

# Coastal Fisheries and

# Brackishwater Aquaculture in Sri Lanka

- PN-ABT-073 ISSN 91069 -



Leslie Joseph

**This report is published by the Coastal Resources management Project (CRMP) of the University of Rhode Island as part of its cooperative agreement with the United States Agency for International Development (USAID) Office of Environment and Natural Resources, Bureau of Research and Development. Additional assistance has been provided for editing by the CRMP of the Natural Resources and Environmental Policy Project (NAREPP) of USAID, Sri Lanka.**

PN-ABT-073  
ISBN 91069

*Coastal Fisheries  
and  
Brackishwater Aquaculture  
in Sri Lanka*

*Leslie Joseph*

Coastal Resources Management Project of  
The University of Rhode Island,  
The Government of Sri Lanka,  
United States Agency for International Development.  
1993

A

**Coastal Fisheries and Brackishwater Aquaculture  
in Sri Lanka**

**Leslie Joseph**

**1993**

Published by the Coastal Resources Management Project of the University of Rhode Island

Funding for the preparation and printing of this document was provided by the United States Agency for International Development (USAID) Office of Environment and Natural Resources, Bureau for Research and Development with The University of Rhode Island Coastal Resources Center. Additional Assistance for editing was provided by the Coastal Element of the Natural Resources Environmental Policy Project (NAREPP) of USAID Sri Lanka.

Printed in Colombo, Sri Lanka.

Joseph, Leslie 1993. Coastal Fisheries and Brackishwater Aquaculture in Sri Lanka. Coastal Resources Management Project, Colombo, Sri Lanka, 46 p.

Cover Photo: Fisherman in Hambantota, A. White

All Rights Reserved

Printed at the State Printing Corporation. (93166)

B

**COASTAL FISHERIES  
AND  
BRACKISHWATER AQUACULTURE**

**CONTENTS**

	<i>Page</i>
1. Introduction .. .. .	01
2. Fishing Population .. .. .	03
3. Fish Production and Resources .. .. .	06
3.1 Fish Production from the Sea .. .. .	06
3.2 Fish Production from the Lagoons and Estuaries .. .. .	13
3.3 Marine Fisheries Resources around Sri Lanka .. .. .	13
4. Fishing Fleet .. .. .	15
4.1 Marine Fishing Fleet .. .. .	15
4.2 Lagoon Craft .. .. .	23
4.3 Fishing without Craft .. .. .	24
4.4 Cost of Fishing .. .. .	25
5. Imports, Exports and Supply Situation .. .. .	27
6. Brackishwater Aquaculture .. .. .	31
7. Non-Fish Aquatic Resources Exploited from the Coastal Zone .. .. .	36
7.1 Shrimp Capture Fishery .. .. .	36
7.2 Lobster Fishery .. .. .	37
7.3 Squid/Cuttlefish .. .. .	37
7.4 Bivalve Resources .. .. .	37
7.5 Sea-Weeds .. .. .	39
7.6 Brine Shrimp (Artemia) .. .. .	40
7.7 Beche-de-Mer .. .. .	40
7.8 Chank Fishery .. .. .	41
8. Conclusions .. .. .	43
9. References .. .. .	44

C

# REPORT ON COASTAL FISHERIES AND BRACKISHWATER AQUACULTURE

## 1. INTRODUCTION

Situated between latitudes 6 and 10 North and longitudes 80 and 82 East in the Indian Ocean, the 65,600 sq. km. island of Sri Lanka has a coastline of approximately 1700 km. The continental shelf around it is narrow, averaging 25 km. in width and rarely exceeding 45 km; its total area is 28,000 sq. km. Sri Lanka enjoys jurisdiction over 400,000 sq. km. of sea and its resources. There are also brackishwater lagoons, estuaries, mangrove swamps and inland freshwater reservoirs important for both capture and culture fisheries.

Although Sri Lanka has a tradition in fishing dating back several centuries, the development of fisheries in the country has been a slow and gradual process, with little state assistance until recent times. Around the 1920's state assistance was directed mainly towards revenue generating fisheries such as those for pearls, chank and window pane oyster. With the discovery of the Wadge Bank trawling grounds in the mid 1920's, the Government became actively involved in the development of trawl fisheries during the 1930-1960 period. The setting up of a Fisheries Research Station and the enactment of the Fisheries Ordinance were major events during the 1930-1940 era. From about the mid-fifties, the Government assumed a more active role in general fisheries development through the promotion of motorization of traditional craft and the introduction of new types of fishing craft and nets. These developments led to a rapid increase in fish production until the mid-sixties. The rate of development was slower during the period 1965-1977, owing to insufficient replacement of fishing craft, and shortage of fishing nets and engine spare parts caused by import restrictions. This period saw the setting up of a separate Ministry of Fisheries and the establishment of the Ceylon Fisheries Corporation (C.F.C.), the Ceylon Fishery Harbours Corporation (C.F.H.C.), a Fisheries Training Institute, a Fish Technology Institute and District Fisheries Extension Offices (D.F.E.Os) (Fig. 1).

The fisheries sector experienced high growth during the 1977-1983 period, in response to heavy capital inputs (mainly from the Government), liberalization of imports of essential inputs, rapidly growing consumer demand for fresh fish etc. While fish production increased by 8.4 percent during this period, the growth of fisheries GDP (8.8%) was higher than the overall economic growth rate (5.7%) and growth in the agricultural sector (4.7%). The share of fisheries in GDP increased from 1.4 percent in 1977 to 2.1 percent in 1988 (Table 1).

Fish is the most important source of protein in the country, contributing approximately 60 percent of the animal protein intake and about 15 percent of the total protein consumption (FAO Food Balance Sheet 1990). Consumption of fish meets with few or no religious or cultural taboos, unlike other animal products. Domestic fish production has always been insufficient to meet local demand, resulting in substantial import requirements. The strong growth in local production and the removal of restrictions on imports have led to an increase in per capita consumption of fish from 10.5 kg. in 1977 to 18.1 kg. in 1988. The trends in fish supply and per capita consumption from 1977 to 1989 are shown in Table 2.

Government capital expenditure on fisheries increased from Rs. 36 million in 1977 to Rs. 266 million in 1980. It has varied thereafter between Rs. 110 million and Rs. 160 million at current prices. Fisheries capital expenditure as a percentage of fisheries GDP increased sharply from 5 percent in 1977 to 24 percent in 1980, thereafter declining to 4 percent in 1986 (Table 3).

# DISTRICT FISHERIES EXTENSION OFFICES

## References

District Fisheries Extension Offices

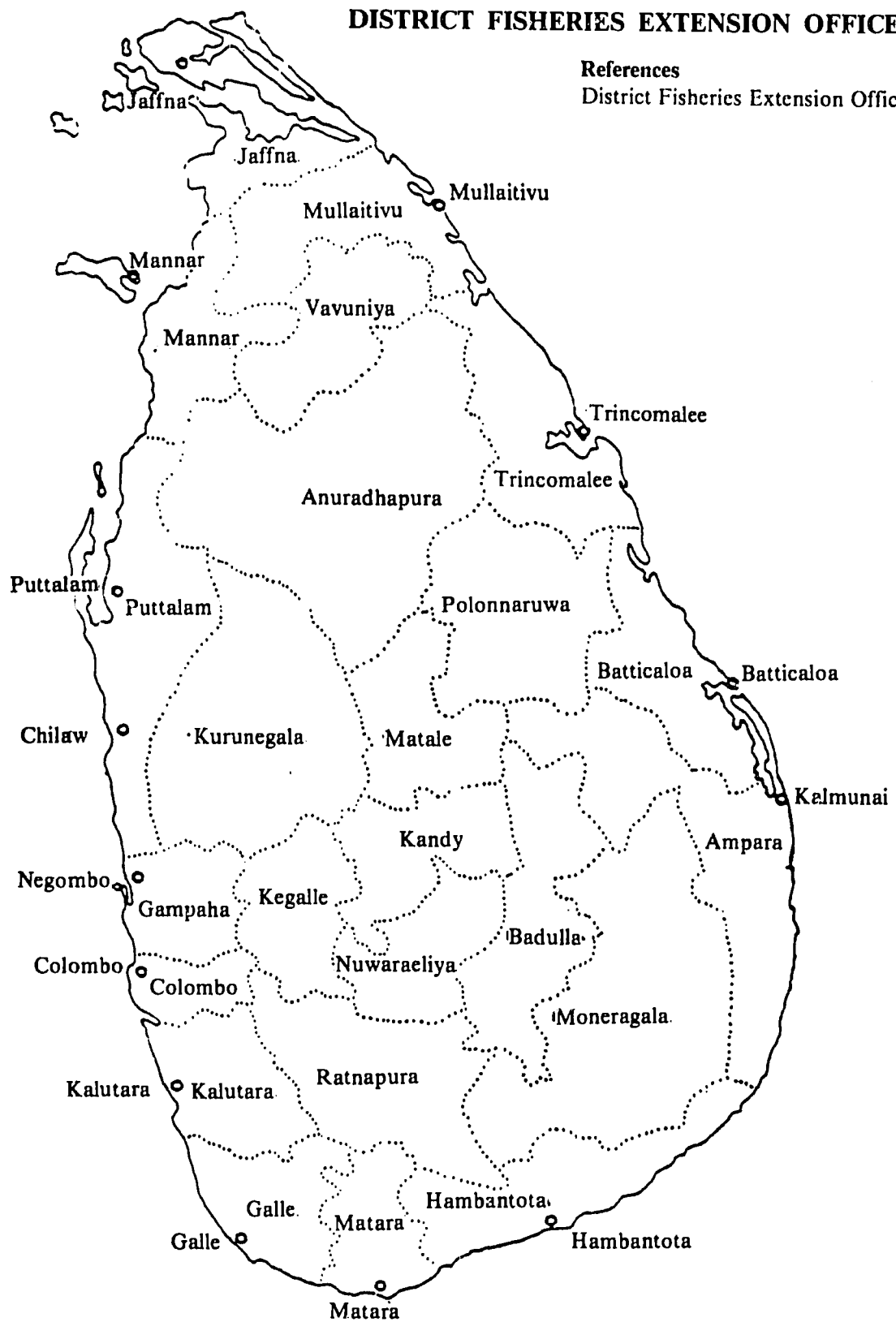


Fig. 1 - Map of Sri Lanka Showing Coastal District Fisheries Extension Office Areas.

## 2. FISHING POPULATION

There were about 78,000 active fishermen supporting a total fishing population of about 332,000 in the marine sector during 1985. Some 13,500 fishermen were involved in inland fishing. Those employed in ancillary activities numbered 18,500, including fish marketing (7,900), fish processing and curing (8,300) and other activities such as boat building, and net and ice making. Employment in fishing represented about 1.75 percent of total employment and about 4 percent of agricultural employment. When ancillary activities too are considered, the respective shares amounted to about 2.5 and 5 percent respectively.

TABLE 1  
GDP AND PERCENTAGE CONTRIBUTION FROM FISHERIES SECTOR TO THE GDP

Year	National GDP at Current Prices (Rs. Million)	Contribution of Fisheries to National GDP	
		(Rs. Million)	(percent)
1978	44,562	856	1.92
1979	54,920	1074	1.96
1980	68,338	1130	1.65
1981	84,527	1311	1.55
1982	97,528	1586	1.63
1983	119,202	1733	1.45
1984	147,344	2590	1.76
1985	157,764	2663	1.69
1986	172,440	3158	1.83
1987	188,822	3766	1.99
1988	218,155	4647	2.13
1989*	248,230	5087	2.05
1990*	316,706	5800	1.83
1991*	339,058	7882	2.32

\*Provisional.

Source: Ministry of Fisheries and Aquatic Resources

TABLE 2  
TRENDS IN FISH SUPPLY AND PER CAPITA CONSUMPTION

	Unit	1977	1980	1983	1986	1987	1988	1989
<b>FAO/ADB Mission Estimates:</b>								
Domestic Production	tonnes	138,766	187,678	220,806	183,056	190,002	197,536	205,286
Imports <sup>1</sup>	tonnes	13,047	55,357	41,952	80,997	95,335	114,050	89,969
<b>SUB-TOTAL</b>	<b>tonnes</b>	<b>151,813</b>	<b>243,035</b>	<b>262,758</b>	<b>264,053</b>	<b>285,337</b>	<b>311,586</b>	<b>295,275</b>
Less Exports	tonnes	5,275	6,090	6,540	8,525	6,042	8,742	9,955
Availability	tonnes	146,538	236,945	256,218	255,528	279,295	302,844	285,320
Mid-Year Population*	millions	13.9	14.7	15.4	16.15	16.4	16.7	16.9
Per Capita Consumption	kg	10.54	16.11	16.63	15.87	17.13	18.13	16.88

<sup>1</sup> Converted to live-weight equivalent using a factor of 2.5.

\*Note: Population growth assumed at 1.6 per cent/year (actual average 1976-1986).

Source: FAO/ADB Fisheries Sector Study 1988



**TABLE 3**  
**FISHERIES GDP AND BUDGET OF MINISTRY OF FISHERIES (MOF)**  
**1975 — 1986 AT CONSTANT (1975) PRICES AND 1987-1991**  
**AT CONSTANT (1982) PRICES**

Year	Fisheries GDP		MOF Budget			
	Current	Constant (1975) Prices Rs. Million	Capital Rs. Million	as % of fisheries GDP	Total Rs. Million	as % of fisheries GDP
1975	375	375	58.7	15.7	NA	NA
1976	NA	NA	49.7	NA	NA	NA
1977	704	407	35.5	5.0	44.7	6.3
1978	NA	NA	75.0	NA	106.5	NA
1979	1074	486	115.7	10.8	129.4	12.0
1980	1130	528	266.2	23.6	285.9	25.3
1981	1311	602	152.0	11.6	171.3	13.1
1982	1586	641	140.2	8.8	186.8	11.8
1983	1733	660	148.4	8.6	180.5	10.4
1984	2590	490	162.1	6.3	195.7	7.6
1985	2663	498	115.6	4.3	158.1	5.9
1986	3030	NA	113.7	3.8	157.9	5.2
		Constant (1982) prices (Rs. Million)				
1987	3766	2191	192.8	5.12	240.7	6.39
1988	4647	2279	181.6	3.91	236.8	10.34
1989	5087	2370	371.4	7.29	443.9	8.73
1990	5800	2252	120.1	2.06	187.9	3.24
1991	7882	2522	278.7	3.53	359.6	4.56

Source: Ministry of Fisheries and Aquatic Resources Statistics.

Marine and inland fisheries, as well as ancillary activities such as marketing, processing and boat building employ a wide spectrum of people of different ethnic and religious backgrounds and socio-economic status. Women however play a negligible role in fisheries.

Data available from a fisheries survey in 1989 reveal that 62.6 percent of the country's population live in the five coastal provinces, (Table 4). The fishing population makes up about 4 percent of the total population in these provinces. Ninety three percent of the fishing population belong to the marine sector; the largest concentrations are found in the Northern and Eastern Provinces. Fishing populations in the marine sector and the numbers of fishermen in the different coastal District Fisheries Extension Office (D.F.E.O.) areas are given in Table 5. The Jaffna, Batticaloa, Kalmunai, Negombo and Chilaw areas have the largest numbers of fishermen. Active fishermen make up 24 percent of the fishing population in the marine sector. The fishing population in the inland fisheries sector and the number of active fishermen in this sector within the coastal areas are shown in Table 6. The active inland fishermen within the coastal areas comprised 22.6 percent of the total inland fishing population.

Information on the different levels of dependency of coastal fishermen on fishing is presented in Table 7. Fishing is the sole source of income of 79 percent of the total number of fishermen, the main source of income of 15 percent and a secondary source of income of 6 percent. According to census data from 1971 to 1981, the fishing population has increased at a rate of 2.2 percent per annum while the total population growth rate was 1.7 percent (FAO/ADB, 1988). The FAO/ADB Fisheries Sector Study has estimated that the total number of fishermen will be 108,000 by the year 2000, assuming that the same annual rate of growth of 2.2 percent is maintained. However, data

available from the 1989 Fisheries Survey suggest that the number of fishermen may increase not by 30 thousand but by about 50 to 60 thousand, by the year 2000. Prospects being limited for increased fish output, the fishing industry is unlikely to be able to absorb this extra labour without a significant drop in per capita earnings, even allowing for the possibility of real price increases. Development of land based jobs for fishing communities therefore needs to be explored and promoted.

More than half of the under-exploited marine resources are located in offshore and deep sea fishing grounds. Exploitation of such resources involves relatively capital intensive operations, even if small multi-day boats are used for the purpose. Additional employment in the marine sub-sector cannot be expected for more than 5000 fishermen. The development of inland fisheries could have created some 12,000 part-time jobs, but the recent policy decision by the Government to withdraw state patronage to this sector may affect employment opportunities in this sector. Brackishwater aquaculture, particularly shrimp culture, may create about 750 to 1000 jobs. Thus, the fishery sector per se offers only very limited opportunities for increased employment.

