

# Socioeconomic and Bioeconomic Analysis of Coastal Resources in Central and Northern Java, Indonesia

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## Abstract

Indonesia's fisheries exports rose from 2 206 t in 1970 to 598 385 t in 1996 with a subsequent export value rise from US\$0.69 billion to US\$1.78 billion. The surplus in the balance of trade (BOT) was US\$1.59 billion in 1996. The fisheries exports were predominantly shrimp, tuna, skipjack and demersal fishes. Large scale fisheries operations are prevalent in the Java Sea. The dominant fishing gear is hook-and-line (40%), gillnet (31%), traps (10%), seine net and lift-net (6%), purse seine (1%), shrimp net with BED (0.04%) and others (6%). The large scale fisheries e.g. purse seine, tuna long line, shrimp trawl and fish net use larger vessels, while most of the large scale fisheries utilize boats between 5 - 30 GT. Small scale fisheries exploit the coastal waters resulting in overcrowding in the Java Sea.

In terms of production and technological efficiency, the combination of manpower inputs, total volume of fuel/day and total number of vessels are not optimal either for small or large scale vessels. It is recommended in the large scale fisheries that the volume of fuel/day should be increased, while the total number of boats should be reduced. Conversely the use of fuel/day for large scale fisheries should be increased. Expanded use of fuel/day for large scale vessels would increase offshore operations, which would lessen the fishing pressures in near-shore waters. In the northern part of Java, large scale fisheries do not generate any discards or by-products because most of the fishers utilize the fish captured for family consumption, local market or commercial export purposes.

Budget analysis, using the internal rate of return (IRR), net present value (NPV), payback period (PP) and benefit-cost analysis (B/CA), showed that almost all vessels are profitable and ready for new capital investment, except for Danish seine A vessels. Results using the Schaefer surplus yield production model indicate that the existing total fishing effort remains lower than the maximum sustainable yield (MSY) level in the inshore waters. The utilization rate in 2001 is currently 99.4%.

It is recommended that an in-depth study be conducted using simultaneous equation modeling that will integrate the Schaefer model, demand function, production, taxation policy and the feasibility constraints into one general model.

## Socioeconomic Profile

### Review of the Status of Fishery Resources: Volumes and Values of Fish Production

Over 1960 - 96, the national fisheries production increased nearly 5.88 times, increasing from 756 765 t to 4 452 000 t. The national fish production includes the marine capture sector that provides the highest share at 75.98%, followed by the coastal brackish-water culture at 9.08%, and finally by the inland fish production (capture at 7.54% and culture at 7.39%).

Marine capture fisheries consist of the small pelagic fish (37.21%), demersal fish (28.58%), large pelagic fish (9.978%), coral fish (2.45%), penaeids (1.89%), squids (0.58%) and ornament fish, estimated at around 1.5 billion of fish. The large pelagic fish are the skipjack (3.37%), eastern little tuna (*tongkol*, 2.92%), tuna (2.05%), king mackerel/*tenggiri* (0.84%) and shark/marlin/sailfish/sword fish (0.42%).

Following (Kmenta 1971) the logistic growth curve (LGC) model of marine capture production in Central and Northern Java can be estimated using:

$$\ln Z = 2.700\ 245 - 0.071\ 79\ T$$

t test: (-47.23)

$$R^2 = 0.98; n = 37; df = 35$$

Where :

Z = equal to the value of (MSY/X - 1)

MSY = maximum sustainable yield estimated at 6 285 000 t annually

X = production of marine capture annually (t)

T = time trend

**Table 1. Projected marine capture fish production using the LGC model.**

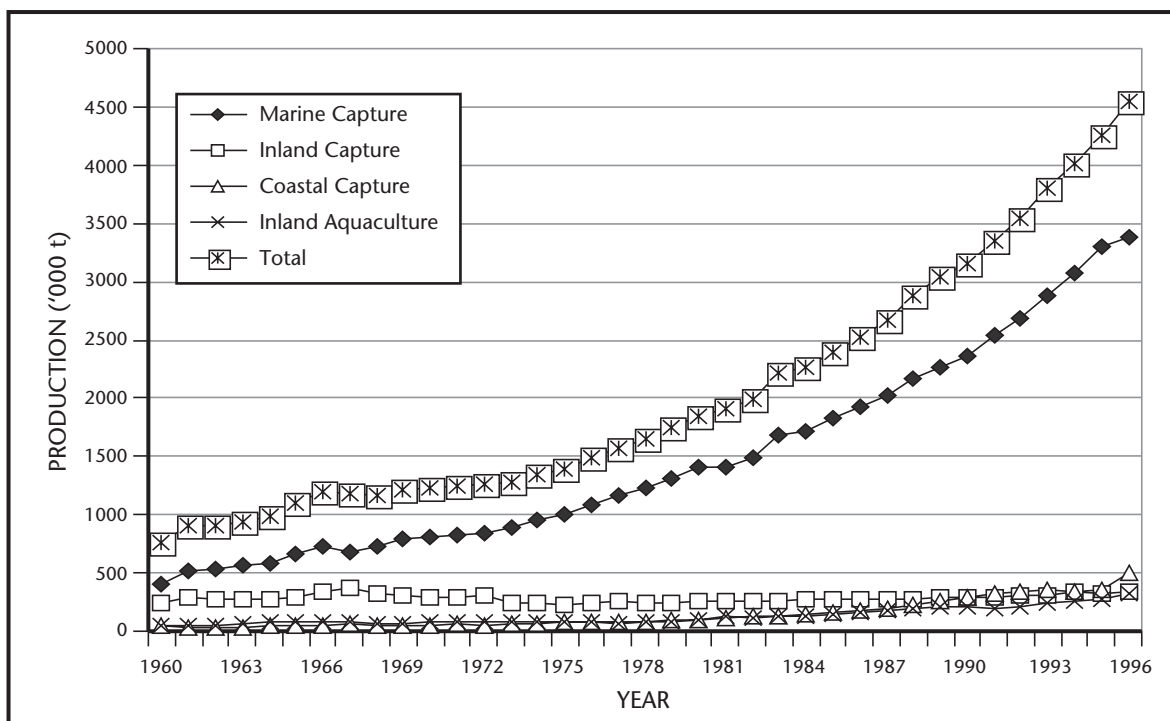
Year	Production (t)
1996	3 073 353
1997	3 186 139
1998	3 298 812
1999	3 411 085
2000	3 522 670
2001	3 633 292
2002	3 472 680
2003	3 850 580
2004	3 954 109
2005	4 060 961
2006	4 163 011

Fish production from the capture fisheries (marine and inland) and culture (coastal brackish-water and inland) during 1960 - 96 showed that the growth of marine capture fisheries is relatively high, compared to other fish production that more or less remained the same (Table 2, Fig. 1).

**Table 2. National fish production (t) from capture and culture fisheries, 1960 - 96.**

Year	Capture		Culture		Total
	Marine	Inland	Coastal	Inland	
1960	410 043	249 674	43 078	53 970	756 765
1961	525 198	297 988	32 807	54 288	910 281
1962	537 983	281 449	32 704	56 157	908 293
1963	558 970	279 165	39 239	57 720	935 094
1964	590 000	272 860	42 421	87 573	992 854
1965	665 107	296 007	53 413	87 808	1 102 335
1966	720 236	347 591	54 067	79 934	1 201 828
1967	677 933	364 875	56 750	80 876	1 180 434
1968	722 512	320 410	43 528	72 590	1 159 040
1969	785 344	314 201	51 876	62 978	1214 399
1970	807 391	286 519	55 908	78 694	1 228512
1971	820 447	285 745	60 788	77 595	1 244 575
1972	836 289	301 412	51 203	80 005	1 268 909
1973	888 518	249 592	60 481	78 921	1 277 512
1974	948 566	240 893	66 756	80 053	1 336 268
1975	996 856	228 511	78 776	85 871	1 390 014
1976	1 081 589	246 711	80 158	74 484	1 482 942
1977	1 157 691	254 243	87 604	72 314	1 571 852
1978	1 227 386	249 146	87 995	83 137	1 647 664
1979	1 317 744	248 161	93 664	88 848	1 748 417
1980	1 401 000	250 900	95 300	93 000	1 840 200
1981	1 408 272	264 983	112 916	128 334	1 914 505
1982	1 490 719	265 348	129 279	112 195	1 997 541
1983	1 682 019	265 562	134 072	132 328	2 213 981
1984	1 712 804	269 321	142 404	136 460	2 260 989
1985	1 821 725	269 266	156 367	148 204	2 395 562
1986	1 922 781	273 012	170 310	163 787	2 529 890
1987	2 017 350	276 291	192 123	184 649	2 670 413
1988	2 169 557	281 264	233 283	197 065	2 881 169
1989	2 272 179	296 385	258 491	208 213	3 035 268
1990	2 370 107	292 537	287 073	212 752	3 162 469
1991	2 537 612	294 477	323 156	194 356	3 349 601
1992	2 692 068	300 896	337 431	212 937	3 543 332
1993	2 886 289	308 649	355 284	245 100	3 795 322
1994	3 080 168	336 141	346 214	251 308	4 013 831
1995	3 292 930	329 710	361 239	279 708	4 263 587
1996	3 382 457	335 706	494 335	328 760	4 541 258

Source: Directorate General of Fisheries (DGF) 1998.



**Fig. 1. National fisheries production from capture and culture fisheries 1960 - 96.**  
**Source: Directorate General of Fisheries (DGF) 1998.**

### Economic Growth and Welfare: Contribution of the Fishery Sector to Economic Growth and Welfare

Below are the major analyses based on relevant fisheries statistics from 1985 to 1997.

- During 1985 - 97, the gross domestic product (GDP) valued at constant market price increased from 79 679 to 433 685 billion Rupiahs (1US\$ = 2 360 Rupiah, annual average from 1993 - 97), an increment of almost 5.44 times. Similarly, the gross national product (GNP) at constant market prices also multiplied from 76 602 to 418 418 billion Rupiahs a rise of 5.46 times.
- The human population increased on average by 2.21% between 1980 - 87 and by 1.57% between 1988 - 97.
- Per capita GDP during 1985 - 97 rose from 487 730 to 2 170 200 Rupiahs annually (almost 4.45 times). Economic growth was thus increasing significantly during these periods.
- The per capita gross regional domestic product (GRDP) in DKI-Jakarta was the highest among all provinces with an annual average of Rps 7 324 400. From the agricultural sector and industries, the manufacturing of oil, non-oil and gas made the highest contribution to the national GDP at 21.86%. Other contributions came from trades/hotel and restaurants at 13.74%, agriculture/livestock/forestry and fisheries at 14.79% and other services at 8.22%.
- The fisheries sector with a 1.51% share contributed minimally to the GDP.
- In 1988, the contribution of non-oil and gas to the national GDP increased at a rate of 90.86%. This suggests that oil and gas will be less important in the future.
- Information on the national GDP, gross national product (GNP) and population is given below (Table 3, Fig. 2).

Table 3. Indonesian GNP, GDP and GVA gross value-added from 1985 to 1997 at constant market prices.

Year	Total GNP (billion Rupiah)	Total GDP (billion Rupiah)	Industry and Others (billion Rupiah)	Services (billion Rupiah)	Agriculture (billion Rupiah)	Fishery (billion Rupiah)	Population (million)	GDP per Capita (Rupiah)
1985	76 602	79 679	57 086	3 291	19 302	1 311	163 367	487.73
1986	78 646	90 014	59 518	3 270	19 687	1 398	166 358	495.77
1987	90 270	94 302	62 655	3 422	20 230	1 484	169 850	530.20
1988	96 454	99 936	75 198	3 570	21 168	1 557	173 415	576.28
1989	103 723	107 321	81 519	3 716	22 086	1 626	177 056	606.14
1990	110 986	115 217	88 879	3 981	22 357	1 745	178 170	646.67
1991	118 746	123 181	96 303	4 215	22 663	1 814	181 384	679.12
1992	126 146	131 102	102 466	4 497	24 139	1 893	184 491	710.61
1993	135 872	139 707	110 241	4 897	24 569	2 053	187 584	751.83
1994	341 676	354 641	261 065	34 285	59 291	5 660	190 676	1 859.91
1995	367 012	383 767	286 594	35 406	61 767	5 974	193 750	1 980.74
1996	402 376	414 419	414 419	36 610	63 743	6 249	196 813	2 105.65
1997	418 418	433 685	433 685	37 724	64 149	6 562	199 837	5 170.20

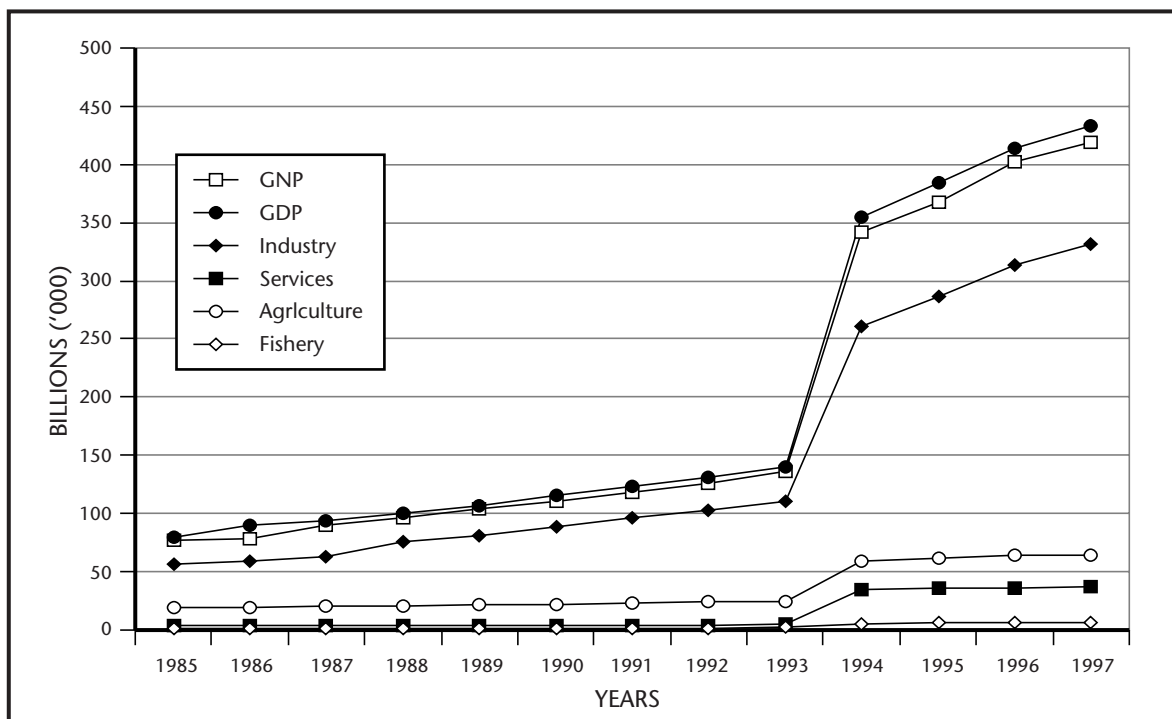


Fig. 2. Contribution to the GNP and GDP by agricultural, non-agricultural and fisheries sectors in Indonesia from 1985 to 1997.

