FAO/Norway Programme of Assistance to Developing Countries for the Implementation of the Code of Conduct for Responsible Fisheries

Sub-programme F: Assistance to Developing Countries for Improving the Provision of Scientific Advice for Fisheries Management

FAO/NORWAY GOVERNMENT COOPERATIVE PROGRAMME | **GCP/INT/648/NOR Field Report F-3-Suppl. (En)**

FISHCODE MANAGEMENT

PAPERS PRESENTED AT THE WORKSHOP ON THE FISHERY AND MANAGEMENT OF BALI SARDINELLA (*SARDINELLA LEMURU*) IN BALI STRAIT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, JUNE 2000

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Denpasar, Bali, Indonesia, 6-8 April 1999

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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The Workhop on the fishery and management of Bali sardinella (*Sardinella lemuru*) held in Denpasar (Bali), 6-8 April 1999 has produced a workshop report under the FISHCODE project (GCP/INT/648/NOR) as Field Report F-3. The current report is a supplement to the above report and comprises papers presented during the workshop. The papers include a review of the lemuru fishery by Merta *et al.*, a paper addressing environmental issues by Ghofar *et al* , the status of the fishery status as reported by the Provincial Fisheries Services of East Java and Bali respectively and notes used for the process to developing a management plan for lemuru fishery by Pollock.

CONTENTS

STATUS OF THE LEMURU FISHERY IN BALI STRAIT ITS DEVELOPMENT AND PROSPECTS[1]

by

I.G.S. Merta[2], K. Widana[3], Yunizal[4] and R. Basuki[5]

1. INTRODUCTION

The fishery for lemuru (*Sardinella longiceps*) in the Bali Strait is one of the main small pelagic fisheries in Indonesia. This fishery is very specific as it exploits a single species and it is concentrated in a relatively narrow area. Fishing has been largely conducted by fishermen from the Bali Province and Muncar (East Java Province).

Fishermen from both sides of the Strait have benefited from the development of lemuru fishery. Over time the number of fishermen has increased and fishing technology has improved. Following the adoption of fishing by purse seine in 1974 the catch increased rapidly, which has resulted in an increase in the number of processing units. Canning factories were built in the coastal area of Bali Province and of Muncar District of the East Java Province. Similar development also took place as regards the increase in construction of fishmeal processing units on both sides of the strait.

Various studies have been conducted in this fishery. Several studies on resources, oceanography, post harvest and socio-economic aspects have been carried out by the staff of RIMF and also some students from various Universities in Java and Bali. The fishery also attracted foreign interest as early as the 1970s when a student from the University of Hawaii completed his MSc thesis based on his research on the population biology of lemuru in the Bali Strait in 1973. In a later year, some staff of Brawidjaya University, in cooperation with the staff of the Wageningen University in Holland, also conducted research on the socio-economic aspects of fishermen in the Bali Strait.

The dynamic nature of small pelagic resources such as lemuru has resulted in the fluctuation of catch and thus the supply of raw material for the processing industry. The rapid increase in the number of fishing boats has also caused great concern re its impact on the resources. In response to these concerns on the situation of the fishery, the central Government (represented by the Directorate General of Fisheries) and the Provincial Governments bordering the Bali Strait (represented by the Provincial Fisheries Office of East Java and of Bali) held several workshops to address fisheries problems. These initiatives led to a greater effort in the management of the fishery under the responsibility of the two Provincial Governments. The joint agreement in 1977 stipulated allocation of fishing for the two provinces. Gradually, the subsequent development in the fisheries has led to the two provincial governments revising management measures to meet the continued challenge faced by the fisheries. In particular, the rapid development of the fisheries has not been accompanied by comparable effort in their management. Monitoring of the fishery has been weak, let alone the enforcement of the law as

[1] This document is a translation of an Indonesian text. A number of editorial changes were made.
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stipulated in the joint management. This review study is aimed at helping readers to address the right questions in the current stage of fisheries, a major step in developing a management plan for the fisheries.

2. THE RESOURCE AND ITS EXPLOITATION

2.1 The Area

Bali Strait is an area of 2,500 km^2 located between Bali and East Java Province, it is funnel-shaped and shallow in the northern part while deeper in the southern part (Figure 1). The shelf on the Java side is narrower than that of the Bali side, being only 0.5 to 1.8 km wide

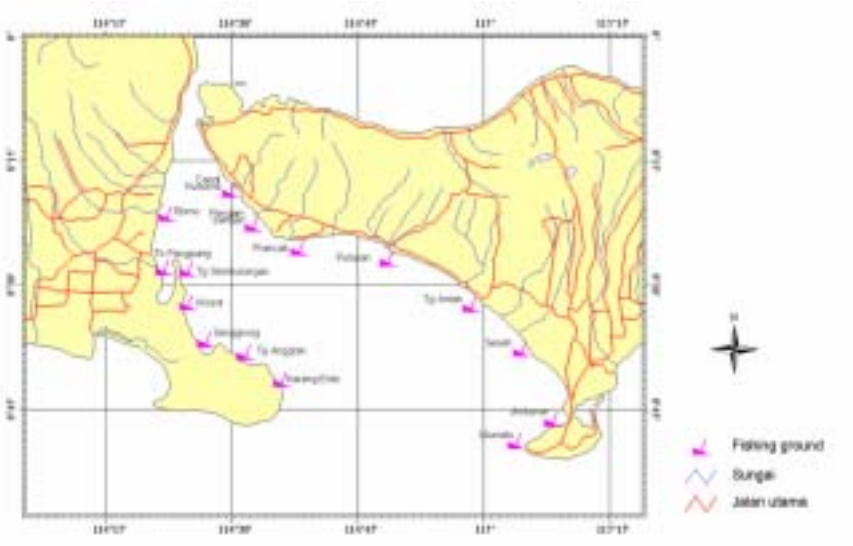

Figure 1. Fishing grounds of lemuru

as opposed to 3.5 to 15 km in the Bali side (Ritterbush, 1975). The northern opening of the strait which is only 2.5 km wide with an average depth of 50m, is the transportation route for ferries between East Java and Bali. The southern opening is wider, about 55km. From the central to the southern part the depth of the water is between 400 to 1,400 m. The Princess van Orange Bank is located in the southern part with a depth of 12m.

The oceanographic conditions in the Bali Strait are very much influenced by the monsoons (Wyrtki, 1961; Ritterbush, 1975). During the northwest monsoon that lasts from December to the end of February or the beginning of March and fully developed in January, the winds generate a coastal current that flows along the south coast of Java towards the east. This coastal current reaches its high peak in February. The current becomes weak in the subsequent months during the inter-monsoon period in April and May.

With the start of southeast monsoon in June, the coastal current moves in the opposite direction, namely from east to west. As the southeast monsoon develops the speed of the coastal current reaches its maximum around July which generates an upwelling in the area south of Sumbawa, Lombok, Bali and the eastern tip of Java.

Upwelling in the Bali Strait reaches its peak in July (Burhanuddin and Praseno, 1982; Saliyo, 1973) as reflected by the high concentration of phosphate and nitrate in the euphotic zone and causes phytoplankton to flourish in the area. The diatom cell count in July reaches as high as $61.6*10^3$ cells/m^3 (Saliyo, 1973). The average surface water temperature in July is generally lower (26.20°C) than the other months (27.74°C). The amount of dissolved oxygen in July (3.00-4.63 ml/l) is also lower than that in March (4.20-4.36 ml/l). There is an indication that the timing of the upwelling process may be delayed to August as reported by the recent cruise record as the surface water temperature in August 1997 was as low as 24.50°C.

2.2 Fishing Season

Fishing in the Bali Strait takes place all year round although the peak catches occur in certain months of the year as shown in Table 1. It appears that the average high catch does not correspond with the upwelling month; in fact high catches were obtained during the months of the northwest monsoon (November to January). The rough sea condition during these months normally prevented fishermen from the Bali side (Kedonganan beach) from going fishing. It is during this season, some of the fishermen in Kedonganan use their time to get involved in tourism activities.

Table 1. Monthly production of lemuru, 1984-1989 (kg)

Month	Year						Average
	1984	1985	1986	1987	1988	1989	
January	1861408	944848	734438	78155	161851	1689813	911752*
February	1532872	797529	31211	0	364657	753446	579953
March	1309790	619279	0	447402	513539	117669	501279
April	2566300	654112	305	157186	835040	431446	707398
May	2563280	1252521	46252	195598	1402352	940727	1066788*
June	1623933	507255	998	122787	503523	1310577	678179
July	2584724	573417	25008	94197	1115484	521068	818983
August	2262428	393323	20279	144862	198763	210656	538385
September	1372755	161728	44953	976303	2452511	847661	975985*
October	800638	1388005	287168	1243152	3355400	1570477	1440807*
November	1708733	484785	155928	1053529	1957024	1992975	1225496*
December	1176562	769630	236352	700108	2324088	1968242	1195830*
Total	21363423	8546432	1582893	5213279	15184232	12354757	
General Average							892292

Source: KUD Mina Karya, Pengambengan, Bali, * Fishing Season

2.3 Distribution of lemuru

Lemuru (*Sardinella lemuru*) inhabits tropical waters of the Indo-Pacific region. According to Whitehead (1985), the fish inhabits a wide area of the ocean from eastern Indian

Ocean, i.e. Pukhet, Thailand, south coast of East Java and Bali, western Australia, and western Pacific Ocean (from the Java Sea to the north until the Philippines, Hong Kong, Taiwan Island and southern Japan). In the south of East Java and Bali, lemuru is concentrated mainly in the Bali Strait.

The results of acoustic surveys in the Bali Strait indicated that lemuru is mainly concentrated in the shelf area, on the Java shelf as well as on the Bali shelf. It was unusual to detect lemuru outside of the shelves at depths of more than 200 m (Merta, 1972 and 1976). The largest and densest concentration of schools was generally found in waters of less than 100 m deep. The Bali shelf is wider than the Java shelf, and it is richer than the latter (Venema, 1976 and 1996). Several acoustic surveys also indicated that there were more lemuru schools in the Bali shelf than in the Java shelf (Merta, 1976; Amin and Sujastani, 1981).

During day time, dense schools are found close to the bottom of the waters, while during night they move to the layers near the surface forming scattered schools. Once in a while, lemuru schools are found on the surface during day time when the weather is cloudy and drizzly. However, it is normally difficult to catch the fish as they are quick. Fishing is normally conducted during night time when the fish move close to the surface.

Juvenile lemuru inhabit shallow water and become the target of traditional gears, such as liftnet, gillnets, etc. (Figure 1). They are common in Pangpang Bay, on the tip of Sembulungan and Senggrong peninsula on the Java side and in the Jimbaran Bay on the Bali side. These small fish less than 11cm long (locally called sempenit) are common during May to September and sometimes extend to December. The bigger fish inhabit deeper waters and in general the size of the fish increases towards the south.

2.4 Trend of catch

In his research work, Soerjodinoto (1960) was the first scientist to use *Clupea* (*Harengula*) *longiceps* (C.V.) as the scientific name for lemuru in the Bali Strait. In later years many scientists have used *Sardinella longiceps* C&V, the scientific name for the oil sardinella in India. Gloerfelt-Tarp and Kailola (1984) used the old name *Sardinella lemuru* (Bleeker 1853), based on research by Whitehead (1985). The FAO Species Catalogue published in 1985, also used *Sardinella lemuru* for the lemuru caught in the Bali Strait and its adjacent waters, with its English name Bali sardinella. Since then *S. lemuru* has been used to denote the scientific name of lemuru.

In Indonesia, the term “lemuru” is used to represent several species of sardines (Burhanuddin *et al.*., 1984) and in the annual publication “Indonesia Fishery Statistics” lemuru comprises *Sardinella longiceps* (*S. lemuru*), *S. aurita, S. leiogaster and S. clupeoides*. Apart from *S. lemuru* there are five other species caught in the Bali Strait as can be seen in Table 2. For certain months *S. lemuru* was not dominant; in February the catch was dominated by small tuna species (Table 2). In May, on the other hand, the dominant species was round scad (*Decapterus* spp.). However, on average lemuru dominated the catch. Fishermen did not change their gear although the targeted fish were not dominant in the catch.

The low level of lemuru catch in 1986 was partially compensated for by the increase in catch of other species although its rate of increase is not comparable to the rate of decline

of lemuru catch (Table 3). The catch increase of other species was made up of round scad (*Decapterus spp.*), *Rastrelliger kanagurta*, *Scomber australicus*, *Euthynus sp.* and *Auxis sp.*

Table 2. Species caught by purse seine in the Bali Strait, 1997 (kg and %)

Month	Lemuru	Tembang	Layang	Slengseng	Tongkol	Lain-lain	Total
January	85680 (61.7)	0	52960 (38.1)	0	200	0	138840 (100.0)
February	0	0	0	0	45600 (100.0)	0	45600 (100.0)
March	6880 (12.9)	3200 (6.0)	2960 (5.5)	0	36400 (68.0)	4080 (7.6)	53520 (100.0)
April	60960 (32.0)	4720 (2.5)	44240 (23.2)	640 (0.3)	80080 (42.0)	0	190640 (100.0)
May	84560 (15.7)	0	369320 (68.5)	1840 (0.3)	83720 (15.5)	0	539440 (100.0)
June	147620 (72.4)	13980 (6.9)	8880(4.4)	0	19400 (9.5)	14000 (6.8)	203880 (100.0)
July	108380 (66.1)	16600 (10.1)	17840 (10.9)	0	4080 (2.5)	16960 (10.4)	163860 (100.0)
August	1734024 (98.4)	5600 (0.4)	3600 (0.2)	0	0	18406 (1.0)	1761630 (100.0)
September	1761520 (91.7)	0	157280 (8.2)	0	0	1260 (0.1)	1920060 (100.0)
October	3016605 (100.0)	0	0	0	0	0	3016605 (100.0)
November	3145150 (99.2)	0	7600 (0.2)	0	16400 (0.6)	0	3169150 (100.0)
December	2909040 (97.9)	0	2560 (0.1)	1260 (0.1)	57320 (1.9)	0	2970180 (100.0)
Average	1088368.2 (62.3)	3675.0 (2.2)	55603.3 (13.3)	311.7 (0.1)	28600.0 (20.0)	4558.8 (2.1)	

Note: - Source: Research Institute for Marine Fisheries
Lemuru = *Sardinella lemuru;* Tembang = *Sardinella* spp.; Layang = *Decapterus* spp.; Slengseng = *Scomber australasicus;* Tongkol = *Euthynnus* sp. and *Auxis* spp.

Table 3. Composition of purse seine catch landed at KUD Mina Karya, Pengambengan, Bali, in the period of 1984-1989 (unit, % weight)

Year	Fish species								Total
	Lemuru	Tembang	Layang	Banyar	Slengseng	Kenyar	Tongkol	Others	
1984	97.95	0.13	0.85	0	0.08	0.07	0.15	0.77	100.0
1985	82.71	0.69	4.79	0.03	0.25	0.35	10.50	0.68	100.0
1986	32.85	4.24	28.99	0.52	4.53	0	19.12	9.75	100.0
1987	66.31	2.86	19.75	0.34	3.42	0.00	4.58	2.74	100.0
1988	97.32	0.27	0.03	0.04	0.58	0.04	0.40	1.32	100.0
1989	94.48	0.10	0.63	0.01	1.76	0.02	0.72	2.28	100.0

Note: - Data Source: KUD Mina Karya, Pengambengan, Bali
Kenyar = *Sarda orientalis,* Banyar = *Rastrelliger kanagurta*

Fishermen recognize well the different size categories of lemuru as the catches are normally grouped by size. The smallest size group, locally called “sempenit”, is less than 11 cm TL, “protolan” is 11-15 cm TL, while “lemuru” is 15-18 cm TL and “lemuru kucing” is larger than 18 cm TL. The catch of lemuru by size at Pengambengan, Bali, during 1984 to 1989 is presented in Table 4. The percentage of juvenile fish (sempenit) landed at Pengambengan ranged from 0.5 - 28.4%, with an average of 8.1% per annum. Assuming that this figure also applies to the whole Bali Strait (landed at Pengambengan and Muncar), the development of purse seine in the Bali Strait could have a negative impact on the productivity of lemuru fishery. Sadhotomo (1991) indicated that if juvenile fish caught are more than 5% of the total lemuru landing, increasing the effort of Danish-seine and lift net would have a significant impact on the productivity of lemuru fishery in the Bali Strait.

Table 4. Lemuru landed at Pengambengan by size category (sempenit, protolan and lemuru)

Year	Lemuru by size (kg)			Total
	Sempenit	Protolan	Lemuru	
1984	1944242 (9.1)	5364378 (25.1)	14054803 (65.8)	21363423 (100.0)
1985	434359 (5.1)	472067 (5.5)	7640006 (89.4)	8546432 (100.0)
1986	8225 (0.5)	49451 (3.1)	1525217 (96.4)	1582893 (100.0)
1987	44989 (0.9)	422837 (8.1)	4745453 (91.0)	5213279 (100.0)
1988	4475155 (28.4)	6727511 (42.6)	4567160 (29.0)	15769826 (100.0)
1989	583205 (4.7)	3631377 (29.4)	8140175 (65.9)	12354757 (100.0)
Range	8225 - 4475155 (0.5 - 28.4)	49451 - 5364378 (3.1 - 42.6)	1525217 - 14054803 (29.0 - 96.4)	
Average	(8.1)	(19.0)	(72.9)	

Remarks: - Data source: KUD Mina Karya, Pengambengan, Bali
- Figures in brackets are percentages

The catch of lemuru has shown clear fluctuations in the last three decades (Table 5). The first three peaks appeared in 1977, 1979 and 1983 and were then followed by a rapid decline until the lowest level of 4,661 t was reached in 1986 which the fishermen considered the disappearance of lemuru. Since then, the catch increased and reached the highest peak in 1991 of 61,669 t. This peak had never been reached since the introduction of purse seine in 1974. In subsequent years the catch then declined again, reaching a level of 13,327 t in 1996. Finally in 1997 it increased again to 50,202 t (Figure 2). Based on this trend and the catch of the latest two years that had increased from 29,716.5 t in 1997 to 34,136.7 t in 1998, one would have expected the catch to increase again in the subsequent years.

Table 5. Trend of lemuru production in the Bali Strait in 1974-1997 (tonnes)

Year	Bali (tonnes)	Muncar (tonnes)	Total (tonnes)	Year	Bali (tonnes)	Muncar (tonnes)	Total (tonnes)
1974	1146.8	5623.3	6770.1	1987 **SE**	8823.4	3823.5	12646.9
1975 **SE**	2534.0	6368.4	8902.4	1988	22560.1	15222.3	37782.4
1976	5665.9	17073.0	22738.9	1989	15177.7	26460.8	41638.5
1977	15863.1	8706.7	24569.8	1990	24913.3	22967.8	47881.1
1978	9326.3	8152.6	17478.9	1991 **WE**	27957.6	33710.9	61668.5
1979	15977.2	11336.7	27313.9	1992 **WE**	25964.8	29658.4	55623.2
1980	10471.5	11158.9	21630.4	1993	14202.6	31760.6	45963.2
1981	11888.7	7538.2	19426.9	1994 **WE**	15898.1	31838.6	47736.7
1982 **SE**	28460.2	11698.8	40159.0	1995	13597.1	13836.6	27433.7
1983 **SE**	39355.7	8719.5	48075.2	1996 **LN**	8880.8	4445.9	13326.7
1984	34192.1	8404.5	42596.6	1997 **EN**	29716.5	20485.1	50201.6
1985	11792.3	5312.9	17105.2	1998 **LN**	34136.7		
1986	2380.1	2281.3	4661.4				
Average (1974 -1997)							30,972

Remarks: SE = strong El Niño; WE = weak El Niño; EN = EL Niño (not known, strong or weak); LN = La Niña

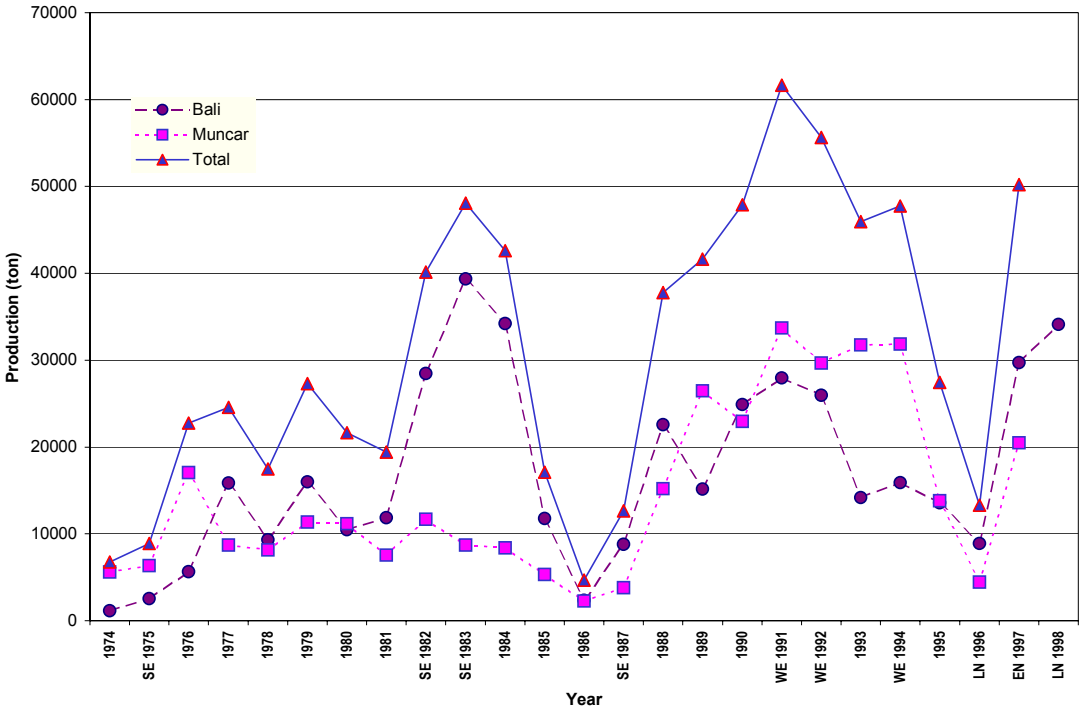

Figure 2. Trend of lemuru catch in the Bali Strait

Landing places on both sides of the Bali Strait are still not adequate to cater to the needs of unloading the catch; this is particularly true during the peak season. This is because fishing is only a one night operation and therefore unloading will only be done in one day. This has led to a situation where during the peak season some of the catch would go directly to the processing units and thus the catch would not be recorded in the auction. This could be a cause for underreporting in the collection of statistics. The problem in the collection of statistics has been aggravated by the new Decree by the Ministry of Home Affairs (1997/1998) which promulgated that collection of fees in the landing places is prohibited. The operation of landing places has been financially supported to a great extent by the collection of fees for the services rendered. With this new Decree the auction has become helpless, it could not serve properly and thus the reliability of statistics has been affected.