TABLE 4  
FISHING POPULATIONS IN THE COASTAL PROVINCES

Province	Population (× 1000)	Fishing Population			Percentage of total population
		Marine	Inland	Total	
Western	4,404	48,530	2,778	51,308	1.17
Southern	2,074	46,918	8,311	55,229	2.65
Northern	1,185	143,664	5,423	149,087	12.58
Eastern	1,252	125,965	8,292	134,257	10.72
North-Western	1,998	47,123	7,311	54,434	2.72
All 5 Coastal Provinces	10,918	412,200	32,115	444,315	4.07
All 9 Provinces in Country	17,433	412,200	55,909	468,109	2.69

Source: Fisheries Survey 1989 - Ministry of Fisheries & Aquatic Resources

TABLE 5  
MARINE FISHERMEN AND FISHING POPULATION IN DFEO AREAS

DFEO Division	Fishing Population	Number of Fishermen
Colombo	6,577	1,610
Negombo	29,226	7,419
Chilaw	29,302	7,173
Puttalam	17,821	4,539
Kalutara	12,727	3,157
Galle	14,813	3,590
Matara	18,213	4,426
Tangalle	13,892	3,354
Mannar	24,252	5,684
Mullaitivu	13,286	3,183
Trincomalee	28,456	6,502
Batticaloa	55,292	12,843
Kalmunai	42,217	9,022
Jaffna	106,126	25,942
Total	412,200	98,444

Source: Fisheries Survey 1989 - Ministry of Fisheries & Aquatic Resources

**TABLE 6**  
**NUMBER OF FISHERMEN AND FISHING POPULATION ASSOCIATED**  
**WITH INLAND FISHERIES IN COASTAL PROVINCES**

<i>Province</i>	<i>Inland Fisheries Station</i>	<i>Fishing Population</i>	<i>Number of Fishermen</i>
Western	Panapitiya	1,649	391
	Pitipana	1,129	285
Southern	Galle	4,451	1,058
	Muruthawela	3,680	881
Northern	Mankulam	5,423	1,170
Eastern	Inginiyagala	8,292	1,722
North-Western	Pambala	2,816	695
	Rambodagalla	4,495	1,062
Total for 5 Coastal Provinces		32,115	7,264
Country Total		55,909	12,891

Source: Fisheries Survey 1989 - Ministry of Fisheries & Aquatic Resources

**TABLE 7**  
**DEPENDENCY LEVELS OF FISHERMEN ON FISHING AS A SOURCE OF INCOME**

<i>Province</i>	<i>Number of Fishermen</i>			<i>Fishing as Source of Income</i>					
	<i>Marine</i>	<i>Inland</i>	<i>Total</i>	<i>Sole Source</i>		<i>Main Source</i>		<i>Secondary Source</i>	
				<i>No.</i>	<i>(%)</i>	<i>No.</i>	<i>(%)</i>	<i>No.</i>	<i>(%)</i>
Western	12,186	676	12,862	10,522	(81.8)	1,654	(12.9)	686	(5.3)
Southern	11,370	1,939	13,309	11,990	(86.3)	967	(7.3)	852	(6.4)
Northern	34,809	1,170	35,979	27,369	(76.0)	6,933	(19.3)	1,677	(4.7)
Eastern	28,367	1,722	30,089	22,657	(75.3)	5,812	(19.3)	1,620	(5.4)
North-									
Western	11,712	1,757	13,469	11,582	(86.0)	790	(5.9)	1,097	(8.1)
Total for 5 Coastal Provinces	98,444	7,264	105,708	83,620	(79.1)	16,156	(15.3)	5,932	(5.6)
Country Total (9 Provinces)	98,444	12,891	111,335	86,240	(77.5)	16,962	(15.2)	8,133	(7.3)

Source: Fisheries Survey 1989 - Ministry of Fisheries & Aquatic Resources

### 3. FISH PRODUCTION AND RESOURCES

#### 3.1 Fish Production from the Sea

Fish production in Sri Lanka from the marine and inland sectors and the value of the catch (where available) are given in Table 8. Marine catches are further sub-divided into coastal and offshore/deep sea sub-sectors. The bulk of this production (averaging 83 percent of total annual production during 1977-1988) comes from the coastal marine fishery. Production from the coastal fishery has declined after a peak in 1983, largely because of the civil disturbances in the North and East. The other sub-sectors, offshore/deep sea and inland fisheries, have shown significant increases in recent years. While inland fish production is heavily dependent on the capture fisheries in the reservoirs, the marine offshore/deep sea fishery is at present more or less confined to the western and southern coasts. Fish catch by weight and value in the marine sub-sector in 1987 and 1989 are shown in Table 9.

**TABLE 8**  
**FISH PRODUCTION IN SRI LANKA: QUANTITY AND VALUE OF CATCH**

Year	Marine Fisheries				Inland Fisheries			
	Offshore/Deep Sea		Coastal		Qty.	Value	Qty.	Value
	Qty.	Value	Qty.	Value				
1980	2148	14.1	165264	1218.9	20266	58.0	187678	1291.1
1981	2178	18.2	175075	1690.0	29590	136.9	206843	1845.3
1982	1078	11.5	182532	2306.9	33323	235.8	216933	2554.2
1983	689	N.A.	184049	N.A.	36068	N.A.	220806	N.A.
1984	823	N.A.	136642	N.A.	31882	N.A.	169347	N.A.
1985	2400	N.A.	140266	2375.8	32743	263.9	175409	2375.8
1986	3400	N.A.	144266	5432.9	35390	N.A.	183056	N.A.
1987	4259	110.7	149278	4510.5	36465	N.A.	190002	N.A.
1988	4425	N.A.	155099	N.A.	38012	N.A.	197536	N.A.
1989	8155	361.3	157411	5163.0	39720	N.A.	205286	N.A.

Quantity (Qty.) — Metric tons  
 Value — Rs. Million  
 N.A. — Not Available  
 Source: — Ministry of Fisheries and Aquatic Resources

**TABLE 9**  
**TOTAL MARINE (COASTAL AND OFFSHORE/DEEPSEA) FISH CATCH (1987 AND 1989)**  
**BY WEIGHT AND VALUE**

	1987		1989	
	Catch Weight (Mt.)	Value Rs. Million	Catch Weight (Mt.)	Value (Rs. Million)
Coastal	149,278	4510	157,411	5163
Offshore/deep sea	4,259	111	8,155	361
Total	153,537	4621	165,566	5524

Source: Ministry of Fisheries and Aquatic Resources

The coastal fishing fleet can be divided into three broad categories — craft with inboard engines, craft with outboard motors and non-mechanised craft. Fish production by these three categories of craft during 1979 to 1987 is shown in Table 10 (Arapattu, 1989).

Coastal marine fish production during 1980–1989 in each D.F.E.O. division is presented in Table 11. Despite the recent decline in fishing activity and fish production in the North, the major fish producing area continues to be Jaffna, followed by Puttalam and Chilaw.

Coastal sector fish production by varieties for the period 1981–1989 is presented in Table 12. Data are available for important species and/or species groups. A drastic reduction in the production of shore-seine varieties (sardines, anchovies, mackerel etc.) is seen after 1982. However, the volume of production listed under "others" shows a remarkable increase from 1983 onwards. It appears probable that a considerable fraction of the shore-seine production has been listed under "others" since 1983. The decline in the quality of fisheries statistics in recent years is also evident from the fact that the production figures for some varieties which were reported separately earlier are not shown for recent years. Some of the groups for which separate production figures were available are shown in Table 13.

**TABLE 10**  
**FISH PRODUCTION FROM COASTAL MOTORISED/MECHANISED AND ARTISANAL FISHERIES, 1979-1987**

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
<b>1. Inboard Motorised Craft</b>									
Catch per boat per year (mt.)	16.2	23.8	25.5	18.0	20.0	16.7	17.5	17.8	19.2
No. of operating crafts	3,109	2,305	2,209	3,347	2,861	2,781	2,727	2,766	2,657
Out-put (mt.)	50,405	54,825	56,454	60,379	57,375	46,625	47,862	49,249	50,960
<b>2. Outboard motorised craft</b>									
Catch per boat per year (mt.)	4.5	7.2	7.4	6.8	7.0	4.5	4.3	4.2	4.7
No. of operating craft	9,723	8,020	8,865	9,745	10,086	10,800	11,515	11,340	10,543
Out-put (mt.)	43,848	57,432	65,512	66,727	70,539	48,660	49,950	47,684	49,341
<b>3. Traditional (Artisanal) craft</b>									
Catch per boat per year (mt.)	3.6	3.4	4.1	3.9	3.9	2.9	3.2	3.5	3.5
No. of operating craft	15,330	15,722	12,885	14,101	14,312	14,404	13,303	13,412	13,865
Out-put (mt.)	54,598	53,007	53,109	55,426	56,135	41,357	42,454	47,333	48,977
Total Output (mt.)	148,851	165,264	175,075	182,532	181,049	136,642	140,266	144,266	149,278
artisanal fisheries (percent)	37	32	30	30	31	30	30	33	32

Atapattu (1989).

**TABLE 11**  
**COASTAL SECTOR FISH PRODUCTION BY DFEO DIVISIONS**

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Colombo	2356	1390	1482	2014	1633	1676	2087	2208	2293	2328
Negombo	20458	19636	21056	16589	10350	10625	11227	11878	12341	12524
Chilaw		10738	12738	11342	13623	13986	14386	15220	15812	16047
Puttalam	21094*	14835	15899	22205	20972	21528	21239	22471	23347	23695
Kalutara	4466	5353	6817	6090	5182	5319	5965	6311	6557	6654
Galle	8101	8680	10309	10264	12902	11622	11550	12220	12696	12885
Matara	9661	9245	10554	11489	9552	10125	9700	10263	10663	10821
Tangalle	5696	5650	5878	7062	8949	10196	10252	10847	11269	11436
Mannar	14763	13175	13403	17768	9026	8246	8240	8567	8694	8694
Mullativu	10534	11205	8490	6254	3215	3426	3669	3669	3812	3868
Trincomalee	15305	13245	14354	12308	8256	9258	10336	10009	10612	10899
Batticaloa	6675	8837	9283	4098	3582	3256	3256	3256	3382	3432
Kalmunai	5136	8585	8917	7789	6248	7228	8584	8584	8918	9050
Jaffna	41019	43797	43350	48776	23161	23775	23775	23775	24702	25078
<b>Total</b>	<b>165246</b>	<b>175075</b>	<b>182532</b>	<b>184049</b>	<b>136642</b>	<b>140266</b>	<b>144266</b>	<b>149178</b>	<b>155099</b>	<b>157411</b>

DFEO - District Fisheries Extension Office.

\* Combined figure for Chilaw and Puttalam.

Source: Ministry of Fisheries and Aquatic Resources

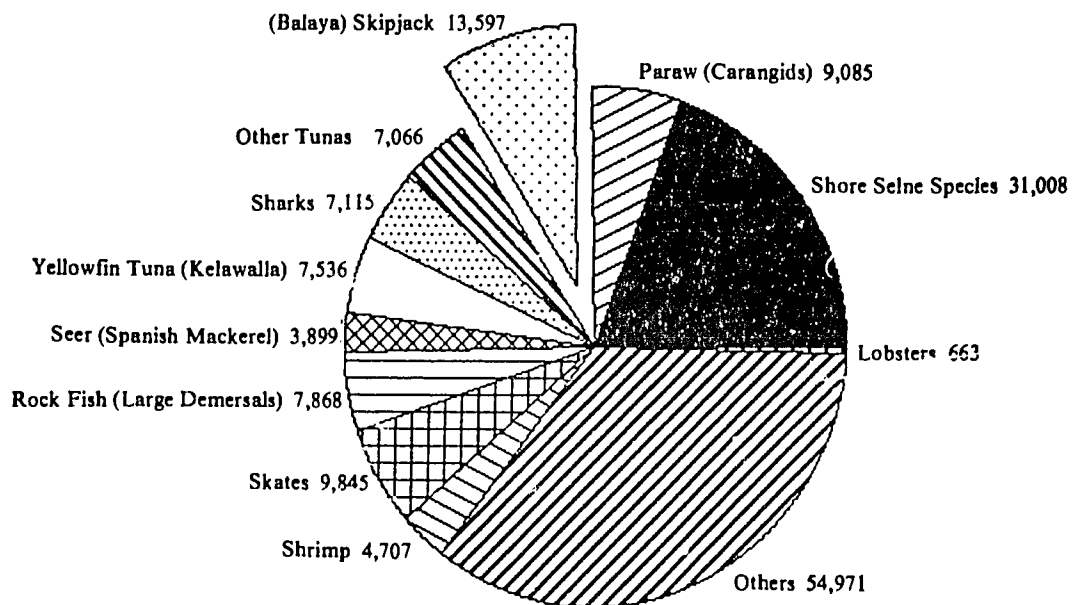
**TABLE 12**  
**COASTAL SECTOR FISH PRODUCTION BY VARIETIES**

Annual Production (in metric tons) 1980-1989

<i>Fish Varieties</i>	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Seer (Spanish mackerel)	6230	4542	3408	3429	3385	3475	3574	3698	3842	3899
Paraw (Carangids)	10049	10325	8273	6080	7887	8096	8327	8616	8552	9085
Balaya (Skipjack)	12702	13762	13462	14195	11805	12118	12463	12896	13398	13597
Kelawalla (Yellowfin)	6907	7665	8484	9137	6542	6716	6907	7147	7426	7536
Other Blood Fish (other tuna)	8666	11402	12715	8629	6135	6298	6477	6702	6963	7006
Shark	8406	9793	6639	8868	6177	6341	6521	6248	7011	7115
Skate	5766	11174	10288	10310	8545	8772	9022	9335	9699	9845
Rock Fish (large demersals)	15511	17520	21347	8249	6331	7012	7211	7462	7753	7868
Shore Seine Varieties	81513	77346	82714	45673	27467	27467	27682	28477	29460	31008
Shrimp	3302	4547	7736	4829	4081	4192	4311	4461	4635	4707
Lobsters	204	589	626	571	577	592	608	629	654	663
Others	6008	6412	6830	64679	47710	48972	50324	52124	54158	54971
<b>Total</b>	<b>165264</b>	<b>175075</b>	<b>182532</b>	<b>184049</b>	<b>136642</b>	<b>140266</b>	<b>144260</b>	<b>144266</b>	<b>149278</b>	<b>157411</b>

Source: Ministry of Fisheries and Aquatic Resources

**FIGURE 2**  
**COASTAL SECTOR FISH PRODUCTION IN 1989 BY VARIETY**  
**(Quantity in Metric Tons)**



Source: Ministry of Fisheries and Aquatic Resources

**TABLE 13**  
**PRODUCTION OF SELECTED MARINE VARIETIES 1980-1983**  
**(Metric tons)**

	1980	1981	1982	1983	1984
Crabs	1422	1405	1592	2309	1973
Squid/Cuttle fish	-	508	796	616	792
Turtles	-	227	37	-	-
Chank/shells	-	29	20	-	-

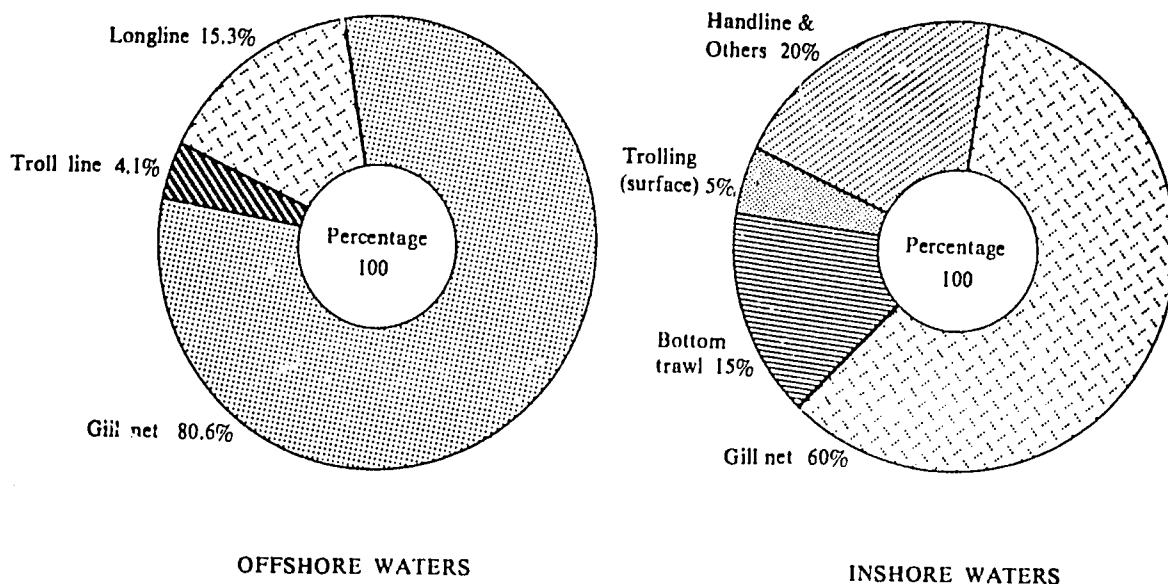
(in metric tons)

Source: Ministry of Fisheries and Aquatic Resources

Figures of catch by species appearing in the national statistics after 1983 are open to question, since the percentage composition of each species or group of species is shown to have never changed throughout the period 1984 to 1989. Although somewhat outdated, species composition recorded between 1972 to 1982 are more reliable and shows 78 percent pelagic and 19 percent demersal species in the catch (Figure 2). Among the pelagic species, sardines, anchovy, mackerels etc. caught by beach seines and small mesh gillnets constitute more than half the total, followed by skipjack, yellowfin, carangids, other tunas, sharks etc. Rock fish, which include economically important fish such as groupers, snappers and bream has been the leading group among the demersal species. These are caught with bottom set longlines and hand lines.