## Gini Coefficient

In 1986, the Directorate General of Fisheries (DGF) studied the Gini Ratio using Lorenz Curves to show the family income distribution of the gillnet and purse seine activities on the north coast of Java. Gini coefficient is a measure of the degree of inequality of a variable (e.g. income) in a distribution of its elements and ranges from 0 where there is no concentration (perfect equality) to 1 where there is total concentration (perfect inequality). Table 4 gives the results of the study suggesting the presence of inequality on the family income distribution for those fishers using purse seine and gillnet.

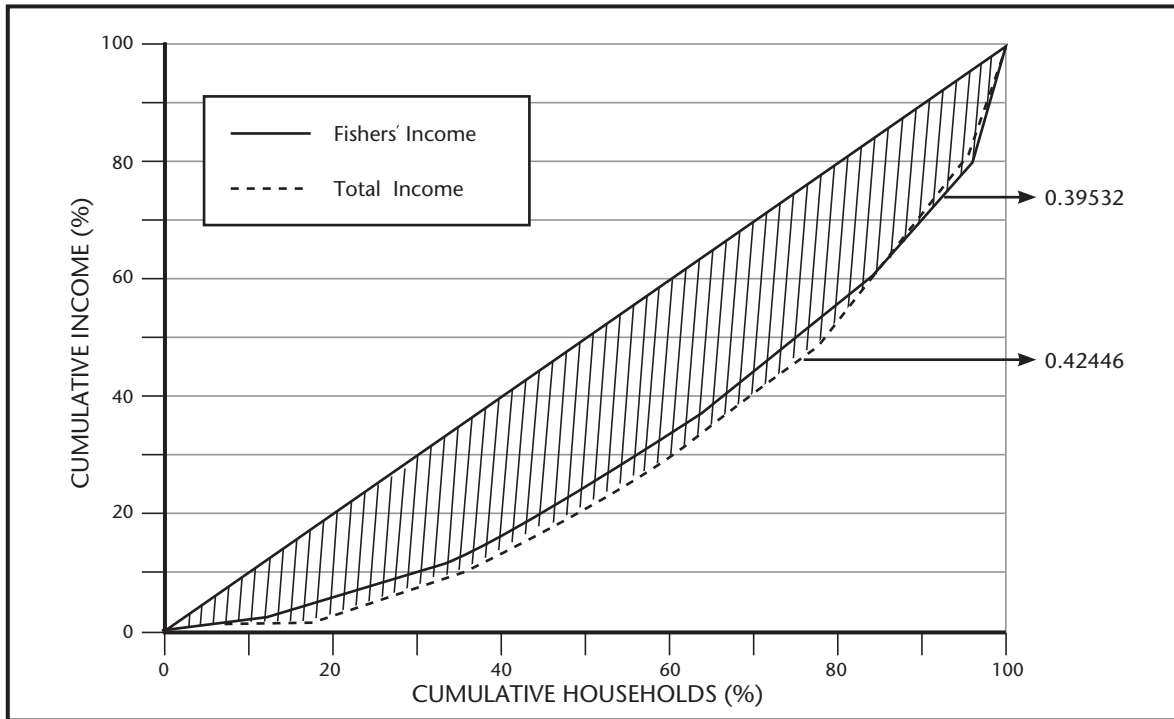
**Table 4. Gini ratio of family income distribution using two types of fishing gear.**

Type of Gear	Gini Coefficient Ratios of Total Income
Purse Seine	0.425
Gillnet	0.371

The main results of the study are given below.

- In Pekalongan, Central Java where there are mostly purse seiners and gillnetters, there is more equal income distribution. A study done in 1988 showed that a Gini Coefficient below 0.40 means a more equal income distribution.
- Purse seine fishers in the northern part of Java operated full time for 6 - 30 days•trip<sup>-1</sup>, either to the South China Sea or to Masalembo-Mata-siri at Makasar Strait in the east. These are medium/semi large scale fisheries and more efficient than gillnetting.
- Fishers using gillnets operate along the coast line for 1 - 6 days•trip on a smaller scale.
- Income distribution between skipper and engineer are more varied for purse seiners.

Lorenz curves for the purse seine and gillnet activities are reported in Figs. 3 and 4.



**Fig. 3. Total fishers' income using purse seine as derived from the Lorenz curve.**

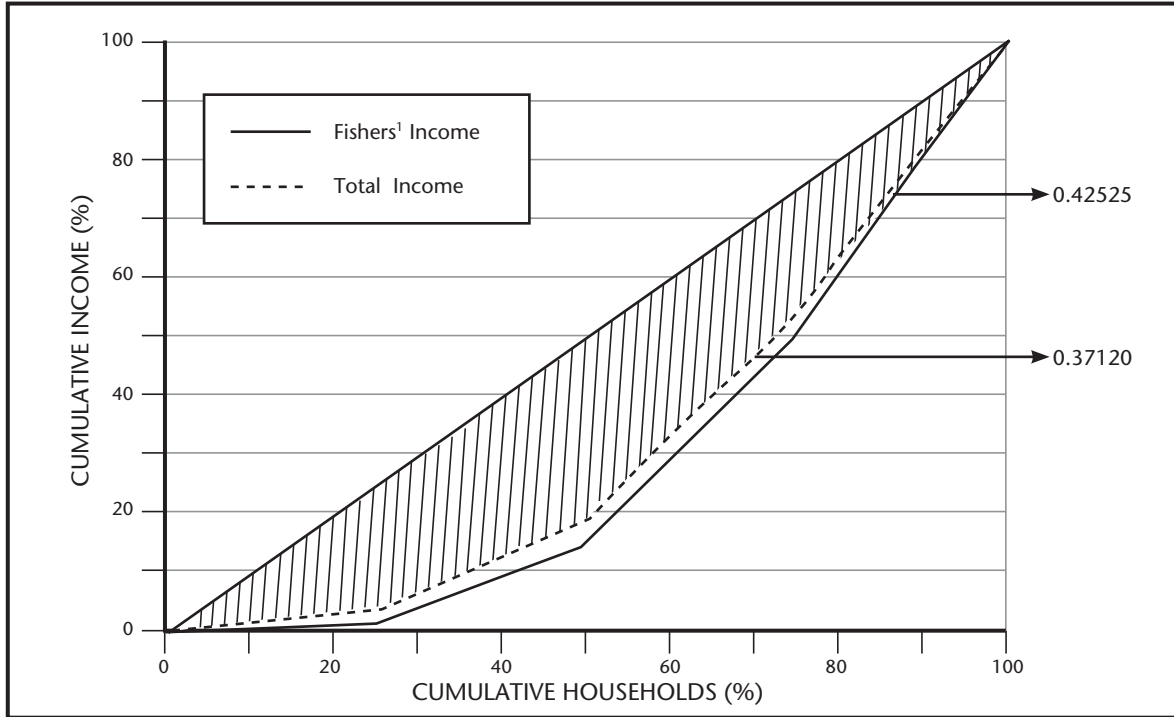


Fig. 4. Total fishers' income distribution using gillnet as derived from the Lorenz curve.

### Volumes and Values of Fish Exports and Imports 1970 - 96

From 1970 to 1996, the balance of trade (BOT) showed a surplus for Indonesia, increasing from US\$5 994 000 (1970) to US\$1 658 827 000 (1996), giving an annual average increase of 10.25%. The foreign exchange earnings (FEE) in 1996 were US\$1 658 827 000.

In 1997, the volume of exports was more than

twice (2.14 times) as large as imports. The biggest share of the imports came from fishmeal at 82.07% and this quantity increased by 26.65% over 1985 to 1994. In terms of values, exports were 17 times higher than imports in 1997. Shrimps (tiger, banana and white species) contributed 16.75% and tuna and skipjack contributed 14% to the total fish exports. The total exports increased at an average rate of 18.25% over 1987 - 96, when shrimp increased an annual rate of 22.52% while tuna and skipjack increased annually by 21.41%.

**Table 5. The quantity and the value of fish export and imports and the balance of trade (BOT) in Indonesia from 1970 to 1996.**

Year	Quantity (t)			Value (US\$'000)		
	Exports	Imports	BOT	Exports	Imports	BOT
1970	2 206	2 801	19 259	6 959	965	5 994
1971	30 756	6 741	24 015	18 994	1 518	17 476
1972	41 156	4 883	36 273	34 941	1 605	33 336
1973	52 178	7 732	44 446	68 185	2 463	65 722
1974	54 953	6 980	47 975	92 344	2 438	89 406
1975	40 738	6 696	34 042	8 891	2 374	85 817
1976	54 389	26 784	27 605	131 380	10 339	121 941
1977	57 510	25 437	32 073	163 018	10 481	152 557
1978	63 485	27 099	36 386	193 424	10 029	183 395
1979	68 264	31 018	37 246	236 827	6 716	230 111
1980	78 705	39 517	39 188	226 354	20 971	505 383
1981	75 178	63 220	11 958	225 387	38 475	186 912
1982	89 629	83 140	6 219	254 416	45 544	208 872
1983	88 365	57 878	30 487	257 048	34 347	222 701
1984	75 695	50 668	25 027	248 063	28 789	219 274
1985	84 497	54 287	30 210	259 444	23 891	235 553
1986	107 443	57 426	50 017	374 113	28 177	345 940
1987	140 378	65 371	75 007	475 523	27 832	447 691
1988	181 218	37 861	143 357	712 199	20 704	691 495
1989	228 590	56 726	171 864	825 125	32 884	792 241
1990	320 241	73 285	246 956	1 039 680	47 684	991 996
1991	409 043	71 552	337 491	1 255 663	52 383	1 203 280
1992	421 367	81 082	340 285	1 263 535	64 688	1 198 847
1993	529 213	177 200	352 013	1 503 748	109 197	1 394 551
1994	545 371	276 829	268 542	1 678 720	136 713	1 542 007
1995	563 065	163 240	399 825	1 783 489	115 917	1 667 572
1996	598 385	154 893	443 492	1 785 799	126 972	1 658 827



## Socioeconomic Analysis of the Artisanal or Large Scale Fishery Sector

The majority of Indonesia's fishing fleet is small scale with a limited capacity to sail offshore, and powered by sails or both sails and engine. The DGF in Indonesia has divided the small scale fishing fleet into three categories.

- a. Dug-out boats (*jukung*) comprised 31.8% of Indonesia's fishing boats in 1993. Most (77%) of these boats were in the eastern part of Indonesia, such as Moluccas, Irian Jaya, Sulawesi and the Lesser Sunda Island.
- b. Three types of non-powered plank-built boats divided into: (i) small (< 7 m in length), (ii) medium (7 - 10 m) and (iii) large (> 10 m). The total number of vessels in this fleet was 57 557 or 14.7% of all Indonesian fishing boats.
- c. Outboard engine boats. Some have modified gasoline or diesel engines mounted along the

side with a long trailing propeller shaft and 2 - 15 HP engines. About 21% of all boats were outboard and 42.9% of all boats were operated in the north coast of Java.

Large scale boats are classified according to the fishing gear used. Commonly used gear in large scale fishing are seine nets, gillnets, traps and other traditional methods, such as shellfish collection, seaweed collection and cast net. The total number for each gear type is shown in Table 6.

In general, a crew of two to three fishers is adequate for most large scale operations, and in some cases vessels are operated alone.

Table 6 provides information on the fishing gear employed in Indonesia. The dominant gear in the large scale fisheries are hook-and-line (40%), gillnet (30.60%), traps (10%), lift-net (5.80%), seine net (5.84%), purse seine (1.34%), shrimp net with BED (0.04%) and other gear (7.37%).

**Table 6. The types of fishing gear and production per gear in Indonesia from 1993 to 1997.**

Type of Fishing Gear	1993		1994		1995		1996		1997	
	Gear (Unit)	Production (t)	Gear (Unit)	Production (t)	Gear (Unit)	Production (t)	Gear (Unit)	Production (t)	Gear (Unit)	Production (t)
1. BED shrimp net	359	56 652	894	79 619	1 449	95 536	1 387	113 596	296	85 667
2. Seine net	38 584	411 549	32 314	380 679	41 662	369 686	37 193	408 437	40 641	467 984
3. Purse seine	8 599	515 291	6 891	611 464	7 300	586 241	7 386	554 573	9 341	637 458
4. Gillnet	183 984	636 795	179 706	685 307	191 079	708 428	183 485	748 414	213 024	813 759
5. Lift-net	45 902	306 889	40 355	294 099	44 025	430 183	42 268	308 215	40 457	359 445
6. Hook-and-line	251 052	511 013	285 082	556 784	269 700	599 091	277 750	640 455	271 321	661 678
7. Traps	47 757	217 090	45 096	221 870	61 722	235 315	16 237	247 062	69 864	249 489
8. Other gear	59 747	231 010	50 484	251 346	52 675	268 450	53 990	363 122	51 332	337 481
TOTAL	635 984	2 886 289	640 822	3 081 168	669 612	3 292 930	619 696	3 383 874	696 276	3 612 961

Source: Directorate General of Fisheries (DGF) 1998.

## Characteristics of the Fishery Labor Force in Commercial Fisheries

### Total Number of Fishers in Indonesia

The fishers population in Indonesia accounts for only 1% of the total labor force and has not changed significantly since 1990. Most of the fishers are working full-time (51.1% in 1997), part-time as major occupation (34.3%), and part-time as minor occupation (14.8%). A combination of fisheries, agriculture and traditional fish processing as a means of livelihood is common in the coastal

villages of Indonesia.

Most fishing households have 4 - 5 family members working in non-fishing activities. In 1997, 49.4% of the fishing population were owners of non-powered boats used for large scale fishing, 22.3% had boats with outboard engines, 16.8% had inboard engines and 11.5% did not have boats. As regards marine fishing, during 1988 - 97, 60.6% of the fishers had non-powered boats, 23.2% owned boats with outboard engines and 16.2% owned boats with inboard engines .

