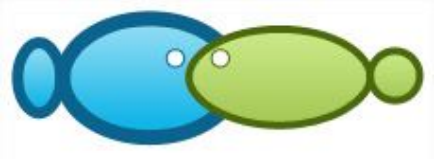

The impact of demersal Danish seine prohibition on marine fisheries production in Pemalang Regency, Indonesia

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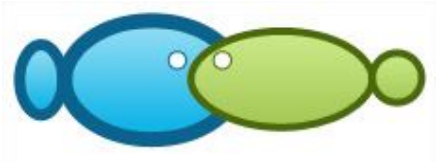

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Abstract. 'Cantrang' (demersal Danish seine) is the second largest contributor to the production of marine fisheries in Pemalang Regency. In 2018, the production of demersal Danish seine in Pemalang Regency was 5,353 tons. Marine fisheries practices in Pemalang Regency are multigears fisheries. The use of demersal Danish seine is considered by some stakeholders to be non-environmentally friendly. In 2015, the Indonesian government issued regulations on the prohibition of demersal Danish seine. These regulations created a national level debate, both pro and contra. Then, the regulations were postponed for certain regions (including in Pemalang Regency). The purpose of this research was to estimate the impact of demersal Danish seine ban on the marine fisheries production of Pemalang Regency. This research used a modified Schaefer model. We used the data of production and fisheries efforts (trips) from 2014 to 2018. The results of research showed that the ban on demersal Danish seine can increase the production of other fishing gears that is affected by the demersal Danish seine operation. It was estimated that the average additional production in 2014 to 2018 was 24,889 tons year^{-1} if demersal Danish seine was not used.
Key Words: CPUE, demersal Danish seine, multigears, modified Schaefer model, Pemalang Regency.

Introduction. Pemalang Regency (Central Java Province, Indonesia) has 19 coastal villages that rely on marine fisheries as one of 'the backbone' of economy (BPS-Statistics of Pemalang Regency 2019). Marine fisheries production in Pemalang Regency was 21,893,749 kg in 2018. The number of fishermen in Pemalang Regency was 15,748 persons (MFAD of Pemalang Regency 2019). Therefore, the economic development of fisheries cannot be ignored by the local government of Pemalang Regency.

'Cantrang' (demersal Danish seine) is one of the main fishing gears in Pemalang Regency. In 2018, there were 20,704 units of demersal Danish seine that landed in Pemalang coastal with the production of demersal Danish seine was 5,352,981 kg (MFAD of Pemalang Regency 2019). However, demersal Danish seine is considered not environmentally friendly by some stakeholders. Demersal Danish seine in Indonesia has been modified by Indonesian fishermen and not in accordance with Indonesian national standard, including in Pemalang Regency. The modified Danish seine could be categorized as a mini trawl (BSN-National Standard 2006; Riyanto et al 2011; Sasmita 2013; Adhawati et al 2017; Wijayanto et al 2019b). Therefore, the Indonesian government established a ban of demersal Danish seine in all Indonesian territorial waters (Marine and Fisheries Ministerial Regulation No. 2/2015), including in Pemalang Regency. This regulation subsequently became a public debate, both pro and contra. Demersal Danish seine fishermen have rejected the ban and held demonstrations.

There are more than 18 types of fishing gears in Pemalang Regency. But the main fishing gears are purse seine, demersal Danish seine, pelagic Danish seine, mini trawl, and gill net. The demersal Danish seine has the most varied catches (more than 17 types of fish). It means that demersal Danish seine is indeed not a selective fishing gear. According to Gianni (2004), bottom trawl (including modified demersal Danish seine) is the major threat to the biodiversity of vulnerable deep-sea ecosystems. In the condition of multi gears, demersal Danish seine in Pemalang Regency has interrelated with other

fishing gears, including purse seine, pelagic Danish seine, mini trawl, and gill net. The purpose of this research was to estimate the impact of demersal Danish seine prohibition on marine fisheries production in Pemalang Regency.

Material and Method

Research location. This research was conducted at the fishing base of the Pemalang Regency. There are 5 fishing bases in Pemalang Regency, i.e. Tanjungsari, Asemdoyong, Mojo, Ketapang, and Tasikrejo.

