SEASONAL DYNAMICS OF FISHING GEAR ON MULTIGEAR COASTAL SMALL-SCALED FISHERIES IN PELABUHANRATU BAY, INDONESIA

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ABSTRACT

Considering the operational needs on fisheries management, this research was aimed for understanding the adjustment processes of small-scaled fishing gear dynamic by measuring and analysing the seasonal fishing gear dynamic including seasonal fishing pattern and fishing gear interaction. To understand the fishermen's adaptation of their fishing effort from any changes factors, the study was conducted on coastal small scale fisheries, Pelabuhanratu Bay, Indonesia. The data (catch landing of commercial fishing, number of fishing gear landing, and price of fish) were collected from Pelabuhanratu Fishing Port. The analysis shows that the fishing gear was fluctuated seasonally. The seasonal pattern dynamic of fishing gear was caused by fish abundance both in volume and value. Because of limited fish abundance and season, fishing gears compete each other and have caused the fishing gear interaction. Three groups of the fishing gear interaction in Pelabuhanratu Bay could be found; i.e., outboard gillnet -handline, inboard gillnet-longline, and liftnet-seine net interaction.

Keywords : seasonal dynamic, seasonal pattern, fishing gear interaction, multispecies, coastal small-scaled fisheries.

INTRODUCTION

Indonesian fisheries are characterized by multispecies and multigear fisheries. Species and volume of catch landing in Indonesian waters depends on weather and seasonal fishing. About 45 finfish, 7 crustacean species and 4 other species groups (seaweeds, turtles, sea cucumber and jellyfish) were landed annually. To exploit the fish resources, about 29 types of fishing gear (from traditional to modern and fully technology) were operated. The operation of fishing gears greatly depend on the fishing season and weather [1].

Similar to other developing countries, Indonesian fisheries are mostly composed by small-scaled fisheries. About 80% fishing activities are small-scaled and concentrated in coastal area.

Although some technologies have been introduced, until now small-scaled fisheries are still growing steadily and give a significant role both in economic and social aspect [2].

To manage the fisheries especially small scale fisheries, Indonesian government has introduced some of management approaches. But the result has not been implemented well. The impact of this regime is very clear, as the fact that the fisheries condition in some area become overfishing and overcapacity. Therefore, the Indonesian Ministry of Fisheries and Marine Affair decided to manage the fisheries by reducing and relocating the fishing gear.

Before implementing that policy, it is important to know the behaviour dynamic of fishing gear in Indonesian waters.   Like natural predator, fishermen have a dynamic behaviour to response the change of catch and economic in fisheries by allocate or redistribute the effort. Fishermen responses the changing of catch by modifying gear, increasing technology and expands fishing ground. Since the fish abundance is still available and give a profit, fishermen tend to add vessel until reaching the bioeconomic equilibrium [3]. The major problems in analysis of effort dynamic is how the fishermen adapt their effort to any changes occurring in the resource ability, market prices and/or fishing strategies of other fishing units, and non-stable allocation of effort [4]. To understand the fishermen adapt their effort from any changes factors, the case study has been conducted in Pelabuhanratu Bay, Indonesia.   The objective of this research is to clarify the adjustment processes of small scale fishing gear dynamic by measuring and analysing the seasonal fishing gear dynamic including seasonal fishing pattern and fishing gear interaction.

MATERIAL AND METHODS

Study Location
The study was carried out in Pelabuhanratu Bay, Indonesia. Pelabuhanratu Bay is a small bay facing to Indian Ocean at southern coast of West Java, Indonesia, located at $6^o55'$ and $7^o55'$ S, and $106^o15'$ E and $106^o35'$ E

Material
The major data used in this study were: 1) catch landing of commercial fishing which was recorded per gear per species 2) fish price for each species and 3) operation cost of each fishing gear. Volume and price of catch landing were collected from Pelabuhanratu Fishing Port Statistical Report, which were recorded daily based on fisheries auction activity. The data of operation cost of fishing gear were collected by conducting sampling of about 10% of fishing gear population.