**Table 7. Total number of fishers (full-time and part-time) in Indonesia from 1988 to 1997.**

Year	Total Fishers	Full-time	Part-time	
			Major	Minor
1988	1 417 000	702 000	525 000	191 000
1989	1 464 000	727 000	540 000	197 000
1990	1 524 000	755 000	564 000	205 000
1991	1 633 000	817 000	618 000	198 000
1992	1 742 000	859 000	619 000	264 000
1993	1 890 000	937 000	667 000	285 000
1994	1 850 000	925 000	648 000	277 000
1995	1 958 000	979 000	686 000	292 000
1996	2 055 000	1 037 000	713 000	305 000
1997	2 088 000	1 067 000	717 000	308 000

Source: Directorate General of Fisheries (DGF) 1998.

**Table 8. Total fishing households and fishing population using various fishing vessels in Indonesia from 1988 to 1997.**

Year	Number of fishing households	Without boat	Population per fishing vessels		
			Non-powered boats	Outboard engines	Inboard engines
1988	356 000	53 000	202 000	64 000	37 000
1989	258 000	45 000	208 000	65 000	40 000
1990	380 000	53 000	216 000	69 000	42 000
1991	377 000	44 000	216 000	71 000	46 000
1992	406 000	60 000	225 000	74 000	47 000
1993	426 000	53 000	231 000	90 000	53 000
1994	426 000	57 000	232 000	82 000	55 000
1995	436 000	58 000	228 000	89 000	61 000
1996	450 000	55 000	240 000	90 000	66 000
1997	435 000	50 000	215 000	97 000	73 000

Source: Directorate General of Fisheries (DGF) 1998.

### Effect of Development Interventions, Investment and Other Trends in Coastal Communities

Fishing communities in Indonesia exploit fishery resources in the fishing grounds close to their home base, particularly in the coastal areas. Thus, over-exploitation of fisheries resources in Indonesia is mainly in the Java Sea and Malacca Strait. Fishery resources in the eastern part of Indonesia, mostly in the offshore zone and EEZ, are considered to be under-exploited. Except in the Arafura Sea, where the targeted fishing is shrimp trawling, the fishery resources in the eastern part seem to be very close to over-fishing conditions. Generally, the issues of developing marine fisheries in the eastern part of Indonesia lack human skilled resources, limited availability and capacity of capital and fisheries infrastructure, and a low level of demand. The demand for fish is very high in the western part of Indonesia, especially in Java and Sumatra, contributing to a higher GRDP. The supply of fish is relatively more abundant in the eastern part of Indonesia. This situation creates several problems such as: (1) transportation costs, (very expensive), (2) processing development in the eastern part of Indonesia, (3) lack of infrastructure, (4) insufficient or lack of training and extension and (5) requires more research and development.

The large scale fishing fleet is usually more efficient than the small scale fishing fleet if the target species is a highly valuable fisheries commodity such as shrimp, tuna and skipjack and demersal fishes. The government of Indonesia is exerting efforts to closely manage the coastal fishing zones, but the marine fishery is an open-access one. This is due to ineffective monitoring, and lack of compliance, surveillance and enforcement of regulations. Consequently, there is competition among the various fishing groups, large scale vs. large scale. In most cases, the large scale fishers are the less effective.

The National Scientific Committee on the Assessment of Marine Fishery Resources has studied the level of utilization of fishery resources (Table 10). Other issues on the utilization of fishery resources are functions of recruitment, growth, harvesting and natural mortality.

Deteriorating environmental conditions can reduce recruitment and growth rates and intensify mortality rates. Unfortunately, there is continuous degradation of the environment due to natural occurrences and human interventions that threaten the sustainability of the coastal ecosystem and the fishery resources.

**Table 9. Classification and number of marine fishing boats in Indonesia from 1991 to 1995.**

Indicators	1991	1992	1993	1994	1995	Increasing rate (% per year)
1. Non-powered boat	231 659	229 377	247 745	245 486	245 162	1.49%
Powered boat	123 125	129 529	141 753	150 699	159 491	6.70%
2. Outboard engines	75 416	77 779	82 217	87 749	94 024	5.68%
Inboard engines	47 709	51 750	59 536	62 950	65 467	8.31%
3. Boats according to size						
< 5 GT	35 179	37 913	43 396	45 331	48 855	8.62%
5 - 10 GT	7 391	7 936	9 791	9 604	9 562	7.10%
10 - 20 GT	2 726	3 156	2 812	3 376	2 789	1.89%
20 - 30 GT	909	984	1 558	1 688	1 519	16.23%
30 - 50 GT	738	1 049	1 170	1 869	1 682	25.85%
50 - 100 GT	185	208	351	567	687	40.97%
100 - 200 GT	272	184	213	340	253	4.36%
> 200 GT	309	320	245	175	120	-19.97%
TOTAL	354 784	358 906	389 185	396 185	404 653	3.38%

Source: Directorate General of Fisheries (DGF) 1998.

**Table 10. Maximum sustainable yield (MSY) and production of marine fisheries of Indonesia in 1997.**

Commodities	Resource potential (t)	Total Production (t)	Percentage
1. Small pelagic	3 235.8	1 415	43.73%
2. Large pelagic	1 053.5	364	34.55%
- Tuna	223.7		
- Skipjack	392.5		
- King mackerel	150.5		
- Eastern little tuna	235.1		
- Billfish	51.7		
3. Demersal	1 786.4	1 087	60.85%
4. Shrimp	78.6		
- Penaeid	73.8	70	94.85%
- Lobster	4.8	2	41.67%
5. Squid	28.3	22	77.74%
6. Coral fishes	76.0	93	122.00%
7. Ornamental fishes*	1.5 x 1 000 000	N/A	N/A
TOTAL	6 285	3 803	60.51%

Source: Directorate General of Fisheries (DGF) 1995.

Note: \* Number of individuals; N/A = Not available.

## Fleet Operational Dynamics The State of the Fishing Fleet

The study covered six districts in the northern part of Java. It was based on questionnaires and interviews from the boat owners or the skippers.

Since the declaration of Presidential Decree (Kepres No. 39/80) that banned trawl operations in Indonesian waters, except in the Arafura Sea, many fishers have modified the trawl into traditional gear such as *arad*, *cantrang*, *dogol*, *lampara dasar*, gillnet and others. This traditional gear also captures demersal and bottom fishes and is operated similarly to the traditional trawlers with some modifications.

The socioeconomic variables of demersal fishing were studied in the northern part of Java. Respondents were selected by the type of fishing gear they operate. There were twelve different types of gear for fish, shrimp, molluscs, squid and crabs. These

are (1) shrimp-trawl, (2) *payang/dogol* (Danish seine A), (3) *arad* (Danish seine B), (4) *pukat pantai* (beach seine), (5) *jaring klitik* (monofilament gillnet), (6) *jaring insang tetap* (set gillnet), (7) trammel net, (8) *bagan tancap* (stationary lift-net), (9) *rawai tetap* (traditional long-line), (10) *cantrang* (Danish seine C), (11) mini purse seine, and (12) large purse seine. In every area, at least one to two respondents were chosen for each type of gear. For the shrimp-trawl, data for production efficiency were collected through logbook fisheries in the Arafura Sea.

Stratified random sampling was chosen to include the different qualitative measures between location and technology. Table 11 presents the number of respondents per area. During the study in the northern part of Java, the total samples covered 46 unit vessels. However, these were incomplete data sets that made the cost and return analysis and the production function of demersal fisheries difficult to estimate.

**Table 11. Number of respondents per fishing area in northern Java in 1999.**

Fishing gear	Location							Total
	Indramayu	Pemalang	Pekalongan	Batang	Tuban	Brondong	Arafura	
1. Shrimp-trawl	-	-	-	-	-	-	70	70
2. Danish seine A	1	1	1	1	-	-	-	4
3. Arad (Danish seine B)	1	1	1	1	-	1	-	5
4. Beach seine	1	1	-	1	-	-	-	3
5. Monogillnet	1	1	1	1	1	1	-	6
6. Set gillnet	1	1	1	1	1	1	-	6
7. Trammel net	1	-	-	-	-	1	-	2
8. Stationary lift-net	1	-	-	-	-	-	-	1
9. Traditional long-line	1	1	1	1	1	1	-	6
10. Danish seine	1	1	1	1	1	1	-	6
11. Mini purse-seine	1	1	1	1	1	1	-	6
12. Large purse-seine	-	-	1	-	-	-	-	1
TOTAL	10	8	8	8	5	7	70	116

### Vessels, Engine and the Fishing Grounds

The large scale fishing vessels range between 7 - 34 GT with 10 - 160 HP engines and employ 3 - 10 crew, except beach seines and mini purse seine which are more labor- intensive using 25 - 34 crew members. They mostly fish in the coastal areas of the Java Sea leading to a highly crowded fishing ground. The average total number of boats per gear is nearly 3 959 units or an equivalent of 47 503 units for all fishing gear operating in the northern part of Java. The large scale boats operate for 1 - 12 days/trip at a distance of 1 - 30 miles. The exception is mini purse seine vessels, which sometimes travel up to 60 miles from the fishing-base to capture scads, sardinella, mackerel, trevallies, etc.

A boat's average CPUE (catch per unit effort) (catch/craft/day) is between 90 - 488 kg which is composed of *ikan sebelah* (Indian halibut), *peperék* (pony fishes), *manyung* (sea catfishes), *bambangan* (red snapper), *kerapu* (grouper), *kakap* (giant perch), *tiga waja* (drums), *cutut* (shark), *pari* (rays), *bawal hitam/putih* (black/silver pomfret), *alu-alu* (barracuda), *layang* (scads), *selar* (trevallies), *tembang* (Sardinella), *lemuru* (*Sardinella longiceps*), *kembung*

(Indian mackerel), *tenggiri* (mackerel), *layur* (hair-tails), *tongkol* (eastern little tuna), *rajungan* (crabs), *udang dogol* (*Metapenaeus* spp), *udang putih* (white shrimp), *cumi-cumi* (squids), and *sotong* (cuttle fish).

The large purse seine vessels employ 39 crew members, are constructed of wood, have an average size of 96 GT and have 325 HP engines. These vessels are capable of operating from their Pekalongan fishing-base to the South China Sea (in the west) and Masalembo Island and Makasar Strait in the east. Amazingly, boats are able to capture on the average 32 168 kg·trip<sup>-1</sup>. Thus, with an average per trip of 30 days, CPUE of the large purse seine can be up to 1 072 kg, composed mostly of scads, Sardinella, Indian mackerel, trevallies and others.

The shrimp-trawl represents the large scale fishery using 17 - 18 crew, larger boats of 193 GT and 597 HP engines and are constructed of steel/fiberglass. These vessels are capable of operating from their Ambon and Sorong fishing bases to the Arafura Sea, near Dolak Island at the southern part of Merauke. The shrimp-trawl has the capacity to capture shrimp at an average of 13 772 kg and other fish at 20 657 kg·trip<sup>-1</sup>. Since one trip is equivalent

to 66 days on the average, catch/craft/day of the shrimp-trawl is 522 kg, including shrimp and other fish. Catch composition is mainly *udang dogol* (*Metapenaeus* spp), *udang putih* (white shrimp), *udang windu* (jumbo-tiger prawn), other shrimp and other fish. Log book data from P.T. Dwibina Utama showed that the catch composition covers

19.59% *Metapenaeus* spp, 13.84% white shrimp, 6.58% jumbo tiger prawn and 60% other shrimp and fishes. Tables 12 and 13 show information on the types of fishing gear and its operation and investment costs. The dominant fishing gear and species that are targeted by this gear in northern Java are presented in Table 14.

**Table 12. Types of fishing gear and fishing operations in the northern part of Java in 2000.**

Types of fishing gear	Fishing distance from port (nm)	Man-power	days·trip <sup>-1</sup>	Fishing days ·month <sup>-1</sup>	Fishing months ·year <sup>-1</sup>	Catch (kg)	CPUE (kg)	No. of vessels in Northern Java
1. <i>Payang/Dogol</i> (Danish seine A)	7	8	2	22	11	421	211	5 473
2. Beach seine	1 - 3	25	1	25	10	714	714	701
3. Mini purse seine	60	34	12	22	11	5 850	488	2 968
4. Monofilament-gillnet	7	4	1	25	10	116	116	8 434
5. Gillnet (JIT)	3 - 12	7	4	25	11	360	90	4 464
6. <i>Bagan tancap</i> (Stationary lift-net)	1 - 3	3	1	25	10	114	114	1 244
7. <i>Cantrang</i> (Danish seine C)	3 - 6	7	2	25	11	960	480	2 598
8. Bottom - longline	30	5	7	22	11	655	116	844
9. Large purse seine	100 - 400	39	30	24	10	32 168	1 072	297
10. Shrimp trawl	400 - 500	17 - 18	60	28	10	14 044	234	6306
11. <i>Arad</i> (Danish seine B)	7	5	1 - 3	25	10	371	185	5 473
12. Trammel net	12	10	1	30	10	200	200	14 401

Table 13. Investment costs and details of the fishing fleet operating in Northern Java in 2000.

Types of fishing gear	No. of vessels in Indonesia in 1997*	Average capital investment (in mil Rp)	Length of boats (m)	Tonnage (GT)	HP (PK)	Length of gear (m)	Mesh size (inch)	Fuel (t)	Labor (persons)	Fisher age	Education
1. <i>Payang/Dogol</i> (Danish seine A)	6 173	39.75	9 - 12	5	25 - 30	140 - 200	1 - 1.5	32.25	8	30 - 40	SD, SMP
2. Beach seine	10 268	28.00	9 - 12	5	25	1 500	1 - 1.75	6.37	25	40 - 50	SD, SMP
3. Mini purse seine	24 200	224.00	15	34	160	810	1	76.20	30	25 - 40	SD, SMP
4. Monofilament - gillnet	24 470	15.50	7	2 - 5	12 - 16	750	1.75	3.50	4	40 - 50	SD, SMP
5. Gillnet (JIT)	58 129	45.00	11 - 12	10	65	4 000	3 - 4	27.00	7	30 - 40	SD, SMP
6. <i>Bagan Tancap</i> (Stationary lift-net)	11 738	11.50	6	3 - 4	10	6 x 6	1	1.16	3	40	SD, SMP
7. <i>Cantrang</i> (Danish seine C)	N/A	200.00	13.75	20	100	145	1 - 2	41.50	11	25 - 40	SD, SMP
8. Bottom - long-line	24 710	17.50	8	6	25	2 500	-	9.85	5	25 - 40	SD, SMP
9. Large purse seine	9 341	675.00	25	96	325	500	1 - 2	117.00	39	20 - 40	SD, SMP
10. Shrimp trawl	1 387	4 500.00	26	193	597	27.4+warp	N/A	127.54	17 - 18	20 - 40	SMP, SMA
11. <i>Arad</i> (Danish seine B)	N/A	70.00	11.24	10 - 15	45 - 65	N/A	1 - 1.5	35	5	30 - 40	SD, SMP
12. Trammel net	30 931	N/A	N/A	55	20	N/A	N/A	45	10	40	SD, SMP

Source: \*Directorate General of Fisheries (DGF), 1998; Field studies for Indramayu (West Java), Pemalang - Pekalong-Batayang (Central Java), and Brondong-Tuban (East Java).