As a typical small pelagic fish, lemuru has a schooling behaviour whose features are at present not well understood. It is well known that small pelagic fish belong to a "difficult" fish category in the context of stock assessment as opposed to demersal fish (Csirke, 1988). The fluctuation of catch as shown in Table 5 may represent this behaviour and no one knows for certain how much the environment plays a role in the Bali Strait as compared to the impact of fishing. There is no clear relationship between the catch and the climatic conditions as represented by strong El Niño and weak El Niño as can be seen from Table 5 and Figure 2. Although catch declined steadily following the strong El Niño in 1982 and 1983, such a case did not happen again after the strong El Niño in 1987 when the catch started to increase. In analysing the lemuru fisheries using the POPSYS programme, Dr. Saila of the University of Rhode Island suggested that about 55% of the variability of abundance is caused by environmental factors (vide Merta, 1992). The prevailing uncertainty in the behaviour of lemuru should encourage the establishment of a management unit in the Provincial Fisheries Services of Bali and East Java for managing the fishery.

2.5 Fishing Boats and Gears

In the early years before the introduction of purse seine in 1974, fishermen in the Bali Strait used traditional fishing gears such as Danish seine (locally called "payang oras"), scoop net, gillnet (locally called "jaring eder"), lift net and cast net (Soemarto, 1959). Introduction of purse seine in 1974 by owners of canning factories in Muncar caused protests by traditional fishermen and even led to riots, and as a result seven purse seines out of ten were burnt by fishermen. These riots led to the local government decision to provide credit to fishermen to buy purse seines and in the early phase 50 fishermen received credit. Because of the successful catch of purse seines, the new technology was finally adopted by fishermen and in the following year, 1975, fishermen from the Bali side also started employing purse seine.

One unit of purse seine consisted of a fishing boat for net carrier and another for hauling the ring rope which is locally called "sleret". In addition a canoe for carrying kerosene lamps became part of the unit during the fishing operation. The dimensions of fishing boats in Muncar were as follows: net carrier 11*2.7*1.5m equipped with an outboard motor of 13 HP, "sleret" boat 13*2.8*1.5 m with outboard motor of 13 HP and canoe 4*0.6*0.35 m with 4-5 kerosene lamps (Barus and Nasoetion, 1982). Gradually the boat size increased and ten years later (1984), the size had become (15-18 m)*(4.0-4.5)*(1.6-2.0m) with 4-5 outboard motors of 23-25 HP for the fleet in Muncar. While in Pengambengan (Bali) the sizes of fishing boats were smaller, (11-16.4 m)*(2.8-3.8 m)*(1.1-1.6 m) with 2 outboard motors of 24-25 HP each. For the "sleret" boat, the dimensions were (10-14 m)*(2.0-3.8 m)*(1.1-1.4 m) with 3 outboard motors of 24-25 HP each. However, in Kedonganan (Bali) the boats were slightly bigger, they

were of (13-18 m)*(3.0-4.0 m)*(1.2-1.8 m) with 2 outboard motors of 19-25 HP each. By this time (1999) one unit of purse seine fleet consisted of only two boats: the net boat equipped with 2 outboard motors and the "sleret" boat with 4 outboard motors. There were even two big boats equipped with 6 outboard motors and an electric generator of 5000 W. The common outboard motors used were Yanmar 300 Hupper of 30HP or Kubota KND 250 Hupper of 25 HP.

The number of fishermen aboard the boats was 13-15 of which 8-11 were on the net boat, 3-4 on the "sleret" boat and 1 on the "pelak" boat (Barus and Nasoetion, 1982). As the size of boat increased it could accommodate more people. The crew number reached 25-40 of which 5-8 were on the "sleret" boat and the rest were on the "net" boat.

Table 6. Total production of marine fish by purse seine and other type of gears in Muncar (kg and %)

Year	Purse seine	Other gears	Total	Year	Purse seine	Other gears	Total
1976	14352327 (71.6)	3686415 (28.4)	20038742 (100.0)	**1986**	2949240 (93.1)	218204 (6.9)	3167444 (100.0)
1977	11279236 (81.9)	2497132 (18.1)	13776368 (100.0)	**1987**	7975579 (97.2)	230198 (2.8)	8205777 (100.0)
1978	9635822 (94.5)	556425 (5.5)	10192247 (100.0)	**1988**	13214207 (97.9)	279099 (2.1)	13493306 (100.0)
1979	12256230 (95.8)	532706 (4.2)	12788036 (100.0)	**1989**	14162752 (95.7)	633255 (4.3)	14796007 (100.0)
1980	11538236 (91.5)	1071589 (8.5)	12609825 (100.0)	**1990**	10909659 (93.5)	759802 (6.5)	11669461 (100.0)
1981	9400665 (82.8)	1959393 (17.2)	11360058 (100.0)	**1991**	22828011 (97.4)	268855 (1.4)	18699409 (100.0)
1982	12461174 (93.7)	832949 (6.3)	13294123 (100.0)	**1992**	18430554 (98.6)	268855 (1.4)	18699409 (100.0)
1983	10599968 (95.1)	550293 (4.9)	11150261 (100.0)	**1993**	23030473 (97.3)	642606 (2.7)	23673079 (100.0)
1984	9387743 (96.7)	317260 (3.3)	9705003 (100.0)	**1994**	23343762 (93.7)	1565075 (6.3)	24908837 (100.0)
1985	6611226 (95.7)	296630 (4.3)	6907856 (100.0)				
Range					2949240 – 23343762 (71.6-8.6)	218204 - 5686415 (1.4 - 28.4)	
Average					14258423 (92.8)	1027064 (7.2)	15285487

Remarks: -Source: Research Institute for Marine Fisheries
-Figures in brackets are percentages

The size of purse seine nets used in Muncar was 165-204 m long and 21-28 m deep while in Pengambengan (Bali) it was 135-142.5 long and 19.5-52.5 deep (Bandie (1976), vide Kusuma (1980)). As the size of fishing boat increased, so did the size of the net. Nowadays the size of

net commonly used in Muncar is 240-285 m by 60-66 m, while in Pengambengan it is 140-145 m by 80-95m and in Kedonganan 120-180 m by 50-65 m. It is interesting to know that fishermen no longer use light attraction, contrary to the early years of development of purse seine, instead they rely on the bio-luminescence generated by the fish schools. The fishing operation is therefore conducted during the dark, and 2-3 days before and after full moon the fishermen do not go fishing. This type of fishing operation is locally called "gadangan" as opposed to "oncoran" for those who still use light attraction.

The catches of marine fish are presented in Table 6. From the Table it is clear that 92.8% of the total catch was from purse seine and the rest from other traditional gears such as Danish seine, gillnet, longline, hook and line, liftnet and barriers. The liftnet was used for catching juvenile lemuru and it was estimated that the catch of liftnet (mobile and fixed) was in the order of 5,165 t a year (Merta, 1992).

The status of fisheries in Bali Strait could be gauged by the number of fishing boats as represented in Table 7. While there has been a general increase in fishing boats both in Muncar and on the Bali side, some decline was observed. The drastic drop in number of fishing boats in Bali in 1980 from 106 to 48 posed a problem and no explanation was available. It was also interesting that in the early years of development the number of boats in actual operation were more than the licences granted which meant that some illegal fishing had taken place. The situation was completely reversed in 1986 for Bali, for which the number of boats in operation was always less than the number of licences granted. In Muncar, on the other hand, since 1985 the number of boats in operation has always been the same as the number of licences, except for 1998.

Table 7. The development of the number of purse seiners in Bali and Muncar, 1994-1998

Year	Bali	Muncar	Total	Year	Bali	Muncar	Total
1974	0	10	10	1987	79(83)	190(190)	269(273)
1975	26	44	70	1988	76(83)	190(190)	266(273)
1976	43	96	139	1989	68(83)	190(190)	258(273)
1977	74(50)	119(50)	193(100)	1990	72(83)	190(190)	262(273)
1978	102(60)	122(73)	224(133)	1991	70(83)	190(190)	260(273)
1979	106(60)	166(73)	272(133)	1992	73(83)	190(190)	263(273)
1980	48(60)	173(73)	221(133)	1993	73(83)	190(190)	263(273)
1981	65(60)	185(73)	250(133)	1994	72(83)	190(190)	262(273)
1982	78(60)	200(73)	278(133)	1995	75(83)	190(190)	265(273)
1983	82(75)	200(125)	282(200)	1996	76(83)	190(190)	266(273)
1984	86(75)	200(125)	286(200)	1997	76(83)	190(190)	266(173)
1985	86(83)	190(190)	276(273)	1998	79(83)	140(190)	219(273)
1986	81(83)	190(190)	273(273)				

Remarks: - Figures in brackets are number of licences granted (SIUP)

It was reported that once in a while some purse seiners from the north coast of East Java went fishing in the southern part of the Bali Strait. They were single boat seiners equipped with light attraction devices and net hauler (modified version of a car engine). They did not land

their catch either on the Bali side or Muncar as they were not welcome by the local fishermen. Their presence in the area was of a very limited nature.

Statistics on the number of gears are also available as presented in Table 8 for Muncar for the years 1993 to 1997. Apart from purse seine, in general there had been an increasing trend in the number of other gears. However, no explanation is available on the marked increase of

Table 8. Number of fishing gears operating in the Bali Strait, 1993-1997

Gear type	1993	1994	1995	1996	1997
Purse seine	190	190	190	190	190
Danish seine	48	81	87	106	115
Gill net	428	386	326	256	253
Long line	341	383	326	256	253
Hooks	393	375	385	419	413
Lift net	66	66	71	76	74
Weirs	16	130	130	125	114
Others	79	76	67	19	17

Remarks: - Source: Muncar District Fisheries Office

Table 9. Monthly effort and catch by purse seiners landing in Muncar in 1997

	Effort (boats)			Catch (kg)			CPUE
Month	BWC	BNC	TBO	Lemuru	Others	Total	kg/boat
January	59	147	206	85680	53160	138840	415.9
February	21	116	137	0	45600	45600	0
March	30	146	176	6880	46640	53520	39.6
April	99	103	202	60960	129680	190640	301.8
May	146	130	276	84560	454880	539440	306.4
June	89	165	254	147620	56260	203880	581.2
July	72	161	233	108380	55480	163860	645.2
August	449	69	516	1734024	27606	1761630	3347.5
September	670	41	711	1761520	158540	1920060	2477.5
October	793	25	815	3016605	0	3016605	3701.4
November	815	19	834	3145150	24000	3169150	3771.2
December	728	5	733	2909040	61140	2970180	3968.7
Total	3971	1127	5095	13060419	1112986	14173405	
Average	331	94	425	1088368.0	92748.8	118111.1	2563.4

Remarks: - Source: Research Institute for Marine Fisheries
- BWC = boat with catch
- BNC = boat without catch
- TBO = total number of boats operating (boat-day)

Danish seine that occurred in 1996 from 87 units to 106 units. Fishermen using gillnet for catching large pelagics operate outside the Bali Strait, while liftnets are operated in the Pangpang Bay in the area Muncar. Only some movable liftnets are operated in the southern part in the area of Sembulungan peninsula.

Scientists from RIMF have monitored the catch of lemuru in Bali Strait and have assigned an enumerator to monitor the catch in Muncar landing places. Table 9 shows the monthly catch of lemuru by purse seiner.

2.6 Level of Exploitation

In an effort to understand the impact of fishing on the resources, various stock assessment studies have been carried out in the last two decades. From 1972 to 1975 acoustic surveys were conducted in the Bali Strait by R/V Lemuru. Through the acoustic technique it was estimated that the potential yield of the pelagic resources in the Bali Strait was 66,000 t and the number of purse seine needed to exploit the resources was 150 units (Sujastani, Amin and Merta, 1977). Employing surplus production model, Buzeta, Dwiponggo and Sujastani (1978) came up with an estimate of MSY of 55,000 t with an optimum effort of 200 units of purse seine. Later another estimation came up with an MSY of 33,000-38,000 t with its corresponding effort of 154-196 units of purse seine (Sujastani and Nurhakim, 1982). All of these analyses indicated that the level of fishing in those years already surpassed the MSY level or in other words overfishing has occurred (see Table 7). In later studies such situation was also confirmed (see Tables 10 and 11).

Table 10. Various stock assessment studies of lemuru fishery in the Bali Strait, using surplus production models

Year	Model	MSY (t)	f_{opt} (p.s. unit)	Level of exploitation
1986 [1)]	Schaefer Fox	66,306 62,317	238 242	Over-fishing Over-fishing
1986 [2)]	Schnute	80,332	207	Over-fishing
	Gulland's moving average	60,559	123	Over-fishing
	Schaefer:			
	q = 0.00108	49,440	260	Over-fishing
	q = 0.00068	48,835	257	Over-fishing
	Jacknife:			
	q = 0.00108	49,581	259	Over-fishing
	q = 0.00068	47,512	320	Over-fishing
1992 [3)]	Schaefer	40,000	180	Over-fishing

Remarks: 1) Martosubroto, Naamin and Nurhakim, 1986); 2) Salim (1986); 3) Fisheries Department, Faculty of Animal Husbandry, Diponegoro University (1992).

Table 11. Various stock assessment studies using analytical models

Model	Y/R_{max} (g)	F_{max} (y^{-1})	Status
Y/R Beverton and Holt [1)]	14.22 - 11.85	0.5 - 0.8	Fully exploited
Y/R Beverton and Holt [2)]	3.90	1.2	Over-fishing
Y/R Jones [3)]	25.83	3.0	Over-fishing
Model	Yield total (t)	F array	Status
Thompson and Bell [4)]	34,041	X = 0.8	Over-fishing

Remarks: 1) Ritterbush (1975); 2) Gumilar (1985); 3) Merta (1992);
4) Merta and Eidman (1994)

2.7 Other Studies

Early acoustic surveys were conducted by R/V Lemuru (160 GT) in the period 1972-1975. In later years similar surveys were carried out by other boats such as R/V Bawal Putih I (190 GT), R/V Tenggiri (300 GT), R/V Madidihang (300 GT), R/V Baruna Jaya IV (750 GT) and M/V Sardinella (50 GT). The result of the later surveys did not show disagreement with the result of R/V Lemuru.

In understanding the dynamics of the lemuru population, some studies have concentrated on the population parameter, especially growth and mortality of the fish. Such studies were started from the early 1970s as shown in Table 12 and Table 13.

Table 12. Estimates of growth parameters of lemuru in the Bali Strait

$L\infty$ (cm TL)	K (th^{-1})	To (th)	Method	Author
23.8	0.50	-0.0012	MCPA	Dwiponggo, 1972
21.5	0.95	-0.0153	MCPA	Ritterbush, 1975
21.2	1.0056	-0.3817	MCPA	Sujastani and Nurhakim, 1982
20.6	0.79	-0.23	ELEFAN	Gumilar, 1985
21.1	0.80	-	ELEFAN	Dwiponggo *et al*., 1986
22.3	0.85	-	ELEFAN	Dwiponggo *et al*., 1986
22.5	1.0	-	ELEFAN	Dwiponggo *et al*., 1986
23.2	1.28	-	ELEFAN	Dwiponggo *et al*., 1986
21.4	1.37	-	MCPA	Mudihardjo, Amin and Rusmadji, 1990
22.71	0.961	-0.1789	ELEFAN	Merta, 1992

Remarks: - MCPA: Modal Class Progression Analysis
- ELEFAN 1 Programme (Brey and Pauly, 1986)

Table 13. Estimation of total mortality rate (Z), natural (M), fishing (F) and exploitation rate of lemuru fishery in the Bali Strait

Mortality (year-1)			Exploitation Rate	Author
Total (Z)	Natural (M)	Fishing (F)	(E)	
1.4	0.8-0.9	0.5-0.6	0.36-0.43	Ritterbush , 1975
2.74 (1977)	1.42	1.34	0.49	Sujastani and Nurhakim, 1982
2.76 (1978)	1.42	1.34	0.49	Sujastani and Nurhakim, 1982
1.43(1979)	1.42	0.01	0.007(?)	Sujastani and Nurhakim, 1982
2.89(1980)	1.42	1.47	0.51	Sujastani and Nurhakim, 1982
3.23	1.22	2.01	0.62	Gumilar, 1985
5.08	2.17	2.91	0.57	Budihardjo, Amin and Rusmadji, 1990
4.48	1.00	3.38	0.75	Merta, 1992

3. SOCIO-ECONOMIC ASPECTS

3.1 Coastal village profiles in the Bali Strait

Fishermen operating in the Bali Strait come from the fishing communities around the Bali Strait, mainly from those in the Muncar District (East Java) and Jembrana Regency (Bali). Muncar District consists of six villages of which four are coastal. The four villages cover an area of 49.06 km^2 with a population of 89,359 who originate from various ethnic groups (Javanese, Maduranese, Buginese and Chinese). The average population density is 2,058 people per km^2 with the high density in the Kedung Rejo village (see Table 14).

Table 14. Number of population, its density and household in coastal villages in Muncar District, 1997

Village	Area (km^2)	Density (Pop./km^2)	Population	Household	Population/ household
1. Tembok Rejo	5.48	2477	13574	2469	5.5
2. Kedung Rejo	8.51	2880	24515	4485	5.5
3. Sumber Beras	25.04	1495	37438	9359	4.0
4. Sumber Sewu	10.03	1379	13832	3438	4.0
Total/Average	49.06	2058	89359	19751	4.8

Source : Muncar District statistics, 1998.

While the population in Muncar was 102,197 in 1989 (which was less than in 1981 – (103,115) according to Budihardjo and Hardoyo, 1982 and Zulfikar, 1990), it had increased to 115,544 in 1997. The Sumber Beras village had the highest number of households, but in terms of the number of family per household, Tembok Redjo and Kedung Rejo were the highest (5.5). On average the number of family members per household was 4.8. On the other

hand the number in 1981 was only 3.9 (Budihardjo and Hardoyo, 1982) which means that there has been an increase in the population in the last decade.

Fishermen from the Bali side are largely from the Jembrana Regency with the highest concentration from the Negara District. This District extends over an area of 122.47 km^2 with a population of 93,380 who are distributed in 22 villages, of which 8 are coastal and with a population density of 674 per km^2. Among these villages the highest concentration of population is found in the Air Kuning village (674 people per km^2), while the lowest one is in the Baluk village (411, see Table 15 for details). In terms of labour force, the ratio between the number of population and the labour force was 1.7 for the whole six villages of the Negara District.

Table 15. Number of population, its density and the number of household in coastal villages in Negara District, 1997

Village	Area (km^2)	Density (Pop./km^2)	Population	Household	Population/ household	Labor force	Loading of labor force
1. Cupel	6.4	426	2726	627	4	1589	1.7
2. Tegal Badeng B	4.02	781	3139	943	3	2049	1.5
3. Pengambengan	10.3	723	7445	1961	4	4242	1.8
4. Perancak	3.74	841	3144	797	4	1922	1.6
5. Air Kuning	2.71	1076	2917	796	4	1628	1.8
6. Yeh Kuning	4.21	514	2162	652	3	1346	1.6
7. Baluk	10.55	411	4336	926	5	2633	1.6
8. Banyubiru	9.39	618	5805	1486	4	3466	1.7
Total/Average	51.32	674	31674	8188	4	18875	1.7

Source: Negara District Statistic, 1998.

3.2 The role of fisheries in the economy

The fisheries sector plays an important role, not only as a source of protein but also as a source of income, for the fishermen and other people involved in the processing and marketing industry. According to statistics there were 11,469 people in the Muncar District (or 12.8% of its total population) and 6,504 people in the Negara District (19.1% of its total population) working in marine fisheries. In terms of fishermen, the number in the Muncar District was about 57.4% of the total fishermen in Banyuwangi Regency, while in the Negara district the number of fishermen reached about 61.6% of the total number of fishermen in the Jembrana Regency.