Fish production by type of gear does not appear in the published national statistics. An estimate of catch by gear is however presented in Figure 3. In the case of coastal waters (inshore waters), it is estimated that about 60 percent of the total landings are from gillnets, followed by 15 percent from bottom trawling, 5 percent from surface trolling and the remaining 20 percent from other miscellaneous gear such as handlines, beach seines, traps, small longlines, and purse seines.

**FIGURE 3**  
**SHARE OF PRODUCTION BY TYPE OF FISHING GEAR**



Source: Ministry of Fisheries and Aquatic Resources

Within the coastal zone, the fishery resources in the inshore areas — up to 8 to 10 miles (12.8 to 16.0 km.) from the coast are numerous and varied compared to the resources beyond. Small pelagic species that are mostly harvested from the inshore waters include the sardines (*Clupeidae*), anchovies (*Engraulidae*), scads (*Carangidae*), barracudas and mackerel (*Rastrelliger* spp.). Over thirty species belonging to eight families dominate the small pelagic catches.

Sri Lanka's catch of small pelagic fish increased from about 35,000 mt. in 1967/68 to nearly 76,000 mt. in 1981, amounting to 44 percent of the total marine catch. Reduction in fishing along the North and East coasts in later years due to civil disturbances has affected production of small pelagics, the 28,000 mt. in 1986 representing only 20 percent of the total marine catch. The maximum sustainable yield of small pelagic resources is estimated to be around 95,000 mt. (FAO/ADB, 1988). The surplus available, estimated on the basis of production in the early 1980's is around 19,000 mt. Beach seining and small mesh gillnet fishing are the principal methods of exploiting small pelagic resources. The beach seine fishery which contributed nearly 40 percent of the total marine fish catch during the 1940–1950 era now contributes less than 10,000 mt. per year. Studies by NARA also indicate significant reduction in beach-seining effort along the west, north-west and south coasts. NARA studies also show a reduction in catch rates in both gillnet and beach seine fisheries. For this reason, a significant increase in fishing effort (number of craft) over the early 1980's level would not be an economically viable option for achieving optimum exploitation.

The coastal fisheries with declining catch per unit effort include the shrimp and lobster fisheries, the beach seine fishery on the western and southern coasts and the small mesh gillnet fishery on the west coast. Although these trends suggest that some of the inshore stocks in certain areas are over-exploited, there are other resources/stocks which show potential for increased contribution to coastal fish production without further increase in current fishing effort. Examples include the following:

- (a) The troll fishery which brought in large quantities of smaller tuna (Frigate tuna) in the 1960's and 1970's declined with the rise in fuel prices and the switch over to gillnet fishing. Although a certain amount of this resource is still taken in the inshore purse seine fishery of the south-west region, a revival of troll fisheries with smaller craft and low powered engines (such as the 28 foot fibre-reinforced-plastic (FRP) canoe powered by an 8 Hp Out Board Motor (OBM) introduced by the FAO/Bay of Bengal Programme (BOBP) could significantly increase the production from this resource. The frigate tuna stocks in the coastal waters are widely considered to be under-utilized at present.
- (b) Experiments conducted by FAO/BOBP with low cost inshore Fish Aggregation Devices (FADs) in the mid 1980's brought in large quantities of Dolphin fish (*Coryphaena hippurus*) and Rainbow runner (*Elegatis bippinulatus*). These varieties do not normally make significant contributions to the catches in any other fishery and represent an underutilized resource which could be exploited by deployment of inshore FADs. The work with FAD's has however not gone beyond the experimental stage.
- (c) The ringnet fishery conducted by traditional canoes in the Southwest has brought in large quantities of half beak fish (*Hemiramphidae*) which also do not make significant contributions to the catches of any other fishery.

About ten groups of demersal finfish are predominant in commercial catches: the emperor fish (*Lethrinidae*), snappers (*Lutianidae*), jacks and travellies (*Carangidae*), groupers (*Serranidae*), grunts/sweetlips (*Pomadasyidae*), pony fish (*Leignathidae*), whitefish (*Sillaginidae*), catfish (*Ariidae*), pomfrets (*Stromateidae*) and cartilagenous fish (sharks, rays etc.). Demersal fish production rose from 30,000 mt. in 1975 to a peak 48,000 mt. in 1981 and then declined to 40,000 mt. in 1982 and still further to 26,000 mt. in 1986. Trawling accounts for the largest share of demersal fish catch (31%), the shares of bottom set gillnets and hand lines are about 25 percent each, bottom longlines 16 percent and traps 2 percent. The Northern part of Sri Lanka



between 8 and 10 latitude where trawling dominates contributes about 80 percent of total demersal production.

In the coastal zone outside the inshore waters and in the offshore areas, pelagic resources such as tuna, shark and billfish are exploited using gillnets, longlines and troll lines. The tuna resources sustain the motorized fishing fleet operating beyond the inshore waters; they contribute 15 to 20 percent of all fish landed in Sri Lanka. Fishing effort is directed through drift gillnets (71%), troll lines (19%), drift longlines (6%) and pole and line (4%) in the coastal tuna fisheries and through drift gillnets and drift longlines in the offshore tuna fisheries (Joseph and Moyiadeen 1988). Of the offshore catches, it is estimated that nearly 80 percent of the catch comes from gillnets, followed by 15 percent from drift longlines and 4 percent from trolling (Figure 3). Skipjack (*Katsuwonus pelamis*) 35-45 percent and Yellofin (*Thunnus albacare*) 23-28 percent are the dominant tuna species caught in these multigear, multispecies fisheries. Eastern little tuna (*Euthynnus affinis*) and frigate tuna (*Auxis sp.*) contribute the bulk of the smaller tuna landed. Billfishes (marlin, sailfish and swordfish) and sharks are incidental catches in the coastal and offshore tuna fisheries, while sharks dominate the drift longline catches. Billfish catches have ranged from 3 to 14 percent of all fish landed by the offshore boats (the Abu Dhabi fleet) in different areas during 1983-1984 while shark catches have ranged from 10 to 34 percent.

Offshore fishing in Sri Lanka is at present carried out with smaller boats of 9 to 11 m. length. The success of the Abu Dhabi fleet, introduced in the 1982-1985 period for offshore multi-day fishing, has spurred the smaller, less well equipped 9-10 m. boats to enter this fishery. During the last 3 to 4 years increasing numbers of 9 to 10 m. boats have been observed to enter offshore fishing by installing insulated fish holds or by carrying insulated boxes on board. In addition increasing numbers of 9 to 10 m. boats operating within the coastal zone have extended their fishing range and are fishing in the offshore range, particularly along the west, south and east coasts. It is difficult to accurately estimate the number of boats (9-10 m. class) presently operating in offshore waters, in addition to the 80 Abu Dhabi boats. The offshore fleet is growing rapidly, particularly with the conversion of the 3.5 GT day boats to multi-day boats.

The fishing fleet presently operating in the offshore can be divided into three categories:

- |                                 |              |
|---------------------------------|--------------|
| (a) 11 ton Abu Dhabi boats      | (10.9 m.)    |
| (b) 3.5 - 4 ton multi-day boats | (9 to 10 m.) |
| (c) 3.5 ton day boats           | (9 m.)       |

\* UN - Food and Agricultural Organization FAO Bay of Bengal Programme (BOBP)

The Fisheries Sector Study of FAO/ADB (1988) estimated that 1800 of the 3.5 ton boats are partly operating in offshore waters, i.e. beyond the continental shelf. According to this study, the offshore fishing effort at present is as follows:

11 ton Abu Dhabi boats	—	80
3.5 - 4 ton multiday boats	—	100 - 120
3.5 ton day boats	—	1800 (partly offshore)

Dayaratne (1990) has estimated that a total of 626 boats of 3.5-4 ton class operate in offshore waters.

The production from the offshore fishery is estimated in the Ministry of Fisheries statistics at 8155 mt. in 1989. The FAO/ADB study (1988) puts it at 23,000 mt. While the Ministry of Fisheries estimate is for waters beyond 40 km. (25 miles), the FAO/ADB estimate is for waters beyond the continental shelf. Dayaratne (1990) gives an estimate of 17,800 mt.

### 3.2 Fish Production from the Lagoons

The term lagoon is popularly used in Sri Lanka to describe many brackish water bodies that should correctly be designated basin estuaries. Statistics on fish production from the lagoons are often incorporated into those for coastal marine fisheries. For this reason, no separate information is available on lagoon fish production, fishing effort or catch composition. The **FAO/ADB Study (1998)** estimated that no less than 30,000 part-time and full time fishermen are engaged in the lagoon fisheries in Sri Lanka, using gillnets, cast nets, trammel nets, hook and lines, traps, stake nets etc. Small canoes are the most common type of craft used in lagoon fisheries. Vallams and FRP boats are also used for fishing in the lagoons, at least seasonally. The total number of craft employed in lagoon fisheries is estimated to be around 4,000.

Research into fishery resources in the lagoons has been rather poor and incomplete, both in terms of the number of lagoons studied and the aspects covered. About 125 species of fish have been recorded from the lagoons. At least 80 of them are of marine origin, including the penaeid shrimp. In a study of the fishery in Puttalam lagoon, Jayasuriya (1985) estimated a total annual fin fish catch of over 700 mt. and a shellfish catch of over 450 mt. (shrimp making up nearly 98 percent of the shellfish catch). Approximately 2,000 fishermen are engaged in different types of fisheries in Puttalam lagoon. The catches have consisted of over 50 species of fish and shellfish, the dominant ones being *Liza* sp, *Mugil* sp, *Aries* sp, *Lates calcarifer*, *Penaeus indicus* and *Penaeus semisulcatus*.

Average production of lagoon waters was estimated at 25 lb./acre (28 kg./ha.) in the 1960's (**FAO/ADB, 1988**); on this basis, the production from lagoons would be in the region of 2000-3000 mt. per annum.

Jayasuriya (1985) has obtained an estimate of 49 kg./ha. as the average annual production from the Puttalam lagoon, the figure for fin fish being 30 kg./ha. This is higher than the 15 kg./ha obtained by Wijeratne (1984) for the Negombo lagoon. If the average annual production of 49 kg./ha. obtained by Jayasuriya (1985) is applied to the 80,000 ha. of deep lagoons and estuaries in Sri Lanka, the total annual production would be 3,920 mt. It would be 5,880 mt. if this rate is applied to all of the 120,000 ha. of brackishwaters in Sri Lanka. The annual production from capture fisheries from the lagoons and estuarine waters in Sri Lanka would therefore not exceed 6000 mt.

### 3.3 Marine Fisheries Resources around Sri Lanka

Natural limitations on the marine fish resources around Sri Lanka are imposed by a rather narrow continental shelf and lack of any significant up-wellings. The continental shelf around the 1,700 km. long coastline is very narrow, averaging fourteen miles (22.5 km.) in width and rarely extending beyond twenty five miles (40 km.). There are also no up-wellings of any significance to bring up nutrients from the deep sea and enrich the surface waters to support large fish resources.

With a narrow continental shelf, the resources of demersal fish (those that live on or near the bottom of the sea) cannot be very large. There are some off-shore areas capable of sustaining trawling operations for lobsters, shrimp and a few commercially important species of fish. These were discovered during a survey with the Soviet Vessel "Optimist" in 1972. The survey was conducted in the 100 mile (160 km.) zone adjacent to Sri Lanka but outside its territorial waters. Fish resources were surveyed using bottom trawling. As much of the continental shelf lies within the territorial waters, trawling was possible only in limited areas such as the Wadge Bank, Gulf of Mannar and the southern part of the Island. Most of the fish stocks discovered during these deep water trawling trials were only suitable for incorporating into fish meal. Whether the deep water lobsters and shrimp can support a commercial fishery is a question which needs further investigation. Furthermore, certain fishery resources identified by the "Optimist" survey now lie within Indian territorial waters.

A Norwegian research vessel ("Dr. Fridtjoff Nansen") which carried out acoustic surveys of fish resources around the coastal waters of Sri Lanka in 1987, 1979, and 1980 estimated the

potential yield from the coastal fish resources to be around 250,000 metric tonnes per year. Out of this potential yield 80,000 tonnes were estimated to be available from demersal resources. The present production of demersal fish is around 35,000 tonnes. On the whole, demersal fisheries do not present substantial potential for expansion, other than for small scale trawling and bottom long line operations mostly within the continental shelf.

The principal resources within the country's Exclusive Economic Zone (EEZ) are the pelagic species which sustain the present in-shore fishery. Pelagic fish resources can be grouped into three categories: the small pelagics, medium sized pelagics and the large pelagic species. Sardines, herrings, anchovies etc., comprise the small pelagics exploited from in-shore waters, upto a limit of approximately 10 miles (16 km.) from the shore. The mackerel, barracuda, spanish-mackerel, frigate mackerel etc. comprise the medium sized pelagics. These have a wider distribution compared to the small pelagics. Some like the spanish mackerel, skipjack and mackerel tuna are to be found in the off-shore range as well. The large pelagics include species like the yellowfin tuna, big-eye tuna, billfish and the sharks. These species during their young stages could be found in in-shore waters, but move into deeper waters as they grow in size. The existing fisheries for the pelagic species cover mainly the in-shore range and to a limited extent the fringes of the off-shore range.

The principal fish resources outside the coastal area are the pelagic fish resources, represented mainly by tuna, billfish, pelagic sharks and oceanic species of flying fish. These are also resources of ocean-wide significance. Reliable estimates are not available of the potential yield from the offshore/deep sea areas of Sri Lanka. Some estimates based on the commercial fishery, surveys, sighting schools etc., are however available. These are summarised in Table 14.

TABLE 14  
AVAILABLE ESTIMATES OF POTENTIAL YIELD FROM OFFSHORE/DEEP SEA AREA OF SRI LANKA

Source	Method	Estimated Potential Yield (mt.)
Sivasubramaniam (1978) BOBP/WP/31 (1985)	Using information on existing fisheries. Based on exploratory fishing, resource surveys, school counting etc.	29,000 mt.
	a. Yield/Unit area	98,874 mt.
	b. School count	56,600 mt.
	c. Mean catch rate	44,188 mt.
FAO/ADB study (1988)	Based on available information	40,000 mt.

Present production levels of all the offshore varieties indicate that there is potential to increase production from the offshore area even on the basis of the lowest potential yield estimate. Further the deepsea component of the yellowfin and bigeye tuna are virtually unexploited at present.

Demersal resources in the offshore and deep sea waters include deepwater finfish, shrimps, lobsters and cuttlefish. With the establishment of the Exclusive Economic Zone (EEZ) regime in the region, Sri Lanka lost access to the Wadge Bank after 1979, and one third of the Pedro Bank plus areas to the north of it which are now in Indian waters. These areas were the only known grounds suitable for the use of large trawlers.

Nishida and Sivasubramaniam (1986) examined the unexploited resources available in the Exclusive Economic Zones of the countries around the Bay of Bengal. Besides the deep sea demersal resources, the mesopelagics are the only other unutilised deep sea fish resource in the region. No surveys have been specifically directed on these resources. The study had to make use of available data to identify the composition of the deep sea demersal resources and their distribution pattern and abundance. The study was restricted to a depth zone of 100-600 m. since typically deep sea fishes generally begin to appear around 100 m. depth and the maximum depth trawled during past surveys was 500 m. The EEZ of Sri Lanka is approximately 256,000

sq. km. in area. While the shelf area (0–200 m.) is 30,000 sq. km., the area covered by the 100–600 m. depth range is estimated at 11,000 sq. km. of which only 2,000 sq. km. have a smooth bottom and are considered trawlable.

The following percentage species composition was obtained during the surveys by R/V Dr. Fridtjof Nansen during 1978, 1979 and 1980 (Table 15).

TABLE 15  
PERCENTAGE COMPOSITION OF TRAWL CATCHES AT DEPTH RANGES OF 100–300 M. AND 300–600 M.

	100–300 m. depth range	300–600 m. depth range
Acropomatidae	—	31.1
Centrolophidae	—	5.1
Chlorophthamidae - Green Eyes	—	5.1
Nemipteridae - Threadfin Bream	13.9	—
Priacanthidae - Bulls Eyes	2.4	—
Sciaenidae - Jew fish/Croakers	13.9	—
Sphyrnidae - Hammerhead Sharks	13.9	—
Synodontidae - Lizard Fish	13.9	19.0
Deep sea crabs	2.5	5.2
Deep sea lobsters	7.10	5.2
Deep sea prawns	9.3	19.0
Octopuses	—	10.3
Squids/cuttlefish	16.2	—

Source: Nishida & Sivasubramanian (1986)

The occurrence of fish species and catch rates in the 300–600 m. depth zone is found to be significantly less than those in the 100–300 m. depth.