1 US\$ = 8,005 Rupiah (source: oanda.com)

Note: N/A = Not available.

**Table 14. Target species captured by various fishing gear in Indonesia.**

Traditional bottom longline	Shrimp trawl	Danish seine	Beach seine	Mini purse seine	Monofilament gillnet and hand line	Gillnet (JIT) and hand line	Danish seine B (Cantrang)	Statutory lift-net	Large purse seine
1. Rays	<i>Metapenaeus</i> spp	Drums	Yellowtail	Scads	Pony fishes	Mackerel	Pony fishes	Pony fishes	Scads
2. Shark	White shrimp	Hairtails	Drums	Indian mackerel	Ray	Giant-perch	Drums	Drums	Indian mackerel
3. Red snapper	Tiger shrimp	Finger scale Sardinella	Rays	<i>Sardinella longiceps</i>	Sea catfishes	Shark	Deep leatherskin	Eastern little tuna	Trevallies
4. Sea catfish	Other fishes	Barred garfish	Squids	Trevallies	Drums	Red snapper	Trevallies	Shark	Shark
5. Groupers		Common window-shell	Common window-shells		Barracuda	Sea Catfish	<i>R. sardines</i>	Hairtails	<i>Sardinella longiceps</i>
6. Hairtails		Rays			Silver pomfrets	Grouper	Squid	Squid	Rainbow Sardines
7. Giant perch		Squids			<i>Metapenaeus</i>		Cuttlefish	Cuttlefish	
8.		<i>Metapenaeus</i>				Rays			
9.		Shark							
10.		Indian halibut							
11.		Black pomfret							
12.		Eastern little-tuna							
13.		Sea catfishes							



A description of the design and operation of each fishing gear is provided below.

a. *Cantrang* (Danish seine C) and *Dogol* (Danish seine A). The design and construction of the gear are similar to *payang* or *pukat kantong* that use an extra sinker. They encircle the fish school, tightening two edges with ropes and winches, which in turn help to pull out the net during adverse weather.

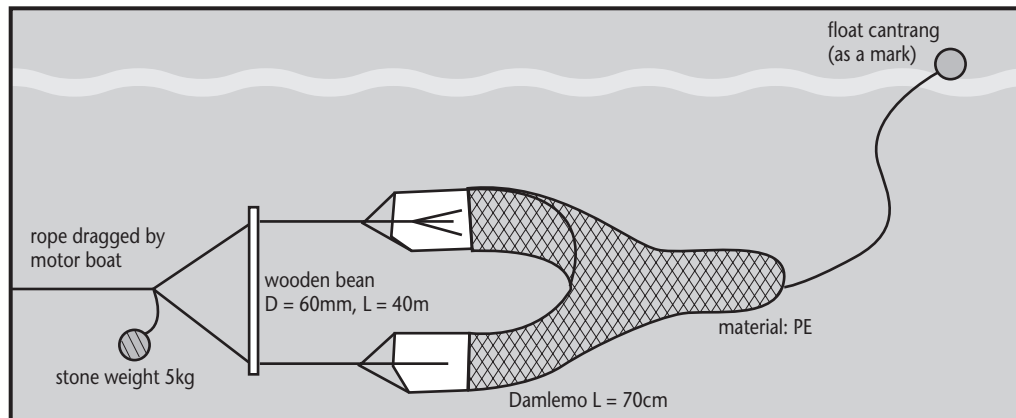
The differences between the trawl operations and the *cantrang* or *dogol* are:

- trawl operations are established in a straight line while *cantrang* or *dogol* encircle the fish school;
- *cantrang* is a modification of *dogol* in which the

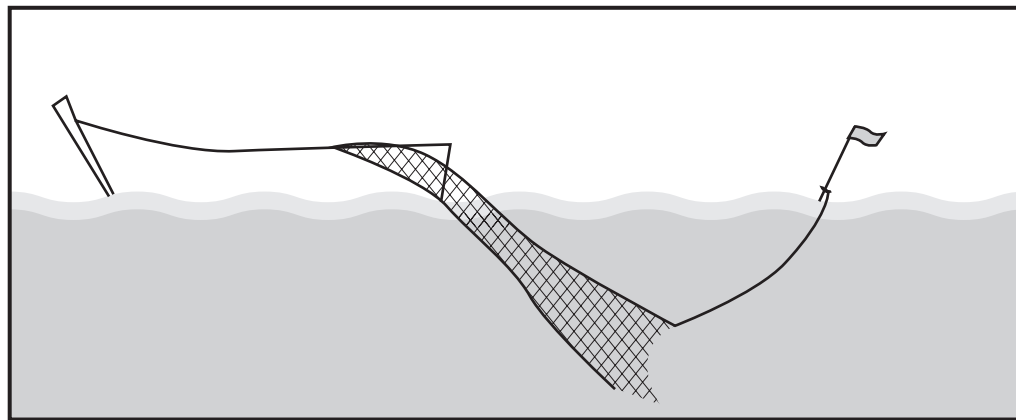
former utilizes small lengths of wood ( $\pm 6$  metre length) such as in the beam trawl operation (Fig. 5 and 6);

- *dogols* have 5.5 - 13 GT and 10 - 18 HP engines while *cantrangs* have 15 - 37 GT with 16 - 40 HP engines. In the northern part of Java, the fishers who construct their fishing boats use teak wood and engines made by Dong Feng (China). Mitsubishi, Kubota, and Yanmar are the most popular brands of engine in the fishing villages but most fishers find their prices too expensive.
- *cantrang* or *dogol* boats use compass (diameter 15 - 25 cm) and winch/capstan; crews consist of skipper, engineer, and crew (6 - 7 persons); and
- fish captured by the *cantrang* or *dogol* include shrimp, *gulamah*, *beloso*, *pepetek*, *kurisi*, squid, red snapper and *bawal putih*.

Fig. 5. Danish seine C (*cantrang*) fishing gear used in Indonesia.

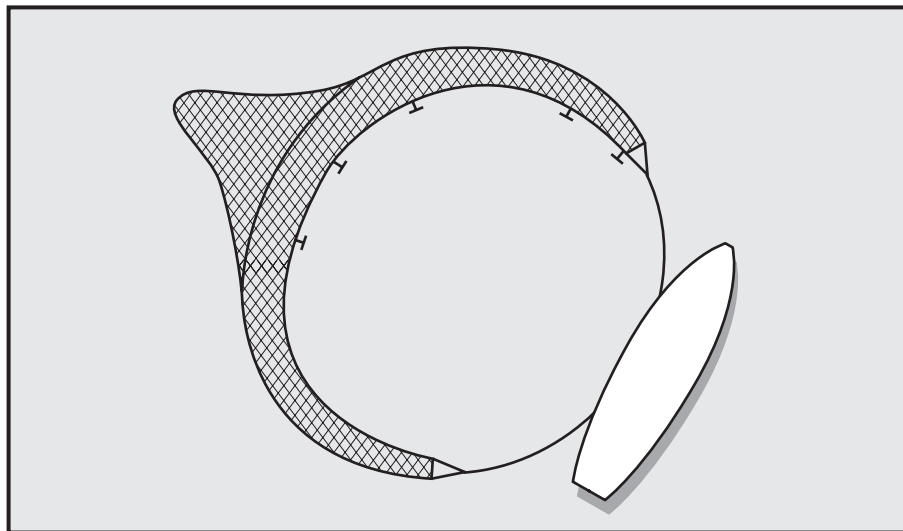


a. assembly of the net.



b. hauling the net

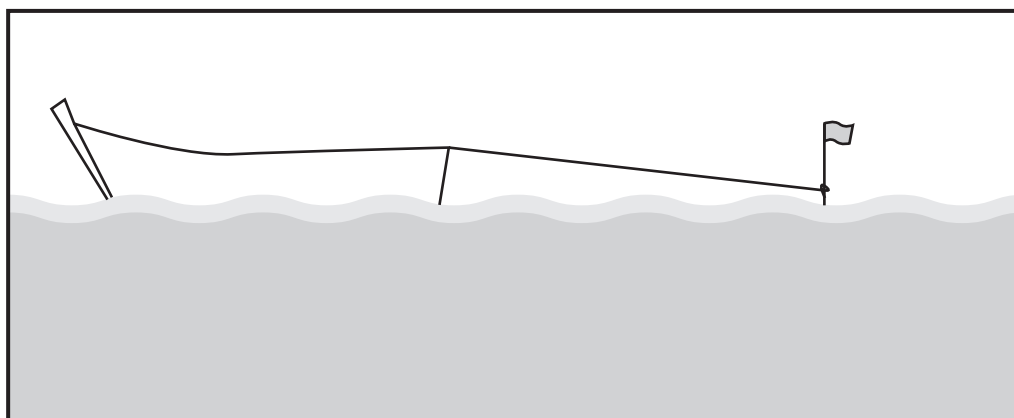
Fig. 6. Danish seine A (*dogol*) encircling the fish school.



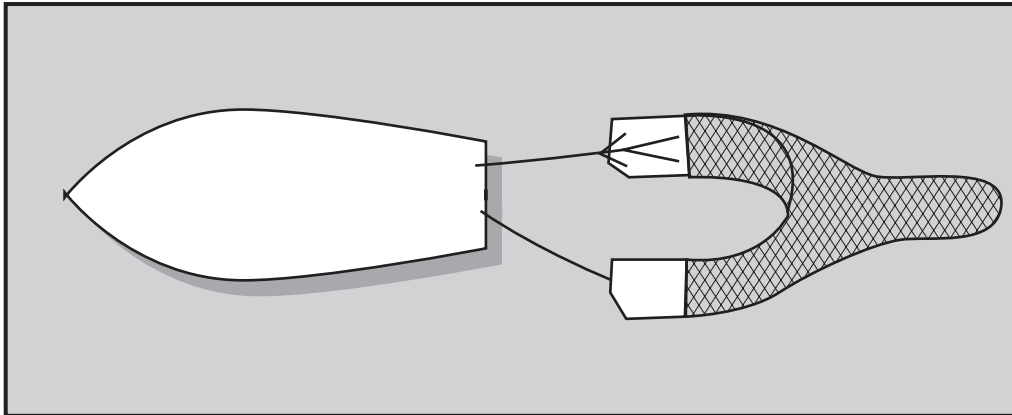
b. *Arad* (Danish seine B). The design and construction of this net is similar to a beam trawl using an extra sinker. When the boat is moving forward, the net will be dredging the bottom thereby capturing the demersal fish (Fig. 7). The size of the vessel is 5.5 - 43 GT with 12 - 25 HP engines (Dong Feng, China) and the body is built of teak. The *arad* boats usually use compass (diameter 12 - 25 cm) and winch/capstan for pulling the net from the water. The fishing team consists of skipper, engineer and crew (5 persons). The species captured by the *arad* are shrimp, *beloso*, *pepetek*, *kurisi*, *kuniran*, halibut, crab and sea cucumber.

c. *Rawai dasar* (Traditional bottom long-line). The design and construction is almost similar to a traditional long-line which is operated at the bottom of the sea. Vessel size ranges from 10 - 42 GT with engines of 10 - 95 HP (Kubota, Yanmar and Mitsubishi) while the body is of teak wood. The *Rawai dasar* uses compass and the fishing team is comprised of skipper, engineer and crew (6 persons). The fish species captured by this fishing gear are red snapper, groupers, *kurisi*, shark, stingrays, *manyung* and others.

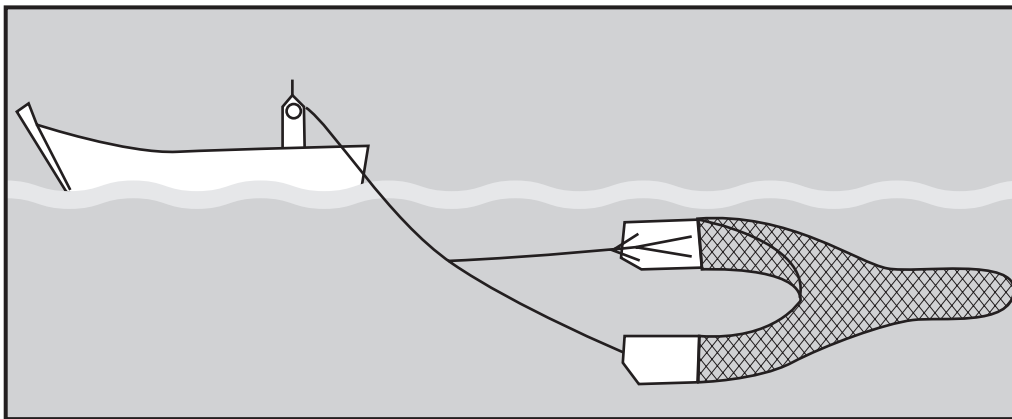
Fig. 7. Danish seine B (*arad*) fishing gear used in Indonesia.



a. Hauling the flag



**b. Hauling the net and otter board.**



**c. Danish Seine B in operation.**

Table 15. Summary of information on fishing gear operated in Indonesia in 1999.

Item	Arad	Cantrang	Dogol	Gillnet	Rawai Dasar
1. Vessel					
a. size (GT)	5.5 - 43	15 - 37	5.5 - 13	18 - 42	10 - 42
b. engine (HP)	12 - 25 (Dong Feng)	16 - 40 (Mitsubishi, Kubota, Yanmar)	10 - 18 (Dong Feng)	25 - 95 (Yanmar, Dong Feng)	10 - 95 (Mitsubishi, Kubota, Yanmar)
c. compass	Merk Seco O 15 - 25 cm	Seico/Honocon	Seico/ Columbus	Seico/ Honokon	Honokon
d. auxiliary gear	Capstan O 20 cm	Capstan O 25 cm	Capstan O 25cm	Capstan	-
e. winch,	-	Winch, SSB	-	Winch, SSB	-
2. No. of crew					
a. skipper	1	1	1	1	1
b. engineer	1	1	1	1	1
c. crew	3	4	5	5	4

## Productivity and Technology Efficiency

Using 92 samples of cross-section data from large- and large scale boats, the Cobb-Douglas production function with the dummy variable for the groups was introduced in order to provide the best-fitted model. The catch per craft per day depends on the following variables: (1) total number of boats/gears operated in the area (JUK), (2) the distance from the fishing ground (JFG), (3) total manpower for each gear (MP), (4) the boat size (GT), (5) the engine size (HP), (6) total volume of fuel consumed (FDAY) and (7) the dummy variable (D1) which captures the differences between large- and small scale boats or the differences between fishing areas or the efficiency differences between gears.