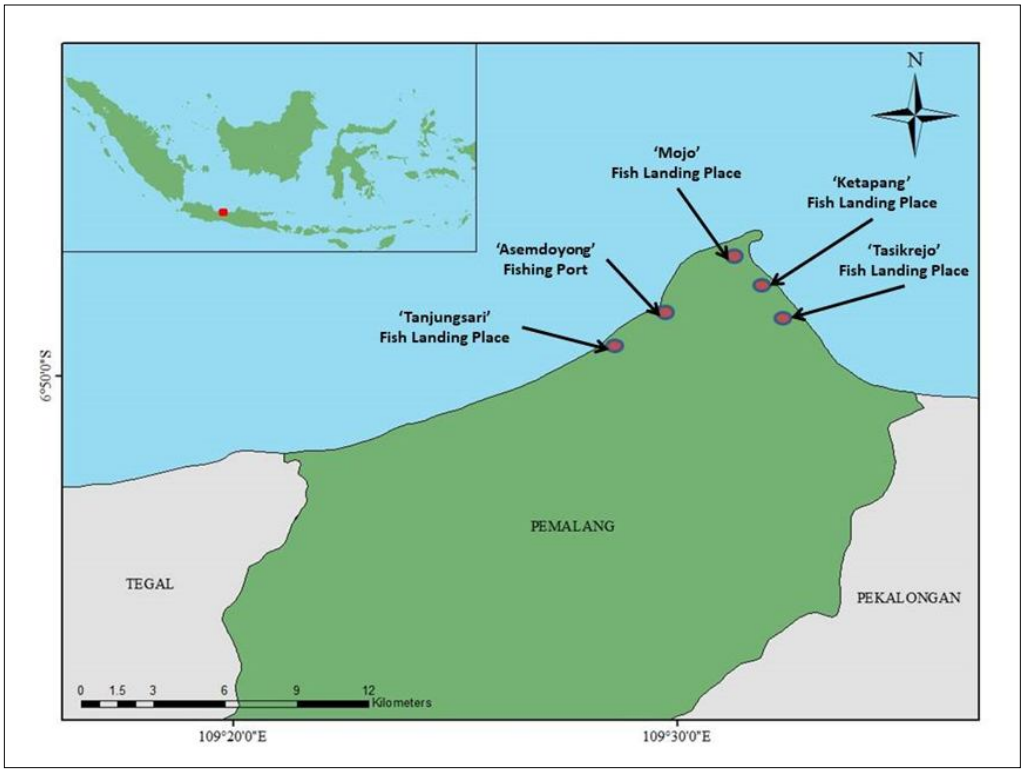

Figure 1. The research location.

Data collection. We collected data, both production and trips for 5 fishing gears (purse seine, demersal Danish seine, pelagic Danish seine, mini trawl, and gillnet) from 2014 to 2018 (MFAD 2019). We also conducted in-depth interviews with fishermen respondents (owners and captains), both fishermen of demersal Danish seine (30 respondents) and non-demersal Danish seine (30 respondents).

Data analysis. We analysed the data by using the Schaefer model that has been modified by Wijayanto et al (2019b). Surplus production models (including Schaefer model) are the first analytical method for stock assessment using data of catch and fishing effort in time series (Bousquet et al 2008). A model is a simplification of the complex real world. Some models can be used to analyze the implications of policy plans in case of fisheries (Padilla & Charles 1994). Schaefer's model is so simple, and the simplicity of the Schaefer model becomes both the strength and weakness of the model. Schaefer model is too simple to represent the complex phenomenon of the fish population. However, the simplicity of the Schaefer model can avoid the interaction or correlation among different parameters and assumptions (Wang 2004).

The Schaefer model uses a single gear assumption. We made modifications to the Schaefer model into a multi-gears model:

$$Cdi = a.Ed - b.Ed^2 - c.Ei \quad (1)$$

$$Cdi / Ed = a - b.Ed - c.(Ei/Ed) \quad (2)$$

where: Cdi = the dependent fishing gear production that influenced by independent fishing gear (tons year^{-1});

Ed = the fishing effort of dependent fishing gear (trip);

Ei = the fishing effort of independent fishing gear (trip);

a, b, c = constants.

Result and Discussion

CPUE progress. The demersal Danish seine productivity in Pemalang Regency tends to decrease. This can be seen on the progress of CPUE which tends to decrease (Figure 2). CPUE trends tend to decrease indicating that there was an increase in pressure on fisheries resources.