The only deep water demersal fishery existing in Sri Lanka is the developing bottom set longline fishery for gulper shark (*Centrophorus* sp), exploited for its high priced liver oil. None of the varieties listed above has an established market and the economic viability of exploiting these resources remains doubtful. The consensus of opinion is that the demersal fisheries do not present any substantial potential for expansion outside the coastal zone.

#### 4. FISHING FLEET

##### 4.1 Marine Fishing Fleet

The marine fishery in Sri Lanka has traditionally been a small inshore fishery, producing for local consumption. However, since the 1980's, the fishing effort has been increasingly shifting to the offshore areas while remaining basically small scale. Past attempts to develop industrial fisheries have generally been unsuccessful. The fishing fleet consists mainly of small and medium size craft (less than 11 m. L.O.A. and maximum 60 horsepower). All these boats are exclusively owned and operated by the private sector.

The diverse types of indigenous and introduced fishing craft in Sri Lanka can be divided into three broad groups;

- Mechanised craft — Craft propelled by an engine and equipped with mechanical deck equipment,
- Motorised craft — Craft propelled by a motor fitted inboard or outboard,
- Non-Motorised craft — Craft propelled by sail and/or oars.

Despite development efforts during the last decades, the indigenous or traditional craft have remained predominant and continue to play an important role in the fisheries in coastal inshore waters and brackish waters. Major types of indigenous craft include:

**Log Rafts (Theppams and Kattumarans)**

Theppams and Kattumarans are made of logs tied or pegged together. Theppams are 3 to 5 m. in length. Propelled by oars they operate within 2 to 3 km. from shore with gill netting and hook and line fishing. Kattumarans are longer (4 to 7 m.) and can be operated with an outboard motor. These are used in beach seine fishing in the northern region.

**Outrigger canoes (Oru, Thony)**

Have narrow dugout hulls with side strakes and a solid counterpoised wooden float outrigger attached by a pair of curved arms. Canoe sizes vary from 3 m. to 10 or even 11 metres.

Smaller ones (3 to 5 m.) propelled by sail or oars are used for lagoon and coastal gillnetting and hook and line fishing. The larger ones (10 to 12 m.) are propelled by oars and sail and are used for coastal fishing, beach seining, trawling and hand lining. Some of these craft are motorized for coastal gillnetting and ring net fishing.

**Plank beach seine craft (Paru, Padahu)**

Flat bottomed craft made of beams or stitched planks with an overall length of 10 to 12 m. Used with oars for beach seining in northwestern, western and southern regions.

**Dug-out beach seine craft (Karavalai Vallam)**

Dugout canoes of 10 to 12 m. length without side strakes; the outrigger is attached to the hull. Propelled by oars and used for beach seining in northern and eastern regions.

**Dugout with outrigger but without sidestrakes (Vallam)**

Dugout canoes ranging from 3 to 6 m. in length. Propelled by oars and sail; used in lagoons and inshore coastal waters for cast netting, gillnetting, hook and line and trap fishing.

In recent years, because of the scarcity of large logs, fibre-reinforced plastic (FRP) copies of outrigger canoes and vallams are being built. The major types of introduced craft now in operation include:

**Fibreglass Reinforced Plastic (FRP) Boats (5.2 to 6.2 metres)**

Open decked boats made of fibreglass reinforced plastic (FRP) and propelled by an outboard motor (8-15 Hp). Used mainly for coastal gillnetting, hand lining, bottom set longlining and trolling in many regions.

**3.5-4 ton Boats**

The majority of these boats are in the E26 type class, 8 to 10.2 m. in length and with a displacement load for fishing of 3.5 to 4 tonnes. Most of these are made of FRP and are powered by inboard marine diesel engines of 30-40 Hp. Drift gillnetting, drift longlining, bottom set longlining and pole and line fishing are carried out on board these craft in all regions.

**11 ton Boats**

The 10.4 m, 11 ton class boats were introduced under the North-West Coast Fisheries Development Project financed by the Abu Dhabi Fund. The fleet of 80 combination (gillnetter/longliner) boats is operating in the offshore fishery of the western, southern and north-western regions. The fleet of ten trawlers of the same size are not in operation at present. Some of the 11.6 m., 11 ton boats introduced through the Asian Development Bank (under the South-West Fisheries Project) for offshore use are now engaged in trawling in the coastal areas of the north-western region.

**19.5 m. Steel Boats**

Two of these boats were introduced under the North-West Coast Fisheries Development Project for deep water trawling and offshore fishing (long line, purse seine). Presently operated by the Ceylon Fisheries Corporation for trawl fishing.

The FAO/ADB study (1988) has estimated the fishing fleet operating in the marine and brackish waters at the end of 1987 to be 26,350, making allowance for craft lost or damaged due to civil disturbances. The breakdown of the fishing fleet as determined by this study is shown in Table 16.

TABLE 16  
ESTIMATED COMPOSITION OF MARINE AND BRACKISHWATER FISHING FLEET AT END-1987-FAO/ADB

	Non-Motorized	Motorized	Mechanised	Total	
				Number	Percent
A. Traditional Craft	13,450	2,827	—	16,277	61.8
b. Introduced Craft					
5.2-6.2 m. boats		7,230	—	7,230	27.5
3.5-4 ton boats		2,750	—	2,750	10.5
11 ton driftnetters		—	70	70	0.2
11 ton trawlers		—	9	9	
14.0 m. boats		—			
(trawler/purse-seiner)			12	12	
19.5 m. boats (trawler/longliner)			2	2	
Total	13,450	12,807	93	26,350	100.0

Source: FAO/ADB Study (1988)

Of the estimated 16,277 traditional, non-motorized craft 4,000 are believed to be operating in brackish waters. According to the above figures, nearly 62 percent of the fishing fleet still comprises traditional craft, of which 17.3 percent are motorized.

The following distribution of fishing craft in 1987 and 1989 is taken from Ministry of Fisheries records (Table 17).

TABLE 17  
COMPOSITION OF MARINE AND BRACKISHWATER FISHING FLEET 1987 AND 1989  
MINISTRY OF FISHERIES ESTIMATE

	1987		1989	
	Number	Percent	Number	Percent
10-11 ton boats	97	0.4	—	2.2
10.5 m. boats	—	—	576	6.7
9.0 m. (3.5 t.) boats	2,560	9.4	1,781	27.9
5.2-6.2 FRP boats	7,442	27.5	7,406	6.1
Motorized traditional craft	3,101	11.5	1,622	6.1
Non-motorized traditional craft	13,865	52.2	14,074	53.1
Madel (beach seine) craft			1,061	4.0
Total	27,065	100.0	26,520	100.0

Source: Ministry of Fisheries and Aquatic Resources

It seems that some craft categories have not been accounted properly in both years. While the 10.5 m. boats appear to have been grouped with the 9.0 m. boats in 1987, the larger ones in the 10-11 ton class are not accounted for in the 1989 figures. The National Fisheries Development Plan of 1990-1994 gives the following breakdown of the marine fishing fleet in 1988.

**TABLE 18  
COMPOSITION OF MARINE FISHING FLEET - 1988-NFDP ESTIMATE**

	<i>Number</i>	<i>Percentage</i>
Non-motorized traditional craft	12,946	47.3
Motorized traditional craft	3,491	12.7
FRP boats (5.2 -6.2 m.)	7,491	27.3
3½ ton boats (9.0 m.)	3,289	12.0
Boats over 3½ tons	184	0.7
<b>Total</b>	<b>27,401</b>	<b>100.0</b>

*Source: National Fisheries Development Plan (NFDP) 1990-1994,  
Ministry of Fisheries and Aquatic Resources*

According to FAO/ADB (1988), the major contributions to the GDP of marine fisheries comes from the following craft categories;

**TABLE 19  
CONTRIBUTION OF PRINCIPAL CRAFT CATEGORIES TO MARINE FISHERIES  
GDP IN 1988**

(a) 3.5 t. boats	1/3rd GDP
(b) Motorized traditional craft and 5.2-6.2 FRP craft	1/3rd GDP
(c) Non-motorized traditional craft and beach seines	1/3rd GDP

*Source: FAO / ADB Study (1988)*

The 3.5-4 ton fishing fleet employs 20 percent of the active marine fishermen, the motorized traditional crafts and the FRP craft employ 25 percent and the non-motorized traditional crafts and beach seines employ approximately half the total number of marine fishermen. The average yearly income per crew member is of the order of Rs. 19,000 in a craft of the first category, Rs. 12,000 in the second category and Rs. 8,000 in the third category. Boat owners profit is estimated at about Rs. 31,000 per annum for a craft in the first category. (equivalent to a return on investment of about 20 percent and Rs. 11,000 for a craft in the second category (equivalent to a return on investment of around 30 percent).

No estimates are available in regard to the monetary value of Sri Lanka's fishing fleet. It is also an arduous task to compute because of the diversity of fishing craft available and the numerous craft/gear combinations observed in the multispecies multigear fisheries. Age profiles of the different fishing fleets are also not available. Differences in the service life of the different components of a fishing unit (hull, engine and fishing gear) make it further difficult to assess the current value of the fishing fleet as the value of one unit may differ considerably from that of another unit of the same fleet. Despite these difficulties, an attempt has been made to place a monetary value on Sri Lanka's fishing fleet on the basis of the following assumptions;

- (a) Due to wide variations observed in the fishing fleet, (as given in Ministry of Fisheries annual reports), the composition of the fishing fleet operating in 1987 as estimated in the FAO/ADB study of 1988 has been used for this exercise as it gives a more detailed breakdown of craft types. However, the fleet of 11 ton driftnetters operating should be 80 and not 70 as given in the FAO/ADB study report.
- (b) The current replacement value of a fishing unit (hull, engine/equipment and fishing gear) is determined for various types of fishing fleets. The replacement value of 50 percent of each fishing fleet is then considered to be the current value of that particular fishing fleet.

The prices approved by the Ministry of Fisheries for various sizes of fishing boats as at September, 1990 and upward price revisions requested by some boatyards for certain sizes of boats are given in Tables 20 and 21 respectively. In the case of large boats of 9 m. and above, there seem to be wide differences in prices owing to price differentials between open deck boats and those with fish hold, crew accommodation, wheel house and other facilities for offshore multi-day fishing.

The current prices of some of the marine engines are shown in Table 22.

TABLE 20  
APPROVED PRICES OF FISHING CRAFT BELOW (28 M.) LENGTH (AS AT SEPTEMBER '90)

<i>Boatyard/Boat type</i>	<i>Approved prices (Rs.)</i>	<i>Revision requested</i>
<b>1. Ceynor</b>		
18½ ft. FRP	—	39,000
12½ ft. Boat	35,770	
24 ft. Traditional craft	25,000	
24 ft. Marine oru	21,580	
21 ft. Marine oru	17,590	
18.6 ft. lagoon oru	8,270	
<b>2. Neil Marine</b>		
18 ft. Boat	27,070	35,771
19.3 ft. Boat	27,810	37,340
<b>3. Blue Star</b>		
18.6 ft. boat	36,500	39,500
<b>4. Consolidated Marine</b>		
19 ft. boat	18,600	—
<b>5. Diyakawa</b>		
14 ft. oru	7,300	—
17 ft. oru	9,600	12,237
19.4 boat	24,400	44,845
21.8 ft. oru	16,100	21,877
<b>6. St. Anthony</b>		
18 ft. oru	15,750	—
18.6 ft. boat	33,000	—

Source: Ministry of Fisheries and Aquatic Resources

TABLE 21  
APPROVED PRICES AND REVISIONS REQUESTED FOR FISHING BOATS OF 28 FT. AND OVER (1990)

<i>Boatyard/Boat type</i>	<i>Approved price</i>	<i>Revision requested</i>
<b>1. Ceynor</b>		
28 ft.	98,275	133,500
<b>2. Neil Marine</b>		
32 ft.	142,350	—
34 ft.	261,670	338,965
<b>3. Blue Star</b>		
30 ft. (SRL./15)	294,000	—
32 ft.	394,840	—
<b>4. Consolidated Marine</b>	278,250	—
<b>5. Sithumind</b>		
32 ft.	225,220	387,796
<b>6. Nandanle</b>	151,604	—
<b>7. Kumari</b>		
32 ft.	199,930	275,092
<b>8. Taos</b>		
32 ft.	415,000	

Source: Ministry of Fisheries and Aquatic Resources



Current prices of some of the marine engines are shown in Table 22.

TABLE 22  
CURRENT (1991) PRICES OF MARINE ENGINES

<i>In-Board</i>		<i>Out-Board</i>	
Yanmar 26 Hp (2TDG)	Rs. 260,000	Yamaha 8 Hp	Rs. 35,000
Yanmar 30 Hp (2SME)	Rs. 260,000	Evinrude 10 Hp	Rs. 34,000
Yanmar 39 Hp (3TDG)	Rs. 293,000	Suzuki 9.9 Hp	Rs. 44,000
Isuzu 51 Hp	Rs. 420,000	Yamaha 15 Hp	Rs. 49,490
Isuzu 35 Hp	Rs. 360,000	Tohatsu 18 Hp	Rs. 49,490

Source: Ministry of Fisheries and Aquatic Resources

The monetary value of Sri Lanka's fishing fleet is worked out in Table 23. In the case of the two Korean trawler/longliners, the current price is taken to be the same as the original price since the two vessels are only three years old. The fleet of 11 m. Abu Dhabi boats were introduced during the 1982-1985 period. In a technoeconomic evaluation study of offshore boats, **Gulbrandson (1991)** gives the cost of building a new Abu Dhabi boat, based on estimates provided by Neil Marine and Cey-Nor, the two boatyards that have built the boat previously. The cost of construction when originally built and the estimated cost in 1988 are shown in Table 24.

TABLE 23  
CURRENT VALUE OF SRI LANKA'S COASTAL (MARINE) FISHING FLEET

Marine Craft <i>Craft type</i>	Fleet <i>strength</i>	Current Replacement Value (Rs.)				Value of fishing fleet (Rs.)
		Hull	Engine equipment	Fishing gear	Total (Rs.)	
1. 19.5 m. boats Trawler/longliner	02				27.5 Nil (Rs.)	55,000,000
2. 14.0 m. boats Trawler/Piselinier	12				2.0 Nil (Rs.)	$\frac{2,000,000 \times 12 = 12,000,000}{2}$
3. 11 ton boats Abu Dhabi: gillnetter	80	950,000	900,000	400,000	2,250,000	$\frac{2,250,000 \times 80 = 88,000,000}{2}$
4. 11 ton boats Abu Dhabi: trawler	10	950,000	900,000	200,000	2,130,000	$\frac{2,130,000 \times 10 = 10,650,000}{2}$
5. 3-4 ton boats Multi-day/offshore	250	300,000	290,000	250,000	840,000	$\frac{840,000 \times 250 = 105,000,000}{2}$
6. 3.5 ton day boats	2500	180,000	250,000	150,000	580,000	$\frac{580,000 \times 2500 = 725,000,000}{2}$
7. 5-6 m. FRP boats with OBM	7230	40,000	50,000	40,000	130,000	$\frac{130,000 \times 7230 = 469,950,000}{2}$
8. Motorised traditional craft - dugout Thonnie/Vallams etc.	952	20,000	35,000	35,000	90,000	$\frac{90,000 \times 952 = 42,840,000}{2}$
9. Non-motorised traditional craft - dugouts Thonnie/vallams etc.	5155	20,000	--	20,000	40,000	$\frac{40,000 \times 5155 = 115,100,000}{2}$
10. Motorised teppams	1848	4,000	35,000	20,000	59,000	$\frac{59,000 \times 1848 = 54,516,000}{2}$
11. Non-motorised teppams	3295	4,000	--	15,000	19,000	$\frac{19,000 \times 3295 = 31,302,500}{2}$
12. Beach seine craft	1000	--	--	--	300,000	$\frac{300,000 \times 1000 = 150,000,000}{2}$
Current value of total marine fishing fleet (craft types 1 to 12 above)						(1,859,358,5000)

Marine Craft	Current Replacement Value (Rs.)					Value of fishing fleet (Rs.)
	Fleet strength	Hull	Engine equipment	Fishing gear	Total (Rs.)	
<b>Lagoon Crafts</b>						
(a) Motorised Dugout canoes, Thonnies & Vallams	507	10,000	35,000	10,000	55,000	$55,000 \times 507 = 13,942,500$ 2
(b) Non-motorised Dugout canoes Thonnies & Vallams	2613	10,000	—	10,000	20,000	$20,000 \times 2613 = 26,130,000$ 2
(c) Motorised Teppams	273	4,000	35,000	10,000	49,000	$49,000 \times 273 = 6,688,500$ 2
(d) Non-motorised Teppams	607	4,000	—	10,000	14,000	$14,000 \times 607 = 4,249,000$ 2
Current value of all Lagoon Craft (Types a to d above)						(51,010,000)
Current value of all Marine and Lagoon Craft						1,910,368,000

TABLE 24  
COST ESTIMATES OF BUILDING AN ABU DHABI BOAT IN 1982 AND 1987

	1982	1988
Hull	730,000	950,000
Engine/equipment	410,000	900,000
Fishing gear	200,000	280,000
<b>Total</b>	<b>1,340,000</b>	<b>2,130,000</b>

Source: Gulbrandsen (1991)

It must be noted that originally the Abu Dhabi boats were issued with 60 nets and 40 baskets of longline. Almost all these boats now operate an average of 80 nets and 75 baskets of longline. The value of fishing gear is therefore set at Rs. 400,000 per boat in Table 23.