### Cobb-Douglas Production Function

$$\begin{aligned} \text{CPUE} &= 774.78 * \text{JFG}^{-0.1884} * \text{JUK}^{-0.31057} * \\ \text{t-test} & \quad (7.043) \quad (-2.06) \quad (-2.64) \\ & \quad \text{MP}^{0.747386} * \text{RGTHP}^{0.3818} * \\ & \quad (6.69) \quad (2.47) \\ & \quad \text{FDAY}^{0.235585} * \text{EXP}^{0.398295} \text{D1} \quad (1) \\ & \quad (3.54) \quad (1.97) \end{aligned}$$

$R^2 = 0.78$ ; Adjusted  $R^2 = 0.76$ ; F-test = 49.05;  
n = 92; df = 85

where,

CPUE = catch·craft<sup>-1</sup>·day<sup>-1</sup> for all gears; covering two kinds of fisheries namely,

- The shrimp-trawl operated in the Arafura Sea (by assumption) captured 40% shrimp and 60% fish;
- The *payang/dogol*, beach seines, purse seine, monofilament, gillnet, bottom gillnet, trammel net, stationary lift-net (*bagan tancap*), Danish seine C and traditional long-line all operated in the northern part of Java.

JFG = distance of operation between the fishing base to the fishing ground

JUK = total number of boats/gears

MP = total number of manpower/gears

RGTHP = ratio of gross tonnage to horsepower

FDAY = total volume of fuel/day

Dummy variable,

$D_1 = 1$ , if the group is a large scale fishery, using > 30 GT

$D_2 = 1$ , if the group is a small scale fishery, using < 30 GT

Results showed that all variables are statistically significant with F-test at 95% level of significance and an  $R^2$  of 78%. The distance of operations between the fishing base to fishing ground (JFG) and the total number of boats/gears (JUK) show negative results indicating that if the distance from fishing base to fishing ground becomes extensive or farther away, then the catch·craft<sup>-1</sup>·day<sup>-1</sup> will decline. Also an increase in the number of boats operating in the same fishing area reduces the catch·craft<sup>-1</sup>·day<sup>-1</sup>. On the other hand, the total number of manpower/gears (MP), the ratio of gross tonnage to horsepower (RGTHP), total amount of fuel/day (FDAY) and  $D_1$  (dummy variable = 1, if the group is a large scale fishery, using > 30 GT) are positive, denoting that an increase in manpower of 10% increases the catch·craft<sup>-1</sup>·day<sup>-1</sup> by 7.47 t. In addition, an increase in the ratio of GT to HP by 10% raises the catch·craft<sup>-1</sup>·day<sup>-1</sup> by 3.82 t. Similarly, an increase in fuel/day by 10% increases the catch·craft<sup>-1</sup>·day<sup>-1</sup> by 2.36 t. The positive dummy variable indicates that the catch·craft<sup>-1</sup>·day<sup>-1</sup> of shrimp trawl for large scale fishing vessels is greater than that for small scale boats.

From the above model, the two groups of fishing vessels namely, *the large scale boats* (the shrimp-trawl and the large purse seine) and *the small scale boats* (the *payang/dogol*, beach seine, monofilament gillnet, stationary lift-net, *cantrang*, bottom long-line, set gillnet, and mini purse seine) can be separated as follows.

- a. The small scale fishing vessel production function for the average product of effort (CPUE):

$$\begin{aligned} \text{CPUE}_1 &= 774.78 * \text{JFG}^{-0.1884} * \text{JUK}^{-0.31057} * \\ & \quad \text{MP}^{0.747386} * \text{RGTHP}^{0.3818} * \\ & \quad \text{FDAY}^{0.235585} \quad (2) \end{aligned}$$

- b. The large scale fishing vessel production function:

$$\begin{aligned} \text{CPUE}_2 &= 777.28 * \text{JFG}^{-0.1884} * \text{JUK}^{-0.31057} * \\ & \quad \text{MP}^{0.747386} * \text{RGTHP}^{0.3818} \\ & \quad \text{FDAY}^{0.235585} \quad (3) \end{aligned}$$

These two groups of production function show that the slope for all variables is the same while the intercepts differ. Hence, if the individuals use the same number of inputs, the catch·craft<sup>-1</sup>·day<sup>-1</sup> of large scale vessels is greater than the large scale. This may be due to the use of better technology by large scale boats (gross tonnage, horsepower, gear, etc.) compared to small scale.

Both vessel size classes have returns to scale = 0.865881 < 1. This result indicates that both fishing vessels are at the “decreasing return to scale” condition wherein if all inputs of production are increased by 10% then the output of production will increase by less than 10%. This situation is very close to the “flat and mature” condition.

Assuming that the total number of boats (JUK), total number of manpower (MP) and total volume of fuel/day (FDAY) were considered as important variables in the model while others are considered as “*ceteris paribus*”, then using the production efficiency analysis the results will be as follows:

a. large scale fishing vessels

$$\frac{MP_{JUK}}{P_{JUK}} = \frac{MP_{FDAY}}{F_{DAY}} = \frac{MP_{MP}}{P_{MP}}$$

$$\frac{0.10308584}{JUK} = \frac{0.00362438462}{FDAY} = \frac{0.24006472}{MP}$$

$$2.3288 (JUK) = 66.23594 (FDAY) = 1 (MP) \quad (4)$$

b. large scale fishing vessels

$$\frac{MP_{JUK}}{P_{JUK}} = \frac{MP_{FDAY}}{F_{DAY}} = \frac{MP_{MP}}{P_{MP}}$$

$$\frac{0.00207913}{JUK} = \frac{0.00362438462}{FDAY} = \frac{0.08496402}{MP}$$

$$40.87 (JUK) = 23.44 (FDAY) = 1 (MP) \quad (5)$$

c. combination factors of production at optimum condition.

Table 16 shows that the use of some input variables is not optimal in terms of cost and production, i.e. there is not allocative efficiency. In small scale boats, the fuel/day should be increased while the total number of large scale boats operating in the same fishing areas should be reduced. It is possible that the total number of small scale boats has already exceeded the optimal condition. In large scale fishing vessels, the fuel/day should be augmented for the vessels to reach farther fishing grounds while the number of vessels fishing in the Arafura Sea can also be improved to reach optimal use of the fishery resources.

**Table 16. Combination factors for large scale and large scale fisheries in Indonesia.**

Item	Combination factor production			Result
	MP	FDAY	JUK	
a. Large scale boats				not optimal either for small- or large scale fishing fleet
- At optimal condition	1	66.24	2.33	
- Combination input production at this period	1	2.72	354.62	
b. Large scale boats				
- At optimal condition	1	23.44	40.87	
- Combination input production at this period	1	7.76	33.77	

## Costs, Earnings and Profitability

### Investment Costs

In terms of capital investment, shrimp-trawls and large purse seines require the biggest capital investment. Shrimp-trawl, Danish seine B (*arad*), large purse seine and Danish seine C (*cantrang*) are capital-intensive gear. The payback period usually

exceeds 35 months (> 3 years), especially for the shrimp-trawl, gillnet, bottom long-line, Danish seine B (*arad*) and large purse seine gear. Mini purse seine, beach seine, monofilament gillnet and Danish seine A (*payang/dogol*) are less capital intensive and more profitable (benefit-cost ratio higher). The characteristics of each fishing gear are presented in Table 17.

**Table 17. Investment costs of the different fishing boats/gear operated in Indonesia in 2000.**

Boat/Gear	No. of vessels		Capital Investment (in million Rp)	Ratio Capital Productivity	Ratio Capital Intensity (Rp/Craft)	B/C benefit/cost ratio	Payback periods (months)
	Indonesia (1997)	North Java					
1. Danish seine A ( <i>Payang/Dogol</i> )	6 173	5 473	3 975	0.36	2 656	1.48	8
2. Beach seine	10 268	701	2 800	0.78	685	1.53	4
3. Mini purse seine	24 200	2 968	22 400	0.45	3 824	1.66	16
4. Monofilament Gillnet	24 470	8 434	1 550	0.48	2 500	1.53	2
5. Gillnet (JIT)	58 129	4 464	4 500	0.15	3 929	1.41	8
6. Stationary lift-net	11 738	1 244	1 150	0.49	2 639	1.45	6
7. Danish seine C ( <i>Cantrang</i> )	N/A	2 598	20 000	0.51	16 369	1.19	40
8. Bottom long line	24 710	844	1 750	0.28	1 983	1.28	10
9. Large purse seine	9 341	297	67 500	0.35	8 547	1.26	35
10. Danish seine B ( <i>Arab</i> )	N/A	5 473	7 000	0.31	8 167	1.28	36
11. Trammel net	30 931	14 401	N/A	–	–	1.17	–
12. Shrimp trawl	1 387	–	4 500	0.08	69 450	1.30	78

N/A = not available

1 US\$ = 9,725 Rupiah in 2000; source: oanda.com

### Cost Structure

The total variable cost of all operations averages 87.68% of the total cost with 67% for the labor cost. The shrimp-trawl, mini purse seine, Danish seine A and Danish seine B vessels operate at further areas, so that they have higher running costs. The shrimp-trawl, Danish seine B, large purse seine and mini purse seine vessels have higher fixed costs since they have more equipment and engine

to operate. The beach seine, monofilament gillnet, bottom long-line and stationary lift-net have higher labor costs, with the exception of the large purse seine, which usually operates in areas such as Pekalongan/Juwana to the South China Sea in the west and Makassar Strait in the east. The total fixed cost is larger than the running cost for these. Fishing vessels with 96 GT and 325 HP engines may be considered as capital intensive. Table 18 shows the cost structures for each type of fishing gear.

**Table 18. Cost structure for various fishing gear/boats in Indonesia in 1999.**

Items	Fishing Vessel/Gear Indicators										
	Danish seine A	Beach seine	Mini purse seine	Mono filament gillnet	Gillnet (JIT)	Stationary Lift-net	Danish seine B	Bottom Long-line	Large purse seine	Shrimp-trawl	Average
1. Total Variable Cost (%)	94.50	96.26	85.20	93.68	93.60	91.90	85.18	94.22	85.38	57.02	87.68
Running cost	19.38	3.58	23.40	9.25	12.86	14.60	17.64	12.48	12.92	33.10	15.92
Labor cost	70.67	88.13	57.42	79.52	71.20	72.96	63.98	77.92	68.69	20.22	67.07
Share cost	4.45	4.59	14.42	4.63	9.62	4.34	3.56	3.82	3.78	3.70	4.69
2. Total Fixed Cost (%)	5.50	3.71	14.76	6.60	6.32	8.10	14.82	5.78	14.62	42.98	12.32
Total Cost (%)	100	100	100	100	100	100	100	100	100	100	100
In Cash (Rp Million)	141.70	221.21	263.16	58.30	167.58	56.29	226.44	81.85	732.05	3.072	

1 US\$ = 7150 Rupiah in 1999; source: oanda.com

### Earnings and Profitability Cost and Return of Fishing Gear in the Northern Part of Java

Costs and returns of *payang/dogol* (Danish seine A), *pukat pantai* (beach seine), *mini purse seine*, *jaring klitik* (monofilament gillnet), *JIT* (set gillnet), *bagan tancap* (stationary lift-net), *cantrang* (Danish seine C), *rawai dasar* (bottom long-line) and large purse seine were calculated based on the average values of each different gear in the six districts of the study.

The information varies depending on the season (dry and rainy), however the data were gathered during the dry season. If pooling of cross section and time series were available, the result of the analysis would be more accurate.

Financial results of cost-and-return analysis are reported in Table 19. The earnings after tax (EAT) range from Rp 19 000 000·year<sup>-1</sup> for the bottom long-line to Rp 160 890 000·year<sup>-1</sup> for large purse seines. The budget financial analysis was calculated using several assumptions including:

- each fishing vessel has an economic lifetime of ten years and after five years the main engine, auxiliary engine and the gear should be replaced;
- profits diminish by 15% after the sixth year;
- in the tenth year, salvage values are added to the

profit where the salvage value is 10% of the capital investment.

Using the above assumptions, the estimated cash flow can be established (Table 19).

With the exception of *cantrang* (Danish seine type C), all fishing vessels are profitable at the interest rate ( $r$ ) = 27% (Table 20). If the fisheries activities are assumed to have a “medium risk” (risk factor + 10% and the existing interest rate = 27%) then we can conclude that:

1. Danish seine A, beach seine, mini purse seine, monofilament gillnet, set gillnet, stationary lift-net, bottom long-line and large purse seine are profitable and investment feasible (assumption: if boat type is profitable NPV ( $r$  = 27%) should be positive and if feasible the internal rate of return IRR > 37%);
2. Danish seine C is not profitable and thus investment not feasible
3. Payback period (PP) showed that Danish seine A, beach seine, mini purse seine, monofilament gillnet, set gillnet, stationary lift-net and bottom long-line were considered as “quick yielding” while others like large purse seines and Danish seine C need longer time periods to recover capital investment.