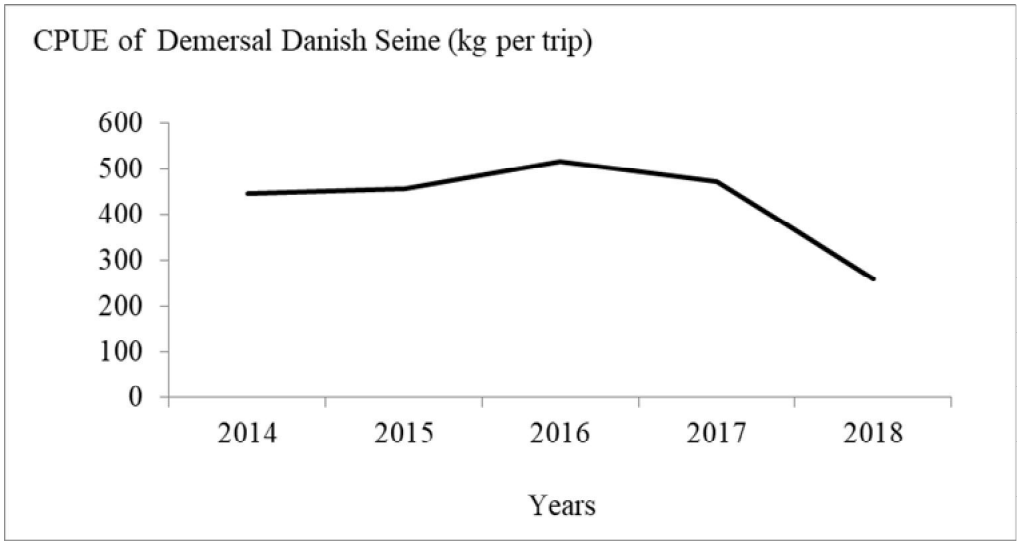

Figure 2. CPUE of demersal Danish seine progress, 2014-2018.

If the CPUE as the fish abundance index increased continuously in several years, it revealed that the biomass has been on the left side of the MSY or maximum sustainable yield (not over-exploited condition), and vice versa (Wang 2004). Therefore, the decreasing trend of CPUE from demersal Danish seine fisheries is one indication that there has been significant pressure on fish resources that be captured by demersal Danish seine.

The catch composition. The demersal Danish seine in Pemalang Regency produces the most diverse catches compared to other fishing gears. There are more than 17 types of animals caught by demersal Danish seine in Pemalang Regency. In 2018, the proportion of demersal Danish seine catches was in the form of demersal fish of 37.01%, pelagic fish of 32.06%, squid and shrimp of 10.37% and mixed fish of 20.56%. Although the target fish is demersal fish, but demersal Danish seine also catches pelagic fish. The catch composition of demersal Danish seine can be seen in Figure 3. Types of fish caught by demersal Danish Seine in Rembang regency also varied with the dominance proportion are demersal and small pelagic fish (Wijayanto et al 2019a).

In Indonesia, demersal Danish seine has been modified by fishermen on a trial and error to increase the fishing power. This modification included the size of the bag, length of rope, mesh size of the net and operated with drag by the ship. Therefore, some parties consider that demersal Danish seine in Indonesia is similar to trawl operations. The modified demersal Danish seine could distract the substrate of waters (Adhawati et al 2017), damage coral reefs and seabed ecosystems (CEA 2018) and also have a high bycatches and use intensive fuel (Hammarlund et al 2018). So, the use of modified Danish seine and trawl are important to be controlled. The catches of demersal Danish seine intersect with other fishing gears (Table 1).