In addition to the fleet of Abu Dhabi gillnetters, about 250 boats of the 3.5 to 4 ton class are estimated to operate in the offshore fishery. Some of these boats are equipped with all the basic facilities required for an offshore boat while others (the majority) are open deck boats with a fish-hold for offshore multi-day fishing. Since the exact numbers of these different types are not known, they are lumped together.

The FAO/ADB study of 1988 reported that a total of 13,450 non-motorised traditional craft were operating in the marine and brackish waters of Sri Lanka during 1987. An estimated 4,000 of these craft were operating in brackishwaters. The remaining 9,450 craft except for around 1,000 beach-seine craft, consist of various types of outrigger canoes, thonnies and vallams, teppams and kattumarams. The motorised traditional craft also belong to this category. Since detailed information on the craft composition was not available for 1987, such data available for previous years (1983 and 1984) were utilised to derive a craft composition for the traditional craft in order to estimate the current value for this category of craft.

**TABLE 25**  
**TYPES AND NUMBERS OF TRADITIONAL CRAFT OPERATING IN THE MARINE**  
**AND BRACKISH WATERS OF SRI LANKA IN 1983 AND 1984**

	1983		1984	
	<i>Motorised</i>	<i>Non-motorised</i>	<i>Motorised</i>	<i>Non-motorised</i>
1. Dug out canoes	408	4,460	763	3,742
2. Thonnie/Vallam	471	2,073	349	1,944
3. Teppam/Kattumaram	2,146	4,261	1,853	3,433
4. Beach seine craft	27	1,465	65	1,196
<b>Total</b>	<b>3,052</b>	<b>12,259</b>	<b>3,030</b>	<b>10,315</b>

The motorised traditional craft (excluding the beach-seine craft) consist of approximately 20 percent outrigger canoes, 14 percent thonnie/vallams and 66 percent teppams/kattumarams. The non-motorised traditional craft comprise approximately 41 percent outrigger canoes, 20 percent thonnie/vallam and 39 percent teppam/kattumarams. These figures have been used to categorize the 1987 fleet of traditional crafts. (Table 26).

**TABLE 26**  
**ESTIMATED NUMBERS OF TRADITIONAL CRAFT OPERATING IN THE MARINE AND**  
**BRACKISH WATERS OF SRI LANKA IN 1987**

	<i>Motorised</i>	<i>Non-Motorised</i>
(a) Dug-out canoes	560	3,465
(b) Thonnie/Vallam	392	1,690
(c) Teppams/Kattumaram	1,848	3,295
<b>Total</b>	<b>2,800</b>	<b>8,450</b>

Source: FAO / ADB Study 1988

In estimating the value of a fishing unit, the replacement value of a dug out canoe and thonnie/vallam has been fixed at Rs. 20,000 and that of a teppam at Rs. 4,000. Motorised traditional craft are usually powered by 8 Hp out-board motors, currently valued at Rs. 35,000 each. While gillnet is the most popular gear amongst these crafts, other gear used include handline, bottom set gillnet, and bottom long line. The total value of fishing gear per craft is fixed at Rs. 15,000-20,000 for a teppam and Rs. 25,000-50,000 for other craft.

The fishery survey conducted by the Ministry of Fisheries in 1989 has estimated the total number of beach-seine craft operating in the country to be 1,061. Available information on the numbers of beach-seine craft operating during 1983 and 1984 are shown in Table 26A.

**TABLE 26A**  
**NUMBER OF BEACH SEINE CRAFT OPERATING DURING 1983 AND 1984**

1983 - 1,492 (27 motorised)
1984 - 1,261 (65 motorised)

Source: FAO/ADB Study 1988

The size of a beach-seine net can vary considerably, depending upon the area of operation. It is also customary for one craft to be in possession of more than one net. The value of one beach seine unit may therefore differ considerably from another. Investigations have revealed that a beach seine fishing unit could be worth from Rs. 150,000 to as much as Rs. 600,000, owing to the possible variations mentioned earlier. An average value of Rs. 300,000 has been considered in this exercise to determine the value of the beach seine fishing fleet in the country.

#### 4.2 Lagoon Craft

4,000 non-motorised traditional craft were estimated to be operating in brackishwaters — lagoons and estuaries in 1987 (FAO/ADB 1988). Detailed information available on the composition of the lagoon craft during 1983 and 1984 are given below.

TABLE 27  
COMPOSITION OF LAGOON CRAFT - 1983 AND 1984

		1983	1984
Motorised	(a) Dug out canoes with or without outrigger	439	377
	(b) Thonnie/Vallam	194	182
	(c) Teppams	699	337
	Total	932	896
Non-Motorised	(a) Dug out with or without outrigger	1,368	1,673
	(b) Thonnie/Vallam	1,378	1,682
	(c) Teppams	690	707
	Total	3,436	4,062

Source: FAO / ADB Study 1988

The percentage distribution of lagoon craft categories and the level of motorisation would be as follows:

TABLE 28  
LAGOON CRAFT CATEGORIES - PERCENTAGE DISTRIBUTION AND LEVEL OF MOTORIZATION 1987

	Percent of total fleet	Motorised (percent)	Non-Motorised (percent)
(a) Dug out canoes	41	21	79
(b) Thonnie/Vallam	37	11	89
(c) Teppam	22	31	69

Source: FAO / ADB Study 1988

In the absence of detailed information on the composition of the lagoon fishing fleet in recent years, the above information has been utilised to derive the approximate craft composition for the lagoon fishing fleet in 1987. The 4,000 lagoon craft are therefore categorised as follows:

TABLE 29  
NUMBER OF LAGOON CRAFT - ESTIMATED DISTRIBUTION AND LEVEL OF MOTORIZATION - 1987

	Motorised	Non-Motorised	Total
(a) Dug out canoes	344	1,296	1,640
(b) Thonnie/Vallam	163	1,317	1,480
(c) Teppams	273	607	880

Approximately 20 percent of the lagoon fleet is motorised. The dug out canoes used in lagoons are often smaller than the canoes used in the inshore marine fishery. The motorised canoes are powered by 6-8 Hp out-board motors, as are the motorised Thonnie/Vallams and the Teppams.

The approved prices of some of the outrigger canoes as at September 1990 are given in Table 23, with upward revisions requested in some cases.

In view of the different sizes of outrigger canoes, thonnies and vallams used in the brackishwater fisheries, a flat price of Rs. 10,000 has been taken as the current replacement value of the craft. In the case of teppams, the replacement value is set at Rs. 4,000, as the approved price ranges from Rs. 3,150 to Rs. 4,740, depending on the size of the teppam and the area of supply. Gill netting, cast netting and traps are the main fishing gear employed in the lagoon fisheries. All lagoon craft are assumed to possess fishing gear currently (1991) valued at Rs. 10,000 per craft.

The estimated current value of the marine and brackishwater fishing fleets based on the above mentioned assumptions, has been worked out in Table 23. The estimated value of the country's total fishing fleet operating in Sri Lanka (in 1991) would therefore be in the region of Rs. 1,910 million.

	<i>Value</i>
Marine fleet	— Rs. 1,859,358,500
Brackishwater fleet	— Rs. 51,010,000
Total fleet	Rs. 1,910,368,500

#### 4.3 Fishing without craft in Lagoons and Brackishwater

A significant portion of the lagoon and estuarine fish production comes from fishing conducted without craft. Cast nets, traps (for crabs), Kattu del, Haras del, Kaddipu del, fish kraals or Jakottu etc. are the gear used. Cast netting and stilt fishing are also practised in inshore seas, close to the edge of the beach. No reliable information exists regarding the numbers of such gear used in all the lagoons and other brackishwater bodies. Some of the gear are also area specific and not found in other lagoons and brackishwaters. For example, fish kraals are found only in the western and southern coastal region while Haras del are reported only from the Chilaw lagoon. Information available for Negombo, Chilaw and Puttalam lagoons, Bolgoda estuary etc. have been used to extrapolate the number and the value of the different types of major gear operated without craft in the total area covered by lagoons and other brackishwaters in the country. As when estimating the value of fishing fleets, 50 percent replacement value of the gear is considered as its current value.

TABLE 30  
FISHING GEAR USED WITHOUT CRAFT (BOATS) IN LAGOONS AND OTHER BRACKISHWATERS  
IN SRI LANKA IN 1987 - ESTIMATES OF CURRENT VALUE

<i>Type of Gear</i>	<i>Total No.</i>	<i>Unit Cost (Rs.)</i>	<i>Current 1991 value (Rs.)</i>
Cast nets	6,000	750	2,250,000
Kadippu net	1,800	3,000	2,700,000
Kattu del	100	8,000	200,000
Haras del	100	4,000	200,000
Crab trap	8,000	15	60,000
Valachchal net	150	3,000	225,000
Fish kraals	100	25,000	1,250,000
Other gear (approximate value)	—	—	200,000
Total			7,085,000

The approximate current value of fishing gear used without craft in lagoons and brackishwater bodies in Sri Lanka is thus shown to be in the region of seven million rupees.

The value of the total fishing fleet operating in the coastal area (both in the seas and brackish waters) plus all fishing gear used without craft would therefore amount to approximately Rs. 1,917 million in 1987.

#### 4.4 Cost of Fishing

##### Multi-day Boats

The performance of some of the offshore multiday boats in recent years in terms of fishing effort, catch, income and operational expenses is presented in Table 31. NW4 is a 34 ft. Abu Dhabi boat while the others are 30-32 ft. (9 to 10 m.) 3-4 ton boats.

TABLE 31  
FISHING OPERATIONS-DATA FROM SELECTED OFFSHORE MULTI-DAY BOATS

	NM207 (32 ft.)	SRL/15 (30 ft.)	NW4 (34 ft.)	NW4 (34 ft.)	SRL/34 (32 ft.)
No. of trips	46	54	52	30	45
No. of sea days	165	214	—	179	104
No. of fishing days	137	173	207	152	90
Total catch (kg)	30,176	30,319	70,650	35,307	16,579
Value of catch (Rs.)	616,877	605,473	1,007,239	689,849	306,957
<b>Expenses (Rs.)</b>					
Fuel	51,761	47,648	226,496	144,984	27,366
Food	34,000	45,650	90,850	45,550	17,800
Ice	34,300	29,850	102,720	75,950	20,680
Bait	1,016	1,188	—	832	—
Others	26,700	27,410	—	21,050	3,033
<b>Total</b>	<b>147,777</b>	<b>151,746</b>	<b>420,066</b>	<b>288,266</b>	<b>68,879</b>
Net Earnings	469,100	453,727	587,173	401,483	238,078
Crew share	234,550	226,863	293,586	200,741	119,039
Boat owner's share	234,550	226,864	293,587	200,742	119,039
Period	Feb. - Oct. 1988	Nov. 87- Oct. 1988	Nov. 86- Oct. 1987	Nov. 87- Aug. 1988	May - Nov. 1987
Base of operation	Galle	Galle	Galle	Galle	Beruwala

Operational data in some cases are available only for periods of less than 12 months. The larger Abu Dhabi boats with a high carrying capacity usually carry more fishing gear (gillnets and long lines) than the smaller boats and record higher catches and incomes. Operations of NW4 boats during 1987/88 were limited by a shortage of fishing gear and other factors, which affected their performance in terms of catch and income, compared to 1986/87. The estimated annual production from these boats has been estimated to be:

NW 4	1986/87	70.7 mt.
NW 4	1987/88	42.4
NM 207	1988	40.2
SRL/15	1987/88	30.3
SRL/34	1987	28.4

The operational expenses on an annual basis, per fishing trip and per sea day for the offshore multiday boats are given in Table 32. The major items of expenditure are fuel food and ice. The smaller boats need Rs. 650 to Rs. 900 per sea day.

**TABLE 32**  
**OPERATIONAL EXPENSES OF SELECTED OFFSHORE MULTI-DAY BOATS (IN RUPEES)**

	<i>SRL/15</i> <i>(1987/88)</i>	<i>NM/207</i> <i>(1988)</i>	<i>SRL/34</i> <i>(1987)</i>	<i>NW 4</i> <i>(1986/87)</i>	<i>NW 4</i> <i>(1987/88)</i>
<b>(a) Annual expenditure</b>					
Fuel	47,648	69,015	46,913	226,496	173,981
Food	45,650	45,333	30,514	90,850	54,660
Ice	29,850	45,733	35,451	102,720	91,140
Bait	1,188	1,355	—	—	998
Others	27,410	35,600	5,199	—	25,260
<b>Total</b>	<b>151,746</b>	<b>197,036</b>	<b>118,077</b>	<b>420,066</b>	<b>346,039</b>
<b>(b) Expenses per trip</b>					
Fuel	882	1,1131	609	4,356	4,833
Food	845	743	396	1,747	1,518
Ice	552	750	460	1,975	2,531
Bait	22	22	—	—	28
Others	508	584	68	—	702
<b>Total</b>	<b>2,809</b>	<b>3,230</b>	<b>1,533</b>	<b>8,078</b>	<b>9,612</b>
<b>(c) Expenses per sea day</b>					
Fuel	223	314	264	1,094	810
Food	213	206	1711	439	254
Ice	139	208	199	496	424
Bait	6	6	—	—	5
Others	128	162	29	—	118
<b>Total</b>	<b>709</b>	<b>896</b>	<b>663</b>	<b>2,029</b>	<b>1,611</b>

Costs of production of one kg. of fish in an Abu Dhabi boat amounted to Rs. 5.95 in 1986/87 and Rs. 8.16 in 1987/88. The landed value of one kg. of fish from this boat yielded Rs. 14.25 in 1986/87 and Rs. 19.50 in 1987/88. The corresponding values for the smaller boats show a better economic return compared to the larger Abu Dhabi boats.

**TABLE 33**  
**OFFSHORE MULTIDAY BOATS - COST OF PRODUCTION AND LANDED VALUE OF CATCH**  
**1986 - 1988**

	<i>Cost of Production</i> <i>(Rs./Kg.)</i>	<i>Landed value of catch</i> <i>(Rs./Kg.)</i>
Abu Dhabi boat (1986/87)	5.95	14.25
Abu Dhabi boat (1987/88)	8.16	19.50
NM 207 (1988)	4.90	20.44
SRL/15 (1987/88)	5.00	19.97
SRL/34 (1987)	4.15	18.51

**Coastal day boats of 3.5 GT class**

The operational expenses of a 3.5 GT day boat amounted to about Rs. 540 per day in 1987, as indicated by the following information obtained from the operation of a 3.5 GT boat at Beruwela monitored during 1987.

Cost of fuel (45.8 lit/day)	Rs. 368
Cost of food	99
Cost of ice/bait	59
Other expenditure	17
<b>Total</b>	<b>543</b>

In estimating fish production through a two stage stratified sampling, the Ministry of Fisheries assumed a total of 240 fishing days per annum (20 days per month) for all day boats. On this basis, the total annual operational expenditure of a 3.5 GT day boat would be Rs. 129,600.

The average annual production from a 3.5 GT class of boat in the coastal fishery was 19.2 mt. in 1987 (Table 10). The cost of production of one kg. of fish from this type of boat therefore works out at Rs. 6.75.

#### Craft with Outboard motors

The annual expenses on fuel and food of a sea going motorised 5-6 m. FRP craft is estimated at Rs. 44,000 and that of a lagoon craft at Rs. 35,000. Considering that these estimates are for a total of 240 fishing days per annum, the daily operational expenses will be Rs. 183 and Rs. 145 respectively. Motorised traditional craft operating in the sea can also be assumed to have the same operational expenses as the 5-6 m. FRP craft.

Fishing operations data from 1988 to 1990 are presented in Table 34 for two types of outrigger canoes operating from Dodanduwa on the south-west coast of Sri Lanka — a traditional canoe (vallam) fitted with a 15 Hp outboard motor (OBM) and a planked canoe (introduced by the FAO/BOBP)\* fitted with a 8 Hp OBM.

TABLE 34  
COMPARATIVE PERFORMANCE OF TRADITIONAL CANOE AND INTRODUCED CANOE

Period	Traditional canoe (vallam)	Introduced Planked Canoe (FAO/BOBP)	
	June 88 - May 89	June 88 - May 89	July 89 - June 90
No. of fishing days	144	208	203
Total catch (kg.)	4,155	6,905	9,258
Value of catch (Rs.)	81,610	138,952	205,231
Running costs (Rs)			
Fuel	16,375	17,556	20,445
Food			19,585
Others			1,950
<b>Total</b>	<b>32,711</b>	<b>32,398</b>	<b>41,980</b>

Source: FAO - Bay of Bengal Project

The average catch per fishing day was approximately 29 kg. for the vallam and 33 kg. and 45 kg. for the planked canoe during 1988/89 and 1989/90 respectively. While the vallam had engaged only in drift gillnet fishing, the planked canoe had also carried out inshore ring net fishing achieving better catch rates. The total running costs averaged Rs. 227 per day for the vallam and Rs. 181 for the planked canoe. The cost of producing one kg. of fish amounted to Rs. 7.87 for the vallam and Rs. 4.60 for the planked canoe.