**Table 19. Cost-and-return analysis of demersal gear in the northern part of Java in 1999.**

Items	Fishing vessel/gear indicators									
	Payang/ Dogol	Beach seine	Mini purse seine	Monofilament gillnet	Gillnet (JIT)	Bagan tancap	Cantrang	Bottom Long-line	Large purse seine	
1. Total Variable Cost (million Rupiah)	133.91	213.01	224.32	54.45	156.98	51.73	192.89	77.12	625.05	
a. Running cost										
- Fuel and oil	22.99	6.07	53.81	3.28	18.83	1.25	31.63	8.40	79.57	
- Ice	1.89	-	3.63	1.16	2.45	-	2.74	0.70	2.88	
- Other (kerosene, water, daily repairs and administration cost)	2.58	1.84	4.14	0.95	0.27	6.97	5.58	1.11	12.11	
b. Labor cost										
- Total labor (in cash)	73.04	138.32	79.60	35.56	97.68	32.80	116.73	44.62	429.69	
- Total labor (in kind)	9.60	36.00	36.00	4.80	8.58	4.35	8.40	6.00	46.80	
- Food	17.51	20.63	35.50	6.00	13.6	3.92	19.75	13.16	26.36	
c. Share cost										
- traditional taxes and fee	6.30	10.15	11.64	2.70	7.11	2.44	8.06	3.13	27.64	
2. Total Fixed Cost (million Rupiah)	7.79	8.20	38.84	3.85	10.60	4.56	33.55	4.73	107.00	
a. Depreciation cost	5.10	3.95	31.20	2.40	6.60	1.90	27.50	2.38	80.00	
b. Annual repairs and maintenance	2.64	4.20	7.50	1.40	3.90	2.61	6.00	2.35	26.00	
c. Annual fishing fees	0.05	0.05	0.14	0.05	0.10	0.05	0.05	0.05	1.00	
3. Total Cost (million Rupiah)	141.70	221.21	263.16	58.30	167.58	56.29	226.44	81.85	732.05	
4. Total Revenues (million Rupiah)	209.89	338.16	436.82	89.20	236.76	81.39	268.73	104.31	921.33	
5. Gross Profit (million Rupiah)	68.19	116.95	173.66	30.90	69.18	25.10	42.29	22.46	1889.28	
6. EAT	57.96	99.41	147.61	26.27	58.80	21.34	35.95	19.10	160.89	

**Table 20. Economic characteristics of the fishing fleet in Indonesia in 1999.**

Items	Danish seine A	Beach seine	Mini purse seine	Monofilament gear	Danish seine C	Set Gillnet	Statutory Lift-net	Bottom Long-line	Large purse seine
1. EAT	63.06	103.36	178.81	28.67	65.40	23.24	63.45	21.48	240.89
2. NPV (r = 27%)	129.31	244.637	276.74	60.23	(9.90)	133.45	50.39	40.38	66.27
3. IRR (%)	158	369	78	184	25	145	202	122	31
4. Payback-period (mo)	8	16	16	2	40	8	6	10	35



### The Sharing System

The sharing pattern for earnings was almost the same for the different craft-gear, the details of which are provided below.

(Option 1)

Crew share = 50% {Total Revenue - (Running costs + Share costs + Food + Total labor in "kind")}

Owner of gear and vessel gets the same as the crew

(Option 2)

In other places, the crew's share is 40% and the share of the owner of gear and boats is 60%

(Option 3)

For some fishing gear such as Danish seine A (*payang/dogol*), mini purse seine, Danish seine C (*cantrang*) and large purse seine, the owner of the fishing vessel and gear also provides a bonus (5 - 10% out of his share) to the captain and engineer. This is done to show appreciation to the captain and engineer for the profits made each trip. In many areas, after several years of experience on fishing vessels, one can establish oneself as the owner of a brand-new or second-hand fishing vessel.

### Cost efficiency and cost effectiveness of fishing vessels

Using annual cost-and-return data, the B/C ratio analysis shows that all fishing vessel types are profitable. However, this calculation is not made over the entire economic-life of the boat, the engineer, and the gear. The B/C ratio value is calculated only for that year where the present value (NPV), internal rate of return (IRR) and payback period (PP) presented for this study are more favourable than the first. Table 21 presents a comparison of the fishing gear in terms of B/C ratio ("annual"- cost efficiency), NPV (total profit of boat's economic-life time), IRR (profit efficiency of boat's economic-life time) and PP capital recovery). Beach seine, stationary lift-net, monofilament gillnet and Danish seine A are cost- and profit-efficient fishing gear while large purse seine and Danish seine C are not.

Results from this study indicated that the large purse seine and Danish seine C are considered as capital-intensive vessels compared to the others. Also, Danish seine C and beach seine are labor-intensive and capital-productive (Tables 21 and 22).

Together with the set-gillnet and shrimp-trawl, the mini purse seine is the least labor productive in contrast to the Danish seine C, which is the most labor productive. The set gillnet is the least capital productive while beach seines and stationary lift-nets are the most capital productive (Table 23).

**Table 21. Cost efficiency, profit and capital recovery of the various types of fishing gear in Indonesia (in ratio).**

Item	Danish seine A	Beach seine	Mini purse seine	Mono-filament gear	Danish seine C	Set Gillnet	Staturory Lift-net	Bottom Long-line	Large purse seine
B/C analysis	4	2	1	2	9	6	5	7	8
NPV analysis	4	2	1	6	9	3	7	8	5
IRR analysis	4	1	7	3	8	5	2	6	9
PP analysis	4	2	7	1	9	4	3	6	8

**Table 22. Cost efficiency and effectiveness of fishing vessels in Indonesia.**

No.	Type of Gear	Rank	Capital Intensity (Rp)	Cost Effectiveness	
				Catch/TVC	B/C ratio
1.	<i>Payang/Dogol</i> (Danish seine A)	5/4	2 656.00	0.38	1.48
2.	Beach seine	1/2	658.00	0.81	1.53
3.	Mini purse seine	6/1	3 824.00	0.52	1.66
4.	Monofilament gillnet	3/3	2 500.00	0.51	1.53
5.	Gillnet (JIT)	7/6	3 929.00	0.16	1.41
6.	<i>Bagan Tancap</i> (stationary lift-net)	4/5	2 639.00	0.53	1.45
7.	<i>Cantrang</i> (Danish seine C)	9/9	16 369.00	0.60	1.19
8.	Bottom long-line	2/7	1 983.00	0.29	1.28
9.	Large purse seine	8/8	8 547.00	0.41	1.26
10.	Shrimp-trawl	–	69 450.00	–	1.30

**Notes:**

1. Capital intensity = investment per person - day

2. Catch landed per variable cost = Catch/TVC

3. Gross revenues/operating cost = B/C ratios

4. Rank in terms of capital intensity and B/C ratios

**Table 23. Labor and capital productivities from the various types of fishing gear in Indonesia.**

No.	Type of Gear	Labor Productivity (kg/person-day)	Capital Productivity (kg-Rp.1000 <sup>-1</sup> )
1.	<i>Payang/Dogol</i> (Danish seine A)	26.38	0.36
2.	Beach seine	28.56	0.78
3.	Mini purse seine	14.35	0.45
4.	Monofilament gillnet	29.00	0.48
5.	Gillnet (JIT)	12.86	0.15
6.	<i>Bagan Tancap</i> (stationary lift-net)	38.00	0.49
7.	<i>Cantrang</i> (Danish seine C)	68.57	0.51
8.	Bottom long-line	18.72	0.28
9.	Large purse seine	27.49	0.35
10.	Shrimp-trawl	32.50	0.08

### Problems of Discarding by Species

In contrast to other fishing nations, Indonesia has few problems in terms of fish discards, because large scale fisheries do not generate by-products or discards. Most of the fishing gear/boats utilize all the fish captured either for family consumption or for commercial purposes. In the case of sharks captured by the traditional bottom long line and gillnet, the fishers use the shark's skin as snack-crackers, the fins for soup gourmet, the bones for traditional medicine, and the meat is salted and dried. In large scale fisheries, where the fishing gear targets only specific fish species (e.g. tuna-long line and shrimp-trawl), discards present a problem. Fortunately, tuna long-liners operate in the Indian Ocean and the shrimp-trawlers operate in the Arafura Sea.

### Analysis of the Market Structure and Price of Fish

Fish and fishery products are sold mostly at the landing sites with few provisions for the fisher's family consumption, or sold elsewhere. In the landing places, fish are sorted for three purposes: (1) fresh fish for export, demersal fish and other valuable fish; (2) fresh fish transported to fill the demand in the big cities; (3) fish processed traditionally for local consumption (Fig. 8). Traditional fish processing usually includes less valuable fish such as *peperék* (pony fishes), *ekor kuning* (yellow-tail), *tiga waja* (drums), *cucut* (sharks), *pari* (rays), *layang* (scads), *selar* (trevallies), *lemuru* (sardinella), *kembung* (Indian mackerel) and others. The main objective of fish processing is to fill the local demand.

Table 24 presents the cross-section data of catch composition and price of fish using the different types of gear and Table 25 provides the Indonesian and English names of some fish species captured in the northern part of Java.

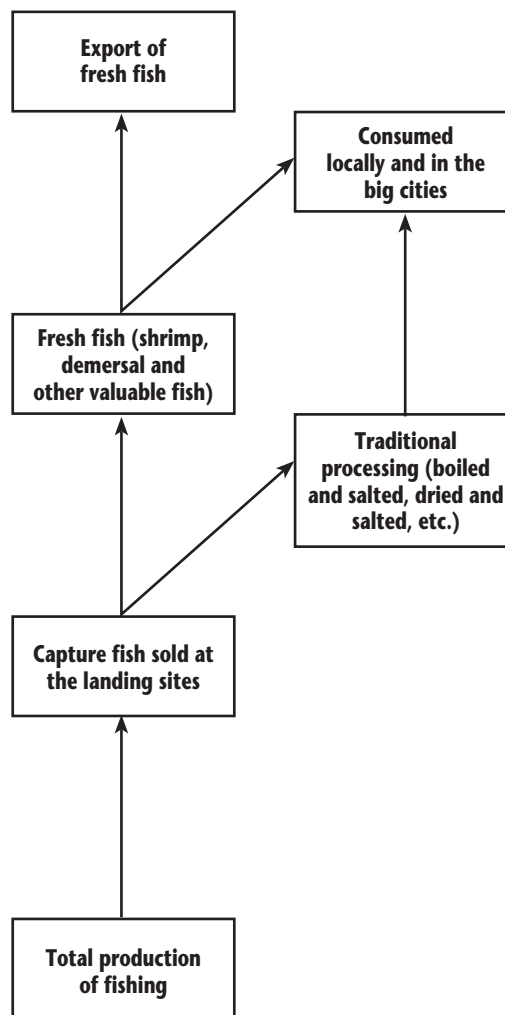


Fig. 8. Marketing system of fish captured in the northern part of Java.

**Table 24. Total catch, catch composition and price of fish by type of fishing gear in Java, Indonesia in 2000.**

Fish Species	Total Catch (t)-Year <sup>-1</sup>									Price of fish (Rp·kg <sup>-1</sup> )
	Payang/Dogol	Beach seine	Mini purse seine	Monofilament gillnet	Gillnet (JIT)	Bagan Tancap	Cantrang	Bottom Long-line	Large purse seine	
<i>Ikan Sebelah</i>	720						2 400			5 000
<i>Ikan Lidah</i>							2 400			5 000
<i>Peperek</i>				7 440		12 480	67 800			1 125
<i>Manyung</i>	480			2 880	500			2 229		5 850
<i>Bambangan</i>					1 532			3 086		8 000
<i>Kerapu</i>					510			2 160		8 850
<i>Kakap</i>					7 950			206		10 650
<i>Ekor Kuning</i>		147 360								1 875
<i>Tiga waja</i>	15 840	12 000		2 880		5 040	12 000			2 075
<i>Cucut</i>	1 680				2 701		6 000	6 034	2 400	4 050
<i>Pari</i>	4 080	9 600		6 000	701		4 680	7 577		2 250
<i>Bawal Hitam</i>	960									6 875
<i>Bawal Putih</i>				1 600					400	8 000
<i>Alu-alu</i>				2 880					800	2 000
<i>Layang</i>			40 000						180 864	3 150
<i>Selar</i>			16 220			1 200			17 600	3 900
<i>Talang-talang</i>						3 120				1 800
<i>Julung-julung</i>	4 800									2 100
<i>Teri</i>						2 400				12 000
<i>Japuh</i>						960			800	2 500
<i>Tembang</i>	5 520									2 500
<i>Lemuru</i>			20 780						4 800	2 000
<i>Kembung</i>	720		40 000						49 440	5 150
<i>Tenggiri</i>					11 685		600		160	10 300
<i>Layur</i>	6 960					240	6 000	1 166		3 250
<i>Tongkol</i>	480						10 920			6 000
<i>Rajungan</i>						480				7 500
<i>Dogol (udang)</i>	2 640									22 000
<i>Simping</i>	2 880	1 200		2 160						5 500
<i>Cumi-cumi</i>	2 880	1 200		1 920		720	2 400		80	7 300
<i>Sotong</i>						720				8 000
<b>TOTAL</b>	<b>50 640</b>	<b>171 360</b>	<b>117 000</b>	<b>27 760</b>	<b>25 534</b>	<b>27 360</b>	<b>115 200</b>	<b>22 458</b>	<b>257 344</b>	

1 US\$ = 9725 Rupiah in 2000. Source: oanda.com

**Table 25. Indonesian and English names of some fish species in Northern Java.**

No.	Indonesian Name	English Name
1.	<i>Ikan Sebelah</i>	Indian halibuts
2.	<i>Ikan Lidah</i>	Fourlined tongue sole
3.	<i>Petek/Peperek</i>	Pony fishes, ship mounts
4.	<i>Manyung</i>	Sea catfishes
5.	<i>Bambangan</i>	Red snapper
6.	<i>Kerapu</i>	Grouper
7.	<i>Kakap</i>	Giant perch
8.	<i>Ekor Kuning</i>	Yellow tail
9.	<i>Tiga waja</i>	Drums
10.	<i>Cucut</i>	Shark
11.	<i>Pari</i>	Rays
12.	<i>Bawal Hitam</i>	Pomfret black
13.	<i>Bawal Putih</i>	Pomfret silver
14.	<i>Alu-alu</i>	Barracuda
15.	<i>Layang</i>	Scads
16.	<i>Selar</i>	Trevallies
17.	<i>Talang-talang</i>	Deep leatherskin
18.	<i>Julung-julung</i>	Berred garfish
19.	<i>Teri</i>	Anchovies
20.	<i>Japuh</i>	Rainbow sardines
21.	<i>Tembang</i>	Fringescale sardinella
22.	<i>Lemuru</i>	Sardinella
23.	<i>Kembung</i>	Indian mackerel
24.	<i>Tenggiri</i>	Mackerel
25.	<i>Layur</i>	Hair tails
26.	<i>Tongkol</i>	Eastern little tuna
27.	<i>Rajungan</i>	Swimming crabs
28.	<i>Dogol (udang)</i>	Crustacea ( <i>Metapenaeus</i> )
29.	<i>Simping</i>	Common window shell
30.	<i>Cumi-cumi</i>	Squids
31.	<i>Sotong</i>	Cuttlefish

## Bioeconomic Analysis of Demersal Fishing in the Northern Part of Java

### Rationale - Bioeconomics Concepts: Optimal Utilization of the Fishery Assets

The best use of fishery resources as economic assets was determined. Based on Surplus Yield models (Schaefer, 1954), there is a certain natural increase  $F(x)$  for each level of biomass, and the expression  $X(t)$  represents the biomass at time  $t$  (see Equation 1).  $F(x)$  may also be interpreted as the natural surplus production and is positive for  $0 < x < k$ , where  $k$  is the natural carrying capacity of the aquatic environment.

$$\frac{\partial x}{\partial t} = F(x) \quad (1)$$

In accordance with capital theory,  $F(x)$  may be interpreted as the rate of investment in the stock of natural capital. Biological equilibrium is the condition where  $F(x) = h(t)$  and  $h(t)$  is the rate of withdrawal due to fishing. Hence, the basic resource management problem is to determine the rate of withdrawal,  $h(t)$ , that will optimize the benefits from the fishery resources. To do this, assume a specific form of the harvest function by employing the model below. Equation (2) is the sustainable yield equation which implies the equality of  $Y_t$  and  $F(x)$ .

$$Y_t = a E_t - b E_t^2 \quad (2)$$

where

$E_t$  is the fishing effort per unit time

$Y_t$  is the corresponding catch or yield from the resource or the rate of harvest

The Schaefer model implies that yield increases with fishing effort until it reaches a maximum, and then declines as effort is further increased. The Schaefer model may be transformed into the following form:

$$(Y_t / E_t) = \text{CPUE} = a - b E_t \quad (3)$$

Equation (3) means that the CPUE (catch per unit effort) is a linear function of effort where maximum yield is,

$$E_{t(\text{msy})} = \left\{ \frac{a}{2b} \right\} \quad (4)$$

$$Y_{t(\text{msy})} = a \left\{ \frac{a}{2b} \right\} - b \left\{ \frac{a}{2b} \right\}^2$$

Suppose a (constant) price of output,  $p$ , cost of fishing effort,  $c(E_t)$  and net return from the use of the resources may be represented by fishing profits,  $\pi$ .

$$\pi = p \cdot (a E_t - b E_t^2) - c(E_t)$$

The optimal rate of harvest may be denoted by,

$$\frac{\partial \pi}{\partial E_t} = p \cdot (a - 2 b E_t^*) - c = 0 \quad (5)$$

The value of  $E_t^*$  is the optimal fishing effort that maximizes the differences between marginal revenues and marginal costs of effort. However, this will only occur if the fisheries resource is dictated by “sole owner” conditions, wherein the individual chooses the level of effort that will maximize profits. In reality however, fisheries resources are open-access. This Open-Access Equilibrium can be denoted by Equation (6).

$$\pi = p \cdot (a E_t - b E_t^2) - c(E_t) = 0 \quad (6)$$

The value of  $E_t^{(QAE)}$  is the level of fishing effort at open-access equilibrium where the profit from the fishery is zero or at “break-even point” (BEP).