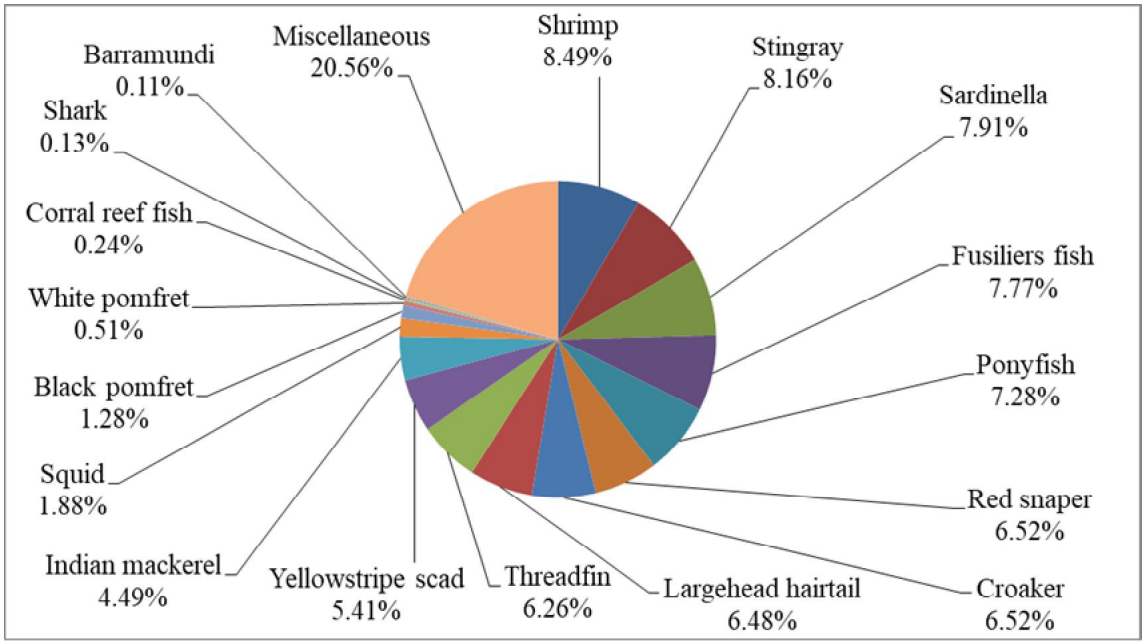

Figure 3. The catch composition of demersal Danish seine, 2018 (Source: MFAD of Pemalang Regency 2019).

Table 1

The similarities of demersal Danish seine catches with other fishing gears in Pemalang Regency

Others fishing gears	*The similarities of animal catches by demersal Danish seine*
Purse seine	Yellowstripe scad, *Sardinella*, Indian mackerel, largehead hairtail, croaker, black pomfret, squid.
Pelagic Danish seine	*Sardinella*, Indian mackerel, largehead hairtail, white pomfret.
Mini trawl	Stingray, coral reef fish.
Gill net nylon	Indian mackerel, largehead hairtail, fusiliers fish, ponyfish, barramundi, croaker, shark, threadfin, stingray, white pomfret.

The production function. The growth of fish production is significantly influenced by technology progress. The productivity in fisheries will make fish available at a cheaper price and improve food security (Kumar et al 2004). But fisheries resources have limited carrying capacity, so the exploitation of fish resources should care for sustainability interest. By using the equations (1) and (2), the production function of several fishing gears studied in this research can be formulated (Table 2). It is proven that demersal Danish seine operations can significantly reduce the production of other fishing gears. This result of research is supporting our previous research finding in Rembang Regency (Wijayanto et al 2018) and Tegal coastal area (Wijayanto et al 2019c).

Fisheries management is important to multi-objectives, both for sustainability resources, food security, and fishermen welfare. The common property problem is the fundamental problem of economic inefficiency in fisheries. There are inadequate property rights in the underlying natural resources. Fishermen who are usually free to operate fishing activities tend to refuse if regulated by the government. But the government must regulate fisheries management, including finding solutions for conflicts of interest between fishermen (Évora & Kristófersson 2016). In multi-gears and multi-species fisheries, the level of technical interactions between various fishing gears is high. There is a competitive externality when fishermen capture the same common resources or catch fish in the same fishing ground. In multi-gear and multi-species fisheries, the level of technical interaction between various fishing gears is high. There are competitive externalities when exploiting the same fish resources or the same fishing ground (Ulrich et al 2001).