Methods
To understand the relationship between dynamics of fishing effort and its influence factor, the data were analysed using seasonal index analysis. The indexes were computed by decomposition moving average procedure [5] based on the following formula:

$$SI_j = \frac{1}{K} \sum_{k=0}^{K-1} \frac{x_{j+12k}}{T_{j+12k}} x 100\% \tag{1}$$

where SI_j is the seasonal index for month j (j=1 to 12), k = {0,1,2…, K-1} K being the number of seasons for the whole time series, x_{j+12k} is the raw data in months $j+12k$, and T_{j+12k} is corresponding trend values estimated by centred 12 moving average procedures. For comparison of fishing pattern each other, the seasonal index expressed in percentage and computed by Statistical Product and Service Solutions (SPSS) software [6]. An index number more than 100 percent of given month means that a month was more than average season.

To classify the interaction between fishing gear, each seasonal index of fishing gear compared each other and analysed using descriptive methods.

RESULT

Fishing gear composition

Various fishing gears operated in Pelabuhanratu Bay, could be classified into 6 fishing gears types, i.e., hand lines, seine nets, inboard gillnets, lift nets, long line, and trammel net. Actually, before 1998 fisherman in Pelabuhanratu Bay also operated fixed gillnet and outboard engine gillnet. But after hairtail fisheries developed and give more attractive income some of outboard engine gillnet switched to hand line and trammel net switched to trammel net.
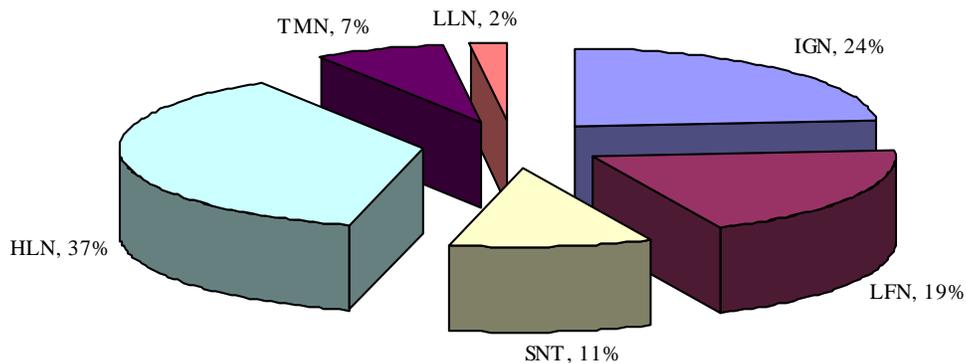

Figure 1. Gear Composition in Pelabuhanratu Bay (2002) (*Remarks:* HLN: hand lines, SNT: seine nets, LFN: lift nets, IGN: inboard gillnet, LLN: long lines, TMN: trammel nets)

Composition of fishing gear fluctuate both annually and seasonally depend on the catch composition and climate dynamic. The composition of fishing gear in Pelabuhanratu Bay in

2002 was dominated by hand line (37%) followed by inboard engine gillnet (24%), lift nets (19%), seine nets (11%), trammel nets (7%) and long line (2%).

Based on the target species and operation area, fishing gear in Pelabuhanratu Bay can be classified into two groups that are coastal and offshore fisheries. The coastal fisheries characterized by traditional and small-scaled fisheries but offshore fisheries characterized by high capital and industrial fisheries. Among 6 fishing gears operated in Pelabuhanratu Bay, 4 fishing gear (hand line, seine nets, trammel net and lift net) categorized as small scale fisheries and 2 fishing gears (long line and inboard gillnet) categorized as industrial fisheries. The small-scaled fisheries are usually operated in near coastal area for one day fishing, but industrial fisheries are usually operated in offshore area, near mouth of bay until Sumatera island for about 3 until 10 days fishing operation.