## Objective

When the goal of sustainable fishery management is to maximize the yield of the resource where the state of *responsible fisheries* occurs, then the society will choose  $E_{t, (MEY)} < E_{t^*, (existing)} < E_{t, (msy)}$ , this  $E_{t^*, (existing)}$ . This represents the precautionary approach where management approaches can be applied in two situations. Firstly, control can be applied to the total amount of effort at  $E_{t^*, (existing)}$  to retain the yield at a sustainable level for the future or secondly, the total amount of effort at  $E_{t^*, (existing)}$  that will maximize the profits can be limited. In other words, the  $E_{t^*, (existing)}$  will ensure that both yield and profit are at a sustainable level.

The participation of the government and the community through community-based fishery management and other schemes is important in order to attain the above conditions. When  $E_{t^*, (existing)}$  is known, policies and regulations should be established by the government. These policies should then be applied to all sectors involved in the fishing industry. Furthermore, monitoring, control, surveillance (MCS) and enforcement should be developed to prevent illegal fishing.

## Review of the Fisheries Legal Environment

In order to attain the objectives of fisheries management, the government of Indonesia has issued several laws and regulations, namely:

1. Act No. 9, 1985 - enacted to deal with all aspects of fisheries;
2. Ministerial Decrees No. 277, 1986 on fishing permits in Indonesian waters and EEZ;
3. Presidential Decrees No. 39, 1980 on banning the use of trawls from Indonesian waters;
4. Presidential Instruction No. 11, 1982 on extending the trawl ban throughout all Indonesia waters except the Arafura Sea;
5. Ministerial Decree No. 995/Kpts/Ik-210/0/1999 on potential of the resources and total allowable catch (TAC) in Indonesian waters;
6. Ministerial Decree on Monitoring, Controlling, Surveillance and Enforcement;
7. Ministerial Decree on fishing zones for Indonesian waters.

The results of this study, together with the application of the laws and regulations including the MCS and enforcement, will support fisheries management of demersal resources, so that their health and sustainability is maintained.

## Framework and Estimation Model Specification

Application of the surplus yield production model will correspond to three specification models that can be used to determine the sustainable use of fishery resources.

1. (Schaefer, 1954) Model  
 $Y_t = a_1 E_t - a_2 E_t^2$
2. (O'Rourke, 1971) and (Anderson, 1977)  
 $(Y_t / E_t) = CPUE = b_1 - b_2 E_t + b_3 T$
3. (Fox, 1970) and (Pauly, 1984)  
 $\ln CPUE = c_1 - c_2 E_t$

where  $a$ ,  $b$  and  $c$  are parameters to be estimated

**Data: Catch-effort of Traditional Gear (Using Standard Effort Of Danish Seine A):**

The time series data of catch-effort using Danish seine A (*payang/dogol*) is presented in Table 26, together with information of the demersal species from 1977 - 1995 using traditional gear like Danish seine B (*arad*), bottom long-line, set gillnet (*jaring insang tetap*) and beach seine (*pukat pantai*) from the regional statistics offices in West Java, Central Java and East Java. This showed that from the average CPUE per gear, the fishing power index (FPI) was as follows: (a) Danish seine A = 1, (b) Danish seine B = 0.822071, (c) set gillnet = 0.242506, (d) bottom long-line = 0.330667 and (e) beach seine = 16.077598.

**Model Estimation**

Following (Schaefer, 1954), the surplus yield production with a quadratic function was estimated to be:

$$Q_t = 0.092729 E_t - 0.000000033321 E_t^2$$

t-ratio: (3.74) (-2.35)

$$+ 5188.068 T \text{ (a)}$$

(6.80)

$$R^2 = 0.77; F\text{-test} = 26.82$$

where,

$Q_t$  = total catch of Danish seine A in time  $T_t$  (t·year<sup>-1</sup>)

$E_t$  = total effort of Danish seine A in time  $T$  (units·year<sup>-1</sup>)

$T$  = time trend to capture the other variables that were not available in the database

Comparison among the three models namely, (1) the linear CPUE model by (O'Rourke 1971) and (Anderson 1977), (2) the exponential function by (Fox 1970) and (Pauly 1984) and (3) the quadratic function by (Schaefer 1954), indicates that the Schaefer model has the best linear unbiased estimator (BLUE) characteristics. The Schaefer model is statistically significant at 95% confidence levels for t-test and F-test (partial and joint significant test). The algebraic sign of each variable is theoretically sound. The model also shows no serial auto-correlation by the Durbin Watson test (a test statistic designed to detect errors). Therefore, this model is statistically acceptable for further economic analysis.

**Table 26. Catch and effort data of traditional gear in the northern part of Java in 1977 - 95.**

Year	Total standard effort using dogol (fishing trip days)	Total yield (t)	CPUE (kg·trip <sup>-1</sup> ·day <sup>-1</sup> )
1977	1 503 209	78 613	52.30
1978	1 247 665	87 665	70.26
1979	1 853 206	100 033	53.98
1980	1 534 702	104 790	68.28
1981	1 545 191	77 602	50.22
1982	1 144 009	92 306	80.69
1983	1 511 106	86 080	56.97
1984	1 563 211	86 821	55.54
1985	1 615 316	92 10	57.21
1986	1 881 144	98 189	52.20
1987	1 679 298	112 023	66.71
1988	1 477 452	111 045	75.16
1989	1 110 388	112 034	101.81
1990	1 275 347	125 777	98.62
1991	1 184 138	134 047	113.20
1992	1 180 475	143 125	121.24
1993	1 069 277	168 233	157.34
1994	1 473 618	179 538	121.84
1995	1 342 004	186 195	138.75

**Source: Directorate General of Fisheries (DGF), 1998.**

**Note: dogol = Danish seine A**

From the model (a) the total effort and total yield can be calculated at maximum sustainable yield (MSY) as follows,

$$E_{t(msy)} = 1\ 391\ 434 \text{ trip-days of Danish seine A/annum}$$

$$Q_{t(msy)} = 116\ 187 \text{ t·year}^{-1}$$

The total allowable catch (TAC) and the important point where the code of conduct for responsible fisheries (CCRF) can be allocated according to the precautionary approach is estimated at,

$$E_{t(TAC)} = 1\,252\,291 \text{ trip-days of Danish seine A/annum}$$

$$Q_{t(TAC)} = 115\,542 \text{ t}\cdot\text{year}^{-1}$$

On average 5 218 units of Danish seine A can operate for 240 days annually in the northern part of Java.

The open-access equilibrium (OAE) point is where the total revenue equals total cost of Danish seine A operation, or where there is an absence of economic profit. The calculated result was as follows,

$$E_{t(OAE)} = 1\,435\,746 \text{ trip-days of Danish seine A/annum}$$

$$Q_{t(OAE)} = 116\,122 \text{ t}\cdot\text{year}^{-1}$$

At open-access equilibrium, there would be 5 982 units of Danish seine A gear operating in the area.

The optimum economic yield (OEY) point can be found whenever the marginal revenues equal the marginal cost of effort for the Danish seine A operation. Suppose the price of fish that was captured by Danish seine A is on the average equal to Rp 7 300 000·t<sup>-1</sup>. The average cost of effort is the total cost per boat (or the opportunity cost of the vessel) divided by the total trip-days per boat. Annually, this equals Rp 590 416.67·trip-day<sup>-1</sup>.

$$TC = 590\,416.67 * E t$$

$$TR = 7\,300\,000 * Q t$$

The result will be,

$$E_{t(OEY)} = 67\,108.3 \text{ t annually}$$

$$Q_{t(OEY)} = 177\,812 \text{ trip-days of Danish seine A}$$

Where

TC = total cost

TR = total revenue

### Analysis of Management Objectives and Schemes

a. The relationships between total allowable catch (TAC) with maximum sustainable yield (MSY)

and optimum economic yield (OEY) with open-access equilibrium (OAE) are given below.

- Table 27 explains the relationship between these points (OEY, TAC, MSY and OAE), the changes of total yield, total effort, total number of vessels (standard *dogol*), which is calculated from total effort divided by total trip-days/boat annually, CPUE, the changes of profit/boat annually and the changes of profit after income taxation and ad valorem taxation in each condition.
- Fig. 9 explains the relationships between total yield, total effort, marginal cost (derived from the derivative of cost to quantity) and average cost (derived from total cost divided by quantity).

Results of the calculations can be seen in Table 28. Prior to 1988, the total amount of effort is relatively high, so that on many occasions the mean total effort is larger than total effort at MSY or OAE level. In the last five to eight years, the total amount of effort has been smaller than E<sub>t</sub>, MSY.

b. Suppose income taxation of 2.5 % is introduced, then theoretically the result will be,

$$\pi = (TR - TC) * (1 - 0.025)$$

The producer should not pay tax if the firm experiences loss of profits. If the price of output is a fixed number, then the output will not change when a tax is introduced.

c. Suppose an ad valorem tax of 2.5 % is introduced, then theoretically the outcome will be,

$$\pi = TR * (1 - 0.025) - TC$$

The producer should pay the tax even though the firm has experienced loss of profits. If the price of output was estimated through the demand function where the 'price' and 'output' fluctuated continuously, then whenever a tax is introduced by the government, the price of output will increase and the quantity of output will decline. The ad valorem tax has a bigger impact since increasing price will reduce the total quantity of supply and profits of the industry. Therefore, in the long run, the producer will reduce the total amount of effort. The result can be seen in Table 27.

d. Suppose there are several changes in the "existing total effort". Alternative 1 will be when the existing total effort (E<sub>t, existing</sub>) is the mean of total effort during 1977 - 95. Alternative 2 is



when  $E_{t, \text{existing}}$  is the mean of total effort for the last ten years (1985 - 95). Alternative 3 is when the  $E_{t, \text{existing}}$  is the mean of total effort for the last five years (1990 - 95). Alternative 4 is whenever the  $E_{t, \text{existing}}$  is the mean of total effort for the last five years - given income taxation at 20%.

Results from Table 27 show that:

- i. profit after income taxation declined up to the point where  $E_{t, \text{OAE}}$  is approaching and at  $E_{t, \text{OAE}}$  profit has disappeared;
- ii. at  $E_{t, \text{existing}} > E_{t, \text{OAE}}$ , (Alternative 1), the industry suffers from loss of profits;
- iii. profit after ad valorem taxation will place more burden on the industry. The calculation shows that “profit after income taxation” has a bigger impact compared to “profit after ad valorem taxation”. For example, at  $E_{t, \text{OAE}}$ , profit after income taxation was zero but ad valorem taxation reduces the zero profit to Rp 3 540 785. Comparing Alternatives 3 and 4, if the income taxation level increases to 20% then the result of “profit after income taxation” will be equal to “profit after ad valorem taxation”.

The fishing industry would be better off if the government introduced income taxation rather than ad valorem taxation.