#### Non-motorised traditional craft

Non-motorised traditional craft which fish inshore and in lagoons for a few hours a day (not exceeding 12 hours) may incur operational expenses of Rs. 10 to 20 per day. The higher expenditure is mostly on kerosine for the night lamp during night fishing. This works out to an annual expenditure of Rs. 4,800 per craft.

#### Imports, Exports and Supply Situation

Fish and fish products are imported into Sri Lanka mainly in the form of prepared and preserved fish (canned fish), dried fish and maldive fish. The quantity and value of fishery products imported during the period 1977 to 1989 are given in Table 35. There is no consistent pattern in regard to imports. The imports have fluctuated between 5,000 and 22,000 mt. per year upto 1982. A marked increase in imports is seen after 1983 as a result of reduced local fish production. Dried fish (74%) and canned fish (20%) made up the bulk of fish imports in 1989. The dried fish comes from India, Pakistan and recently, Thailand and the Maldives. Canned fish imports are from South America, Thailand and Japan.



TABLE 35(A)  
VOLUME OF IMPORTS OF FISH AND FISHERY PRODUCTS, 1977-1989

Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Maldive fish	670	236	132	235	97	224	840	679	1,188	1,390	1,891	1,320	2,284
Dried fish	2,745	3,029	6,750	11,441	3,919	7,164	10,345	33,357	23,412	22,641	28,470	29,248	17,053
Preserved or prepared (tinned) fish	1,794	1,856	11,886	10,714	3,192	6,418	5,594	10,975	11,338	8,356	7,740	8,311	6,941
Others	10	73	23	553	78	6	2	186	36	12	33	8,741	9,718
Total	5,219	5,194	18,791	22,943	7,286	13,812	16,781	45,197	35,974	32,399	38,134	45,620	35,996
Wet equivalent of imports	19,289	18,749	25,821	34,606	10,921	21,430	26,009	80,005	61,798	80,997	95,335	114,050	89,989

Source: Customs Returns

TABLE 35(B)  
VOLUME AND VALUE OF IMPORTS OF FISH AND FISHERY PRODUCTS, 1985-1989

Description	1985		1986		1987		1988		1989	
	Volume <sup>1</sup>	Value <sup>2</sup>	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Maldive fish	1,188.40	56.51	1,389.85	72.95	1,891.10	94.67	1,319.60	108.30	2,283.68	129.72
Dried fish	23,412.40	453.05	22,641.14	550.87	28,470.30	660.28	29,247.60	832.90	17,053.27	438.94
Prepared and preserved fish	11,337.92	244.37	8,356.40	209.42	7,740.47	169.69	6,310.70	191.80	6,941.40	280.76
Others	25.77	0.40	1.14	0.67	3.23	0.82	8,741.30	1.20	9,649.52	206.29
Crustaceans, molluscs and others	9.85	1.84	11.07	5.08	30.02	11.12	13.10	2.82	68.06	3.16
Total	35,974.34	756.17	32,399.60	838.99	38,135.12	956.58	45,632.30	1,137.02	35,996.03	1,056.97

Source: Ministry of Fisheries and Aquatic Resources

1. Volume in metric tons
2. Value (cif.) Rupees million.

Export of fish and fishery products from Sri Lanka on a commercial scale began in the early 1970's and has grown rapidly in recent years. The main items of export are processed shrimps and lobsters, shark fins, cuttlefish, crabs, Beche-de-Mer, and live tropical fish. Export of various fishery products (quantities and values) from 1985 to 1989 are given in Table 36. Exports comprised less than 3 percent of all fish and fishery products produced in the country. The composition of 1989 exports, worth Rs. 845 million and the form (condition) in which these were exported is given in Table 37.

TABLE 36  
VOLUME AND VALUE OF EXPORTS OF FISH AND FISH PRODUCTS 1985-1990

Description	1985		1986		1987		1988		1989		First half 1990	
	Volume <sup>1</sup>	Value <sup>2</sup>	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Shrimp	1,648.05	303.31	1,973.03	427.93	1,231.39	339.13	1,826.00	526.80	2,597.92	767.17	921.84	275.41
Lobsters	64.23	6.38	138.74	20.17	168.36	31.13	223.30	28.40	228.47	98.92	109.68	44.27
Shark fins	26.17	10.24	34.46	13.81	50.23	25.40	45.40	30.70	100.65	64.02	20.10	16.84
Beche-de-Ner	23.23	6.40	41.14	9.76	12.66	3.55	54.10	24.03	51.26	26.91	16.89	9.87
Fish alive	104.38	30.53	123.56	29.63	119.42	35.61	161.80	74.20	259.59	105.58	114.33	56.00
Chank and shells	151.14	5.53	165.55	7.55	145.79	7.61	310.00	23.00	—	—	232.92	6.71
Other crustaceans	1,219.65	89.83	933.96	99.60	648.81	133.45	575.40	106.30	729.42	69.71	344.42	39.64
Other dried fish, smoked fish	3.74	0.89	0.37	0.03	0.12	0.04	0.93	0.08	1.95	0.38	8.38	5.68
Frozen fish	0.01	—	—	—	0.01	0.01	300.00	10.90	12.968	4.50	272.26	25.27
Total	3,240.60	453.11	3,410.81	608.48	2,376.79	575.93	3,496.93	824.41	3,982.24	1,137.19	2,040.82	479.69

Source: Export Development Board

1. Volume (metric tons)
2. Value (cif.) Rupees million.

**TABLE 37  
EXPORTS OF FISHERY PRODUCTS IN 1989**

<i>Product Composition of Exports</i>		<i>Form (Condition) of Exports</i>		
<i>Product</i>	<i>Percentage of total Exports of Fishery Products</i>	<i>Form of Export</i>	<i>Percentage of total Exports of Fishery Products</i>	<i>Products so exported</i>
Shrimps	60.4	Frozen	71.6	Shrimp, lobster, cuttlefish
Lobsters	9.3	Fresh/chilled Live	9.8	food fish crabs, ornamental fish
Live fish	9.1		8.9	
Cuttlefish	5.9	Dried	7.7	shark fins, Beche-de-Mer
Shark fins	4.9			
Crabs	4.6	Others	2.0	
Beche-de-Mer	2.0			

Source: Customs Returns

Exports of fishery products are made mostly in the frozen form. Major items thus exported are shrimp, lobsters and cuttlefish. Ornamental fish and crabs are the major items of live export. Shark fins, Beche-de-Mer and sea weeds are exported in the dried form. Other products which form a minor sector of the exports include fish liver oil, sea shells and fish meal.

The steady growth in exports in recent years has had a favourable impact on the country's balance of trade in fish and fish products (Table 38). The disturbances in 1983 resulted in a trade deficit which continued until 1988. The improved internal security situation in 1989 again made the trade balance favourable. This sensitivity to internal stability is due to that fact that most of the supplies for export originate in the North and East, the major areas of civil unrest.

**TABLE 38  
BALANCE OF TRADE IN FISH AND FISH PRODUCTS — 1977 TO 1991 (RS. MILLION)**

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Exports	95	233	295	173	346	437	423	615	453	609	576	825	1,137	883	856
Imports	20	34	192	298	109	318	345	623	756	839	956	1,137	1,058	950	2,003
Balance	+75	+199	+103	-125	+237	+119	+78	-8	-303	-230	-380	-312	+79	-67	-1,147

Source: Ministry of Fisheries and Aquatic Resources

The numbers of registered exporters in the Fisheries sector are shown in Table 39.

**TABLE 39  
NUMBER OF EXPORTERS OF FISHERY PRODUCTS**

<i>Product/s</i>	<i>Number of Exporters</i>
Chank shell	14
Conch shell	17
Ornamental sea shell	3
Shrimp, lobsters	24
Ornamental fish	60
Shark fin	4
Shark liver oil	4

Source: Export Development Board / Ministry of Fisheries and Aquatic Resources

Shrimp is the major item of export. The development of shrimp aquaculture in recent years has contributed significantly to the growth of shrimp exports in recent years.

The quantities and value of shrimp exports in recent years are shown in Table 40.

TABLE 40  
SHRIMP EXPORTS — 1985 TO 1991 — QUALITY AND VALUE

	Quantity (Metric tonnes)	Value (Rs. million)
1985	1,648	303
1986	1,923	427
1987	1,271	343
1988	1,826	532
1989	2,598	767
1990	1,855	486
1991	943	455

Source: Customs Reports

The supply of export items, like shrimp and lobster (from the wild) and beche-de-mer from the North and East have been affected by civil disturbances. Although the development of shrimp farming has compensated for the loss of supplies from these areas, some of the farms have met with disease problems. Entrepreneurs are therefore cautious about expansion, because of the concomitant heavy expenditure.

Meanwhile, new forms of fish products are in demand in export markets, but the uncertainty of the supply situation, whether from the wild or from farms, inhibits investment to re-equip processing plants to handle these new products. For the same reason, exporters continue to export shrimp and prawn in bulk, without adding further value; had value added processing been developed, it would have enhanced export earnings and helped to offset the lower volumes being exported because of inadequate supplies.

More than 100 businesses are registered as exporters, but not all of them are processors. Some merely pack and export products processed by others. The traditional export products were seashells, shark fins and beche-de-mer. Fins are severed from the shark's body at the time of selling the fish, then merely dried, sorted and packed for export. Beche-de-mer has to be boiled, dried and sorted before packing for export. These products are shipped mostly to Hong Kong and China where they are reprocessed and further value is added. There has been no serious attempt to add more value to these products in Sri Lanka by further processing.

Less traditional exports are Crustacea (Shrimp, Crab) and Cephalapods (Squid, Cuttle fish). These are processed to suit overseas buyers, but again very little value is added and they continue to be shipped in bulk. Processing facilities have been established for these products and the processed products are subjected to close inspection and supervision by the Sri Lanka Standards Institute. As a result, these Sri Lankan products enjoy a good reputation abroad. Products so processed are:

- Lobster — frozen tails, frozen whole, cooked and frozen whole.
- Shrimp — headless shell on, peeled and de-veined, peeled and cooked, all frozen.
- Lagoon Crab — frozen meat.
- Cuttle fish — cleaned, wrapped, frozen.

Of about 20 processing companies in operation five years ago, only about 3 or 4 are now active; the others have folded up. Those still active are operating at well below their capacity, because of inadequate supplies of raw materials.

Exports of live ornamental fish have shown steady growth, with earnings increasing from Rs. 30 million in 1985 to Rs. 105 million in 1989. While small quantities of marine ornamental fish had been exported since the 1960's, exports of both marine and freshwater ornamental fish have shown a marked increase during the last decade. The marine fish captured from the wild make up 80 percent of the exports, the balance being locally bred. Eighty percent of the world trade in ornamental fish is however freshwater fish; the remainder comprise marine and brackishwater fish and marine invertebrates. A fishery for export of juvenile fish for cage culture — mainly grouper

fingerlings — also developed in the mid-1980's. Large populations of juvenile groupers found in Negombo, Chilaw and Puttalam lagoons supported a thriving export trade during 1987-1988. During 1988, a total of 26 million juvenile groupers were exported, earning Rs. 30 million out of the total exports worth Rs. 81 million that year. The supply of juvenile groupers from the lagoons has slowed down since 1988.

Ornamental fish exports are also experiencing a drop in supplies from the wild and exporters have had to resort in increasing degree to tank-breeding. While Sri Lanka is respected for the high quality of fish that it breeds and exports, it has to develop an assortment of fish that can be offered to the international market. Lowering the cost of production and further improvement of quality are guidelines for future development work.

Exports of other commodities like beche-de-mer, shark fins and seashells also registered a drop as most of these originated from the North. All in all, the export prospects are, as of this moment, somewhat bleak. Supplies from the wild will increase once normalcy returns to the North and the East, but the full potential of the export sub-sector will still remain to be realized.

Total fish supply in the country was 286,000 tonnes in 1989, made up as shown in Table 2. From 1991 fish supplies are projected to grow at an annual rate of around 5.5 percent reaching 222,750 tonnes in 1994 (MFAR Development Plan). In broad terms, production from the marine fisheries is expected to increase with increased exploitation of off-shore areas.

The output from the inshore marine fisheries is likely to stabilize at around current levels. Production from the inland fisheries sub-sector may well decline as a result to the Government's withdrawal of support to this sub-sector. The gap which has always existed between internal supply and demand will thereby be perpetuated and will have to be met by continued and increased imports of dried and canned fish if per capita levels of fish consumption are to be maintained. In 1990 imports of dried fish and canned fish provided over 40 percent of the total national fish protein supply.

Further levels of consumer demand for fish will depend on,

- population growth
- per capita income patterns, and
- fish prices relative to other sources of protein.

Population projections based on recent trends forecast an increase in population from 16.99 million in mid-1990 to 18.10 million in 1995 and 19.09 million in the year 2000. Assuming that the per capita consumption is maintained at the 1989/1990 level of 16.9 kg, the total demand would be 305,9000 tonnes in 1995 and 322,600 tonnes in the year 2000. It is difficult to estimate future deficits in domestic fish supplies owing to uncertainties involved in projecting future performance of the offshore, inshore and inland fisheries.

The growth in marine fisheries has averaged 4 percent per annum during the past few years. If supplies do not increase from the 1989 level of 205,000 tonnes, the shortfall could reach 120,000 tonnes in the year 2000. Sri Lanka's ability to finance fish imports of this magnitude is questionable, indicating the urgent need for strong measures to increase production in both marine and inland sectors of the fishing industry.

## 6. BRACKISHWATER AQUACULTURE

The total extent of brackishwater areas in Sri Lanka has been estimated at 120,000 ha, consisting of extensive lagoons, tidal flats, estuaries, swamps etc. (Jayasekera, 1990) (Table 41).

TABLE 41  
EXTENTS OF BRACKISH WATER AREAS IN SRI LANKA

Deep lagoons and estuaries	80,000 ha
Shallow lagoons/tidal flats	40,000 ha
Total	120,000 ha.

Source: Jayasekera (1990)

While the deep lagoons and estuaries are the sites of important fisheries, the shallow lagoons, mangrove swamps and saline marshes represent potential areas for aquaculture. Land that is potentially suitable for aquaculture has been estimated at 6,000 ha (Samaranayake, 1986), 57 percent of such land being situated along the north and east coasts.

TABLE 42  
THE EXTENT OF AREA SUITABLE FOR COASTAL AQUACULTURE

District	Extent ha.
Puttalam	1,200
Hambantota	400
Galle	200
Batticaloa	1,600
Mannar	800
Jaffna	400
Trincomalee	600
Mullaitivu	800
Total	6,000

Source: Samaranayake, 1986

### Milkfish Culture

Brackishwater aquaculture in Sri Lanka is still in its infancy, with limited information and documented data being available. The only species utilized in the development of brackishwater aquaculture are *Chanos chanos*, the milk fish, and the marine shrimp species, *Penaeus monodon*, *P. indicus*, *P. merguensis* plus the *Metapeneaus* species entering the ponds naturally. Milkfish culture had developed to some extent during the last decade. The fry collected from the northern province were nursed up to the fingerling stage in the Ministry of Fisheries stations at Pitipana (Negombo) and Pambala (Chilaw) for distribution to fish pond operators. Culture of milkfish has been concentrated in the north-western and western areas with seed being collected from the wild. There were 58 establishments engaged in extensive culture of milkfish in 1987 in a total water area of 3.68 ha. Production and value of cultured milkfish are shown in Table 43.

TABLE 43  
CULTURED MILKFISH — PRODUCTION AND VALUE

	Production (mt.)	Value (Rs. '000)
1981	0.35	3.2
1982	0.70	7.2
1983	1.00	13.5
1984	1.00	15.0
1985	1.10	19.3
1986	2.30	42.5
1987	6.60	92.0

Source: Siriwardena (1989)

Because of high fry potential (Ramanathan & Jayamaha, 1972) and the availability of 10,000 ha. of brackishwater areas suitable for milkfish farming (Thayaparan & Chakerabarty, 1984) milkfish (*Chanos chanos*) still remains an important culture species. The seasonal availability of fry often allows only one culture cycle in most cases. The richest fry supply area of Mannar has also been out of reach since 1983 due to civil disturbances. These factors account for the poor growth and development of milkfish culture since 1981. The producer price per kg. of milkfish had increased from Rs. 9.00 in 1981 to Rs. 20.00 in 1987.

### Shrimp Culture

Thirty one species of shrimps have been recorded from Sri Lankan waters. Of these only the penaeid shrimps have commercial value. *Metapenaeus dobsoni* is the most abundant among those species that are found in both estuarine and marine waters. Being one of the smallest in size it is however not as commercially important as less abundant species such as *P. indicus*, and *P. semisulcatus* (de Bruin 1970). At landing sites shrimps are divided into two groups — large and small. In Sri Lanka shrimps are generally referred to as prawns.

Large shrimps ("prawns") comprise mainly:

- *Penaeus indicus*
- *Penaeus monodon*
- *Penaeus semisulcatus*
- *Penaeus merguensis*

Small shrimps ("prawns") comprise mainly:

- *Metapenaeus dobsoni*
- *Parapenaeopsis stylifera*

The producer's price is determined by the size, and not by the species. (Siriwardena, 1990).