Seasonal Pattern of Fishing Gear

Generally, fishing gears in Pelabuhanratu Bay were operated along the year, but each fishing gear fluctuated monthly and have specific peak season. The result of seasonal index analysis for fishing gear in Pelabuhanratu showed that each fishing gear have a specific seasonal pattern (Table 1). Fixed gillnet, outboard gillnet, seine nets and lift nets have one period of fishing season. Period of fishing season for fixed gillnet was from August to January. The peak season of fixed gillnet was happened on November. Period of fishing season for outboard gillnet, seine nets and lift nets was almost simultaneously, started around May or June and finish around September – November. Hand line and inboard gillnet have two periods of fishing season, i.e., October – November and January – March for hand line and June – November and January for inboard gillnet. Longlines have different fishing season, i.e., 3 period of fishing season. These are May, July – September and November – December (Table 1).

Table 1.   Seasonal index (%) of fishing gear on coastal small-scaled fisheries in Pelabuhanratu Bay.

Month	FGN	HL	OGN	SN	LN	IGN	LL
January	171	165	85	82	78	109	98
February	64	138	71	75	41	87	96
March	46	117	95	94	59	83	97
April	40	65	90	71	86	68	98
May	28	86	124	99	117	88	104
June	82	38	106	113	108	121	90
July	64	75	132	135	108	104	108
August	116	45	132	127	133	103	110
September	123	70	104	117	131	101	100
October	146	162	92	106	133	121	93
November	213	154	71	98	114	115	104
December	108	85	98	82	90	99	102

Remarks: HLN: hand lines, SNT: seine nets, LFN: lift nets, IGN: inboard gillnet, LLN: long lines, TMN: trammel nets

The seasonal index in this study was also used to analysis the stability of seasonal pattern of fishing gear. The seasonal index which was fluctuated monthly indicated that the fishing season for the gear changed seasonally. Conversely, if seasonal index was stable along the year, it indicated that the fishing season for the gear is stable along the year. Based on this criteria, Table 1 shows that hand line, lift nets, and fixed gillnet have a dramatically changing of seasonal pattern and categorized as seasonally fishing gear. On the other hand, seine nets, lift nets, inboard gillnet, longline, and outboard gillnet showed a relative stable season pattern along the year.

Fishing Gear Competition

By comparing seasonal index for each fishing gear we can also assess the competition of fishing gear. Based on the seasonal index dynamic and related to their target species, fishing gear competition was determined. Based on the pattern of seasonal index dynamic, fishing gear competition in Pelabuhanratu Bay can be classified into two groups, there are non-competition and competition fishing gear.

Non-competition

Non-competition means a group of fishing gear, whereas no competition each other because of their specific tools, gear, vessels, and target species. Based on the seasonal index and catch competition of fishing gear, fixed gillnet, hand line, and longline were grouped into this group. Seasonal index analysis showed that this three fishing gears have a different seasonal pattern comparing with another fishing gear. Longline which was focused for catch big species has a relative stable season pattern along the year. Hand line which was focused for catching hairtail in a specific area, especially in rocky and reef zone have a specific seasonal pattern too. The peak season for hand line happened when the other fishing gear reached low season. The peak season of hand line happened around December – March coincide with a peak of rainy season. Fixed gillnet which targeted for demersal fish reached a peak season around November (Figure 2 and 4). The specific fishing vessel, fishing ground and target species made them as an autonomous fishing gear.
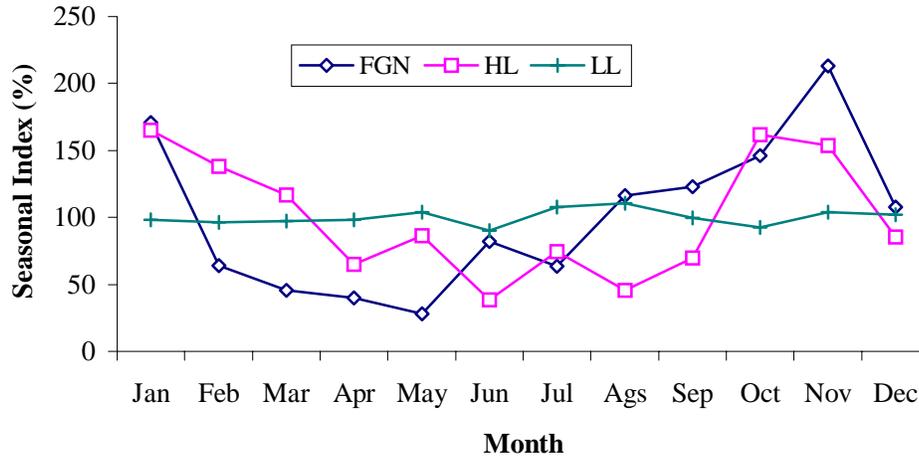
Figure 2.   The non-competition fishing gear in coastal small scale fisheries of Pelabuhanratu Bay (*Remarks:* HL: hand lines, FGN: fixed gillnet, LL: long lines)

