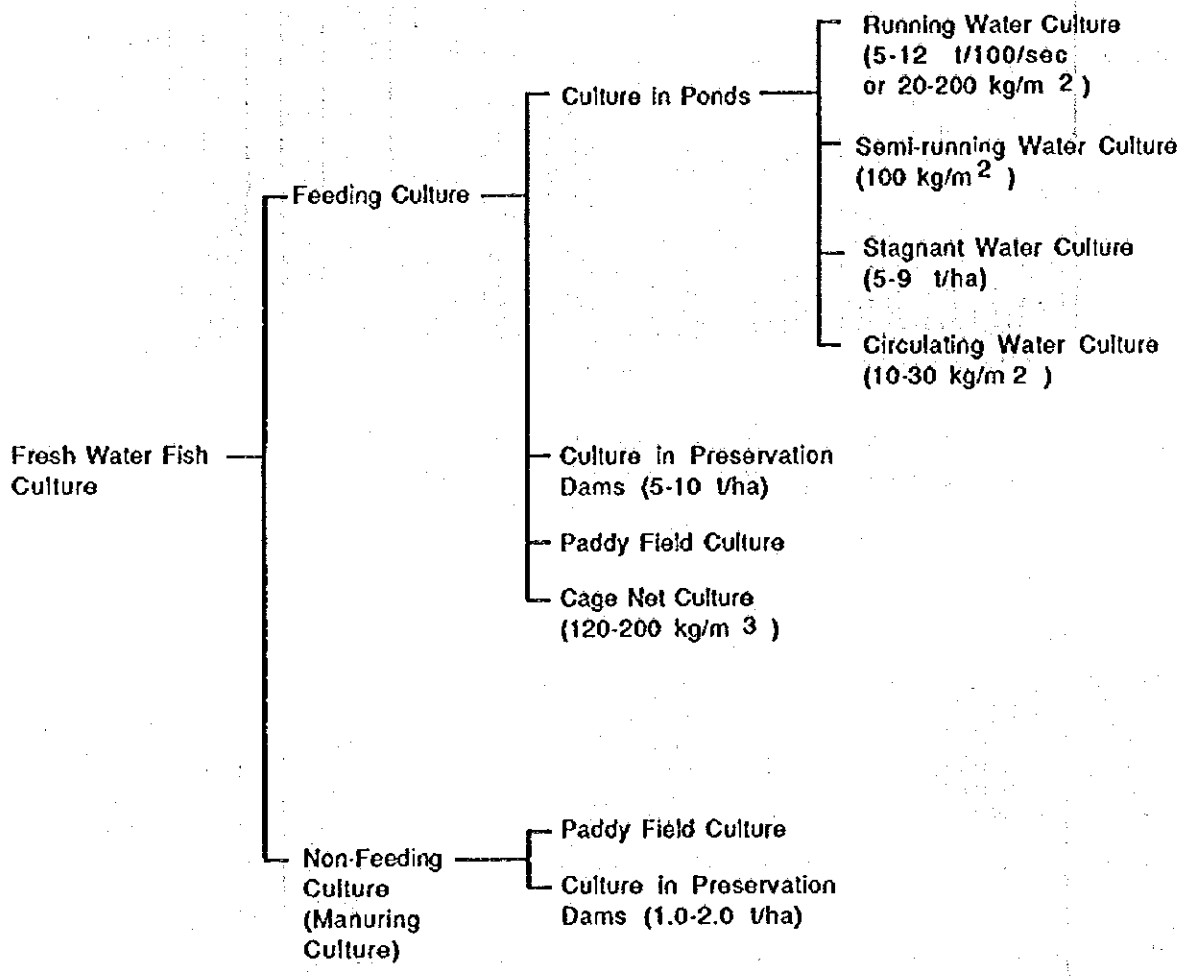

Notes: Adopted from Nomura 1982
Productivity in parentheses

Figure 3.6 Classification of Fresh Water Fish Culture