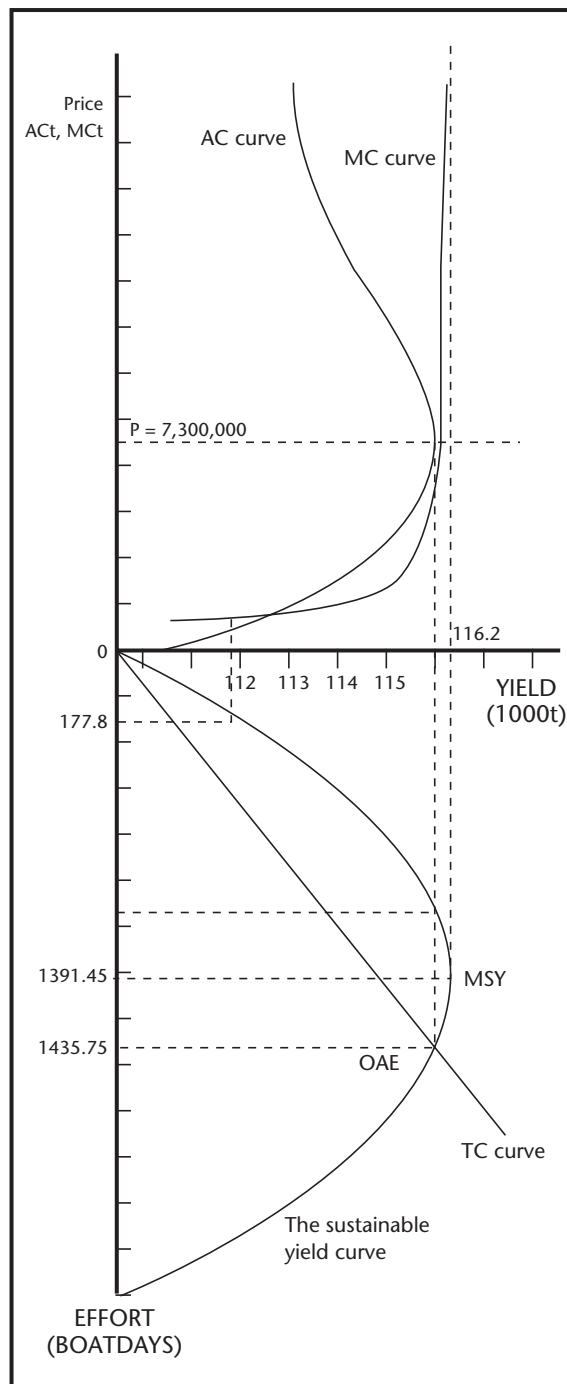


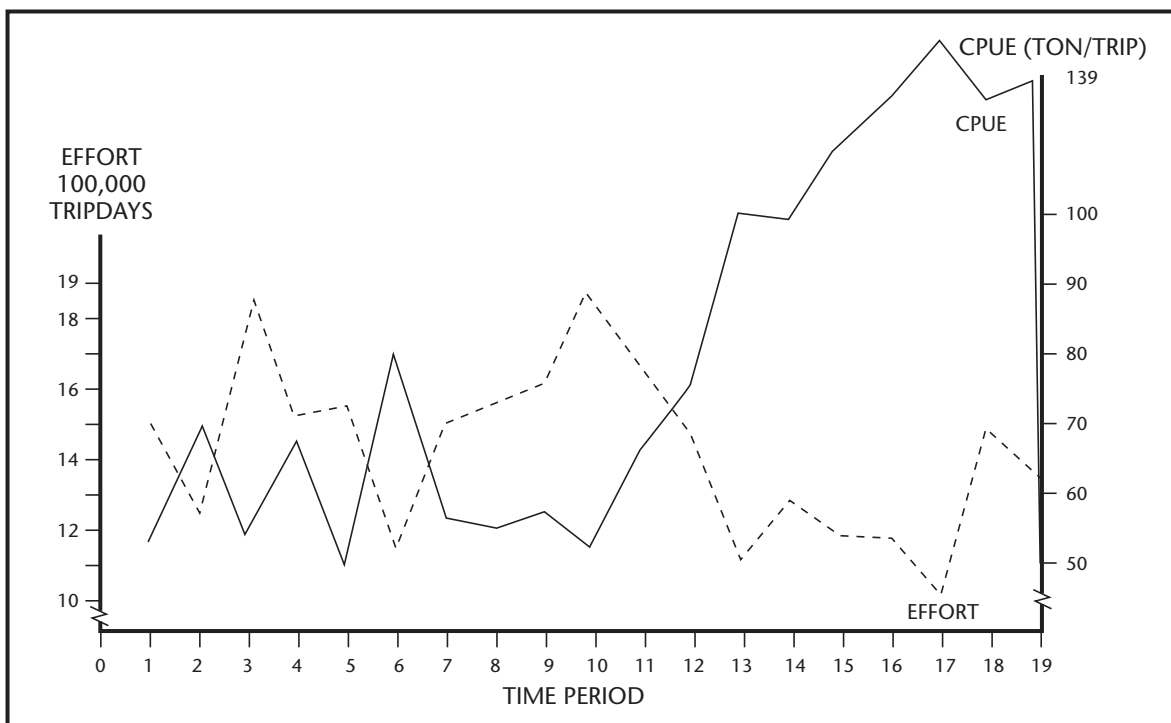
Fig. 9. Relationship between efforts, yield,  $MC_t$ ,  $AC_t$ ,  $P_t$ .

**Table 27. The relationship between MSY, OEY, and OAE points.**

No.	Items	Qt (t-year <sup>-1</sup> )	Et (trip-days)	Total number of boats (units)	CPUE (kg-trip-day <sup>-1</sup> )	Profits* boat <sup>-1</sup> -year <sup>-1</sup> (Rp )	after 2.5% taxation*	
							Income taxation (Rp )	Ad valorem taxation
1.	Optimum Economic Yield (OEY) points	67 108.30	177 812	3 568	377.41	519 522 054	506 534 003	502 991 761
2.	Total Allowable Catch (TAC)	115 543	1 252 305	5 218	92.27	19 946 991	19 448 316	15 915 613
3.	Maximum Sustainable Yield (MSY)	116 188	1 391 450	5 798	83.50	4 594 423	4 479 563	934 699
4.	Open Access Equilibrium (OAE)	116 122	1 435 746	5 982	80.88	-	-	(-3 540 785)
5.	Existing Total Effort	114 554	1 435 882	6 058	78.79	(-3 656 743)	0	(-7 110 923)
	(Alternative 1)	116 168	1 367 315	5 697	84.96	7 149 919	6 971 171	3 428 671
	(Alternative 2)	115 520	1 249 903	5 208	92.42	20 219 839	19 714 434	16 171 843
	(Alternative 3)	115 520	1 249 903	5 208	92.42	20 219 839	16 171 843**	16 171 843
	(Alternative 4)							

\* Assuming price of output ( $P_{qt}$ ) and AC of effort, or q is a fixed number; calculation, results, using the Schaefer model, data price of output ( $P_{qt}$ ), average cost of effort (q).

\*\* When approaching alternative 3 with 20 % income taxation.



**Fig. 10. Relationship of CPUE and Effort to Time period.**

**Table 28. The relationships between effort, yield,  $MC_t$ , AC and P.**

No.	Total effort (1 000 trip-days)	Yield (t)	$MC_t$	AC	P	Items
1.	177.81	67 108.3	7 299 963	1 564 370	7 300 000	OEY
2.	1 069 30	112 729	27 499 375	5 600 445	7 300 000	$E_v$ '93
3.	1 110 39	113 555	31 519 667	5 773 350	7 300 000	$E_v$ '89
4.	1 144 00	114 147	35 801 104	5 917 253	7 300 000	$E_v$ '82
5.	1 180 48	114 705	42 001 570	6 076 240	7 300 000	$E_v$ '92
6.	1 249 90	115 520	62 593 469	6 388 174	7 300 000	Average $E_v$
7.	1 252 31	115 543	63 700 474	6 399 217	7 300 000	TAC
8.	1 391 45	116 188	Infinity	7 070 741	7 300 000	MSY
9.	1 435 75	116 122	Negative	7 299 98	7 300 000	OAE
10.	1 503 21	115 771	Negative	7 666 171	7 300 000	$E_v$ '77
11.	1 545 19	115 771	Negative	7 880 263	7 300 000	$E_v$ '81
12.	1 615 32	114 517	Negative	8 328 125	7 300 000	$E_v$ '85
13.	1 679 30	113 426	Negative	8 741 255	7 300 000	$E_v$ '87
14.	1 853 21	109 082	Negative	10 030 675	7 300 000	$E_v$ '79
15.	1 881 15	108 197	Negative	10 265 186	7 300 000	$E_v$ '86

Following (Anderson 1977),  $MC_t$  can be calculated as,

$$\begin{aligned}
 MC_t &= \frac{q}{\{(b)^2 - 4 * (a) * (c)\}^{1/2}} \\
 &= \frac{590\,416.67}{\{(0.092\,729)^2 - 4(0.000\,000\,033\,321 * (Q_t - 51\,673.67))\}^{1/2}} \\
 &= \frac{590\,416.67}{\{(0.008\,598\,667\,441) - 0.000\,000\,133\,284 * (Q_t - 51\,673.67)\}^{1/2}}
 \end{aligned}$$

$$AC_t = \frac{TC}{Q_t} = \frac{590\,416.67 * E_t}{0,092\,729 E_t - 0,000\,000\,033\,321 E_t^2 + 518\,80.67 T}$$

### Comparison with Other Demersal Resource Potential Studies

- a. At a similar location in the northern part of Java and southern Kalimantan, studies conducted by Martosubroto et al. (1997) and Badrudin et al. (1997) showed similar results. In the northern part of Java  $Q_{t,(msy)} = 116\ 187\ t \cdot year^{-1}$  with an average landing of 115 520 t while the  $E_{t,(msy)} = 1\ 391\ 450$  trip-days and the average total effort equals 1 249 903 trip-days (Alternative 3). These figures indicate that the demersal fisheries in the northern part of Java are still below the MSY level where the  $E_{t,OAE} > E_{t,MSY} > E_{t,existing}$ . These conditions imply that demersal fisheries in the northern part of Java was still profitable since  $E_{t,existing} < E_{t,OAE}$ . Given the 2.5% income taxation level, annual profit/boat equals Rp 19 714 343, and at the 2.5% ad valorem taxation level, annual profit/boat declines to Rp 16 171 843.
- b. Other studies done by Martosubroto et al. (1997) and Badrudin et al. (1997) illustrate that in the northern part of Java, the average utilization rate is 92% for the demersal resources.
- c. For the northern part of Java and southern Kalimantan, studies on the demersal potential resource conducted by Badrudin et al. (1997) and Martosubroto et al. (1997) showed similar results. The quantity of maximum sustainable yield ( $Q_{t,MSY}$ ) ranges from 153 100 - 161 900  $t \cdot year^{-1}$ , with average landings equal to 132 965 t, and the utilization rates are lower - between 82% and 87%, (see Table 25).
- d. In the northern part of Java if  $E_{t,existing} < E_{t,TAC} < E_{t,MSY}$  then the total amount of effort could be increased by 590 trip-days which is equal to two additional units of fishing vessel (Danish seine A standard).

### Conclusions and Recommendations

In 1997, Indonesia fisheries export values were around 17 times higher than import values. Fisheries export commodities are composed mostly of shrimp, tuna and skipjack and demersal fish. The balance of trade (BOT) showed a surplus rising from US\$5 994 000 (1970) to US\$1 658 827 000, or an annual increase of 10.25%. The future of fisheries is promising. In 1998, the DGF introduced PROTEKAN 2003, an export program.

In the small scale fishery, the dominant fishing gear is hook-and-line (40%), gillnet (30.6%), traps

(10%), seine net (5.84%), lift-net (5.80%), purse seine (1.34%), shrimp net with BED (0.04%) and other gear (7.3%). The vessels used are (i) non-powered boat (49.4%), (ii) with outboard engines (22.3%), and (iii) with inboard engines (16.8%). The inboard engines could be further divided into sizes: (a) between 5 - 10 GT (14%), (b) 11 - 30 GT (1.3%), (c) 31 - 100 GT (1.2%), and (d) >100 GT (0.3%). Since small scale fishery activities are limited to the coastal areas, over-fishing occurs in the Java Sea.

In terms of production and technology efficiency, the combined inputs of manpower (MP), total fuel/day and total number of vessels (JUK) are not optimal either for small- or large scale vessels. For large scale fishing vessels (< 30 GT), the amount of fuel/day should be increased while the total number of boats should be reduced. In large scale fishing fleets (> 30 GT), fuel/day should be increased while the total number of fishing fleets (purse seine in the South China sea/Masalembo-Matasiri and shrimp-trawl in the Arafura sea) should be increased. If the volume of fuel/day either for small- or large scale fishing vessels is increased, then these fleets must fish offshore and in larger fishing areas.

On average, labor costs were the dominant expenditures except in shrimp-trawling, where total fixed costs are the dominant expenditure. Note however, that this kind of vessel is the most capital-intensive fishing vessel while cantrang (Danish seine C) may be regarded as the most labor-intensive vessel.

Budget analysis showed that almost all vessels except *cantrang* (Danish seine C) were profitable during the relevant period and at prevailing interest rates ( $r = 27\%$ ). Assuming that fisheries activities have a medium risk factor of 10% and the existing interest rate is 27%, then beach seine, stationary lift-net, monofilament gillnet, Danish seine A and set gillnet are profitable and feasible for investment.

In large scale fisheries, the operations do not entail discarding the by-catch product. In the northern part of Java, most of the fish captured are utilized either for family consumption or for commercial purposes.

For traditional long-line and gillnet, where accidental capturing of sharks occurs, fishers utilize the skin for snack crackers, the fin for "soup-gourmet", the bones for Chinese traditional medicine and the meat is salted and dried and consumed locally.

Problems of by-catch products might occur in the commercial tuna long-liner and shrimp-trawler fisheries but these fisheries operate away from the northern part of Java (i.e. in the Arafura Sea and Indian Ocean).

The Schaefer surplus yield production model, applied to *dogol* (Danish seine A) indicates that the existing total effort in inshore waters is smaller than the total effort at MSY (or  $E_{t,OAE} > E_{t,MSY} > E_{t,existing}$  and  $Q_{t,MSY} > Q_{t,existing}$ ). Therefore, on average, profits of the industry show a positive annual response.

At the maximum sustainable yield, the total existing number of fishing vessels could expand from 5 208 units to 5 797 units, so that the CPUE would be reduced from 92.42 kg·day<sup>-1</sup> to 84 kg·day<sup>-1</sup>. At the same yield level, if 2.5% income taxation is introduced by the government to the industry then on the average, the profit·boat<sup>-1</sup>·year<sup>-1</sup> might

decline from Rp 4 594 425 to Rp 4 479 565. At OAE, income taxation cannot be introduced, since the industry shows no profit at that level.

Other studies (Table 29) showed that during the period of 1991 - 2000, the average utilization rate of the demersal fishes was 92% while this study obtained a utilization rate almost approaching the MSY level.

For future studies, simultaneous equations which integrate the Schaefer, demand function, production technology, taxation policy and the feasibility study constraints, should be used in one general model in order to incorporate the endogenous variables whenever the government policy and the exogenous variables change. This is called modeling in system thinking and system analysis, and might be done to model all parameters affecting demersal fisheries.

**Table 29. Demersal resource studies in the Java Sea, Indonesia.**

No.	Location	Model	$Q_{t,MSY}$ (t)	$E_{t,MSY}$ (effort)	Average landings (t)	Utilization rates (%)	Average existing total effort (trip-days)	Authors
I.1.	Northern part of Java and Southern Kalimantan	Schaefer	153 100	–	132 965 (1995)	87	–	Badrudin et al. (1997)
2.	Northern part of Java and Southern Kalimantan	Schaefer	161 900	–	132 965	82	–	Martosubroto et al. (1997)
II.1.	Northern part of Java	Schaefer	94 700	–	87 240 (1989)	92	–	Martosubroto et al. (1997)
2.	Northern part of Java	Schaefer	116 100	–	87 240	75	–	Badrudin et al. (1997)
2.	Northern part of Java, Southern Kalimantan, Eastern Sumatra	Schaefer	367 100	–	–	–	–	Badrudin et al. (1997)

Sources: Badrudin et al. 1997 Widodo et al. 1998.

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