Competition

The second group is competition, which explained the competition between fishing gears for catching the same target species.   Outboard gillnet, seine nets, lift nets, and inboard gillnet compete each other to catch pelagic fish especially little tuna. Figure 3 shows the seasonal index for four fishing gears which were relatively similar along year. The dynamic of seasonal pattern of fishing gear was expected caused by dynamic change of little tuna, tuna and sardine which have a similar seasonal pattern (Figure 4).

Actually, all fishing gear in Pelabuhanratu Bay was almost operating along year. But fishing intensity that indicated by number of operated fishing gear and number of fishing trip was more increased when the target species reached the peak season.   The fishermen tried to catch fish as much as possible until the low season was coming.
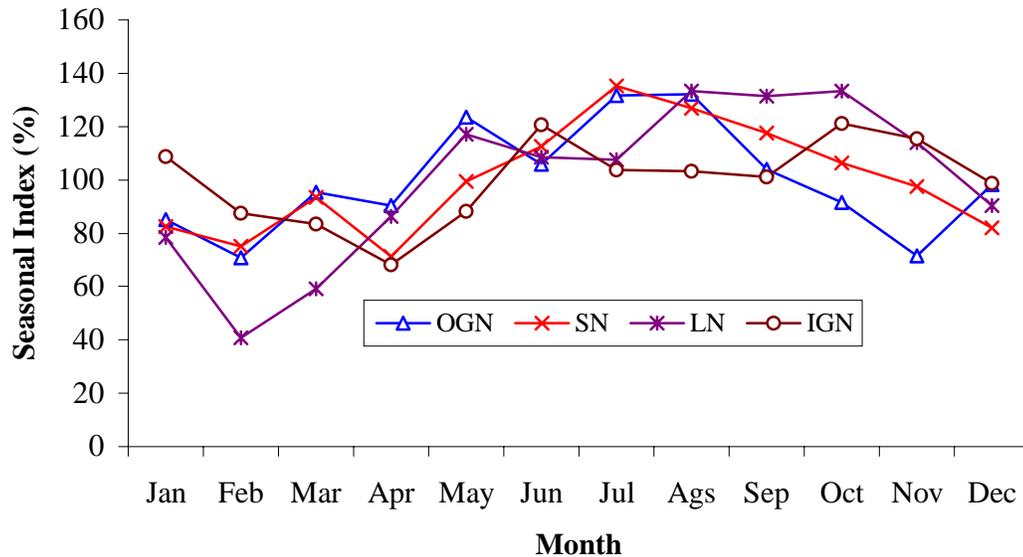
Figure 3. The competition fishing gear in coastal small-scaled fisheries in Pelabuhanratu Bay (*Remarks:* OGN: outboard gillnet, SN: seine nets, LN: lift nets, IGN: inboard gillnet)

DISCUSSION

Period of fishing season of fishing gears in Pelabuhanratu Bay fluctuated seasonally. Analysis of seasonal index of fishing gear in Pelabuhanratu Bay showed that each fishing gear has specific season and generally fluctuated monthly. Difference of period of fishing season for each fishing gear was expected caused by fluctuation of abundance of fish target. Hand line which reached fishing period between October to March and reached peak season around January coincided with peak season of hairtail as target species of hand line. Outboard gillnet, inboard gillnet, fixed gillnet, seine nets, and lift nets have a similar fishing season, started from around May and finished around October or November. They have a similar period of fishing season because they competed each other to catch pelagic fish (little tuna, tuna, sardine, scads and marlin) which reached their peak abundance in that period.