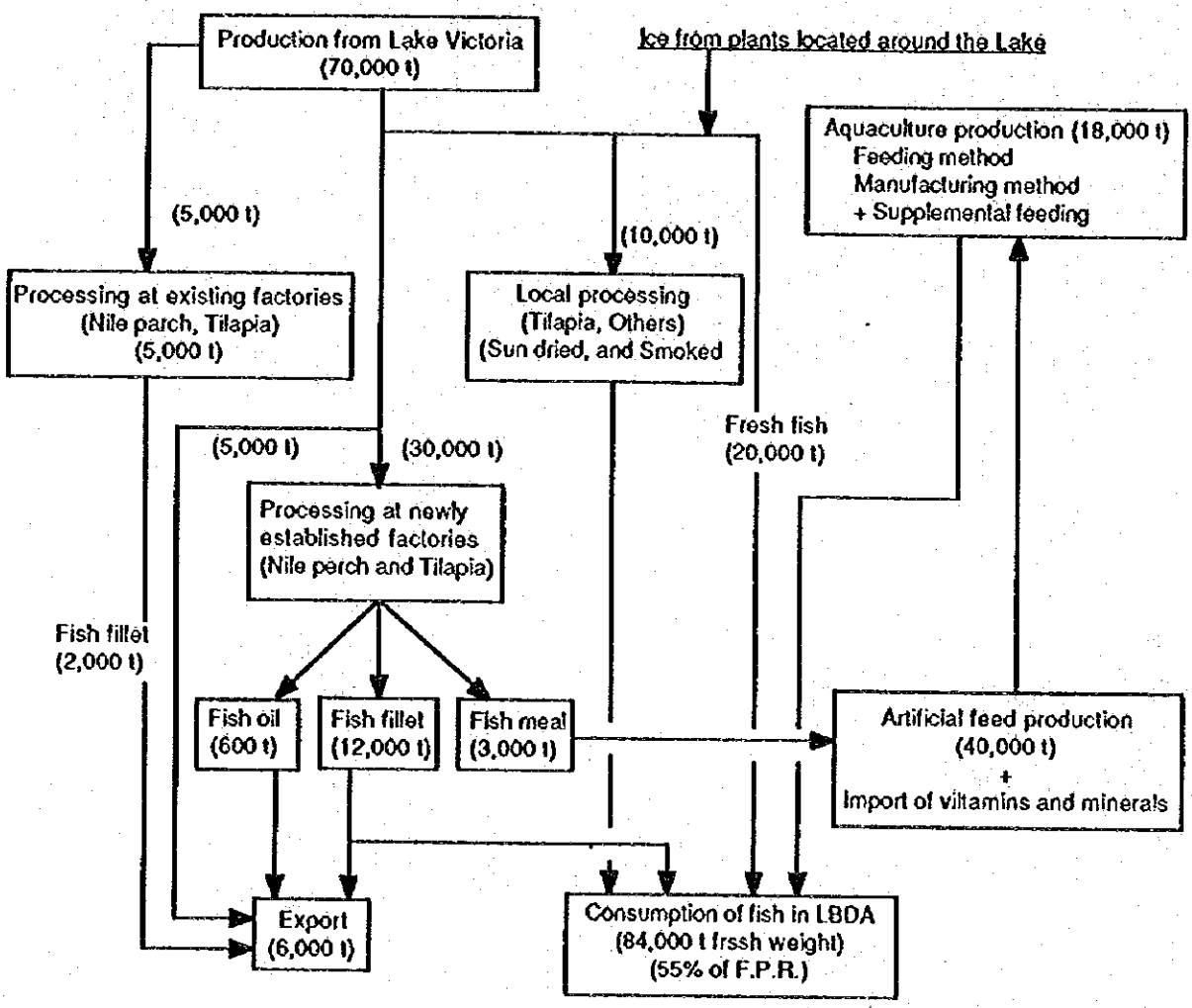

Figure 3.7 Flow of Fish in 2005

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