Interest in shrimp farming developed in the late 1970's with a small shrimp farm commencing operations in Batticaloa in 1977. With the Government offering various incentives, a number of small scale entrepreneurs and a few large multi-national companies have ventured into shrimp farming since 1982. The total pond area approved by the inter-ministerial scoping committee for aquaculture projects was 719.6 ha.; 253.6 ha. of this has been developed (Jayasekera, 1990).

Shrimp culture operations are entirely in the hands of private entrepreneurs who use local labour and, partly, expatriate technicians. Large extents of land adjacent to lagoons have been utilized for shrimp culture which developed rapidly on the western and northwestern coasts in the mid-1980's. Operations along the east coast ceased after the 1983 civil disturbances.

All on-going shrimp farms are located in the coastal belt of the western and north-western provinces. More large scale operations practising intensive culture are located in the north western province (7 out of 10 establishments in 1988) than in the western province. The two farms operating in the western province are small and use semi-intensive culture techniques. The low population density and availability of more land in the north-western province facilitate large scale operations.

TABLE 44  
SHRIMP FARMS IN SRI LANKA 1988

	Farms	Water area under culture	People employed	Yield	Value
Province	No.	ha.	No.	(mt.)	Rs. million
Western	2	1.2	4	2.4	0.6
Northwestern	10	176.0	222	669.0	174.0
Total	12	177.2	226	671.4	174.6

Source: Siriwardena (1989)

Due to its faster growth, large size attained and export potential, black tiger prawn *Penaeus monodon* has been almost exclusively used in brackishwater shrimp culture. Production of *P. monodon* increased from 10 mt. in 1984 to 400 mt. in 1987, the value of production increasing from Rs. 1.5 million in 1984 to Rs. 88 million in 1987.

The quantities of shrimp produced in brackishwater culture and their value are as follows;

TABLE 45  
SHRIMP PRODUCTION FROM BRACKISHWATER CULTURE

	Quantity (mt.)	Value (Rs. million)
1984	10	1.5
1985	50	8.5
1986	200	40.0
1987	400	88.0
1988	699	200.7

Source: Siriwardena (1989)

The total area under shrimp culture increased from 3 ha. in 1984 to 90 ha. in 1987. (Table 45).

TABLE 46  
BRACKISHWATER SHRIMP CULTURE FARMS  
NUMBER AND AREA UNDER CULTURE

	No. of Farms	Area under culture
1984	1	3
1985	1	12.5
1986	3	35
1987	4	90
1988	12	177
1989	52	243

Source: Siriwardena (1989)

There were a total of five shrimp hatcheries in 1988, four run by the private sector and one by the Government, the target species being the black tiger prawn, *P. monodon*. The expansion of hatcheries from 1984 to 1988 is set out in Table 47 (Siriwardena, 1989).

TABLE 47  
SHRIMP HATCHERIES IN SRI LANKA

	No. of Hatcheries	Production Million Postlarvae/month
1984	1	1.0
1985	1	1.0
1986	3	1.75
1987	4	3.85
1988	5	6.25

Source: Siriwardena (1989)

According to a more recent study (FAO/ADB, 1991), 70 shrimp farms with a total pond area of 325 ha. under culture were operating in 1990. These farms are classified in Table 48.

TABLE 48  
SHRIMP FARMS IN SRI LANKA, SIZE AND POND AREA

Large farms (over 5 has)	12
Medium farms (1-5 ha.)	18
Small farms (upto 1 ha.)	40
Total	70

Source: FAO / ADB (1988)

Table 49 gives data on shrimp ("prawn") production from culture as well as from capture fisheries during recent years. Progressive deterioration of pond environments due to intensive culture and the lack of measures to prevent this and disease problems have adversely affected the output from "prawn" farms.

TABLE 49  
SHRIMP PRODUCTION, 1985-1990  
(metric tons)

<i>Year</i>	<i>Wild Catch</i>	<i>Farmed shrimp</i>	<i>Total</i>	<i>% Farmed Shrimp in Total</i>
1985	4,192	100	4,292	3
1986	4,311	200	4,511	6
1987	4,461	375	4,836	12
1988	4,635	500	5,135	15
1999	4,704	600	5,306	22
1990	M.A. <sup>2</sup>	500	-	-

1. Amounts relate to quantities processed. Assumes that rejects and local sales are negligible.

2. 1,200 tons taken for processing for export from wild catch. Total catch not available.

Source: FAO / ADB 1988

Farmers who were committed to intensive culture have without exception responded to the problem of disease by resorting to semi-intensive culture with reduced stocking densities and two crops per year, thereby allowing time for the treatment of ponds. Although it was a step backwards, it was necessary until such time research and development evolve an intensive production system suited to prevailing local conditions which can be profitably sustained. On a semi-intensive basis, production from the existing 325 ha is estimated at 960 to 1,000 metric tons per year.

Prospects for accelerated development of shrimp culture are promising. The scope for further growth will depend on the production potential of the existing brackishwater bodies.

Of the three sizes of shrimp farms the small sector contains the largest number. These farms are viable and their numbers are expected to increase, because of Government policy not to permit the existing large farms to become larger and not to approve any more large scale shrimp farms. The small farms may not be able to benefit from technological advances that are bound to be made in future, and may therefore become inefficient. For this reason it is unlikely that the small scale sector will have the capability to shoulder the main thrust of increased production. The large farms are at present finding it difficult to service the heavy capital investment already made for intensive culture with their present reduced income resulting from their shift to semi-intensive culture. They may have to trim their operations and accept production volumes and turnover well below what had originally been envisaged. The entrepreneurs who comprise the medium scale sector are relatively new in the field and have the benefit of the past experience of the pioneers. Their farm sizes (1 to 5 ha) with individual ponds varying from 0.5 ha to 1 ha, are large enough for efficient operation and for implementation of technological changes and improvements while retaining adequate flexibility. While a more detailed analysis has still to be carried out to ascertain the merits of each farm size the medium scale sector may well represent the main direction in which the industry will grow in the future, (FAO/ADB, 1988).

At present shrimp farming operations are confined to the coastal belt from Negombo to Puttalam. The only large scale farm located in the east coast has been abandoned owing to civil disturbances. It could be quite some time before shrimp culture gets going in the north and east. In the northwest area there are still around 250-300 ha allocated to shrimp farming. With semi-intensive farming, this area could easily yield another 1,000 metric tons a year. Questions have been raised as to whether the inter-connected lagoon complex between Negombo and Puttalam can continue to sustain 600-700 ha of shrimp ponds. The canal that serves as the main source of brackishwater for the farms is apparently polluted and the situation has been aggravated by recent droughts. With the discharge of shrimp farm and other waste the quality of water has become very poor causing low



productivity and disease. Therefore it appears to be necessary for the Government to undertake early the rehabilitation of the main supply canal including its dredging as the private sector has invested considerable amounts of money in developing shrimp farming in this area.

The FAO/ADB study concludes that when the security situation improves and prospects of shrimp farming in the north, east and south are also good, an estimated 2,000 ha would be available for development to achieve a production of approximately 8,000 tonnes. Therefore it is essential that Government also support the industry by way of major schemes in training, extension, research and development, including disease control and nutrition, provision of infrastructure such as electricity, transport, communication and adequate credit through banks.

## 7. NON-FINFISH RESOURCES OF THE COASTAL ZONE

A variety of non-fish resources are exploited from the coastal sea as well as from the brackishwaters within the coastal zone. Although targetted fisheries have developed for most of these resources, detailed information regarding production, potential etc. are generally lacking, except information regarding exports.

### 7.1 Shrimp capture fishery

Until the 1960's, the shrimp capture fishery was confined largely to lagoons and estuaries; annual production was around 100 mt. With the increased demand for export, a trawl fishery developed along the north and northwest coasts. Production of shrimp from the capture fishery increased from 3302 mt. in 1980 to a peak 7736 mt. in 1982. The production and value of shrimp from the capture fisheries from 1980 to 1987 are given in Table 50 (Siriwardena, 1989).

TABLE 50  
SHRIMP CAPTURE FISHERY — PRODUCTION VOLUME AND VALUE

Year	Production Volume (mt.)				Value of Total Production (Rs. Million)
	<i>Penaeid</i>	<i>Metpenaeid</i>	<i>Parapeneopsis</i>	Total	
1980	1155	1321	826	3302	100.69
1981	1591	1819	1137	4547	166.40
1982	2707	3095	1934	7736	343.81
1983	1690	1932	1207	4829	246.27
1984	1428	1225	1428	4081	249.95
1985	1467	1258	1467	4192	272.25
1986	1293	1293	1725	4311	379.17
1987	1338	1338	1785	4461	379.17

Source: Siriwardena (1989)

Of the ten species of shrimps commonly recorded in the commercial catches, only six make significant contributions to the fishery: the white prawn (*Penaeus indicus* and *P. merguensis*), the green tiger prawn (*P. semisulcatus*), the black tiger prawn (*P. monodon*) and the small prawns (*Metapenaeus dobsoni* and *P. stylifera*). The trawl fishery in Negombo is carried out by traditional outrigger canoes while in Chilaw, Puttalam, Mannar and Jaffna areas inboard mechanised crafts of various sizes are used in the fishery. Continuation of the shrimp fishery in the lagoons using cast nets, traps and trammel nets and expansion of the trawl fishery in the sea for different components of the same stock have created interactive and competitive fisheries resulting in conflicts amongst user groups and in damage to the resource.

The results of investigations into shrimp fisheries in Negombo and Chilaw do not present any encouragement for further development. For example, the catch rate in the Negombo trawl fishery has declined from 7 to 8 kg/oru/day in 1978/79 to 4.5 to 4.8 kg/oru/day in 1985/86 (Jayakody and Jayawickrama, 1987). The general trend discourages any further expansion of the trawl fishery for shrimp and management of the resource is felt to be long overdue.

## 7.2 Lobster Fishery

Six species of lobsters, *Panulirus sp.* are exploited from the inshore reefs and rocky areas. The fishery is conducted using bottom set nets, traps and by diving for them in waters up to about 20 m. deep. The resource is heavily exploited to meet the heavy demand for export and for tourist hotels. Production has declined from 2599 mt. in 1977 to 663 mt. in 1989 (Table 51). Quantities exported have also declined from 385 mt. in 1977 to 223 mt. in 1988. Since 1985 the lobster fishery along the south coast which contributes one third of current production, has been investigated by NARA. The recent islandwide decline is reflected here too. (Table 52).

TABLE 51  
LOBSTER PRODUCTION IN SRI LANKA

	<i>Production (mt.)</i>	<i>Value (Rs. million)</i>	<i>Export (Rs. million)</i>	<i>Value</i>
1981	589	--	275	25.6
1982	636	--	480	33.5
1983	571	--	207	38.3
1984	577	--	100	20.9
1985	592	59.2	64	6.4
1986	608	88.2	139	20.2
1987	629	116.4	168	31.1
1988	654	--	223	28.4
1989	663	278.5	--	--

Source: Ministry of Fisheries and Aquatic Resources

TABLE 52  
LOBSTER CATCH ALONG THE SOUTH COAST

1985/86	200 mt.
1986/87	100 mt.
1987/88	100 mt.
1988/89	90 mt.

Source: NARA.

## 7.3 Squid/Cuttlefish

There is no fishery directed specifically at squid/cuttlefish at present. The current production of about 1000 mt. per annum comes mainly as a by-catch from the beach seine and shrimp trawl fisheries. Seasonally, small traditional craft conduct night fishing for squid with gas lamps and scoop nets. Coastal gillnetters also bring in substantial quantities of squid caught in scoop nets during certain times of the year.

## 7.4 Fisheries for Bivalve resources

The continental shelf off the Gulf of Mannar between the three and twelve fathom lines is popularly known as the Pearl Banks. The Pearl Banks in the Gulf of Mannar have been commercially fished for centuries. It has long been customary to use skin divers for pearl fisheries, over 90 percent of them coming from South India and Arab countries. The Pearl Banks have been under more or less continual survey for over one hundred years. The last two major pearl fisheries were held in 1925 and 1958. Dredgers were used during the 1958 fishery and a total of 4.5 million oysters harvested. Two smaller fisheries in 1960 and 1961 yielded only one million and 400,000 oysters respectively. The most recent fishery in 1983 yielded 20 to 30 thousand oysters. The irregularity of the fishery is mainly due to failure in *spat fall*. (The term "spat fall" is used to describe the oyster larvae falling on a substrate conducive to their development).

The other important fishery for oysters has been the Window Pane Oyster fishery for pearls at Thambalagam Lake, off Trincomalee. This fishery yielded two million oysters in 1953 and four

million in 1954. In order to ensure that oyster beds are not depleted by overfishing, a ban on the collection of oysters of less than 5½ inches in shortest diameter has been in force. The fishery is reported to have collapsed due to the major floods of 1985 which destroyed the oyster beds.

Other bivalve resources are considerable in Sri Lanka waters. Yet exploitation at present is far below the level of natural production and is confined to wild stocks, as bivalve culture is not practised in the country. Present utilization of bivalves, mostly of clams and cockles, is at subsistence levels in areas where the resources are plentiful. The utilization of wild stocks of oysters has increased at some locations, with the recent increase of tourism. Distribution of main edible molluscs in Sri Lanka is given in Table 53.

TABLE 53  
DISTRIBUTION OF MAIN EDIBLE MOLLUSCS IN SRI LANKA

1. Kalpitiya	<i>Crassostrea madrasensis</i> (Wild and cultured) <i>Marcia opima</i> <i>M. haentina</i> <i>Donax faba</i> <i>Gelonia coaxans</i> <i>Perna perna</i> (Cultured)
2. Mannar	<i>Crassostrea madrasensis</i> <i>C. belcheri</i> <i>Marcia opima</i> <i>M. hiantina</i> <i>Meretrix meretrix</i> <i>M. casta</i> <i>Gafrarium tumidum</i>
3. Kankasanturai	<i>Donax bicolor</i>
4. Mullativu	<i>Meretrix meretrix</i> <i>Donax faba</i>
5. Trincomalee	<i>Crassostrea madrasensis</i> <i>C. belcheri</i> <i>Saccostrea cucullata</i> <i>Perna viridis</i> <i>Marcia opima</i> <i>M. hiantina</i> <i>Gafrarium tumidum</i> <i>Gelonia coaxans</i>
6. Batticaloa	<i>Saccostrea cucullata</i> <i>Marcia opima</i> <i>M. hiantina</i> <i>Gafrarium tumidum</i> <i>Meretrix meretrix</i>
7. Hambantota	<i>Saccostrea cucullata</i> <i>Perna perna</i>
8. Tangalle	<i>Saccostrea cucullata</i> <i>Perna perna</i>
9. Galle	<i>Saccostrea cucullata</i> <i>Perna perna</i>
10. Kalutara	<i>Saccostrea cucullata</i> <i>Perna perna</i>
11. Negombo	<i>Perna perna</i> <i>Crassostrea madrasensis</i> <i>Saccostrea cucullata</i> <i>Meretrix casta</i> <i>Gafrarium tumidum</i> <i>Gelonia coaxans</i>
12. Chilaw	<i>Saccostrea cucullata</i> <i>Perna perna</i>

According to recent investigations conducted by NARA, bivalve resources in Mundel Lake have been harvested since the mid 1980's in order to use their shells to feed the ten lime kilns located around the lagoon. The female members of about 200 households are engaged in the harvesting, assisted by men particularly during the southwest monsoon periods when they cannot operate their traditional, non-motorised craft in sea fishing. Hence, the peak season for the collection of bivalves is the southwest monsoon period. About 30 to 40 canoes are used in the fishery, with an average of 5 persons working from each canoe. Over 95 percent of the bivalves taken out of Mundel Lake are *Meretrix* species, with *M. meretrix* the dominant species.

While no information is available on quantities harvested in Mundel Lake, NARA studies in Puttalam Lagoon show that annual production of bivalves for lime kilns during 1988 to 1990 varied between 8,500 and 10,000 kg. (wet weight) valued at Rs. 170,000 to Rs. 200,000.

About 75 people are engaged in the collection of bivalves (mainly *Meretrix sp.*) from the Chilaw lagoon, for sale to the nine lime kilns located around the lagoon. The daily harvest per person averages 5 baskets or 50 kg., which provide an income of Rs. 70 per day at Rs. 14 per basket. A much more active fishery is observed in the Chilaw lagoon compared to Mundel Lake. Unlike in Mundel Lake, it is reported that about 25 kg. of mussel meat from bivalves collected in Chilaw lagoon are sold daily to the nearby prawn farms at Rs. 18-20 per kg. In the absence of other reliable information on monthly annual production, Chilaw lagoon could be assumed to yield 25,000 kg. of bivalves per annum, valued at about Rs. 500,000.

Hardly any quantitative information is available regarding harvesting of natural bivalve resources from other brackishwater bodies. On the basis of available information, it is safe to assume an annual bivalve production of 100 metric tons from the brackishwaters of Sri Lanka valued at two million rupees.