The gross domestic product generated from the fisheries sector in the areas bordering the Bali Strait is represented in Tables 16 and 17. The GDP of fisheries fluctuated in accordance with fluctuations of the catch, which was not the case for the total domestic product. In the Banyuwangi Regency the gross domestic product of the fisheries sector had shown an increase of 16.69% per year which was higher than the increase in the total gross domestic product (13.54%). Contribution of the fisheries sector to the total GDP was generally small - 5.31% for 1991 and 1.58% for 1997, although in terms of the number of people involved in the sector it is considered high.

Table 16. Gross Regional Domestic Product (GRDP) based on current price (in million Rp.) in Banyuwangi

Year	Fishery	Change (%)	Total	Change (%)	%. Of fishery
1988	16160.61		716303.88		2.26
1989	24393.6	50.94	782965.52	9.31	3.12
1990	46059.38	88.82	885237.72	13.06	5.20
1991	48980.48	6.34	921905.5	4.14	5.31
1992	39381.02	-19.60	1140544.48	23.72	3.45
1993	59695.79	51.59	1311845.91	15.02	4.55
1994	60239.11	0.91	1517738.65	15.69	3.97
1995	45082.2	-25.16	1732026.1	14.12	2.60
1996	24917.75	-44.73	1910182.67	10.29	1.30
1997	35169.29	41.14	2225732.82	16.52	1.58
Average of change		16.69		13.54	

Source : Statistics Office Banyuwangi Regency.

Table 17. Gross Regional Domestic Product (GRDP) based on current price (in million Rp.) in Jembrana

Year	Fishery	Change (%)	Total	Change (%)	%. Of fishery
1988	36636.75		201124.33		18.22
1989	32183.31	-12.16	218373.93	8.58	14.74
1990	33607.91	4.43	250711.14	14.81	13.41
1991	37205.91	10.71	186105.01	-25.77	19.99
1992	45555.09	22.44	320337	72.13	14.22
1993	65879.2	44.61	400859.31	25.14	16.43
1994	68114.91	3.39	453506.14	13.13	15.02
1995	75239.03	10.46	516185.5	13.82	14.58
1996	83896.12	11.51	599508.19	16.14	13.99
1997	99133.85	18.16	691131.72	15.28	14.34
Average		12.62		17.03	

Source : Statistics Office Jembrana Regency.

In the case of Jembrana Regency, the gross domestic product of the fisheries sector had shown an increase of 12.62% per year (see Table 17), but was smaller than the increase of the total gross domestic product of 17.30%. Compared to the Banyuwangi Regency, the gross domestic product of the fisheries sector in the Jembrana Regency changed only a little. It is

likely that the fluctuating catch of lemuru was compensated for by the catch of other valuable species landed in Jembrana Regency. The fishery sector contributed about 13.4-20.0% of the total gross domestic product in this area.

3.3 Development of fishing fleets

The development of fisheries can be gauged by the trend of fishing fleets. The number of motorized fishing boats has increased, while the non-powered fishing boats decreased, as shown during the development in the last decade (Table 18). For the East Java side, the fishing boats concentrated in Muncar and on average during this period the number of fishing boats in Muncar constituted 36.5% to 49.0% of the total fishing boats in the Banyuwangi Regency.

Table 18. Trend of fishing fleets in Banyuwangi and Muncar

Year	Banyuwangi			Muncar			Percentage in Muncar
	NPB	PB	Total	NPB	PB	Total	
1988	1008	2072	3080	179	1080	1259	40.9
1989	1031	2119	3150	179	1243	1422	45.1
1990	1127	2131	3258	300	1295	1595	49.0
1991	1044	2271	3315	356	1291	1647	49.7
1992	866	2279	3145	180	1308	1488	47.3
1993	1101	2374	3475	71	1457	1528	44.0
1994	1042	2784	3826	230	1165	1395	36.5
1995	1026	2798	3824	230	1165	1395	36.5
1996	958	2189	3147	189	1179	1368	43.5
1997	958	2189	3147	189	1179	1368	43.5

Source : Fisheries Office, Banyuwangi, 1988 – 1998.
Note : PB =Powered boat; NPB = Non-powered Boat

In terms of the number of fishing gear, the trend was similar to that of fishing boats (Table 19). As the majority of the fishing vessels were located in Muncar, the number of fishing gears also were concentrated in Muncar. In terms of total number of fishing gear, Muncar contributed about 27.8% to 29.2% to the total.

Table 19. The development of fishing gears in Banyuwangi and Muncar

Year	Banyuwangi			Muncar			Percentage of Muncar
	Non-PS	PS	Total	Non-PS	PS	Total	
1988	5075	190	5265	1272	190	1462	27.8
1989	5089	190	5279	1286	190	1476	28.0
1990	5158	190	5348	1355	190	1545	28.9
1991	5179	190	5369	1376	190	1566	29.2
1992	5179	190	5369	1376	190	1566	29.2
1993	5181	190	5371	1378	190	1568	29.2
1994	5083	193	5276	1280	190	1470	27.9
1995	5067	193	5260	1280	190	1470	27.9
1996	5069	193	5262	1282	190	1472	28.0
1997	5069	193	5262	1282	190	1472	28.0

Source : Fisheries Office, Banyuwangi, 1988 – 1998.
Note : PS = purse seine

Table 20. Trend of the number of fishing gear in Jembrana

Year	Fishing boat			Fishing gear		
	NPB	PB	Total	Non-PS	PS	Total
1988	883	156	1039	2261	60	2321
1989	899	145	1044	2322	60	2382
1990	895	157	1052	2848	66	2914
1991	1171	164	1335	2151	66	2217
1992	879	134	1013	1970	67	2037
1993	1430	186	1616	3713	66	3779
1994	3398	482	3880	3748	66	3814
1995	1153	339	1492	1985	67	2052
1996	1172	344	1516	2084	68	2152
1997	1013	478	1491	3357	68	3425

Source: Fisheries Office, Jembrana Regency, 1988 – 1998**.**
Note : PB = powered boat; NPB = Non-powered boat; PS = purse seine

Contrary to the availability of statistical data in Muncar, such data on fishing gears are not available in Negara. However, as the majority of fishermen are located in Negara, it is most likely that the number of fishing gears are also concentrated in Negara. The trend of the fishing gears can be seen in Table 20 where the sharp increase of the number of fishing boats in 1994 could have been due to the migration of fishing boats from the north coast of East Java as in the subsequent years the number dropped again appreciably. On average the annual increase of the number of fishing boats reached 15.7%. Most of the increase was represented

by fishing boats other than purse seiners as the number of purse seiners only increased by eight units, and all purse seiners were concentrated in Negara.

3.4 Trend of number of fishermen

On the East Java side, the concentration of fishermen was located in Muncar. The number increased from 55.4% to 67.7% of the number of total fishermen in the entire Banyuwangi Regency. The total number of fishermen in Muncar reached about 12.4% of the total number of its population. While the number of fishermen in the whole Regency of Banyuwangi showed an annual increase of 0.3% in the last decade, the number of fishermen in Muncar District decreased by 1.6% (see Table 21). It is not clear whether the increased number of fishermen only occurred in non-purse seine fleets as the size of the purse seine also increased to accommodate the increased number of fishermen. In 1981, the number of fishermen in Muncar constituted only 9.4% of the total population (Budihardjo and Hardoyo, 1982) indicating that the rate of increase in fishermen was much higher than the increasing rate of the population.

Table 21. Trend of the number of fishermen in Banyuwangi and Muncar

Year	Banyuwangi			Muncar			Percentage of Muncar
	Owner	Labourer	Total	Owner	Labourer	Total	
1988	4046	15751	19797	1810	11602	13412	67.7
1989	4745	16120	20865	1822	11654	13476	64.6
1990	4560	17250	21810	1822	11499	13321	61.1
1991	4532	17465	21997	1822	12630	14452	65.7
1992	3588	17208	20796	1644	11343	12987	62.4
1993	4387	17640	22027	1621	10989	12610	57.2
1994	4243	18093	22336	1411	10954	12365	55.4
1995	3997	15995	19992	1257	10212	11469	57.4
1996	4167	16656	20823	1278	10563	11841	56.9
1997	3997	15995	19992	1257	10212	11469	57.4

Source : Fisheries office Banyuwangi Regency, 1988 – 1998.

On the other hand, the number of fishermen in Jembrana and Negara declined by as much as 9.9 % and 9.1 % per year (see Table 22). The highest number of fishermen (75 %) was concentrated in Negara. Compared to the total population, the fishermen constituted of 19.1 % although in 1981 only 2.9 % (Budihardjo and Hardoyo, 1982).

Table 22. Trend of the number of fishermen in Jembrana and Negara

Year	Jembrana			Negara			Percentage of Negara
	Owner	Labourer	Total	Owner	Labourer	Total	
1988	1606	3491	5097	118			
1989	1606	3491	5097	779	3068	3847	75.5
1990	1404	6194	7598	728	5863	6591	86.7
1991	1889	6823	8712	1177	6645	7822	89.8
1992	2295	7369	9664	1649	6614	8263	85.5
1993	1718	7097	8815	1326	6638	7964	90.3
1994	2010	7397	9407	1326	6638	7964	84.7
1995	1765	7113	8878	2259	4971	7230	81.4
1996	3372	4603	7975	3192	3303	6495	81.4
1997	3432	7118	10550	3192	3312	6504	61.6

Source : Fisheries Office, Jembrana Regency, 1988 – 1998.

In terms of total number of fishermen operating in the Bali Strait, on average it had increased by 2.5 % yearly in the last decade. The sharp increase occurred in 1990 and 1997 (Table 23).

Table 23. Trend of total number of fishermen in the Bali Strait

Year	Number of fishermen			
	Jembrana	Banyuwangi	Total	Change (%)
1988	5097	19797	24894	
1989	5097	20865	25962	4.3
1990	7598	21810	29408	13.3
1991	8712	21997	30709	4.4
1992	9664	20796	30460	-0.8
1993	8815	22027	30842	1.3
1994	9407	22336	31743	2.9
1995	8878	19992	28870	-9.1
1996	7975	20823	28798	-0.2
1997	10550	19992	30542	6.1

During the period 1988 – 1997, the total fish production of Muncar increased annually by 10.7 %. On the other hand, in Jembrana it decreased by 3.9 %. The highest increase took place in 1991 and 1994 for Muncar and in 1992 and 1994 for Jembrana (Table 24 and 25).

Table 24. Trend of total fish and lemuru production by weight and value in Muncar

Year	Volume (tonnes)				Value (000 Rp)			
	Total	Growth(%)	Lemuru	Growth(%)	Total	Growth(%)	Lemuru	Growth(%)
1988	20912.8		15222.3		5012410		2937904	
1989	30875.6	47.64	26460.8	73.83	7825360	56.12	5398003	83.74
1990	25002.7	9.34	22967.5	22.83	6450706	13.44	4771306	27.44
1991	37394.6	21.38	33710.9	30.35	5557299	3.50	4820658	17.95
1992	32995	12.08	29658.4	18.15	5515291	2.42	4419101	10.74
1993	35196	10.97	31760.6	15.85	7459166	8.28	6574320	17.48
1994	37230.6	10.09	31838.6	13.09	9072120	10.39	6845299	15.14
1995	15230.6	-4.43	13836.6	-1.35	4797652	-0.62	3251601	1.46
1996	8576.4	-10.54	4445.9	-14.26	4992169	-0.05	2231842	-3.38
1997	20879.6	-0.02	20485.1	3.35	5663870	1.37	5223700	6.60
Average		10.7		18.0		10.5		19.7

Source : Fisheries Statistic report, Muncar, 1988 – 1998

The annual rate of increase of production by weight in Muncar was not much different from the increased rate in terms of value (10.7% versus 10.5% respectively). This was not the case for Jembrana as the decrease of annual production by weight (-3.9%) was accompanied by the annual increase of value which reached 8.3%. This was due to the fact that the decline of the catch in terms of weight was compensated by the increase in the number of high valued fish in the catch as well as the improved quality of the fish landed.

Table 25. Trend of total fish and lemuru production by weight and value in Jembrana

Year	Volume (tonnes)				Value (000 Rp)			
	Total	Growth(%)	Lemuru	Growth(%)	Total	Growth(%)	Lemuru	Growth(%)
1988	24589.3		19592		5313722		2720673	
1989	15347.4	-37.6	13201.7	-32.6	3907954	-26.5	2491209	-8.4
1990	25602.4	2.0	22557.8	7.3	5464894	1.4	3125934	7.2
1991	26955.5	3.1	25034.5	8.5	5297612	-0.1	4071872	14.4
1992	28919.1	4.1	23195.1	4.3	8265217	11.7	4088645	10.7
1993	23317.1	-1.1	13264.5	-7.5	9993276	13.5	2965826	1.7
1994	29444.7	3.0	14953.6	-4.4	16376951	20.6	4859016	10.1
1995	17342.3	-4.9	11044.1	-7.9	18077082	19.1	7275876	15.1
1996	15396.4	-5.7	7232.5	-11.7	15165635	14.0	3702425	3.9
1997	29914.1	2.2	27838.1	4.0	29116349	20.8	6084265	9.4
Average		-3.9		-4.4		8.3		7.1

Source : Fisheries Office, Jembrana Regency 1988 – 1998.

The total fish production in the entire Bali Strait in the last decade has shown an annual increase of 3.1 % by weight and 10.3 % by value (Table 26 and 27).

Table 26. Trend of total fish and lemuru production in Bali Strait by weight (tonnes)

Year	Total				Lemuru				
	Muncar	Jembrana	Total	Growth(%)	Muncar	Jembrana	Total	Growth(%)	% lemuru
1988	20912.8	24589.3	45502.1		15222.3	19592	34814.3		76.5
1989	30875.6	15347.4	46223	1.6	26460.8	13201.7	39662.5	13.9	85.8
1990	25002.7	25602.4	50605.1	5.5	22967.5	22557.8	45525.3	14.4	90.0
1991	37394.6	26955.5	64350.1	12.2	33710.9	25034.5	58745.4	19.1	91.3
1992	32995	28919.1	61914.1	8.0	29658.4	23195.1	52853.5	11.0	85.4
1993	35196	23317.1	58513.1	5.2	31760.6	13264.5	45025.1	5.3	76.9
1994	37230.6	29444.7	66675.3	6.6	31838.6	14953.6	46792.2	5.1	70.2
1995	15230.6	17342.3	32572.9	-4.7	13836.6	11044.1	24880.7	-4.7	76.4
1996	8576.4	15396.4	23972.8	-7.7	4445.9	7232.5	11678.4	-12.8	48.7
1997	20879.6	29914.1	50793.7	1.2	20485.1	27838.1	48323.2	3.7	95.1
Average				3.1				6.1	79.6

Table 27. Trend of total fish and lemuru production in Bali Strait by value (000. Rp)

Year	Total production				Lemuru production				
	Muncar	Jembrana	Total	Growth(%)	Muncar	Jembrana	Total	Growth(%)	% lemuru
1988	5012410	5313722	10326132		2937904	2720673	5658577		54.8
1989	7825360	3907954	11733314	13.6	5398003	2491209	7889212	39.4	67.2
1990	6450706	5464894	11915600	7.4	4771306	3125934	7897240	18.1	66.3
1991	5557299	5297612	10854911	1.7	4820658	4071872	8892530	16.3	81.9
1992	5515291	8265217	13780508	7.5	4419101	4088645	8507746	10.7	61.7
1993	7459166	9993276	17452442	11.1	6574320	2965826	9540146	11.0	54.7
1994	9072120	16376951	25449071	16.2	6845299	4859016	11704315	12.9	46.0
1995	4797652	18077082	22874734	12.0	3251601	7275876	10527477	9.3	46.0
1996	4992169	15165635	20157804	8.7	2231842	3702425	5934267	0.6	29.4
1997	5663870	29116349	34780219	14.4	5223700	6084265	11307965	8.0	32.5
Average				10.3				14.0	54.1

In terms of productivity there was a significant difference between fishermen from Muncar and Jembrana. In Muncar, the annual productivity per fisherman (tonnes) had increased by 14.7 % (Table 28) but the annual productivity in Jembrana had declined by 2.5 % (Table 29). The average production per fisherman in Jembrana reached 2.8 t per year, while in Muncar it was only 2.05 t per year. On the other hand, in terms of value, the production per fisherman in Muncar was only Rp. 490,690 per year, while in Jembrana it was much higher, i.e. Rp. 1,356,409 per year. In Muncar the production value had increased by 7.4 %, which was lower than the rate of the production volume (Table 28). While in Jembrana, although the production had decreased in volume, it had increased by 14.9 % per year in terms of value.

Table 28. The productivity of fishermen in Muncar District

Year	Number of fishermen	Production		Productivity per fishermen			
		Vol. (t)	Value (000)	Vol.(t)	Change(%)	value (000)	Change(%)
1988	13412	20912.8	5012410	1.56		373.726	
1989	13476	30875.6	7825360	2.29	46.9	580.689	55.4
1990	13321	25002.7	6450706	1.88	-18.1	484.251	-16.6
1991	14452	37394.6	5557299	2.59	37.9	384.535	-20.6
1992	12987	32995	5515291	2.54	-1.8	424.678	10.4
1993	12610	35196	7459166	2.79	9.9	591.528	39.3
1994	12365	37230.6	9072120	3.01	7.9	733.693	24.0
1995	11469	15230.6	4797652	1.33	-55.9	418.315	-43.0
1996	11841	8576.4	4992169	0.72	-45.5	421.600	0.8
1997	11469	20879.6	5663870	1.82	151.4	493.842	17.1
Average				2.05	14.7	490.69	7.4

Table 29. The productivity of fishermen in Jembrana Regency

Year	Number of fishermen	Production		Productivity per fishermen			
		Vol (t)	Value (000)	Vol (t)	Change (%)	Value (000)	Change (%)
1988	5097	24589.3	5313722	4.82		1042.520	
1989	5097	15347.4	3907954	3.01	-37.6	766.716	-26.5
1990	7598	25602.4	5464894	3.37	11.9	719.254	-6.2
1991	8712	26955.5	5297612	3.09	-8.2	608.082	-15.5
1992	9664	28919.1	8265217	2.99	-3.3	855.258	40.6
1993	8815	23317.1	9993276	2.65	-11.6	1133.667	32.6
1994	9407	29444.7	16376951	3.13	18.3	1740.932	53.6
1995	8878	17342.3	18077082	1.95	-37.6	2036.166	17.0
1996	7975	15396.4	15165635	1.93	-1.2	1901.647	-6.6
1997	10550	29914.1	29116349	2.84	46.9	2759.844	45.1
Average				2.98	-2.5	1356.409	14.9

For the whole of Bali Strait, the productivity of fishermen had increased by 1.0 % per year in terms of weight and 12.0 % per year in terms of value. Average productivity per fisherman was 2.52 t per year or Rp. 933,550 which was a little higher than the GRDP in the Bali Strait (Rp. 919,114 per year).

Table 30. The development of productivity of fishermen in Bali Strait

Year	Volume (t)				Value (000)			
	Muncar	Jembrana	Average	Change(%)	Muncar	Jembrana	Average	Change(%)
1988	1.56	4.82	3.19		373.726	1042.520	708.123	
1989	2.29	3.01	2.65	-16.9	580.689	766.716	673.703	-4.9
1990	1.88	3.37	2.62	-1.0	484.251	719.254	601.753	-10.7
1991	2.59	3.09	2.84	8.3	384.535	608.082	496.309	-17.5
1992	2.54	2.99	2.77	-2.6	424.678	855.258	639.968	28.9
1993	2.79	2.65	2.72	-1.7	591.528	1133.667	862.597	34.8
1994	3.01	3.13	3.07	13.0	733.693	1740.932	1237.313	43.4
1995	1.33	1.95	1.64	-46.6	418.315	2036.166	1227.240	-0.8
1996	0.72	1.93	1.33	-19.1	421.600	1901.647	1161.624	-5.3
1997	1.82	2.84	2.33	75.4	493.842	2759.844	1626.843	40.0
Average			2.52	1.0			923.55	12.0

3.5 Purse seine revenue

As presented earlier (Tables 24 and 25) the production of lemuru in Muncar during 1988 to 1997 had increased by 18% per year, while that of Jembrana had shown an annual decrease of 4.4%. On average the production of lemuru constituted 79.6% of total production for the entire Bali Strait and had shown an annual increase of 6.1% which was higher than the total production increase (see Table 26). In terms of value, the rate of increase was lower and the total value of lemuru constituted only 54.1% of the total value of fish.

A feasibility study of purse seine fisheries in the Bali Strait was initially conducted by a team from Diponegoro University (1992) and a summary of the main findings is shown in Table 31. The study indicated that the level of Net Present Value (NPV) at i=20 % was Rp. 84,081,117, Internal Rate of Return (IRR) was 37.18 %. The pay back period of investment at the same rate was estimated about 5.7 years. A previous study conducted by Zulfikar (1990), however, showed a value of Rp. 35,778,112 (with NPV at i=18%), with IRR of 27 % and B/C ratio = 1.49. Based on this earlier study it was concluded that purse seine fishing was lucrative for the long term operation.