Table 2

The production function of demersal Danish seine and other fishing gears in Pemalang Regency

Fishing gears	*The production function of demersal Danish seine that was influenced by other fishing gears*	*The production function of other fishing gears that were influenced by demersal Danish seine*
G	C_{DDS} = 829.44 E_{DDS}-0.01 E_{DDS}^2-543.74 E_G R^2 = 99.53%	C_G = 580.65 E_G-0.02 E_G^2-166.88 E_{DDS} R^2 = 93.49%
PS	C_{DDS} = 1971.23 E_{DDS}-0.04 E_{DDS}^2-1670.06 E_{PS} R^2 = 33.90%	C_{PS} = 5391.24 E_{PS}-0.26 E_{PS}^2-874.47 E_{DDS} R^2 = 86.59%
PDS	C_{DDS} =710.82 E_{DDS}-0.005 E_{DDS}^2-1820.18 E_{PDS} R^2 = 47.86%	C_{PDS} =1223.66 E_{PDS}-0.03 E_{PDS}^2-407.57 E_{DDS} R^2 = 75.25%
MT	C_{DDS} = 1623.23 E_{DDS}-0.04 E_{DDS}^2-640.59 E_{MT} R^2 = 85.47%	C_{MT} = 767.36 E_{MT}-0.03 E_{MT}^2-143.35 E_{DDS} R^2 = 94.44%

Note: G = gill net; PS = purse seine; PDS = pelagic Danish seine; MT = mini trawl; C_{DDS} = production of demersal Danish seine (kg year^{-1}); C_G = production of gill net (kg year^{-1}); C_{PS} = production of purse seine (kg year^{-1}); C_{PDS} = production of pelagic Danish seine (kg year^{-1}); C_{MT} = production of mini trawl (kg year^{-1}); E_{DDS} = effort of demersal Danish seine (trip year^{-1}); E_G = effort of gill net (trip year^{-1}); E_{PS} = effort of purse seine (trip year^{-1}); E_{PDS} = effort of pelagic Danish seine (trip year^{-1}); E_{MT} = effort of mini trawl (trip year^{-1}).

The impact of demersal Danish seine on marine fisheries production. The demersal Danish seine ban will clearly reduce demersal Danish seine production in Pemalang Regency. However, demersal Danish seine in Pemalang Regency is not the largest contributor (24% of total production in 2018). Therefore, the impact of the demersal Danish seine ban in Pemalang Regency is not significant than other regions (for example in Rembang Regency and Pati Regency) that have significant production (Wijayanto et al 2018, Wijayanto et al 2019a). On the other side, the ban on demersal Danish seine can cause an increase in production from other fishing gears, namely gill net, purse seine, pelagic Danish seine and mini trawl. The simulation results can be seen in the following Table 3.

Table 3

The impact simulation of demersal Danish seine ban toward marine fisheries production

Year	*Demersal Danish seine production loss (kg)*	*Increase in other fishing gears production (Kg)*				*Additional production (Kg)*
		Gill net	*Purse seine*	*Pelagic Danish seine*	*Mini trawl*	
2014	10,481,466	3,915,079	20,514,971	9,561,640	3,362,935	26,873,159
2015	9,846,079	3,605,845	18,894,586	8,806,409	3,097,312	24,558,072
2016	10,962,840	3,549,605	18,599,891	8,669,057	3,049,003	22,904,716
2017	9,467,479	3,355,520	17,582,887	8,195,051	2,882,290	22,548,269
2018	5,352,981	3,455,149	18,104,943	8,438,371	2,967,869	27,613,351
Avrg	9,222,169	3,576,240	18,739,455	8,734,106	3,071,882	24,899,514

Avrg = average.

The interview results in this research showed that fishermen of non-demersal Danish seine in Pemalang Regency tended to agree with the demersal Danish seine prohibition regulation. Whereas fishermen of demersal Danish seine tend to disagree with these rules. The result of this study is relatively the same as the survey results in Pati Regency with distance 211 km from Pemalang Regency and Rembang Regency with distance 247 km from Pemalang Regency (Wijayanto et al 2018; Wijayanto et al 2019b).

Fisheries management to push more selective fishing gear by the Indonesian government is relatively appropriate. However, it is more intensive persuasive approach toward demersal Danish seine fishermen, including in Pemalang Regency. Fishing gear engineering to increase fishing selectivity can increase fish resource stock (Prellezo et al 2017).

Conclusions. This research has formulated several production functions of fishing gears that have relevance to demersal Danish seine in Pemalang Regency. Several fishing gears that are significantly affected by demersal Danish seine including: gill net, purse seine, pelagic Danish seine and mini trawl. The ban on demersal Danish seine can eliminate the demersal Danish seine production by an average of 9,222 tons year^{-1}, but can increase the production of other fishing gears with an average of 34,122 tons year^{-1}.

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