## 7.5 Sea weeds

The types and the extent of the sea weed resources in Sri Lanka have not been adequately investigated. A few species of *Chlorophyceae*, *Rhodophyceae* and *Phaeophyceae* (green, red and brown algae respectively) which are common in many coastal areas are of economic importance as food and as a source of industrial chemicals such as agar agar and alginates. Only 20 of the 260 species of sea weeds recorded in the coastal waters of Sri Lanka are of commercial importance (Durairatnam, 1961).

Only two varieties of algal sea weeds, *Gracillaria verrucosa* and *G. edulis* are commercially exploited in Sri Lanka. Export of sea weed from Sri Lanka dates back to the 1800s-exports to England approximated 5700 lb. (2591 kg.) in 1831 and 15,000 lb. (6818 kg.) in 1840; annual exports to India were in the region of 20,000 lb. (9091 kg.) during the 1941 - 1944 period (NARA, 1988). 50 to 100 tons of dried *Gracillaria* were exported from Sri Lanka in the 1970's. The 50 metric tons of sea weed exported in 1972 was worth Rs.76,000 (FOB). Exports increased to 150 metric tons in 1986, with 70 metric tons produced from the Kalpitiya area and the remainder from Trincomalee. Exports have been drastically affected since 1986 by the civil disturbances particularly on the east coast. Only 5 to 10 metric tons of *Gracillaria* are estimated to have been exported in 1987 and 1988. A very small quantity is consumed locally, mainly in the producer areas.

In the Kalpitiya area (Puttalam lagoon, Dutch Bay and Portugal Bay) only *G. edulis* has been reported (Durairatnam and Medcoff 1954). Durairatnam (1965) also reported the presence of large quantities of *G. verrucosa* in *Koddiyar Bay near Trincomalee*. There are also reports of the existence of extensive beds of both *G. edulis* and *G. verrucosa* in the Mannar area.

*Sargassum* is the most economically important species of brown sea-weed found in Sri Lanka; it is rich in alginic acid in the form of sodium and calcium salts. The main use of sodium alginate in Sri Lanka is in the textile industry. *Sargassum* is found in large quantities off the northern coast as well as in the Pearl Banks in the Gulf of Mannar. A potential harvest of 800 metric tons of *Sargassum* has been estimated by Durairatnam (1966) from Ambalangoda to Hambantota

in the southwest area. Attempts made in the late 1960's to extract alginic acid from *Sargassum* failed with the dissolution of the District Development Council promoting it. A pilot project set up in 1973 to produce liquid sodium alginate also failed as the most favourable *Sargassum* species (*S. cervicone*) was found in less abundance in shallow waters (NARA, 1988). *Sargassum* is not exploited on a commercial scale at present.

Despite the marked growth in sea-weed consumption and sea-weed based industries the world over, there has been no sustained interest in the exploitation of this resource in Sri Lanka over the last few decades. It has so far not attracted adequate investment or interest from the industrial sector. In the absence of systematic islandwide surveys, lack of adequate information on the extent and distribution of the resource is considered a factor inhibiting the expansion of the industry in Sri Lanka. Considering the past production of sea-weeds from the North-western and Eastern Coasts, the potential for harvesting, using traditional practices could be in the region of 200 mt. of dried sea-weed. There has been a considerable increase in the price paid for sea-weed over the last 15 to 20 years. A ton of dried *Gracillaria* which fetched Rs. 1,500 in 1972 was worth Rs. 20,000 in 1988.

The imports of alginates, agar agar, alginic acid substitutes like gelatine and related products in 1987 were valued at Rs. 29.5 million. At Rs. 20,000 per ton, the potential of 200 mt. of dried weed represents an annual income of four million rupees.

#### 7.6 Brine Shrimp (*Artemia*)

In view of the high nutritive value of freshly hatched nauplii and the advantage of using dry cysts as a source of live feed, *Artemia* is extensively used in hatcheries of both marine and freshwater fish and crustacea, as well as in the ornamental culture fishery. *Artemia* cysts are imported to Sri Lanka at high cost, the value of imports in 1986 being Rs. 6.56 million (Kuruppu and Ekaratne, 1989).

A survey conducted by the National Aquatic Resources Agency (NARA) has located *Artemia* grounds in Palavi (North-western Province), and in Hambantota and Badulla (Southern Province), in association with the salt pans (Sunderam and Royan, 1984). However, no *Artemia* were located in the salt pans at Elephant Pass and Kurunchativu (Northern Province). *Artemia* populations at Palavi and Hambantota were found to be parthenogenetic. Royan et al (1985) have estimated a potential annual yield of 24.0 kg./ha. from the Palavi salterns which cover an area of 243 ha. In a study conducted by Sundaram and Royan (1985) during March 1984, a net yield of 38kg/ha. of cyst production has been obtained at the Hambantota salterns. However, studies by Kuruppu and Ekaratne (1989) covering longer periods of time — June to October 1986/ and April to October 1987 — have realised average cyst production figures of only 3.10 and 3.73kg/ha in 1986 and 1987 respectively.

In terms of fatty acid content, the Sri Lankan strain of *Artemia* is said to possess a high nutritional quality for aquaculture purposes. Over 2000 ha. of land suitable for salt production in Sri Lanka could be utilized for *Artemia* culture.

#### 7.7 Beche-de-Mer

The sea cucumber or the holothurians abundant in the coastal waters of the Northwest, North and Northeast have been harvested for export as Beche-de-Mer. The Beche-de-Mer fishery in Sri Lanka appears to be several centuries old, although records of exports date back only to 1808 (Joseph & Moiyadeen, 1990). Although 13 of the 70 species recorded from Sri Lanka are consumed in many part of the world, only the dominant species *Holothuria scabra* is selectively harvested. It is not consumed locally, the entire production is exported, mainly to Singapore and Hongkong. Exports of Beche-de-Mer in recent years are presented in Table 54. Exports during 1975-1985 averaged 61 mt. per year, generating foreign exchange to the value of ten million rupees.

Harvesting is done mainly by skin divers at depths of 2 to 16 m. Aids such as triangular wooden feelers or metallic prongs are used in shallow waters. Joseph and Moiyadeen (1990) have shown

that 74 percent of the harvest from the Northwest during 1984 to 1987 was taken by skin diving, the remainder coming from the use of mechanical aids such as feelers (13%) and as by-catch from nearly 40 shrimp trawlers operating in the Kalpitiya area . (13 percent).

TABLE 54  
EXPORTS OF BECHE-DE-MER FROM SRI LANKA, 1975-1989

Year	Weight of Beche-de-mer (kg)	Price per kg (Rs.)	Foreign Exchange Earned (in Rupees)
1975	94,090	34.80	16,940
1976	95,310	34.90	3,207,617
1977	51,338	33.50	3,247,068
1978	30,724	90.15	1,727,047
1979	59,732	105.11	6,278,453
1980	77,656	139.26	10,814,372
1981	70,685	197.08	13,930,529
1982	78,745	210.05	16,540,387
1983	56,141	227.55	12,774,884
1984	36,363	250.42	9,106,095
1985	23,230	275.66	6,403,716
1986	5,432	203.12	1,103,348
1987	32,521	258.35	8,402,105
1988	7,206	395.68	2,851,303
1989	26,587	485.68	12,912,832
Total 1975 to 1989	745,760	—	109,316,750

Source: Joseph & Molydeen (1990)

About 130 divers are reported to be engaged in this fishery along the North and Northwest coasts (Jaffna, Mannar and Puttalam) during the peak season of October to May. During the southwest monsoon months of May to September harvesting reaches a peak on the East coast off Kalkudah, Trincomalee and Mullaitivu.

The decline of the Beche-de-Mer fishery in recent years, as evidenced by the annual production levels shown in Table 54 is attributed to indiscriminate over-harvesting of selected species and by-catch from trawl and trammel net fisheries. Illegal fishing practices such as use of toxic substances and dynamite in the major Beche-de-Mer producing areas also threaten the sustainability of the resource. Annual production levels of 70 to 90 tons could again be feasible with a proper management plan which will ensure more balanced exploitation of the resource and possible extension of the fishery into other areas.

### 7.8 Chank fishery

The fishery for chanks, *Xancus pyrum* is also carried out by skin divers in the shallow coastal waters of the Gulf of Mannar and Palk Bay. The production of around 100 tons in recent years is all exported.

Like the pearl fishery and the Beche-de-Mer fishery, it was one of the important fisheries during the 1940 to 1960 period; it had received prominent mention in the annual Administrative Reports of the Director of Fisheries in that era. Production and value of exports (to Pakistan and India in the past and now to Bangladesh) from the 1940's to the 1970's are presented in Table 55. Annual production averaged over 1000 metric tons during the 1940's but has dropped to around 200 metric tons in the 1950's; a further drop has been observed in the 1960's and the 1970's.

**TABLE 55**  
**PRODUCTION (MT.) AND EXPORT VALUE (RS. '000) OF CHANK SHELLS**

<i>Year</i>	<i>Amount (mt.)</i>	<i>Value (Rs. '000)</i>	<i>Year</i>	<i>Amount</i>	<i>Value</i>	<i>Year</i>	<i>Amount</i>	<i>Value</i>
1940	1042	40,049	1950	601.2	2,075	1960/61	201.6	718,077
1941	1100.7	39,203	1951	220.5	1,090	1961/62	155.8	572,622
1942	259.5	6,434	1952			1962/63	85.8	450,010
1943	430.6	15,478	1953			1963/64	65.7	234,262
1944	997.4	37,076	1954	215.6	1,056	1964/65	54.9	271,182
1945	952.9	38,473	1955	81.1	2,295	1965/66		
1946	936.1	38,342	1956			1966/67	131.9	441,789
1947	1660.7	82,436	1957	201.1	6,794	1967/68	92.3	376,049
1948	1355.1	68,517	1958			1968/69		
1949	687.3	27,163	1959			1969/70	139.5	542,524
						1976	79.8	273,340

Table 56 shows the production of chank and other shells and value of exports in recent years.

**TABLE 56**  
**CHANK AND OTHER SHELLS**  
**PRODUCTION VOLUME AND EXPORT VALUE, 1984, 1986, 1987**

<i>Year</i>	<i>Production Volume (mt.)</i>	<i>Value of Exports (Rs. million)</i>
1984	134	0.45
1986	166	7.55
1987	146	7.61

Ninety percent of the above production consists of chank shells. The chank shells are exported to countries like Bangladesh where they provide the raw material for the manufacture of bangles and other ornaments as a cottage industry. If the technology could be made available to local fisherfold, the income to local communities from this resource will be considerably more than what it is now.

## Conclusions

Fishing is the only source of income of about 80 percent of the country's fishermen. At the current rate of increase of the fishing population, there is a strong likelihood of the industry being unable to offer adequate opportunities of employment to the new entrants to the labour force by the year 2001. The withdrawal of government support to the development of inland fisheries and the continued unrest in the major fish producing region of the country's north and east are critical factors stifling fishing and aquaculture development in the country.

The coastal marine fishery is often described as heavily exploited. Some of the traditional fisheries and inshore stocks of certain resources have in fact shown evidence of depletion. However, new fisheries have developed on hitherto unexploited or under-exploited resources in the coastal sector that have potential for increased production and employment generation. The ring net fishery for smaller tuna and half beak fish, the gill-net fishery for flying fish and the use of fish aggregating devices (FADs) to exploit rainbow runner/dolphin fish are some of the developing fisheries.

The off-shore is the fastest growing sector in the country's marine fishing industry. The fishery is based on migratory pelagic resources of tuna, bill- fish and shark. Exploitation of such resources involve relatively capital intensive operations, even when small multi-day boats are used for the purpose. The resources are also subjected to exploitation by fishermen from other coastal states. The off-shore fishery will therefore need very close monitoring for sustained growth and development.

Environmental concerns may also become crucial to Sri Lanka's marine fisheries by year 2001. There is a heavy dependency on the use of gillnets in Sri Lanka. The worldwide concern over the death of non-target species such as marine mammals, turtles and sea birds in gillnet fisheries may necessitate Sri Lanka curtailing its gillnet fisheries and promote diversification into more environmentally friendly fishing methods.

Brackishwater aquaculture is dominated by shrimp farming which is presently restricted to the northwest. To a large extent, this development has been unplanned and haphazard, bringing into focus several technological, social and environmental issues and constraints. When the security situation improves in the north and east, an additional 2000 ha would be available for shrimp culture. The state and the industry could harness experience gained over a decade of shrimp farming in the northwest for sound development of shrimp farming in other areas.

The paucity of information on brackishwater resources, current use and level of exploitation, development potential etc. needs to be rectified. Monitoring mechanisms and other studies need to be promoted in these highly specialized, economically important sensitive ecosystems.



## References

- Atapattu, A.R. 1989. The Fisheries Industry in Sri Lanka's Coastal Areas. Manuscript Report (unpublished).
- BOBP/WP/31 1985. Tuna Fishery in the EEZs of India, Maldives and Sri Lanka. FAO/Bay of Bengal Program, Madras, India.
- Dayaratne, P. 1990. Offshore Fishery Resources in Sri Lanka. Seminar on Offshore Fishing in Sri Lanka, February 1990. Colombo (unpublished).
- Durairatnam, M. and J.C. Medcof. 1954. Ceylon's Red Seaweed Resources. Ceylon Trade Journal Vol. XIX No. 4 pp. 1-6.
- Durairatnam, M. 1961. Contribution to the study of the Marine algae of Ceylon. Bulletin of Fishery Research Station, Ceylon, No. 10.
- Durairatnam, M. 1965. The Ecology of Gracillaria verrucosa in Koddar Bay, Trincomalee. Bull Fish Research Station, Ceylon, Vol. 18 No. 1. pp. 29-34
- Durairatnam, M. 1966., Quantitative Survey of Sargassum along the South-west Coast of Ceylon. Bull. Fish Research Station, Ceylon. Vol. 19 No. 182.
- FAO/ADB. 1988. Sri Lanka Fisheries Sector Study Report of the FAO/ADB Cooperate Program. FAO, Rome.
- Gulbrandsen, O. 1991. Techno-Economic Evaluation of Offshore Fishing Boats. BOBP/REP/1947. FAO/Bay of Bengal Program, Madras, India. pp. 24-37.
- Jayasekera, A.M. 1990. Inland Fisheries Development, Inland Fishery Division. Ministry of Fisheries (unpublished).
- Jayakody, D.S. and S.J.C. Jayawickrama. 1987. The Status of the Prawn Fishery at Negombo. National Aquatic Resources Agency. Manuscript Report (unpublished).
- Jayasuriya, P.M.A. 1985. The present Status of Fin Fish and Crustacean Fishery of Puttalam Lagoon. Journal National Aquatic Resources Agency, Colombo, Sri Lanka 32 (1985). p. 94-103.
- Joseph, L. and N.M. Moiyadeen. 1990. Ecology of Commercially Exploitable Holothuroids on the North West Coast (Puttalam District). National Aquatic Resources Agency (unpublished).
- Kuruppu, M. and S.U.K. Ekaratne. 1989. Nutritional Evaluation of Sri Lanka Artemia parthenogenetica for use in larval rearing. in De Silva, S.S. (ed.) Fish Nutrition Research in Asia, Proceedings of the 3rd Asian Fish Nutrition Network Meeting. Asian Fish Society Special Publication 4, Manila, Philippines.

- Nishida, T. and K. Sivasubramaniam. 1986. Atlas of Deep Water Demersal Fishery Resources in the Bay of Bengal. BOBP/WP/57. FAO/Bay of Bengal Programme, Madras, India.
- Ramanathan, S. and D.E.S. Jayamaha. 1972. On the Collection, Transport and Acclimatization of the fry of Chanos chanos for brackishwater pond culture in Ceylon. Pillai, T.V.R. (Ed.) Coastal Aquaculture in Indo-Pacific Region. Fishing News (Books) Ltd.
- Royan, J.P., J.De Silva, M. Fonseka and R. Perera. 1985. Artemia cyst potential at Palavi Salterns. Journal National Aquatic Resources Agency, Colombo, Sri Lanka Vol. 32.
- Samaranayake, R.A.D.B. 1986. Status and Prospects for Brackishwater Aquaculture in Sri Lanka. Journal Inland Fisheries, Vol. 3, Ministry of Fisheries, Sri Lanka.
- Siriwardena, P.P.G.S.N. 1989. Survey on Aquaculture (Phase II), Sri Lanka (unpublished) Asian Productivity Organization, Tokyo, Japan.
- Sivasubramaniam, K. 1978. Pelagic Fishery Resources of Sri Lanka and its present level of exploitation with special reference to offshore and deep sea waters. Bull. Fish Research Station, Sri Lanka, Vol. 28.
- Sunderam, R.I.M. and J.P. Royan. 1984. A note on the occurrence of Artemia in Sri Lanka Journal National Aquatic Resources Agency, Colombo, Sri Lanka Vol. 31.
- Sunderam, R.I., and J.P. Royan. 1985. Estimated Cyst Production of Artemia of Hambantota Salterns in Sri Lanka. NARA/OCC/85/1/19-28 (unpublished). National Aquatic Resources Agency, Colombo, Sri Lanka.
- Thayaparan, K. and R.D. Chakrabarty. 1984. Milkfish Aquaculture in Sri Lanka. pp. 161-169. Juario et. al.
- Wijeratne, M.J.S. 1984. Studies on the Biology and Fishery of Grey Mullet in Negombo Lagoon (unpublished).