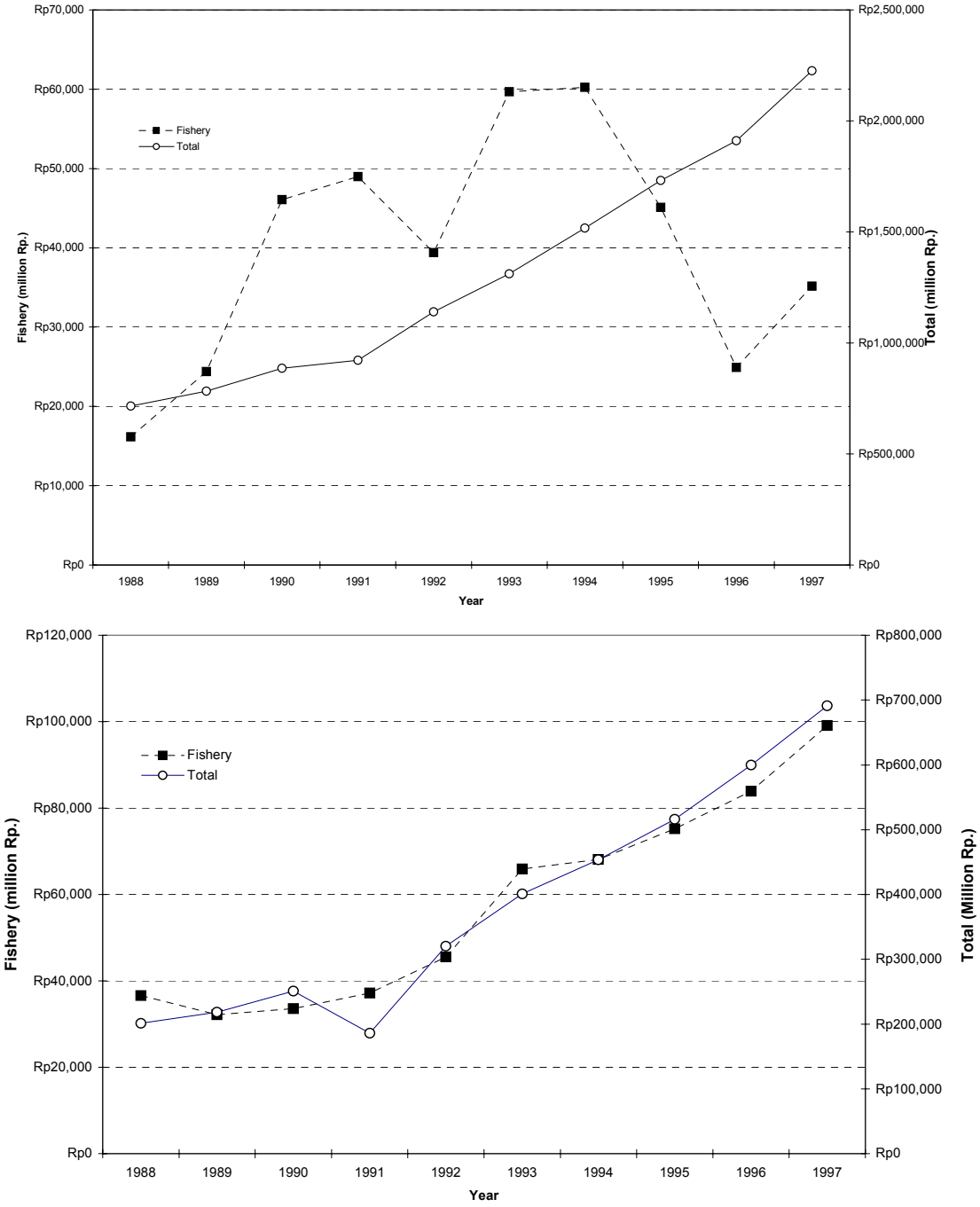

Figure 3. Trend of Gross Regional Domestic Product (GRDP) based on Current price at Banyuwangi (top) and Jembrana (bottom)

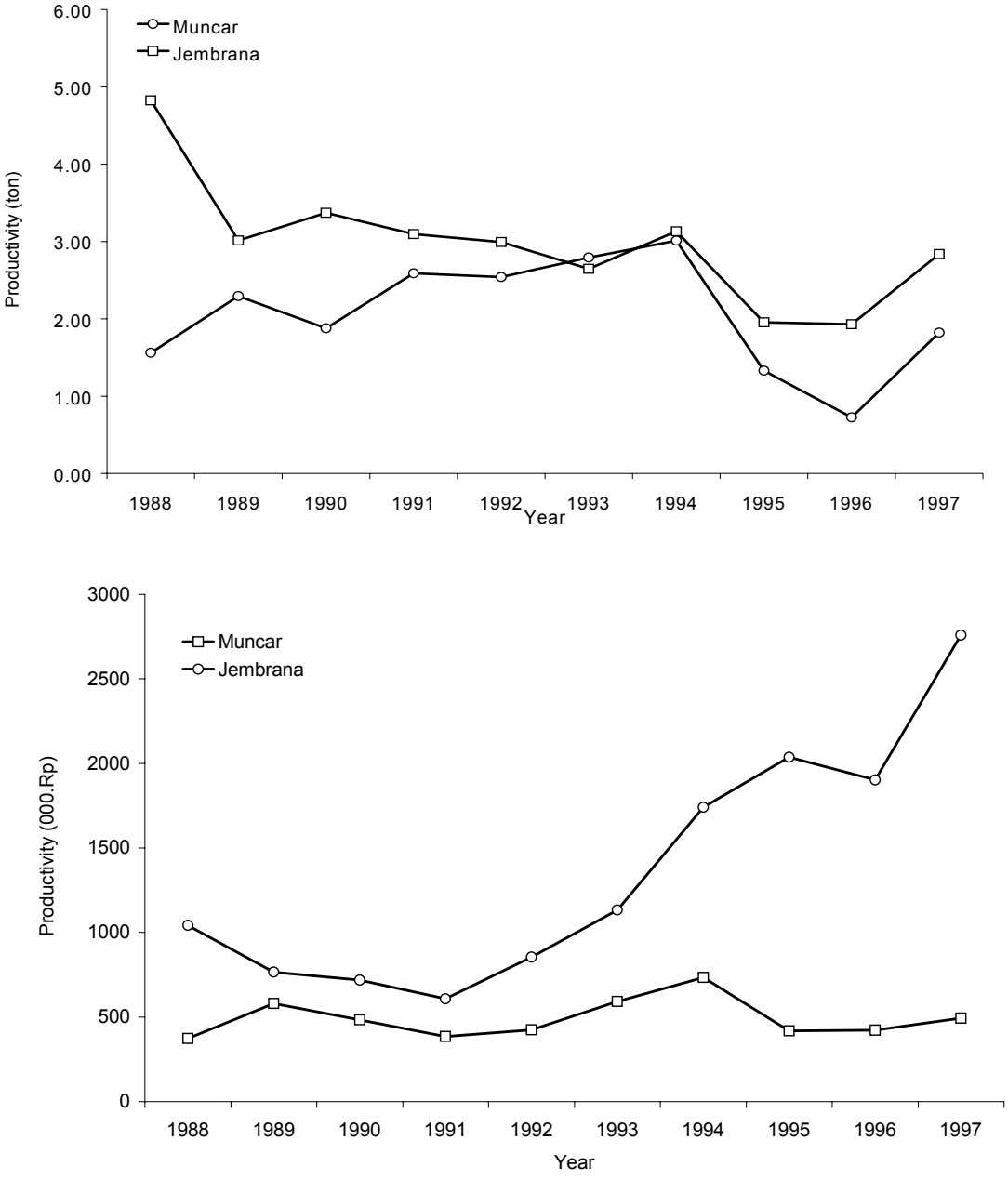

Figure 4. Trend of productivity of individual fisherman at Muncar and Jembrana in terms of volume (top) and value (bottom)

Table 31. Financial analysis of purse seine at Muncar in 1989

Description		Value (Rp)
Gross income		**240,958,000**
Variable costs:		
Operational	Rp. 41,708,640	
Distribution	Rp. 48,669,985	
Sharing system (captain, crew)	Rp. 100,849,300	
Sub total		**191,227,925**
Operating income		**49,730,075**
Fixed costs		**3,570,950**
Net income for owner		**46,159,125**
Subdivisions of crew income:	**Rp. 100,849,300**	
1 man captain (3 shares)		**8,288,984**
2 men engineers (3 shares)		**8,288,984**
2 men divers (3 shares)		**8,288,984**
1 man juru untul (fish spotter) (1.5 shares)		**4,144,492**
26 men crews (26 shares)		**71,837,858**
Income per crew member		**2,762,995**

Source : Processed from Zulfikar (1990).

Table 31 above shows clearly that purse seine fishing was a very attractive business during that period. A captain of a purse seiner had the highest income (3 shares) and crew were the lowest (1 share). Compared to other fishermen's income in Bali Strait, the crew of a purse seiner had a much better income.

The study on social economic welfare for the PS and non-PS was made by Diponegoro University in 1992 which showed a different result. The analysis was based on three criteria of the cost of living index. The calculation of the index was done in three steps, i.e. 1) calculating the indicator index, 2) based on the indicator index, generating the component index, and 3) from the component index, deriving cost of living index.

The results of the study indicated that the scores of economic welfare of fishermen of PS and non-PS in Muncar were 3,007 and 2,527 respectively. In Jembrana regency the scores were respectively 2,966 and 2,596. The analysis indicated that purse seine fishermen in Muncar had higher scores than those for Jembrana. While for the non-PS fishermen, Jembrana had higher scores than those in Muncar. Contrary to the secondary data presented before, the non-PS fishermen had a higher income than the PS fishermen.

4. POST HARVEST AND MARKETING

4.1 Handling and Processing

A large number of fishing boats do not carry ice or other preservatives on board and as a result about 30-40% of the total catch landed in the harbours are not of a quality for canning purposes. This primarily applies to the first catch which is normally at the bottom of the hold. At landing places those catches are rearranged and stored in 30-40 kg boxes to be sold in the auction hall. The fish that will be transported to distant places is stored in a plastic drum to which ice flakes and salt were added for preservation with the ratio of fish to ice and to salt as 2:1 : 0.1 respectively.

A technique to store the catch in chilled sea water during the fishing operation was introduced by a scientist of the Research Station of the Marine Fisheries Research Institute in Slipi (Nasran, 1985). A fish hold of a fishing boat was successfully modified to adopt the technique and was able to store the catch at 0^{o} C during the fishing operation. The small difference in terms of price for the good quality fish over the inferior may have led to the slow adoption of the technique. In recent years, however, about 80% of the fishing boats have improved their fish holds with better insulation.

Table 32. Disposition of catch in Banyuwangi during 1992 – 1996 (t and %)

No	Type of disposition	1992	1993	1994	1995	1996
1	For human consumption	2113.8 (5.9)	2836.4 (7.4)	1153.6 (2.9)	2784.1 (21.8)	822.2 (10.4)
2	Drying/Salting	5754.7 (16.1)	2545.6 (6.6)	3451.1 (8.7)	2893.3 (22.6)	530.1 (6.7)
3	Boiled-salted	7018.6 (19.7)	5008.5 (13.0)	8755.2 (22.1)	809.8 (6.3)	1269.9 (16.0)
4	Blachan	1075.5 (3.0)	2716.3 (7.1)	108.8 (0.3)	109.3 (0.9)	87.5 (1.1)
5	Fermented fish (peda)	40.3 (0.1)	87.3 (0.2)	- -	- -	- -
6	Fish sauce		-	-	-	-
7	Fish smoked	1358.4 (3.8)	574.0 (15)	- -	- -	- -
8	Others	42.3 (0.1)	49.2 (0.1)	- -	- -	- -
9	Freezing	3241.1 (9.1)	2130.9 (5.5)	5957.5 (14.0)	2024.3 (15.9)	1695.8 (21.4)
10	Canning	14454.3 (40.5)	18761.9 (48.8)	3957.5 (10.0)	1784.9 (14.0)	1081.6 (13.6)
11	Fish meal	593.5 (1.7)	3749.3 (9.8)	16662.3 (42.0)	2362.6 (18.5)	2442.8 (30.8)
12	Flake fish	-	-	-	-	-
13	Total marine fishery production	35692.5 (100)	38469.0 (100)	39646.7 (100)	12768.3 (100)	7929.9 (100)

Remark :Figures in the brackets indicate the percentage to total production
Source : Fisheries statistics of East Java, 1992 - 1996

The trend of the disposition of the catch (not only for lemuru) in the Banyuwangi Regency and in the Bali side is presented in Tables 32 and 33 respectively. Table 32 indicates that fresh

fish consumption in East Java (Banyuwangi and Muncar), in the period from 1992 to1996 ranged from 2.9% to 21.8% of the total production in this area. The remaining 78,2% to 97.1% was processed into a variety of products.

For Bali province (Table 33), on the other hand, a good proportion of the catch (31.7% to 45.6%) was consumed fresh, while the remaining 54.4% to 68.4% went to processing units for a variety of products. The catch that was processed to fish meal and fish flake was 6.1% to 12.3% for Bali Province as opposed to 1.7% to 42.0% for East Java Province (Table 32).

Table 33. Disposition of catch in Bali side (Jembrana, Badung and Buleleng Regencies) in1992 - 1996 in tonnes

No	Type of disposition	1992	1993	1994	1995	1996
1	Human consumption	14212.4 (31.7)	10337.8 (35.3)	16742.4 (45.6)	11023.3 (42.8)	8748.4 (34.3)
2	Drying/Salting	1357.1 (3.0)	619.4 (2.1)	665.8 (1.8)	759.1 (2.9)	889.6 (3.5)
3	Boiled-salted	4578.6 (10.2)	3800 (13.0)	5293.6 (14.5)	3148.2 (12.2)	3269.5 (12.8)
4	Blachan	-	-	-	-	-
5	Fermented fish	-	-	-	-	-
6	Fish sauce	-	-	-	-	-
7	Smoked fish	399.9 (0.9)	84.3 (0.3)	72.7 (0.2)	176.6 (0.7)	685.5 (2.7)
8	Others	-	-	-	-	-
9	Freezing	3146.8 (7.0)	-	-	278.7 (1.1)	101.8 (0.3)
10	Canning	7052.5 (15.8)	8489.9 (29.0)	7307.2 (20.0)	6661.5 (25.9)	9321.4 (36.5)
11	Fish meal	6827.6 (15.4)	2353.9 (8.0)	3.153.2 (8.6)	2138.8 (8.3)	2528.2 (9.9)
12	Flake fish	7198.6 (16.0)	3613.4 (12.3)	3401.6 (9.3)	1578.3 (6.1)	-
13	Total marine fishery production	44773.5 (100)	29305.1 (100)	36739.1 (100)	25764.9 (100)	25544.4 (100)

Remark : Figures in brackets indicate percentage to the total marine fishery production
Source : Fisheries statistics of East Java, 1992 - 1996

A large number of catches are processed in various forms and Table 34 presents the number of processing facilities around the Bali Strait. More facilities are found in the East Java Province as the large consumers are found in Java. However, there are more processing units for boiled-salted fish in Bali meeting the increased demands for this traditional processing by the consumers in Bali, especially for communities inland.

Table 34. Fish processing establishments in Banyuwangi, Jembrana, Badung and Buleleng Regencies

No	Type of establishments	Unit of establishments	
		Banyuwangi Regency	Jembrana, Badung, Buleleng Regency
1	Fish canning	12	4
2	Mechanical fish meal	25	2
3	Fish freezing	18	1
4	Fish icing	42	-
5	Boiled-salted	49	155
6	Fish drying	32	4
7	Clam collecting	10	-
8	Fish concentrate	6	-
9	Blachan	1	2
10	Fish flake	-	67

The total number of people involved in the processing activities around Bali Strait is relatively large; it reached 7,792 in 1998 (Table 35). In terms of the quality of fish produced by processing units, there is still potential for improvement (Saleh and Murtini, 1982; Suparno and Azmiati, 1982).

Table 35. Number of workers involved in the processing units in Muncar and Jembrana regencies

Years	Location				Total	% Bali Strait change
	Muncar	% Change	Jembrana	% Change		
1988	7631		nd	nd		
1989	7435	-2.6	nd	nd		
1990	7495	0.8	nd	nd		
1991	7315	-2.4	nd	nd		
1992	7360	0.6	nd	nd		
1993	7360	0.0	nd	nd		
1994	7372	0.2	nd	nd		
1995	7087	-3.9	1465		8552	16.0
1996	7035	-0.7	1412	-3.6	8447	-1.2
1997	7360	4.6	1593	12.8	8953	6.0
Average	7345	-0.4	1490	-4.6	7792	-1.9

Remarks: - nd = no data

4.2 Marketing of fish products

The first marketing channel is through the auction hall. Representatives of the cooperatives (KUD), fishermen groups, middlemen, processors, collectors and retailers purchase the fish in the auction. Some of the catches do not go to the action hall but directly to canning factories; such practice is very common during the peak season to maintain quality since the auction will be normally full of catches. The middlemen, collectors and retailers are important in terms of distributing the product to inland areas.

The price of lemuru fluctuated and very much depended on the supply. During the peak season the price of lemuru could go down to as low as 40% to 50% of the price during the low season. The consumption of fresh fish for food is relatively less than for the processed product. The best quality fish will normally go as bait for longliners. The remaining fish in decreasing order of quality will go to canning factory, boiled-salted processing unit, dried-salted and flake fish processing units.

Marketing of fish in the area surrounding the Bali Strait varies but generally could be grouped into 5 types:

- From the fishermen to the auction, then to collectors, to the retailer and to consumers.
- From the fishermen to processors and then to consumers.
- From the fishermen directly to the middlemen, and then to consumers.
- From the auction to the processors, and then to consumers.
- From the auction to the middlemen, to retailers, and then to consumers.

Fish from the Bali Strait have been marketed in various places in East Java, Central Java and West Java and have gone as far as Jakarta. For fishmeal, a good market has been in Yogyakarta, Temanggung and Surabaya where the animal feed industry is concentrated.

Table 36. The amount and value of fish landed in East Java

Years	Fresh fish		Processed fish	
	Volume (t)	Value (10^6Rp.)	Volume (t)	Value (10^6Rp.)
1992	29,246	45,799	44,085	61,562
1993	31,081	47,450	41,168	64,989
1994	34,747	61,943	41,855	75,062
1995	37,532	91,934	37,835	71,840
1996	31,166	56,303	33,204	59,985

Sources : Fisheries statistics of East Java, 1992 - 1996

Table 37. Trend of processed lemuru by type of processing in Jembrana Regency, 1988 - 1997

Years	Type of processing (t)							
	Boiled	Fresh	Canning	Salted	Fish meal	Freezing	Flake meal	Total
1988	719	2257.7	8232.1	434.7	4632.1	0	3316.8	19592.4
1989	0	6878.9	3288.5	129.7	2259.4	0	2505.1	15061.6
1990	975.7	3867.1	4570.2	497.3	6741.5	0	6205.9	22857.7
1991	799.5	3000.5	9548.4	0	8900.9	0	4815.4	27064.7
1992	964.9	3811.9	5019	0	6303.1	0	7098.2	23197.1
1993	192.4	1578.6	5854.2	0	2353.9	0	3285.4	13264.5
1994	190.3	3402.7	5957.7	0	3046.4	0	2475.9	15073
1995	640.6	0	3246.1	0	2138.8	0	1578.3	7603.8
1996	0	201	4503.3	0	2528.2	0	0	7232.5
1997	0	2849.8	9237.6	0	15750.7	0	0	27838.1
Average	448.2	2784.8	5945.7	106.2	5465.5	0.0	3128.1	17878.5
% prod.	2.5	15.6	33.3	0.6	30.6	0.0	17.5	

Sources : Fisheries statistics of Jembrana Regency, 1988 – 1997

Besides, both provinces also export fish products, and their quantity in the period of 1992 to 1996 is shown in Table 38.

Table 38. Trend of fishery exports from East Java and Bali Provinces

Years	East Java province		Bali province	
	Volume (tonnes)	Value (US $ 1.000)	Volume (tonnes)	Value (US $ 1.000)
1992	82.500	374.946	10.088	59.607
1993	84.213	351.506	17.518	93.630
1994	95.587	397.973	9.746	44.825
1995	100.404	412.200	12.112	62.580
1996	111.343	457.100	12.385	52.637

From the fishery statistics data, the export of fish products from East Java and Bali is presented in Table 38, i.e. for lemuru and its processed products. The volume, value, and form of the lemuru commodity that is exported from East Java is shown in Table 39.

Table 39. Export of lemuru products from East Java province (kg and US $)

Commo-dities	1992		1993		1994		1995		1996	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Sardinella in tomato-sauce	351,003	299,753	157,000	127,500	62,000	51,712	1,980,183	802,643	1,032,464	458,761
Fish oil	97,908	291,760	36,720	413,675	135,802	57,044	71,045	132,319	16,000	16,750
Sardinella oil frozen	13,140	5,256	-	-	1,004,400	484	-	-	65,648	60,045
Waste of sardinella oil	68,250	30,153	89,250	39,143	-	-	-	-	-	-
Total	530,301	626,922	282,970	580,318	1,202,202	109,240	2,051,228	934,962	1,114,112	535,556

Source : Fisheries statistics of East Java province, 1992 - 1996

One of the processed products from lemuru with high potential market internationally is oil. Fish oil is rich in Omega-3 (Ω-3) which has a high demand in medicine as it has an important role in the prevention of various problems leading to heart diseases such as arteriosclerosis and thrombosis. To obtain a good quality of fish oil, there is certainly a need for improvement in the current handling and processing in the lemuru fishery. Until recently, fish oil has just been utilized as an additional component or additive in poultry and animal feed, with the quantity of about 1.5% to 3.0% of total feed, and another small part is used in hide or leather industries, and other small industries. Fish oil processing industries that produce a product with high markup, like Ω-3 concentrated fish oil, has not yet attracted investors to develop the industry, although the product has been available in the country through import from developed countries. The demand for this product is increasing in accordance with the increase of health and prosperity of society, especially for the middle and upper classes (Suparno *et al.*, 1995).