The fluctuation of season pattern of fishing gear was expected to be related to the seasonal pattern of catch abundance and weather. Fishermen decides to go to fishing if the target species give significant revenue and the weather is safe for work in the sea. Because of limited season and abundance of species, the fishing gears which have a similar target species competes each other to catch target species as much as possible.

The competition between fishing gears in Pelabuhanratu Bay have a big impact to dynamic composition of fishing gear. The behavior dynamic of fisherman as response of competition of

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fishing gear on catching fish abundance which fluctuated both in volume and composition can be classified into two behavior strategy, i.e., increasing efficiency and switching fishing gear.
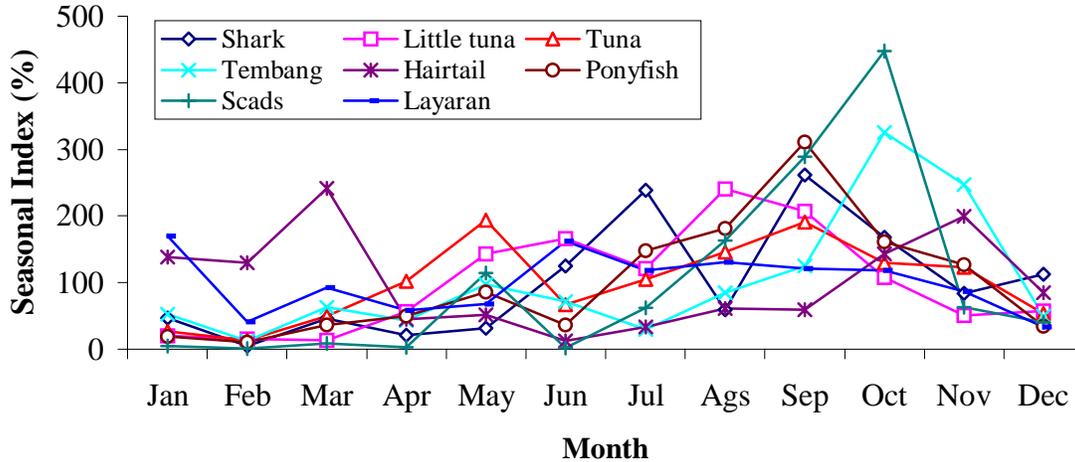

Figure 4. Seasonal Index (%) of main target species in Pelabuhanratu Bay.

Increasing efficiency

Although fish abundance decrease and caused increasing competition between fishing gear, specific fishing gear (like seine nets and lift nets) which have specific tool, gear or vessel are still exist for operation, although their income decrease and defeated compete to the other fishing gear. They don't have another alternative generating income besides fishing to the sea. To increase and maintain their fishing gear existence, fishermen increase fishing gear efficiency by reducing operating cost and increasing technology. Seine nets which operated as dynamic gear, exceed the decreasing fish abundance by extended their fishing ground and increasing vessel moving capability by increasing engine capacity.

Switching

For non specific fishing (like outboard gillnet), their fishing vessel could be switch to operate the other fishing gear. If operate a certain fishing gear on certain season was not give an advantage revenue, they decide to switch to other fishing gear which give an advantage revenue, and vise versa. Descriptive analysis for seasonal index between outboard gillnet and hand line explain the switching process in Pelabuhanratu Bay fisheries.

Generally, fish target of outboard gillnet was similar with seine net, that are little tuna, tuna, sardine, hairtail, ponyfish, shark, scads and marlin.   Because of decreasing abundance of some target species, competition between fishing gear is more intensive.   Outboard gillnet which operated passively defeated compete to seine nets. Finally some of outboard gillnet moving to the other fishing ground and tied up in the coast.   But after hairtail fisheries being developed and given more attractive income, some of outboard gillnet vessel switched to operate hand line in certain season.

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