Fish oil is superior to vegetable oil and other animal oil, because it contains a lot of high unsaturated fatty acid (HUFA) components. Vegetable oil and other animal oil contain only Ω-6 fatty acids and very few Ω-3 fatty acids in which the latter is mostly unsaturated. The main component of Ω-3 unsaturated fatty acids in fish oil are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Data on the quantity of fish oil generated from canning and fishmeal processing are still not available. However, through a conversion ratio of processed production to fish oil (Anonymous, 1996), an estimate was generated as high as 4,300 t of fish oils (from 26,600 t of fish for canning and 32,900 t of fish for fishmeal).

5. MANAGEMENT OF FISHERIES

5.1 Legal aspects

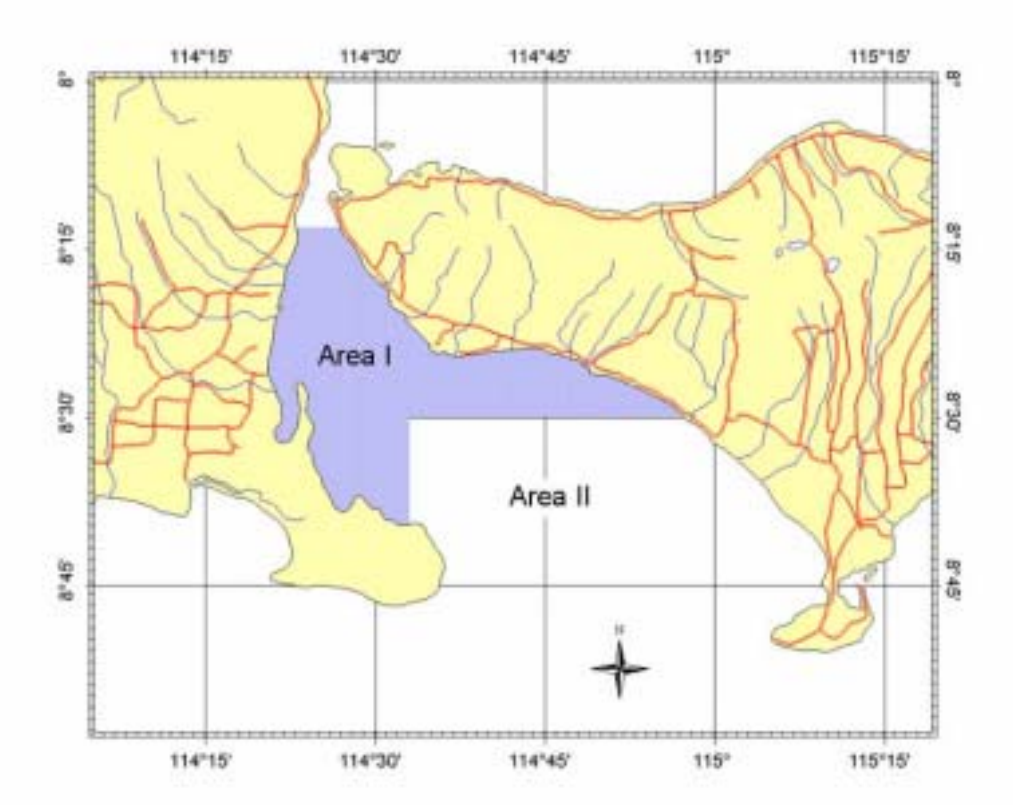

Figure 5 Delineation of fishing zones according to joint agreement of provincial government of East Java and Bali No. 434 year 1992

The constitution of RI 1945 and the Fisheries Act 1985 are the two sources of legal framework used as an important basis in the development of rules and regulations dealing with fisheries management. Rules and regulations enacted so far in the Central Government have been in the form of a Ministry of Agriculture Decree (MAD) and, to a limited extent in the case of Provincial Government, as a Provincial Government Decree. Many of the MADs are of a national character and thus also apply for the fisheries in the Bali Strait as for example in the case of the zoning scheme. The regulation enacted is aimed at ensuring sustainable fisheries and sustainable exploitation by stakeholders.

The management of lemuru has had a long history in the context of development of fisheries management in the country. The earliest initiative took place in 1977 as reflected by the enactment of a joint management agreement between the provincial governments of East Java and Bali for this fishery. The Central Government, in this case through DGF and the Research Institute for Marine Fisheries had been involved from the start of the initiative. Over time as the fisheries also developed, the joint agreement was reviewed and updated. The first revised version was the result of a meeting in 1992 jointly organized by the two provinces and as a result a revised joint agreement was issued as stipulated by Joint Management Decree No. 238/1992-674/1992. In essence the regulation enacted comprises of three important management measures :

(1) Limitation in fishing effort by limiting the number of fishing boats for the two provinces, namely 190 units for East Java and 83 for Bali; and the size of fishing vessel, which should never exceed 30 GT.

(2) A minimum mesh size of the bunt of the purse seine net of 1 inch (=2.54 cm) as based on MAD No. 123/Kpts/Um/3/1975. The maximum sizes of the purse seine net are 300m long and 60m deep.

(3) The zoning scheme for the Bali Strait delineates two important fishing zones, namely zone-I and zone-II which are separated by a border line based on points of coordinate $08^0 13^{'} S/114^0 23^{'} E$, $08^0 S/114^0 27^{'} E$, $08^0 30^{'} S/114^0 57^{'} E$, $08^0 30^{'} S/114^0 33^{'} E$, $08^0 40^{'} S/114^0 33^{'} E$. Zone-I is allocated for traditional fishing, while Zone-II is for mobile gears and bigger fishing boats such as purse seiners.

5.2 Monitoring, Control and Surveillance (MCS)

Monitoring of vessels in the fishing port is the basic MCS activity that staff of the Provincial Fisheries Services had done so far. The existence of an auction scheme in the landing places helps fisheries officers not only to collect catch statistics, but also to know the activity of fishing by individual fishing boats. Checking of gear in the fishing port is another common monitoring of the gears used by fishermen. Through random checking of fishing gear used by various boats in the fishing port it was clear that fishermen had not complied with the regulations on the minimum mesh size used in purse fisheries, the objection of the fishermen being that with mesh size of 1 inch, a large proportion of fish in the catches were gilled and caused a nuisance for fishermen in their operation.

As applicable for other fishing area in Indonesia, monitoring of fishing activities in the Bali Strait is an integral part of the safety and security activities and is under the responsibility of the Coordinating Committee for Marine Safety and Security (BAKORKAMLA). Members of this coordinating committee are representatives from the Customs Office (Ministry of Finance), Immigration Unit (Ministry of Justice), Harbour Master (Ministry of Communication), Directorate General of Fisheries/Provincial Fisheries Offices (Ministry of Agriculture), Marine Police and the Committee is headed by the Navy. BAKORKAMLA is therefore the umbrella agency for MCS in fisheries. This coordinating committee does not have a special budget for MCS which obviously limits its activity. As the Bali Strait is not an extensive area where fishing activities are carried out on a daily basis, the MCS activities are not much of a burden compared to an extensive area such as the Java Sea or the Indian Ocean.

5.3 Management Authority

The Directorate General of Fisheries is the agency responsible for the management of marine fisheries in Indonesia. In support of the work of this agency the Provincial Government through its Provincial Fisheries Office works closely with DGF. One clear delegation of authority to the Provincial Government by DGF in the management of marine fisheries is the granting of fishing licences for vessels of less than 30 GT to the Provincial Fisheries Offices. DGF provides the necessary advisory services to the two provinces surrounding the Bali Strait. The fact that purse seine fleets in the Bali Strait are of less than 30GT, the management of lemuru fisheries in the Bali Strait is under the responsibility of the Provincial Fisheries of East Java and Bali.

Other institutions that have a close link in their activities with fisheries management in the Bali Strait are, among others, the Directorate General of Sea Communication (cq Harbour Master) and the Ministry of Industry. The Directorate General of Sea Communication provides licences for the safety and the operation of boats. The Ministry of Industry grants licences for boat construction and the construction of fish processing facilities such as canneries, fishmeal plants, etc., while the local government is also responsible for the operation of auction halls that are available in various landing places. Cooperation between Provincial Fisheries Agencies with those mentioned in addressing fisheries management issues seems to be minimal as reflected by the continued construction of fishing boats and processing plants without the consent of the Fisheries Agency. Another problem that just emerged recently was the abolishment of auction fees by the Minster of Home Affairs which has led to a decline in service in the auction because its operation had been very much supported by the fee. This obviously causes a problem in the monitoring of the catch and consequently in the collection of catch statistics.

The Provincial Fisheries Services of East Java and Bali and DGF have combined their efforts in strengthening management of the lemuru fisheries. One of the priorities is to discourage the processing industry to build fishing boats by not issuing new fishing licences. Secondly, they encourage all fishermen to join Fishermen's Cooperative Units (KUD) to enable officers get access to them easily through this cooperative unit.

6. SUMMARY AND RECOMMENDATIONS

6.1 Summary

- The abundance of lemuru in Bali Strait is believed to be related to the upwelling process which occurs during the Southeast monsoon with a peak in July. However, as the sea is normally rough during the southeast monsoon, fishing activities during this season are reduced compared to during the northwest monsoon (September to January).

- Average monthly production of lemuru had been about 78.6% that of the total marine fish. The amount of production of juvenile fish which are normally caught by liftnet was about 8.1% of the total lemuru production.

- As is typical of pelagic fish, the catch of lemuru showed much fluctuation. The lowest catch of 4,661.4 t took place in 1986, while the highest catch of 61,668.5 t was in 1991. The number of purse seines had increased and thus the amount of catch as well.

- Purse seine is the main gear used in the lemuru fishery; the average CPUE of purse seine was 2,561.9 kg/boat/day in 1997 while the average catch contributed by purse seine was about 92.8% of the total lemuru catch.

- During the fishing operation some fishermen use light for fish attraction and it is used particularly before and after full moon (locally called "oncoran" operation); others do not employ any light ("gedangan").
- A study has been made to relate the lemuru catch and the occurrence of El Niño, but there is still no conclusive evidence of a direct relationship.

- During the off season some fishermen employ other gears to catch other species. The increased demand of hairtail for export to Korea and the consequential price increase of this particular species (Rp 7,000 to Rp 8,000 per kg) has resulted in the development of hairtail fishing by hook and line.

- A large part of the lemuru catch is processed into various form: canned, boiled-salted, dried-salted, fish flakes and fishmeal. Some of the good quality fish is used as bait in the longline fishery. There are more processing plants in Muncar than in Jembrana. Some of the processed products are exported, the majority in the form of canned products (sardinella in tomato sauce) and as fish oil. There is still potential opportunity for improvements in the post harvest sector.

- Studies on the resources were carried out as early the 1970s when an acoustic survey was first conducted with FAO assistance. On the basis of catch statistics, various stock assessment studies have also been conducted. Almost all of the assessment studies indicated that the lemuru resources are overexploited.

- Management of the lemuru fisheries is under the joint responsibility of the two provincial fisheries services (East Java and Bali) as the fishing vessels are of less than 30 GT. The DGF and the RIMF provide technical and policy advice to the two provinces. Allocation of licences to fishermen of the two provinces is granted according to the number of boats. Current fishing licences granted total 190 for East Java and 83 for Bali, according to the policy based on the 1995 agreement.

6.2 Recommendations

- There is a need to explore potential opportunities for improvements in the post harvest sector. One clear example is the improvement in the processing of oil to take advantage of the high content of Ω-3 fat. Another example is the improvement of fish holds in vessels to enhance the quality of the landings.

- The life history of lemuru is not well understood as there are still some missing links in its life cycle especially from the spawning stage through the larval and juvenile stage. The relationship between fish abundance and its environment is also not well understood. Basic biological and environmental studies need to be focused on in future.

- There is a need to review the Ministry of Home Affairs Decree on the abolishment of fees in the auction to reactivate the system of auction and to facilitate the collection of catch statistics.

- There is a need to re-evaluate the implementation of the government regulation on the minimum size of mesh (MAD No. 123/1975) of 1 inch due to the problem of gilling and the resulting resistance of fishermen.

- Cooperation between DGF and other closely related sectoral agencies (Harbour Master, Ministry of Industry) need to be strengthened to prevent the construction of new fishing boats and processing facilities without the consent of DGF.

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INCORPORATING THE SOUTHERN OSCILLATION INDICES TO THE MANAGEMENT MODEL OF THE BALI STRAIT SARDINELLA FISHERY

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1. INTRODUCTION

In the last few decades the significance of the Bali (Oil) sardinella (*Sardinella lemuru*, locally known as lemuru) fishery in the Bali Strait, Indonesia, has been addressed by fisheries scientists. Several works described the fishery (including Bandie, 1982; Harmony, 1982, Bailey, 1982); fishery assessment using catch and effort data (Sudjastani and Nurhakim, 1982; Tim Perikanan UNDIP, 1992; Merta and Badruddin, 1992), fishery biological information (e.g. Ritterbush, 1975; Dwiponggo, 1982; Budihardjo *et al.,* 1990; Merta and Badruddin, 1992), and description of the Bali Strait environments (Anonymous, 1973; Burhanuddin and Praseno, 1982). A synoptic review of the Bali sardinella resources in Indonesian seas was reported by Burhanuddin *et al.* (1984).

Geographically, the Bali Strait is located between two provinces, East Java in the west and Bali in the east, and between two major body masses, the Flores Sea in the north and the Indian Ocean in the south. The strait covers an area of about 2,500 km^2, having an average small-pelagic fish density of about 7,2 tons km^{-2} (Merta *et al.,* 1998). Lemuru landings, taken by artisanal gear 'payang', were low prior to 1974, when a number of small purse seiners was introduced, after which it rose sharply. Taken as a whole the lemuru landings during 1950-1997 show an overall increase, but with marked fluctuations (Ghofar and Mathews, 1996).

It was indicated during the Indonesia/FAO/DANIDA workshop (1995) on the assessment of the potentials of marine fisheries resources of Indonesia, that the large variability in landings may have influenced the estimation of potential yields. Merta *et al.* (1997) showed that the stock assessment using catch and effort analysis for the Bali Strait Bali sardinella often results in great differences in estimates of the potential yield. Further experience from Japan with long time series of data on the level of fishing and environmental parameters indicated that a drastic decline in small pelagic catches is related to the long term environmental changes. It is recommended, therefore, that any assessment of the small pelagic fish stocks in the Asia-Pacific region should take into account both fishing effort and environmental information (Martosubroto, 1997).

This paper aims at identifying possible uses of environmental indices in the management of the Bali Strait lemuru fisheries.

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2. THE SIGNIFICANCE OF El-NIÑO AND SOUTHERN OSCILLATION

It has long been understood that the life of fishes is governed not only by their internal biological characteristics, but also by the environments they live. Some studies have addressed this aspect, such as their impacts on fisheries (Regier, 1976; Cushing, 1982,1984; Ghofar, 1996) and living ocean resources in general (Bakun *et al.,* 1982; Barber and Chavez, 1986). More specifically Pauly (1980) remarked the relationships between fish growth parameters, mortality and mean environmental temperatures. Ghofar (1998a, 1998b), Ghofar and Mathews (1966) and Willoughby *et al.* (1996) gave account of the methodology for studying the environmental and pollution effects of fisheries. In general these studies indicated that the current knowledge of the environmental impacts at stock levels is rather poor.

The natural environmental variations, known as El Niño and Southern Oscillation (ENSO) events were identified by Quinn (1978) as negative sea level atmospheric anomalies for Santiago and Darwin, and positive anomalies for Jakarta; and by MacLean (1989) as positive zonal wind anomalies and surface temperatures in the near equatorial eastern Indian Ocean and Western Pacific Ocean. El Niño may be described as an anomalous climatic condition which occurs every two to ten years and affects the global climate (Cushing, 1982; NOAA, 1997). El Niño events are indicated by the incidence of high negative values of the Southern Oscillation Indices (SOI), not necessarily implying the simultaneous occurrence of particular oceanographic or climatic events of the Peruvian coast, which was originally used to define the El Niño phenomenon. The opposite condition (i.e. high positive values of SOI) is the Anti El-Niño. Major El Niño events occurred in 1891, 1911, 1917, 1925, 1930, 1941, 1957, 1965, 1972, 1976, 1982, 1986, 1992 and 1997. El Niño has been reported to affect many fisheries, such as the Peruvian anchovy stock (Cushing, 1982) and aquaculture in the Philippines (Guerrero, 1999).

In the last few years, there has been an increasing scientific interest in the effects of ENSO on fish stocks in Indonesian waters. Efforts were made as to assess possible impacts of these variations on small pelagic resources (Ghofar, 1998a), with particular reference to the Bali Strait lemuru (Ghofar and Mathews, 1996; Ghofar, 1998b). It was suggested that El Niño predominantly impacts lemuru landings and that the higher landings in recent years were probably taken from a stock that has become less resilient, with the fishery removing most of the surplus production. This would prevent the spawning stock from recovering during favourable periods, making it more vulnerable to fishing during less favourable periods (Ghofar and Mathews, 1996).

3. MATERIALS AND METHODS

3.1 Data collection

Major data used in the analysis include lemuru landings, the number of purse seine boats, engine power (HP) of the boats and the Southern Oscillation Indices (SOI). Landings, number of purse seiners and HP were derived from both sides (provinces) of the Bali Strait, i.e. the East Java and Bali parts from 1974 to 1999. The primary landings for East Java are generally reported at Muncar and Banyuwangi and the Bali landings at Jembrana and Badung. The SOI, air pressure and air temperature data were obtained from The Climatological Research Unit of the University of East Anglia (U.K.) and from Quinn *et al.* (1978), in particular the data prior

to 1976, and the Agency for Meteorology and Geophysics in Jakarta (Badan Meteorologi dan Geofisika, BMG) for the 1977 data and up.

3.2 Analysis

Although the SOI data are available as early as 1840, the fisheries data including landings, number of purse seiners of the Bali Strait are relatively recent. The earliest data reported for landings data were in 1950 (Ritterbush, 1975), followed by the numbers of purse seiners in 1974. It is therefore only possible to relate these variables for periods when the data set is available, i.e. 1974 - 1999. The purse seine engine power (HP) data were available for some years when observations were made. However, available HP data for the two provinces allows the total fishing effort to be estimated proportionally in HP units. Further analysis includes regressions between SOI and lemuru landings, to allow the landings, effort and SOI to be incorporated together using CLIMPROD (Freon *et al.,* 1993).

4. RESULTS AND DISCUSSION

4.1 Lemuru landings-SOI relationship

Figure 1 shows the regression of lemuru landings on the SOI using the data of 1960-1997:

$$\text{Landings} = 28{,}003.64 - 8{,}124.74 * (\text{SOI})$$

where
$r = 0.44$
$R^2 = 19.4\%$
$p = 0.00575$ at 37 degrees of freedom

This finding shows that, although the coefficient of correlation, r, is only 0.44 the number of observations is relatively large (N = 38) to show such a relationship.

It is not readily clear at this stage, however, as to what oceanographic process(es) beyond the El Niño and Southern Oscillation were happening during those years that affected landings. Previous finding from acoustic surveys in the 1970s (Venema, 1996) revealed that the lemuru schools concentrated in deeper waters and further offshore during the low season, and are generally located beyond reach of the fishing gears currently used.

4.2 Catchability coefficient

Figure 2 shows the relation between fishing effort (in HP) and the numbers of purse seiners in the Bali Strait from 1974 to 1999. Although the number of purse seiners was constant over many years (1985-1991), total effort in HP changed remarkably. It assumes that the catchability (q) in the Bali Strait lemuru fishery is constant. Direct estimates of catchability are not available for the Bali Strait lemuru fishery, however.

This feature differs significantly from that of the Peruvian Anchoveta fishery, where the catchability coefficient tends to increase some ten times during low fish abundance years

Figure 1
SOI-Lemuru landings relationship

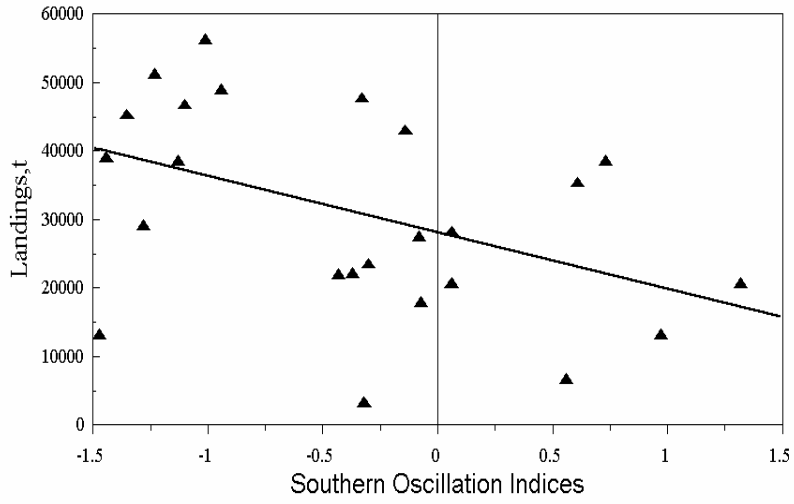
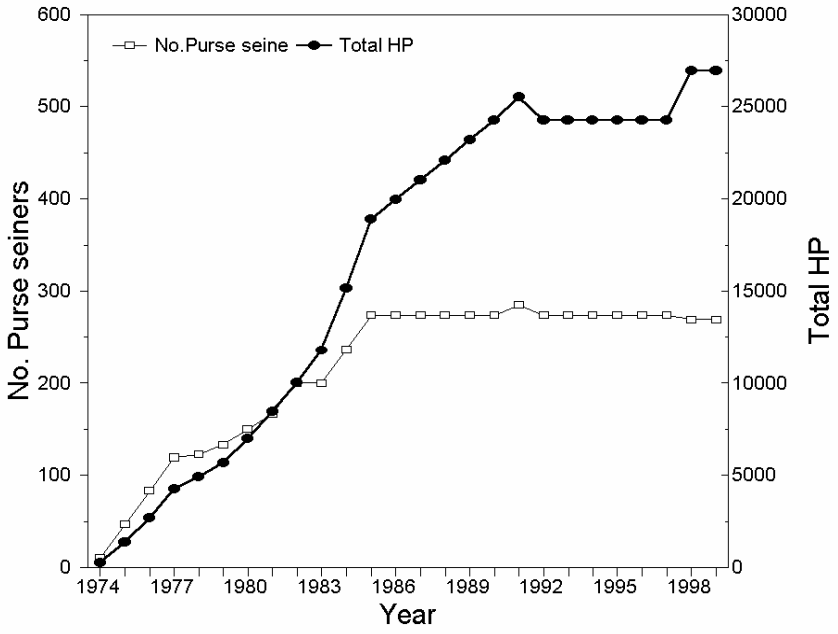


Figure 2 Fishing effort in the Bali Strait lemuru fishery



(Csirke, 1989). If this happened in the Bali Strait, the lemuru fishery would probably have been destroyed, in that case even the prudent effort limitation policy established so long ago would not have been able to cope with the destruction. One could imagine the effect of 237

purse seiners in good years and of 2,370 purse seiners after adjusting for the catchability coefficient in bad years.

4.3 Results of CLIMPROD modelling.

Initial attempts were made to fit the surplus production models (Fox, Schaefer and Pella and Tomlinson) to the Bali Strait lemuru landings and effort data. Results of these attempts were poor with values of the goodness of fit parameter R^2 varying from 8% to 24%.

When the SOI data are incorporated to landings and effort data (Figure 3) a model is obtained with a very high value of R^2 (= 94%), and with a high Jacknife R^2 = 91%. Figure 4 shows that there were very small variations in the Jacknife R^2 over the time series, suggesting that the model is robust. This model may be derived in exponential-linear curve as follows:

$$LPUE = 20.58284.\exp(-0.00024.E) - 0.46228.SOI + 1.00301$$

where LPUE is landing per unit effort of the Bali Strait lemuru fleet in t/HP/year; E is fishing effort; SOI is the Southern Oscillation Indices.

Figure 3 shows the production curves for the Bali Strait lemuru fishery at SOI = +1 and SOI = -1. At values of around SOI = -1 (strong El-Niño) the model suggests that the fishery will produce very high landings of 35,000 - 65,000 t/year at effort levels increasing from around 7,000-30,000 HP. However, at SOI = +1, landings peak at around 25,000t at 3,000HP and fall very sharply to <5,000-8,000 t at effort levels >10,000 HP. The model fits all of the very high and very low landings period observed so far and shows that the fishery, although dominated by effort, is still very sensitive to SOI and the oceanographic conditions that SOI represents.

The model (Figure 3) suggests that the fishery is fully exploited during El Niño years, and over-exploited during Anti El Niño years. For example, landings peaked at 39,000 t in 1977 when SOI reached -1.13 at 4,200 HP, the second peak at 39,000 to 49,000 t from 1983 to 1984 at SOIs of -1.44 and -0.94; and again from 48,000 t to 56,000 t during 1992-1994, at 25,000 HP, when SOIs varied from -1.01 to -1.35. Landings dropped at 21,000t in 1981 when SOI was +0.06, at 3,500t and 20,000 HP when SOI was -0.32; and again at 6,900t and 25,000HP when SOI was +0.56. Combined together with Ghofar and Mathews' (1996) interpretation of the fluctuations in the amplitude of the landings anomalies, the model suggests that the fishery cannot sustain any increase in effort, and is fully exploited even at large negative values of SOI.

4.4 Implications of the model to the Bali Strait fishery

4.4.1 Research Implications

a) Further work should include more detailed time series analyses: preliminary spectrum analyses not discussed here suggest that stronger and more comprehensive models may be obtained by so doing. This work has not been reported here, however, because of the need to clarify landings and especially effort data prior to carrying out such work in more detail.

b) Satellite images, using snapshots for other years, especially years in which SOI was <-1.0, should be studied so as to complete the picture of the relationship between SOI, SST and upwelling. Once this has been clarified it should be possible to establish an objective and quantitative upwelling index. Such data could eventually be used in conjunction with or without, SOI in real time to assist in the management of the Bali Strait lemuru fishery, and eventually of the other fisheries studied here. Further study is also required to facilitate applications of models such as ECOPATH, ECOSIM and ECOSPACE.

Figure 3 Bali Strait fishery model incorporating southern oscillation index

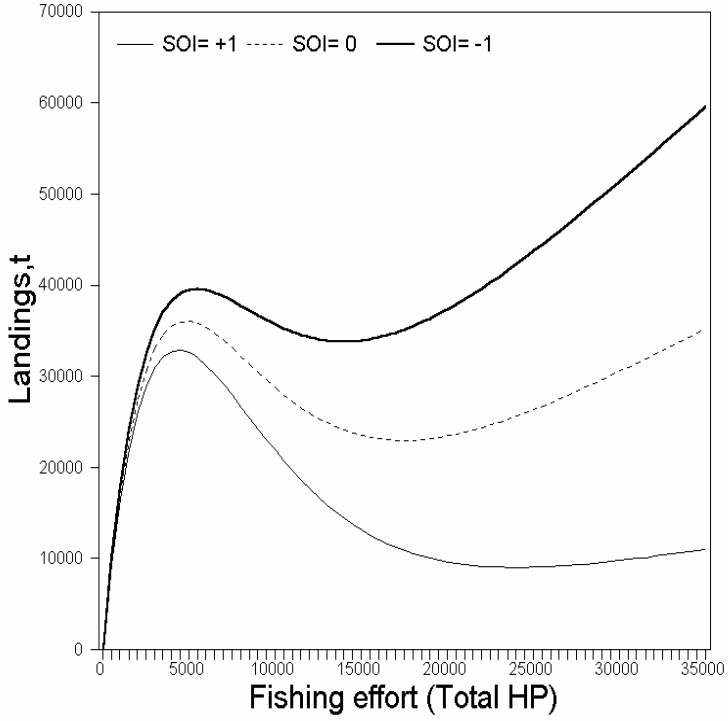
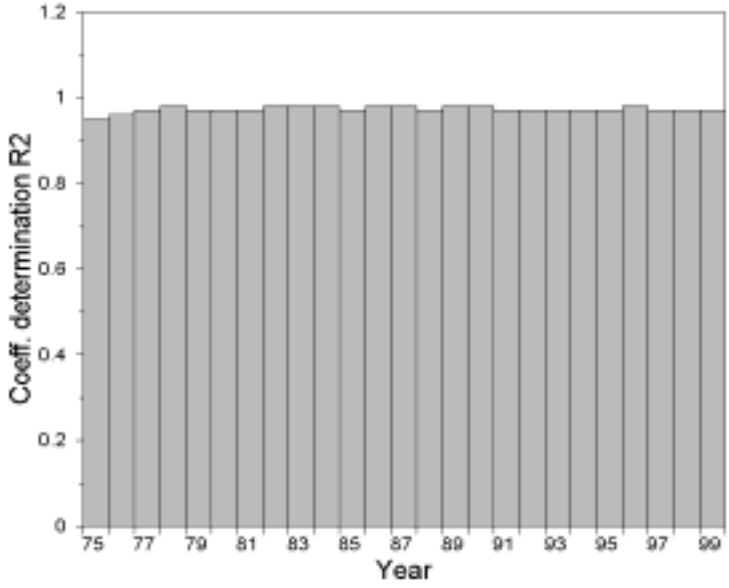


Figure 4 R2-Time plot: Bali Strait lemuru fishery



4.4.2 Policy implications

a) The model identified (above) for the Bali Strait lemuru fishery shows conclusively that the fishery cannot be managed without inclusion of proactive responses to changes in the SOI. The SOI may be predicted with some accuracy for up to three months. Such predictions could be one element in an environmentally sensitive management policy.

b) From around 1980-98, the Bali Strait lemuru fishery was managed on the basis of an effort limitation strategy, based on controlling the number of licenses for fishing, through the advice of scientists and the lemuru fishermen's co-operatives. This policy has succeeded in keeping the fishery in existence, probably because the effort was always fixed just low enough to ensure that spawning biomass even in the worst years would be just sufficient to ensure recovery in the following years. This policy worked partly (i) because the Anti El Niño has been a relatively rare phenomenon and (ii) very strong and long lasting El Niños of unusually long duration (e.g. 1990-94) have occurred since the fishery moved over to purse seines as the principal fishing gear in 1974. Should the environment change to a condition where the Anti El Niño becomes more frequent and the El Niño less intense but of shorter duration (as it was in the 1950s and 1960s), the fishery might be driven to extinction at current effort levels by overfishing and reduction of spawning biomass to very low levels. It is necessary to identify a more comprehensive management policy that will ensure sustainability even under conditions of higher environmental pressure, e.g. from more frequent and more extreme Anti-El Niño conditions.

c) Apart from controlling effort through limiting the number of licenses, it will be necessary to ensure that no further increases in fishing power occur. In particular new increases in HP of the engines should be forbidden: if engine power is kept constant (including a ban on any changes that allow an engine to generate more energy than its registered HP), boat size, net size and number of fishermen are likely to be held constant. The type of net and its materials should probably also be controlled so that its fishing power will not change.

d) The model presented here for the Bali Strait lemuru fishery opens the possibility of introducing a third element into the management of the fishery. In addition to (i) limiting the number of licenses (as has been done) and to controlling the power of the engines (as suggested), it should be possible from results of current and previous research and data, to identify (at least provisionally) levels of LPUE that are so low, that they may threaten the following year's recruitment. This would allow closure of the fishery when LPUE fell below a critical level. The historical data suggest that, had such a policy been in place during the last 15-20 years, a closure might have happened only in 1986 and 1996 when landings fell to 3,500 and 6,800 t/yr and when LPUE fell to around 0.17 and 0.48 t/HP/yr. The possibility of instituting such a policy should be considered.

e) It is essential to carry out a first simple bio-economic study of the Bali Strait lemuru fishery so that the effects on the fishery of any policy aimed at incorporating the effects of (i) varying SOI and (ii) closure when LPUE and spawning biomass are too low, could be estimated.

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PERIKANAN LEMURU SELAT BALI

oleh

DINAS PERIKANAN DAERAH PROPINSI DAERAH TINGKAT- I JAWA TIMUR[10]

(LEMURU FISHERY IN BALI STRAIT by THE FISHERIES SERVICE OF THE PROVINCE EAST JAVA)

SUMMARY

The lemuru fishery in Bali Strait has shown rapid development since the adoption of purse seine fishing in 1974. The increased in lemuru catches is very much related to the increased number of purse seiners, however, catch fluctuations have appeared since its early development till today.

The fish processing industry has developed in line with the development of the fishery. The number of processing units has increased appreciably and in 1997 there were 12 canneries with a capacity of 50-100 t/day/unit, 24 fishmeal plants with a capacity of 10-20 t/day/unit and 15 fish silage plants with a capacity of 3-5 t/day/unit. Operations of fish processing units are subject to the catch fluctuation, as importing fish from other areas is costly.

As lemuru resources have been exploited by fishermen from East Java and Bali , joint management efforts between the two provinces have been made since 1977 with full support of the central government (Directorate General of Fisheries). Since the latest joint agreement in 1992, the total number of purse seiners from East Java operating in Bali Strait has been constant at 190.

One of the constraints in the management of fisheries in Bali Strait rests in the area of monitoring the operation of fishing vessels. Poor coordination between institutions in the fishing port leads to possible fishing activities by unlicensed fishing vessels.

1. PENDAHULUAN

Selat Bali merupakan daerah perairan yang relatif sempit (sekitar 960 mil2). Mulut bagian utara sekitar 1 mil dan merupakan perairan yang dangkal (kedalaman sekitar 50 meter) sedangkan mulut bagian selatan sekitar 28 mil dan merupakan perairan yang dalam. Perairan Selat Bali ini mempunyai kesuburan yang tinggi. Produktivitas tertinggi terjadi pada musim timur, dimana pada musim timur terjadi upwelling dibagian selatan Selat Bali.

[10] PLT Kepala Dinas Perikanan Daerah, Propinsi Daerah Tingkat I, Jawa Timur, Pembina Tingkat I, NIP. 510040937

Sumberdaya perikanan lemuru merupakan sumberdaya perikanan yang paling dominan di Selat Bali sehingga komoditi tersebut paling banyak dieksploitasi oleh nelayan. Eksploitasi sumberdaya perikanan lemuru di Selat Bali secara intensif dimulai sejak dekade 70-an dengan telah berkembangnya alat tangkap purse seine yang mempunyai produktivitas lebih tinggi dibandingkan dengan alat tangkap yang sudah ada sebelumnya. Perkembangan alat tangkap purse seine ini cukup pesat sehingga untuk pembinaan kelestarian sumberdaya perikanan tersebut diperlukan adanya upaya pengendalian.

Sumberdaya perikanan lemuru Selat Bali mempunyai arti penting bagi masyarakat Muncar, dimana Muncar selain sebagai basis penangkapan dan pendaratan sumberdaya perikanan lemuru Selat Bali juga berkembang usaha pengolahan; baik secara tradisional maupun modern. Dengan demikian sumberdaya perikanan lemuru telah memberikan andil yang cukup besar terhadap perekonomian di Jawa Timur, khususnya di Muncar. Produk olahan ini tidak hanya dipasarkan didalam negeri, tetapi juga diekspor keluar negeri.

2. KONDISI PERIKANAN LEMURU DI MUNCAR JAWA TIMUR

2.1. Produksi Lemuru

Di Muncar, produksi sumberdaya perikanan lemuru merupakan yang paling besar dibandingkan dengan jenis ikan lainnya yang tertangkap di Selat Bali. Perkembangan produksi sumberdaya perikanan lemuru Selat Bali yang didaratkan di Muncar sejak tahun 1976 sampai dengan 1997 berfluktuasi. Produksi lemuru di Muncar pada tahun 1976 sebesar 22.058,10 ton/tahun sedangkan pada tahun 1977 sampai dengan 1981 terjadi penurunan, kemudian pada tahun 1982 meningkat selanjutnya menurun kembali sampai pada tahun 1986. Pada tahun 1987 hingga tahun 1991 cenderung meningkat dan pada tahun 1992 turun kemudian naik lagi pada tahun 1993 dan turun lagi pada tahun 1994 hingga 1996 dan pada tahun 1998 naik lagi (data perkembangan produksi lemuru di Muncar dapat dilihat pada lampiran 1). Penurunan produksi terendah terjadi pada tahun 1986 dan tahun 1996 hal ini disebabkan karena adanya siklus laif 10 tahunan.

Berdasarkan data dari Resort Muncar tahun 1998, musim ikan lemuru Selat Bali menurut ukurannya adalah sebagai berikut :

- Sempenit (< 11 cm) Bulan Agustus sampai Desember
- Protolan (11 - 15 cm) Bulan Januari sampai Desember
- Lemuru (15 - 18 cm) Bulan Mei sampai Desember
- Lemuru kucing (>18 cm) Bulan Oktober sampai Desember

2.2. Alat Tangkap

Jenis alat tangkap yang dipergunakan nelayan Muncar untuk menangkap sumberdaya perikanan di Selat Bali meliputi berbagai jenis alat tangkap, antara lain : payang, purse seine, jaring insang hanyut, bagan tancap, pancing dll.

Perkembangan alat tangkap purse seine dan non purse seine yang ada di Muncar sejak tahun 1976 sampai dengan 1997 menunjukan bahwa alat tangkap purse

seine berkembang pesat, pada tahun 1976 sebanyak 54 unit dan sampai tahun 1983 menjadi 200 unit sedangkan pada tahun 1984 turun menjadi 190 unit. Dengan dikeluarkannya SKB Gubernur KDH Tingkat I Jawa Timur dan Bali pada tahun 1985 hingga tahun 1998 tidak berubah, yaitu sebanyak 190 unit. Sedangkan perkembangan alat tangkap non purse seine berfluktuasi setiap tahunnya, hal ini disebabkan oleh adanya nelayan andon di Muncar yang tidak menentu jumlahnya (lihat lampiran 2).

2.3. Penanganan Pasca Panen

Sumberdaya perikanan lemuru merupakan salah satu komoditi perikanan yang mempunyai sifat berlemak tinggi dan mudah mengalami kerusakan fisik (pecah perut) sehingga mempermudah kemunduran mutunya.

Hasil tangkapan ikan lemuru Selat Bali selain dikonsumsi dalam keadaan segar, juga dimanfaatkan sebagai bahan baku olahan, seperti pemindangan, pengalengan, tepung ikan dan pengeringan yang diusahakan oleh nelayan maupun perusahaan swasta.

Sebagai bahan baku olahan, maka tingkat kesegaran ikan lemuru sangat diperlukan. Adapun tingkat kesegaran ikan lemuru yang diperlukan untuk bahan baku olahan adalah sebagai berikut :

Pengalengan:	mutu ikan terbaik
Pemindangan:	mutu ikan baik
Pengeringan:	mutu ikan cukup baik
Tepung ikan:	mutu ikan jelek sampai baik

Jumlah pabrik tepung ikan yang ada di Muncar sebanyak 24 unit dengan kapasitas produksi rata-rata 10-20 ton/hari/unit, sedangkan gaplekan sebanyak 15 unit dengan kapasitas produksi sekitar 3-5 ton/unit. Pabrik pengalengan yang ada 12 unit dengan kapasitas produksi sekitar 50-100 ton/hari/unit dan pemindangan 24 unit dengan kapasitas produksi 3-5 ton/hari/unit.

2.4. Pemasaran Komoditi Lemuru

Pada umumnya nelayan menjual hasil tangkapannya ke pengambeg (juragan darat) dan belantik (pedagang perantara). Dengan adanya pengambeg dan belantik ini nelayan tidak dapat memperoleh hasil yang wajar. Tercatat pada tahun 1998 selisih harga antara produsen dan konsumen terendah Rp. 50,-/kg dan tertinggi Rp. 300,-/kg.

Sumberdaya perikanan lemuru Selat Bali di Muncar, selain dipasarkan dalam bentuk segar juga dalam bentuk olahan. Daerah pemasarannya meliputi Jawa Timur, Jawa Tengah, Jawa Barat, Jakarta dan eksport.

2.5. Pengelolaan Sumberdaya Perikanan Lemuru Selat Bali

Peraturan Daerah yang khusus mengatur usaha perikanan di selat Bali sampai saat ini masih belum ada, namun secara umum Peraturan Daerah yang mengatur usaha perikanan di Jawa Timur sudah ada yaitu Peraturan Daerah Nomor **10 tahun 1989** juncto Peraturan Daerah Nomor **28 tahun 1994** tentang ijin Usaha Perikanan, dimana :

a. Pasal 7 ayat 1: setiap orang atau badan hukum yang melakukan usaha perikanan diwajibkan memiliki ijin usaha perikanan.

b. Pasal 16 ayat 1: untuk menjamin terselenggaranya pemanfaatan sumberdaya ikan secara berdaya guna dan berhasil guna dilakukan perlindungan sumber, pengendalian dan pengawasan terhadap pelaksanaan ketentuan Peraturan Daerah.

c. Pasal 17: Gubernur Kepala Daerah mengatur wilayah-wilayah penangkapan ikan guna melindungi kelangsungan usaha nelayan kecil dan mencegah tumpang tindihnya usaha-usaha lainnya.

Dengan semakin meningkatnya kegiatan penangkapan ikan dengan menggunakan alat tangkap purse seine di Selat Bali dan dalam rangka memanfaatkan potensi sumberdaya perikanan secara bertanggung jawab dengan memperhatikan kelestariannya serta menciptakan ketenangan berusaha bagi para nelayan di Propinsi Daerah Tingkat I Jawa Timur dan Bali, maka pada tanggal 20 Mei 1977 telah dikeluarkan kebijaksanaan dalam pengelolaan sumberdaya perikanan di selat Bali dalam bentuk SKB Gubernur KDH Tingkat I Jawa Timur dan Gubernur KDH Tingkat I Bali Nomor **HK.1/39/77//EK/le/52/77** tentang pengaturan bersama mengenai kegiatan penangkapan ikan di daerah Selat Bali. Dalam SKB ini jumlah alat tangkap Purse Seine yang boleh beroperasi di Selat Bali sebanyak 100 unit, dengan perincian Daerah Tingkat I Jawa Timur 50 unit dan Daerah Tingkat I Bali 50 Unit. SKB ini kemudian direvisi pada tahun 1978, dimana pada ketentuan ini telah ditetapkan jumlah alat tangkap purse seine yang boleh beroperasi di Selat Bali sebanyak 133 unit dengan perincian untuk Daerah Tingkat I Jawa Timur sebanyak 73 unit dan Daerah Tingkat I Bali sebanyak 60 unit. Ketentuan ini masih dilanggar oleh nelayan purse seine, dimana jumlah unit alat tangkap purse seine di Muncar jauh melebihi ketentuan (sampai tahun 1983 sudah 200 unit), sehingga pada tahun 1985 dikeluarkan SKB Gubernur KDH Tingkat I Jawa Timur dan Bali Nomor: **7 tahun 1985// 4 tahun 1985** dengan petunjuk pelaksanaannya berdasarkan SKB Kepala Dinas Perikanan Daerah Tingkat I Jawa Timur dan Bali Nomor **02/SK/Utan/I/85// 523.41/96/Um/K** Pada tanggal 14 Nopember 1992, SKB ini disempurnakan menjadi SKB Gubernur KDH Tingkat I Jawa Timur dan Bali Nomor **238 tahun 1992// SKB 673 tahun 1992** dengan petunjuk pelaksanaannya berdasarkan Kepala Dinas Perikanan Propinsi Daerah Tingkat I Jawa Timur dan Bali Nomor : **10 tahun 1994// 02 tahun 1994.**

Adapun perbedaaan antara SKB Gubernur KDH Tingkat I Jawa Timur dan Bali No. **7 tahun 1985//4 tahun 1985** dan No. **238 tahun 1992// 674 tahun 1992** adalah sebagai berikut :

SKB Gubernur KDH Tk. I Jawa Timur dan Bali tahun 1985	SKB Gubernur KDH Tingkat I Jawa dan Bali tahun 1992
1. Daerah operasi penangkapan ikan: - Daerah I : perahu layar/tanpa motor 08^0 40' LS - 114^0 33' BT 08^0 13' LS - 114^0 27' BT 08^0 30' LS - 114^0 33' BT - Daerah II : untuk kapal/perahu motor	1. Ditegaskan kembali koordinatnya : - Daerah I : perahu layar/tanpa motor 08^0 13' LS - 114^0 23' BT 08^0 13' LS - 114^0 27' BT 08^0 30' LS - 114^0 53' BT 08^0 30' LS - 114^0 33' BT 08^0 40' LS - 114^0 33' BT - Daerah II tetap
2. Jumlah purse seine yang diijinkan 273 unit (Jatim = 190 unit dan Bali = 83 unit)	2. Tetap
3. Ukuran unit purse seine : - Panjang: maks 150 m. - Mata jaring: min 1 inchi	3. Ukuran unit purse seine : - Panjang: maks 300 m - Dalam: 60 m - Mata jaring: min 1 inchi
4. Tanda pengenal (SKB Kepala Dinas Perikanan Propinsi Dati I Jawa Timur dan Bali Nomor : 02/SK/Utan/I/85 523.41/96/Um/K – Warna kasko: ♥ Jatim: biru ♥ Bali: putih – Tiang utama: abu-abu untuk Jatim dan merah untuk Bali	4. Tanda pengenal (SKB Kepala Dinas Perikanan Propinsi Dati I Jatim dan Bali Nomor : 10 tahun 1992 02 tahun 1992 – Warna kasko: bebas – Tiang utama : hijau tua untuk Jatim dan merah untuk Bali – Bendera segitiga sama kaki ukuran atas: 0,5 m; kaki : 1,0 m; dan warna sesuai warna tiang utama
5. Pengawasan Pemda Tingkat II setempat berkoordinasi dengan unsur SATGASKAMLA	5. Pengawasan Tetap, ditambah agar lebih ditingkatkan
6. Pemasaran ikan hasil tangkapan harus dijual di TPI dimana ijin diperoleh	6. Pemasaran – Tetap, ditambah antar KUD Mina kedua daerah dapat mengadakan kerjasama saling menguntungkan dibidang pemasaran
7. Pertemuan rutin dan berkala minimal 6 bulan sekali untuk saling tukar informasi	7. Tetap
8. Tanpa persetujuan masing-masing Dewan Tingkat I dan Mendagri	8. Dengan persetujuan masing-masing Dewan Tingkat I dan Mendagri.

3. PERMASALAHAN

Dengan memperhatikan kondisi perikanan Selat Bali di Muncar Jawa Timur, maka permasalahan yang ada adalah sebagai berikut :

a. Masih adanya pelanggaran terhadap ketentuan dalam SKB Gubernur KDH Tingkat I Jawa Timur dan Bali Nomor **238 tahun 1992// 674 tahun 1992** yang dilakukan oleh

   beberapa nelayan purse seine Muncar di selat Bali, yaitu pemakaian mata jaring kurang dari inchi dan panjang purse seine sebanyak 400 meter (dalam ketentuan maksimum 300 meter).

b. Dari jumlah unit alat tangkap purse seine yang ada di Muncar sebanyak 190 unit, yang mempunyai ijin pada tahun 1997/1998 sebanyak 100 unit dan pada tahun 1998/1999 sebanyak 98 unit. Masih banyaknya nelayan purse seine yang tidak mengurus ijin tersebut disebabkan karena adanya kerusakan armada yang dimiliki nelayan purse seine, baik karena kerusakan mesin maupun perahu/kapal.

c. Hasil tangkapan ikan lemuru Selat Bali masih belum memenuhi kebutuhan bahan baku olahan di Muncar, dimana kebutuhan untuk tepung ikan sebanyak 240-480 ton/hari, gaplekan sebanyak 45-75 ton/hari, dan pengalengan sebanyak 50-100 ton/hari. Sedangkan dengan MSY perikanan lemuru di Selat Bali sebesar 34.000 ton/tahun, hasil tangkapan nelayan sudah lebih tangkap (I Gede Sedana Mertha, 1997).

d. Ukuran ikan lemuru yang tertangkap nelayan Muncar di Selat Bali didominasi ukuran sempenit dan protolan.

4. PEMECAHAN MASALAH

Dengan memperhatikan kondisi perikanan lemuru Selat Bali dan beberapa permasalahan yang ada disana, maka langkah-langkah yang perlu dilakukan antara lain :

a. Perlu dilakukan kegiatan identifkasi terhadap ikan lemuru di Selat Bali.
b. Penetapan pola pengelolaan sumberdaya perikanan ikan lemuru di selat Bali.
c. Monitoring terhadap sumberdaya perikanan lemuru dan lingkungan di selat Bali.
d. Pengelolaan sumberdaya perikanan berbasis komunitas.

5. SARAN-SARAN

a. Perikanan lemuru Selat Bali dengan MSY sebesar 34.000 ton/tahun sudah lebih tangkap (Gde Sedana Mertha, 1997) sedangkan perikanan Selat Bali merupakan perikanan yang spesifik dalam komoditasnya dan jenis usahanya, dimana tingkatan usaha pada tipe industri serta mempunyai dampak sosial ekonomi yang sangat meluas. Atas dasar itu perlu mendapatkan perhatian yang khusus, utamanya dalam hal pemanfaatan dan pengelolaan sumberdaya ikan dan lingkungan yang secara operasionalnya dijabarkan dalam bentuk :

- Pemantauan secara saksama dan mendalam serta berkelanjutan terhadap hasil tangkapan, baik dari sisi jumlah dan ukuran serta tingkat kedewasaannya, demikian halnya terhadap parameter kualitas air Selat Bali.
- Hasil pemantauan segera ditindak lanjuti, utamanya dalam hal penentuan alokasi sumberdaya ikan guna sebagai bahan penetapan pemanfaatannya.
- Dalam pengelolaan sumberdaya perikanan lemuru dan lingkungannya diupayakan melalui pengelolaan berbasis komunitas.

b. Dalam rangka penertiban dan pengawasan terhadap pelaksanaan ketentuan yang telah ditetapkan dalam SKB Gubernur KDH Tk. I Jawa Timur dan Bali Nomor: **238 tahun 1992// 674 tahun 1992** perlu dilakukan operasi penertiban dan pengawasan bersama antara Pemda Tingkat I Jawa Timur dan Bali.
c. Dengan adanya keterbatasan yang ada, maka perlu adanya sharing lembaga internasional terhadap perikanan lemuru di Selat Bali.
d. Perlu adanya kemitraan terhadap pengusaha dalam monitoring ikan lemuru di selat Bali.

LAMPIRAN 1 : Produksi Ikan Lemuru di Jawa Timur dan Muncar, 1976 - 1998

No.	Tahun	Produksi (Ton)	
		Jawa Timur	Muncar
1	1976	24.402,40	22.058,10
2	1977	27.204,40	22.532,30
3	1978	18.738,60	14.048,50
4	1979	14.360,70	11.509,70
5	1980	15.395,40	11.303,50
6	1981	11.827,00	8.429,50
7	1982	13.887,00	10.516,00
8	1983	13.142,60	9.570,10
9	1984	13.671,90	8.517,90
10	1985	10.403,90	6.106,70
11	1986	6.678,80	922,70
12	1987	9.073,10	4.220,00
13	1988	22.204,60	15.222,20
14	1989	27.165,30	19.407,10
15	1990	31.393,10	22.656,90
16	1991	38.243,10	27.837,70
17	1992	34.478,59	25.416,19
18	1993	42.258,00	32.740,80
19	1994	42.004,80	28.542,90
20	1995	17.743,30	6.610,40
21	1996	14.360,20	1.438,00
22	1997	38.653,90	28.403,00
23	1998	*)	25.230,76

Keterangan : *) data belum masuk ke Dinas Perikanan Daerah Propinsi Dati I Jawa Timur

LAMPIRAN 2 : Jumlah Nelayan dan Alat Tangkap di Muncar Tahun, 1976 -1998

No.	Tahun	Jumlah Nelayan (Orang)	Jumlah Alat Tangkap	
			Purse Seine (Unit)	Non- Purse Seine (Unit)
1	1976	9.500	54	1.813
2	1977	3.208	115	791
3	1978	3.401	122	1.029
4	1979	5.982	166	1.187
5	1980	5.982	173	1.127
6	1981	9.936	185	1.490
7	1982	12.767	200	1.619
8	1983	10.050	200	1.619
9	1984	10.045	190	980
10	1985	10.701	190	1.032
11	1986	10.589	190	942
12	1987	13.657	190	1.058
13	1988	13.767	190	988
14	1989	13.857	190	1.219
15	1990	13.587	190	1.078
16	1991	13.630	190	1.750
17	1992	13.643	190	1.221
18	1993	13.339	190	1.223
19	1994	12.657	190	1.430
20	1995	10.657	190	1.392
21	1996	10.354	190	1.261
22	1997	11.845	190	1.752
23	1998	11.800	190	1.834

Lampiran 3 : Perkembangan catch per unit of effort (CPUE) purse seine di Muncar, tahun 1976 – 1998

No.	TAHUN	CPUE (ton/kapal/tahun)
1.	1976	408,48
2.	1977	195,93
3.	1978	115,23
4.	1979	69,33
5.	1980	65,34
6.	1981	45,56
7.	1982	52,58
8.	1983	65,71
9.	1984	44,83
10.	1985	32,14
11.	1986	4,86
12.	1987	22,21
13.	1988	80,12
14.	1989	102,14
15.	1990	119,25
16.	1991	146,51
17.	1992	133,77
18.	1993	172,32
19.	1994	150,32
20.	1995	94,79
21.	1996	7,57
22.	1997	96,86
23.	1998	132,79

PENGELOLAAN PERIKANAN LEMURU DI BALI

oleh
Dinas Perikanan daerah Tkt I Propinsi Bali[11]

(Management of lemuru fishery in Bali by Bali Provincial Fisheries Service)

SUMMARY

The lemuru fishery in Bali Strait has developed rapidly since the introduction of purse seine in 1974. The number of fishing boat has increased and reached 76 in 1976. The catch has shown the typical fluctuations of pelagic fish catch. The low catch of 8,866 t in 1996 was followed by a steep increase to 29,701 t in 1997. Fishermen from the two districts of Bali (i.e. Jembrana and Badung) have been fishing for lemuru for decades and majority of the catch is landed in Jembrana.

The processing industry has developed in line with the development of the fishery. On the average only 20% of the total catch of lemuru has been consumed fresh and about 64% has been processed into the form of canned products or fishmeal. The remaining 16% are used for the production of dried-salted fish and fish silage.

As fishermen from East Java and Bali have been fishing together in Bali Strait, the Governments of the two Provinces have worked together in the management of the fisheries. The joint management effort was started in 1977 and the effort has been updated ever since. As for the last agreement in 1992 which is still valid, the allocation of fishing boats for Bali has been limited to 83.

Complaints by fishermen in the implemenation of management measures have been centered on the mesh size limit for the bunt of purse seine of 1 inch. Fishermen opposed the measure with reason being that 1 inch mesh size causes gilling of fish which results in problems with sorting and poor quality of fish. Purse seine fishermen have frequently strayed into area I, an area reserved for traditional gears, which could lead to a conflict with fishermen using smaller gears.

[11] Kepala Dinas Perikanan Propinsi, Ir. Ibp. Wisnawa Mnuaba, Pembina tk.I, Nip 080030584

1. PENDAHULUAN

Perikanan lemuru di Bali sebenarnya sudah ada sejak jaman dahulu dan secara pasti tidak jelas kapan ini mulai ada. Namun yang pasti perikanan lemuru ini menjadi pembicaraan baik di tingkat lokal, regional maupun nasional semenjak diperkenalkannya penangkapan lemuru dengan purse seine oleh Balai Penelitian Perikanan laut (BPPL) pada tahun 1972, akan tetapi bukan berarti pengenalan teknologi itu menjadi sumber permasalahan, melainkan sebenarnya memang seharusnya kita perlu selalu mengadakan pembicaraan semacam ini di setiap kegiatan perikanan, tidak hanya saja pada perikanan lemuru, untuk menuju peningkatan ke arah yang lebih baik.

Sejak diperkenalkannya penangkapan lemuru dengan purse seine oleh Balai Penelitian Perikanan Laut (BPPL) pada tahun 1972, maka perikanan lemuru di Selat Bali berkembang sangat pesat.

Kemudian pada tahun 1977 di Pengambengan dibentuk KUD Mina Karya dan Pusat Pendaratan Ikan (PPI), sedangkan di Kedonganan pada tahun 1978 di bentuk KUD Unit Mina dan Pusat Pendaratan Ikan (PPI).

Pada tahun itu juga (1977) mulai berdiri perusahaan-perusahaan pengalengan dan penepungan ikan sebanyak 2 unit, dan pada tahun 1978 menjadi 4 unit, pada tahun 1982 menjadi 6 unit dan terus berkembang, hingga sekarang tercatat ada 10 unit dengan total kapasitas produksi 59.117 ton ikan per tahun.

Pesatnya perkembangan perikanan lemuru telah mengkhawatirkan terhadap kelestarian sumberdaya ikan, sehingga pada tahun 1977 dikeluarkan Surat Keputusan Bersama (SKB) antara Gubernur Kepala Daerah Propinsi Daerha Tingkat I Jawa Timur dan Gubernur Kepala Daerah Propinsi Daerah Tingkat I Bali, yang kemudian diperbaharui pada tahun 1978 tentang penentuan jumlah purse seine yang boleh beroperasi di perairan Selat Bali. Pada ketentuan tersebut ditetapkan sebanyak 133 unit purse seine yang terdiri dari 73 unit untuk Jawa Timur dan 60 unit untuk Bali. Namun karena lemahnya pengawasan terhadap pelaksanaan keputusan tersebut menyebabkan jumlah purse seine yang beroperasi melebihi dari ketentuan yang ada, sehingga pada tahu 1983 Direktorat Jendral Perikanan mengeluarkan Surat Keputusan Nomor **EK-230/83.2194/83** tertanggal 8 April 1983, untuk menaikkan jumlah purse seine yang boleh beroperasi di Selat Bali menjadi sebanyak 200 unit, akan tetapi ternyata jumlah purse seine yang beroperasi telah melampaui jumlah tersebut yaitu sebanyak 351 unit. Oleh karenanya pada tahun 1984 diadakan rapat koordinasi antara Gubernur Jawa Timur dan Gubernur Bali dan sebagai tindak lanjut pada tahun 1985 dikeluarkan Surat Keputusan Bersama (SKB) antara dua Pemerintah Daerah tersebut Nomor **7 tahun 1985/4 tahun 1985**, yang menetapkan jumlah purse seine yang boleh beroperasi sebanyak 273 unit terdiri dari 190 unit untuk Jawa Timur dan 83 unit untuk Bali. Kemudian pada tahun 1992 SKB antara dua Gubernur ini diperbaharui lagi dengan Nomor **238 tahun 1992/674 tahun 1992** tertanggal 14 November 1992. Dan selanjutnya pada tahun 1994 SKB tersebut ditindak lanjuti dengan SKB Kepala Dinas Perikanan Jawa Timur dan Kepala Dinas Perikanan Bali Nomor 10 tahun 1994/02 tahun 1994 tanggal 3 Pebruari 1994, dengan tetap menetapkan jumlah purse seine 273 unit yang terdiri dari 190 unit untuk Jawa Timur dan 83 unit untuk Bali hingga sampai dengan sekarang.

Berbeda dengan pesatnya perkembangan purse seine (perikanan lemuru) pada tahun-tahun sebelumnya seperti yang telah diuraikan diatas, maka pada lima tahun terakhir ini perkembangan perikanan lemuru khususnya produksi lemuru di Bali mengalami penurunan yang cukup tajam, bahkan tidak menentu dan ketidak menentuan ini telah mengakibatkan kesulitan bagi perusahaan pengalengan dan penepungan ikan serta masyarakat nelayan. Oleh karena itu pada kesempatan yang sangat baik ini diharapkan dapat memberikan kepastian tentang perikanan lemuru di masa yang akan datang.

2. PERIKANAN LEMURU DI BALI

2.1 Potensi Lemuru di Selat Bali

Potensi lemuru di Bali berada di perairan Selat Bali, yang mempunyai luas 2.500 km2, berbentuk corong, dengan lebar pada bagian yang sempit di utara adalah 2,5 km dan lebar bagian selatan adalah 55 km, dengan panjang 90 km.

Berdasarkan Penelitian Akustik yang dilakukan oleh Balai Penelitian Perikanan Laut (BPPL) dengan menggunakan alat fish finder, ternyata ikan-ikan lemuru di perairan Selat Bali hanya terpusat di paparan saja (paparan Jawa dan Bali) pada kedalaman kurang dari 200m, sedangkan di luar paparan ikan ini tidak dapat ditemukan.

Pada siang hari ikan lemuru ini mempunyai kebiasaan membentuk gerombolan dalam jumlah yang cukup padat di dasar perairan, sedangkan pada malam hari naik ke permukaan dan agak menyebar.

Dari penelitian diperolah data bahwa standing stock sumber perikanan pelagis di Selat Bali diperkirakan mencapai 220.000 ton ikan dan untuk dapat memanfaatkan sumber tersebut secara lestari, maka potensi ikan yang dapat ditangkap maksimal sebesar 66.000 ton ikan per tahun.

Sedangkan pendugaan besarnya sediaan ikan lemuru di perairan Selat Bali (1973-1981), baik dengan menggunakan metode akustik maupun model surplus produksi dari data hasil tangkapan dan upaya yang tersedia, memberikan hasil dugaan potensi yang hampir sama yaitu berkisar antara 35.000 – 66.000 ton ikan (Sujastani, 1982).

Kemudian pada tahun 1986 di perairan Selat Bali diadakan pendugaan sediaan ikan lemuru lagi dengan mempergunakan data hasil tangkapan dan upaya yang diturunkan dari data ekonomi diperoleh nilai dugaan MSY sebesar 62.000 – 66.000 ton ikan per tahun (Martsoubroto *et al.*, 1986).

2.2 Tingkat pemanfaatan ikan lemuru di Selat Bali

Tingkat pemanfaatan ikan lemuru di Selat Bali dapat dilihat dari data produksi hasil tangkapan ikan lemuru di Selat Bali. Karena perairan Selat Bali ini dimanfaatkan oleh dua Pemerintah Daerah yaitu Jawa Timur dan Bali, maka data tersebut sebenarnya harus berasal dari Jawa Timur dan Bali.

Namun karena keterbatasan yang ada maka hanya akan ditampilkan data dari Bali.

Produksi ikan lemuru di Bali pada lima tahun terakhir mengalami penurunan yang sangat tajam, dan baru membaik pada tahun 1997, dengan peningkatan yang cukup tajam pula yaitu sebesar 235% dari 8.866,2 ton ikan pada tahun 1996 menjadi 29.701,7 ton ikan pada tahun 1997.

Ketidakstabilan data produksi ini bukan diakibatkan oleh jumlah upaya penangkapannya yang berkurang akan tetapi lebih cenderung pada keberadaan ikan yang terdapat di Selat Bali, karena kalau dilihat dari jumlah armada yang dioperasikan relatif sama.

Di Bali yang memanfaatkan Selat Bali (khususnya lemuru) adalah dua Kabupaten Daearah Tingkat II yaitu Kabupaten Dati II Jembrana dan Kabupaten Dati II Badung, dengan demikian data yang akan disampaikan berasal dari dua Kabupaten tersebut.

Tabel 1. Data Produksi Ikan Lemuru di Kabupaten Dati II Badung dan Kabupaten Dati II Jembrana Tahun 1993 – 1997 (ton)

TAHUN	BADUNG	JEMBRANA	JUMLAH
1993	930,6	13.264,5	14.195,1
1994	939,7	14.953,6	15.893,3
1995	2.548,8	11.044,1	13.592,9
1996	1.633,7	7.232,5	8.866,2
1997	1.863,6	27.838,1	29.701,7

Dari Tabel 1 tersebut dapat dilihat bahwa pada tahun 1993–1995 produksi lemuru relatif stabil, kemudian pada tahun 1996 menurun sebesar 34% dan pada tahun 1997 meningkat sebesar 235%.

Teknologi yang dipergunakan untuk menangkap ikan lemuru adalah purse seine two-boat system, dengan menggunakan alat bantu lampu petromak (strongking) ataupun dengan menggunakan generator.

Jumlah purse seine yang ada di Bali diatur oleh SKB Kepala Dinas Perikanan Jawa Timur dan Kepala Dinas Perikanan Bali (1994), sedangkan pembagian untuk Kabupaten Badung dan Kabupaten Jembrana diatur oleh Gubernur kepala Daerah Tingkat I Bali (1994).

Tabel 2. Data armada purse seiner di Kabupaten Dati II Badung dan Kabupaten Dati II Jembrana tahun 1993-1997 (unit)

TAHUN	BADUNG	JEMBRANA	JUMLAH
1993	7	66	73
1994	6	66	72
1995	8	67	75
1996	8	68	76
1997	8	68	76

Nelayan secara langsung memanfaatkan lemuru adalah nelayan yang berada di wilayah Kabupaten Dati II Badung dan Kabupaten Dati II Jembrana, khususnya yang berada di Pengambengan dan Kedonganan.

Nelayan-nelayan ini telah terorganisir dalam suatu kelompok nelayan yang pembentukannya berdasarkan atas domisili, dan setiap anggota kelompok nelayan telah menjadi anggota KUD. Yang berada di wilayah Kedonganan menjadi anggota KUD Mina Segara Kedonganan dan yang berada di wilayah Pengambengan menjadi anggota KUD Mina Karya Pengambengan.

Tabel 3. Data jumlah nelayan di Kabupaten Dati II Badung dan Kabupaten Dati II Jembrana, 1993-1997

TAHUN	BADUNG	JEMBRANA	JUMLAH
1993	2.239	8.815	11.054
1994	1.167	9.407	10.574
1995	1.897	9.407	11.304
1996	1.897	7.975	9.872
1997	1.897	7.118	9.015

2.3 Pengelolaan pasca tangkap lemuru

Pada dasarnya perlakuan terhadap pasca tangkap lemuru adalah pengolahan secara tradisional oleh masyarakat dan pengolahan modern oleh perusahaan perikanan, serta sebagian dikonsumsi oleh masyarakat dalam bentuk segar.

Pengolahan tradisional oleh masyarakat dalam bentuk pengeringan (penggaraman), pemindangan dan gaplek ikan, sedangkan pengolahan modern oleh perusahaan perikanan adalah dalam bentuk pengalengan dan tepung ikan.

Tabel 4. Data perlakuan terhadap produksi ikan lemuru yang ditangkap di Kabupaten Dati II Badung dan Kabupaten Dati II Jembrana (dalam ton), 1993-1997

Perlakuan	T a h u n				
	1993	1994	1995	1996	1997
• Segar	2.129,3	3.814,4	3.670,0	1.507,3	4.158,2
• Pengeringan	134,8	222,5	299,0	298,8	193,0
• Pindang	610,4	508,6	810,1	618,9	781,2
• Pengalengan	5.819,9	5.880,8	5.165,3	3.989,8	8.910,5
• Tepung Ikan	2.269,8	2.860,8	1.970,9	2.216,5	15.147,9
• Gaplek Ikan	3.122,9	2.225,1	1.318,5	-	-

Tabel 5. Data perlakuan terhadap produksi ikan lemuru yang ditangkap Di Kabupaten Dati II Badung dan kabupaten dati II Jembrana (dalam persen) tahun 1973-1997

Perlakuan	T a h u n				
	1993	1994	1995	1996	1997
• Segar	15,1	24,70	27,7	17,6	14,7
• Pengeringan	0,9	1,40	2,2	3,4	0,7
• Pindang	4,3	3,20	5,9	6,9	2,6
• Pengalengan	41,2	37,39	38,0	45,57	30,2
• Tepung Ikan	15,9	18,67	18,5	25,58	51,5
• Gaplek Ikan	22,3	14,44	9,7	-	-

Dari data tersebut diatas, maka kelihatan bahwa sebagian besar produksi lemuru dipergunakan sebagai penyediaan bahan baku perusahaan perikanan yaitu untuk pengalengan dan tepung ikan. Selama lima tahun terakhir ini untuk penyediaan bahan baku perusahaan tersebut rata-rata sebesar 63.7%, sedangkan untuk bahan baku pengolahan tradisional (pengeringan, pemindangan dan gaplek ikan) rata-rata sebesar 15,58% dan yang dikonsumsi dalam bentuk segar rata-rata sebesar 20%.

Penentuan perlakuan terhadap produksi lemuru sangat dipengaruhi oleh kualitas (mutu) hasil tangkap. Apabila hasil tangkap termasuk dalam kelompok mutu I maka akan memenuhi persyaratan untuk pengalengan ikan, dan yang termasuk dalam kelompok mutu II untuk tepung ikan, sedangkan yang kualitasnya lebih rendah lagi, tidak dapat diterima oleh perusahaan dan akan dipergunakan untuk bahan gaplek ikan.

Tabel 6. Daftar nama perusahaan pengalengan dan penepungan ikan lemuru beserta kapasitas produksinya.

Nomor	Nama perusahaan	Kapasitas (ton/th)
1.	PT. Bali Raya Permai	240,00
2.	PT. Samudra Raya	134,400
3.	PT. Sumina Akstraksindo	1.920,00
4.	PT. Indo Hama Fish	2.000,00
5.	PT. Jaya Baru	12.000,00
6.	PT. Bali Indah	1.500,00
7.	PT. Indo Bali	23.725,00
8.	PT. Pengambengan Raya	8.400,00
9.	PT. Bumi Bali Mina	8.000,00
10.	Dwipamina Nusantara	1.197,60
J u m l a h		59.117,00

Dalam rangka untuk mendukung pengelolaan pasca tangkap lemuru telah terdapat 10 unit perusahaan pengalengan dan penepungan dengan total kapasitas 59.117 ton ikan per tahun. Kapasitas tersebut sampai dengan sekarang belum pernah terpenuhi kebutuhan bahan bakunya, bahkan pada lima tahun terakhir ini semakin tidak bisa dipenuhi. Akibatnya sebagian perusahaan tidak bisa beroperasi dan perusahaan yang masih beroperasi tidak dapat optimal, akibat lebih jauh adalah

banyak buruh perusahaan yang kehilangan pekerjaan dan buruh perusahaan yang masih bekerja hanya bersifat musiman.

Tabel 7. Data pemenuhan bahan baku (ikan lemuru) untuk 10 unit Perusahaan Pengalengan dan Penepungan pada tahun 1993-1997

Tahun	Kapasitas Produksi (ton/th)	Pemenuhan Bahan Baku Per tahun	
		ton	%
1993	59.117,00	8.089,70	13,68
1994	59.117,00	8.741,30	14,78
1995	59.117,00	7.136,20	12,07
1996	59.117,00	6.206,30	10,49
1997	59.117,00	24.058,40	40,69

Dari Tabel 7 dapat dilihat bahwa pemenuhan kebutuhan akan bahan baku (ikan lemuru) untuk perusahaan pengalengan dan penepungan relatif kecil, rata-rata adalah sebesar 12.75%, kecuali pada tahun 1997 mencapai 40,69%.

2.4 Dampak Perikanan Lemuru di Bali

Dampak perikanan lemuru di Bali secara keseluruhan memang sangat luas sekali, namun disini yang dimaksudkan adalah sebatas pengaruhnya terhadap kehidupan masyarakat kecil.

Pengaruh perikanan lemuru terhadap masyarakat kecil adalah:

(a) Peningkatan pemndapatan

Dengan adanya kegiatan perikanan lemuru secara langsung telah memberikan peningkatan pendapatan bagi masyarakat nelayan, terutama yang berada di wilayah Pengambengan dan Kedonganan

(b) Peningkatan kesejahteraan keluarga

Dengan meningkatnya pendapatan rumah tangga nelayan, maka nelayan mempunyai kesempatan untuk menabung atau untuk mengikuti asuransi jiwa yang dengan demikian maka lebih dapat memberikan jaminan terhadap kesejahteraan keluarga mereka.

(c) Meningkatkan gizi masyarakat

Dengan adanya kegiatan perikanan lemuru, akan menambah penyediaan ikan bagi masyarakat, karena harga ikan lemuru relatif murah dibandingkan sumber-sumber protein hewani lainnya maka akan menjadi alternatif utama dalam pemenuhan gizi masyarakat.

(d) Kesempatan kerja

Dengan adanya kegiatan perikanan lemuru telah membuka lapangan kerja dan kesempatan kerja pada unit penangkapan, unit pengolahan dan unit pemasaran.

Pada unit penangkapan setiap unit armada purse seine diperlukan tenaga nelayan 25-30 orang sedangkan pada unit pengolahan diperlukan tenaga untuk perusahaan untuk pengalengan ikan, penepungan ikan dan tenaga untuk unit pengolahan tradisional.

Pada unit pemasaran telah memberikan peluang kerja sebagai belantik (tengkulak), pedagang pengumpul, buruh angkut dan lain-lain.

3. DASAR HUKUM PENGELOLAAN PERIKANAN LEMURU

3.1 Dasar Hukum

Dasar hukum yang dipergunakan untuk mengatur pengelolaan perikanan lemuru di Bali adalah :

- Keputusan bersama Gubernur Kepala daerah Tingkat I Jawa Timur dan Gubernur kepala Dearah Tingkat I Bali
  Nomor: **138 Tahun 1992//674 Tahun 1992**
  Tanggal: 14 Nopember 1992
  Tentang : Pengaturan/pengendalian penggunaan purse seine di Selat Bali

- Keputusan bersama Gubernur Kepala Daerah Tingkat I Jawa Timur dan Gubernur Kepala Derah Tingkat I Bali
  Nomor: **10 Tahun 1994// 02 Tahun 1994**
  Tentang: Petunjuk Pelaksanaan Kerjasama Antar Daerah Propinsi Daerah Tingkat I Jawa Timur dan Propinsi Daerah Bali di Bidang Perikanan.

- Keputusan bersama Gubernur Kepala Daerah Tingkat I Bali
  Nomor: **392 Tahun 1994**
  Tanggal: 19 Agustus 1994
  Tentang: Penetapan jumlah ijin penangkapan ikan dengan jaring purse seine untuk kabupaten daerah Tingkat II Jembrana dan kabupaten Daerah tingkat II Badung

- Surat Gubernur Kepala Daerah Tingkat I Bali
  Nomor: **523.4/17092/Binoroda**
  Tanggal: 10 Desember 1992
  Tentang: Penertiban Pendaratan Ikan Lemuru di PPI Kedonganan

- Keputusan Gubernur kepala Daerah Tingkat I Bali
  Nomor: **168 Tahun 1995**
  Tanggal: 17 Oktober 1995
  Tentang: Penetapan harga dasar lemuru

- Peraturan Daerah Propinsi Daerah Tingkat I Bali
  Nomor: **17 tahun 1991**
  Tanggal: 5 Desember 1991
  Tentang: Ijin Usaha Perikanan

3.2 Penerapan

Penerapan dari ketentuan-ketentuan hukum diatas belum sepenuhnya dapat dilaksanakan. Untuk penerapan jumlah armada purse seine yang boleh beroperasi pelaksanaannya diatur melalui pembatasan pemberian Ijin Usaha Perikanan (IUP). Berdasarkan hal tersebut, maka jumlah Purse Seine yang ada di Bali adalah sebagai berikut :

Tabel 8. Data Rekomendasi dan Realisasi Jumlah Purse Seine di Bali tahun 1993-1997

Tahun	Kabupaten	Rekomendasi	Realisasi
1993	Badung Jembrana	17 66	7 66
1994	Badunng Jembrana	9 74	6 66
1995	Badung Jembrana	9 74	8 67
1996	Badung Jembrana	9 74	8 68
1997	Badung Jembrana	9 74	8 68

Dari Tabel 8 tersebut diatas dapat dilihat bahwa jumlah purse seine tidak melebihi ketentuan yang ditetapkan, akan tetapi tidak semua purse seine yang ada dapat memenuhi seluruh ketentuan yang ditetapkan.

Beberapa penyimpangan/pelanggaran yang sering dilakukan adalah :

- Ukuran mata jaring pada bagian kantong. Ketentuan 1 inch, sedang kebanyakan yang ada adalah 0,75 inch, hal ini menurutnya yang berukuran 1 inch atau lebih menimbulkan kerusakan pada insang ikan lemuru karena tersangkut.
- Daerah penangkapan bagi purse seine. Ketentuan diluar daerah I, kenyataannya masih banyak purse seine yang beroperasi di daerah I.
- Pendaratan ikan. Ketentuan purse seine asal jawa Timur di PPI Muncar dan purse seine asal Bali di PPI Bali, kenyataannya pendaratan ikan oleh nelayan lebih cenderung mempertimbangkan faktor harga (yang mahal) dan jarak fishing ground dengan PPI (yang lebih dekat). Memang ketentuan ini nampaknya tidak sesuai dengan prinsip ekonomi dan kurang berjiwa kerakyatan, karenanya mungkin akan lebih baik bila diadakan peninjauan ulang.

3.3 Pengawasan

Pengawasan dilakukan melalui BAKORKAMLA. Satgas ini di kabupaten Badung dan Jembrana telah dapat dibentuk melalui Pemerintah Daerah Tingkat II masing-masing, namun pelaksanaan operasionalnya belum dapat dilaksanakan secara optimal.

Hambatan yang sering dialami dalam pengawasan adalah :

- Terbatasnya prasarana dan sarana pengawasan
- Terbatasnya tenaga dan biaya operasional
- Lebih sulitnya medan pengawasan

4. PENUTUP

Materi yang telah diuraikan tersebut diatas adalah lebih bersifat informatif dari sistim pengelolaan perikanan lemuru yang dilaksanakan di Bali, dengan kebijaksanan-kebijaksanaan yang selalu mengacu pada dasar hukum yang mengatur tentang perikanan lemuru di Selat Bali.

Pada akhirnya kami menyadari kurang sempurnanya peyampaian ini, baik materi maupun tata cara penyampaiannya, karena keterbatasan yang kami miliki. Untuk itu pada kesempatan pertemuan yang baik ini diharapkan adanya masukan saran dan pendapat untuk memperbaiki kebijaksanaan dalam pengelolaan perikanan lemuru di Bali ini agar menjadi lebih baik.

TOWARDS DEVELOPING A MANAGEMENT PLAN FOR LEMURU FISHERY

WORKSHOP NOTES – LEMURU FISHERY IN BALI STRAIT

by

Barry Pollock[12]

Introduction: Several subjects and questions were raised at the Workshop on management of the Lemuru fishery in Bali Strait, which was held in Bali in April 1999. These notes are a summary of some of the matters raised and the responses provided.

Contents of a Fishery Management Plan: There are no rules on what should be contained in a fishery management plan. However such a plan would have a title and contain a description of the fishery as well as details on jurisdiction, objectives, operational management (access arrangements and input/output controls), MCS (monitoring control and surveillence0, and details of how and when the plan will be reviewed.

The plan could also contain details of research and stock assessment, pricing policies for the fishery, environmental issues, socio-economic information, consultation arrangements, post-harvest issues, and bycatch.

Practical Models for Fishery Management Planning: New approaches are being developed to provide for effective planning in the management of fisheries. Two examples are given one for a fishery under single jurisdiction and the other for a multi-jurisdictional fishery.

1. **Single jurisdiction**

   Government
   |
   Fishery agency
   |
   MAC (Management Advisory Committee of stakeholders)
   |
   Fishery management plan

2. **Multi-jurisdictional fishery**

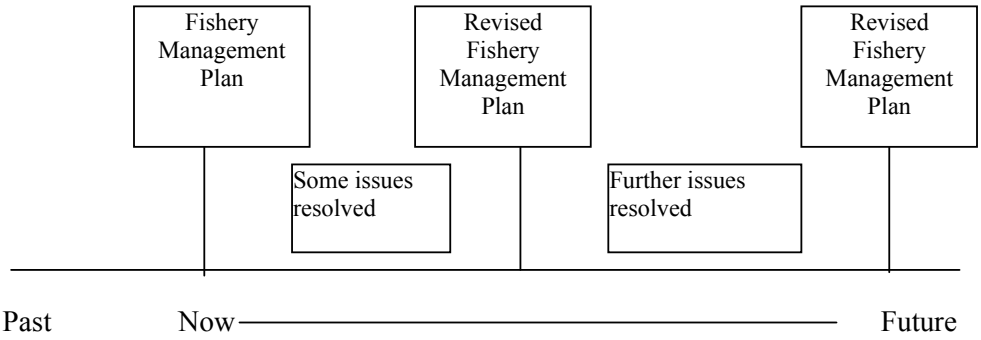
   Governments
   |
   Joint authority
   |
   Fishery agency
   |
   MAC of stakeholders
   |
   Fishery management plan

[12] FAO consultant

A MAC is a management advisory committee of stakeholders, usually chaired by an independent person. The MAC provides advice on the contents of the fishery management plan to the fishery agency and government. The Joint Authority is a high-level committee (often composed of Ministers or their representatives) to agree on the overall policies for management of the multi-jurisdictional fishery.

Fishery Management Planning Process: The fishery management planning process is an iterative one that uses a fishery management plan or similar "vehicle" for detailing all the elements involved and providing a reference to how the fishery is managed. This planning process operates on the principle that the fishery management plan has a series of issues that need to be addressed for the plan to be improved and eventually updated. A simple diagram explains this on-going process.

Diagram of Fishery Management Planning



Common Questions: The following are some of the questions about fishery management planning, with a response provided.

1. Why prepare a fishery management plan?

Answer: The fishery management plan is the document that describes the fishery, what is known about it, and how the fishery is managed. It is the "vehicle" for organising the administration of the fishery, and for ensuring the integration of the functional aspects of the fishery such as jurisdiction, operational management, MCS, research, etc. The plan also enables deficiencies and other problems to be identified and actions taken for their resolution. Another important feature of a fishery management plan is that it provides transparency, that is an open and accountable documentation of the total status of the fishery and its management.

2. When should a Fishery Management Plan be produced?

Answer: The short answer is "now". It is not difficult to draft a plan, provided you have access to all the existing information. The options are for either a small working group to prepare a draft and circulate it to others with expertise or to form a workshop of expert stakeholders to draft the plan.

3. Is there a perfect Fishery management plan?

Answer: No. Fishery management plans are documents that point to various shortcomings and other unresolved issues. These problems need to be worked on and resolved where possible so that the plan can be updated. The above diagram shows the model for continuous improvement of the fishery management plan. One of the issues in beginning a fishery management plan is the lack of information, particularly research information. However this should not be used as an excuse for preparing a plan to manage the fishery – remember the Precautionary Principle.

4. Who are the stakeholders in the fishery management planning process?

Answer: Stakeholders are those with an interest in the fishery and its management. Depending on the fishery they could include some or all of the following; fishers, middlemen, factory operators/owners, consumers, researchers, government officials, MCS operators, conservation agencies.

The documentation used at the Workshop is presented below.

2 FISHERY MANAGEMENT PLAN - POSSIBLE CONTENTS

1. DESCRIPTION OF THE FISHERY

- Area
- Species
- Fishing methods
- Socio-economic information

2. JURISDICTION

- Governments and their agencies with roles in the fishery
- Formal or informal agreements between governments on fishery management
- Roles of all responsible agencies

3. OBJECTIVES OF FISHERIES MANAGEMENT

- Biological
- Social
- Economic

4. OPERATIONAL MANAGEMENT

- Access arrangements including licensing and non-licensed access
- Input/output controls
- Pricing policy/licence costs

5. RESEARCH AND STOCK ASSESSMENT

- Current research and stock assessment program
- On-going data collection
- Socio-economic studies
- Environmental issues
- Implications for management

6. MONITORING, CONTROL AND SURVEILLANCE

- Regulations/rules to be enforced
- Description of existing capacity
- On-going data collection

7. CONSULTATION WITH STAKEHOLDERS AND EXTENSION

- Stakeholders
- Consultation processes
- Provision of information

8. POST-HARVEST SECTOR

- Description of post-harvest sector
- Management implications

9. REVIEW OF THE PLAN

- How and when will the plan be reviewed
- Who has responsibility for the plan and its review

3 INFORMATION FOR WORKING GROUPS ON THE MANAGEMENT PLAN AND ON ASSOCIATED ISSUES

Background: Each of the 8 working groups (with 4 members) will be assigned to one of the headings in the Management Plan for Lemuru in Bali Strait. The tasks of each working group are:

Task 1.

- Provide details of the **current** situation relating to that heading. This should be done briefly, using headlines or bullet points.

- Provide separately a list of any **issues** such as problems, deficiencies or unresolved matters associated with that heading in the management plan

Task 2.

- Combine with one other working group (about 8 persons in total) and review each others work from Task 1, and list the issues in order of priority

Task 3.

- Each combined working group reports back to the whole audience and the results are discussed

Task 4.

- The working group finalises both the details for the management plan and the list of issues. These are supplied to the secretariat by 4pm Wednesday.