KORESPONDENSI MANUSKRIP

Judul : Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia

Jurnal : The Egyptian Journal of Aquatic Research (Terindeks Scopus, Q1 dan SJR 0,725 pada tahun 2020)

No	Aktifitas	Tanggal	Keterangan	Halaman
1	Manuscript submission	9 September 2019 (Tercatat Received 8 September 2019 karena perbedaan waktu Indonesia dan Mesir)	"Your PDF has been built and requires approval" Pemberitahuan bahwa manuscript Submission sudah diterima dan diminta untuk melakukan penyelesaian proses submission dengan melakukan "approval" pada the Elsevier Editorial System sebagai author	3
2	Submission Confirmation	9 September 2019	Pemberitahuan cara track dari status manuskrip melalui Elsevier Editorial System	4
3	Editor Query	19 September 2019	Pemberitahuan informasi mengenai kebijakan penerbitan manuskrip di EJAR	5-6
4	Notice of Manuscript Number	20 September 2019	Pemberitahuan nomor manuscript EJAR-D-19-00210	7
5	Notice that the manuscript is handled by the editor	20 September 2019	Pemberitahuan bahwa manuskrip akan ditangani oleh Editor in Chief	8
6	Editor query	20 September 2019	Permintaan untuk menambah international reviewer untuk mengusulkan reviewer manuskrip. Permintaan direspon dengan mengusulkan 3 calon reviewer tambahan (tanggal 23 September 2019)	9
7	Editor query	10 Oktober 2019	Pemberitahuan bahwa reviewer telah menyelesaikan proses review, dan merekomendasikan naskah diterima dengan perbaikan. Selain itu, juga terdapat tagihan. Email balasan diberikan pada tanggal 11 Oktober 2019 mengenai kesanggupan membayar, serta 16 Oktober 2019 mengirimkan bukti transfer	10-11
8	Review results	17 Oktober 2019	Menyampaikan hasil review dari 2 reviewer. Hasil review juga dapat	12-13

No	Aktifitas	Tanggal	Keterangan	Halaman
			ditelusuri dari Elsevier Editorial System	
9	Submission Confirmation	30 Oktober 2019	Pemberitahuan bahwa submission manuskrip yang sudah direvisi telah diterima melalui Elsevier Editorial System	14
10	Notice that the editor is working on the manuscript	3 November 2019	Pemberitahuan bahwa manuskrip akan ditangani oleh Editor in Chief	15
11	Accepted publication notice	4 November 2019	Pemberitahuan bahwa manuskrip berstatus “accepted”	16
12	Publication is on hold due to file problems notice	7 November 2019	Permintaan file tambahan “Title Page” dan direspon pada tanggal 7 November 2019	17-18
13	Finalize publishing	8 November 2019	Pemberitahuan proses finalisasi publikasi	19-20
14	Manuscript approval	18 November 2019	Mengingatkan untuk melakukan persetujuan publikasi	21
15	Corrections received notice	19 November 2019	Pemberitahuan bahwa koreksi dari penulis sudah tersimpan dalam system	22
16	Problem about Fig. 7	21 November 2019	Pemberitahuan adanya masalah pada figure 7 yang tidak jelas. Respon dikirimkan pada tanggal 22 November 2019	23-26
17	Notice that the manuscript has been published online	1 Desember 2019	Pemberitahuan bahwa artikel sudah tersedia online (article in press). Selanjutnya article terbit pada edisi ke 46 tahun 2020: Egyptian Journal of Aquatic Research 46 (2020) 63–70	27-28

Gmail **Dian Wijayanto <dianwijayanto@gmail.com>**

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Title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Authors: Dian Wijayanto, Ph.D; Indradi Setiyanto, Ph.D; Hendrik A Setyawan, MSi

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Journal title: Egyptian Journal of Aquatic Research
Corresponding author: Dr. Dian Wijayanto
Article title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Manuscript number:

Dear Dr. Dian Wijayanto

Good day to you.

We thank you for being interested to submit your manuscript to our journal the "Egyptian Journal of Aquatic Research" EJAR.
We would like to inform you of the new process of peer-review and production according to EJAR policy starting from 2016.
After your initial submission, the manuscript is forwarded to 5 reviewers for evaluation and comments. The reviewing process will be terminated once 2 reviewers among the 5 replies with their evaluation. If the manuscript is accepted you will receive an email from our part with the acceptance and a due payment of 300 US $ that should be transferred via western union service or Moneygram service to the name of an editorial member. The details of the receiver will be forwarded to you later.
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Please note that due to a large number of submissions, your manuscript, if accepted, might be published online by the first half of the year 2020. However, until that time if the reviewing process is fast and your article is accepted, it will appear as an article in press and you can download it and use it according to your needs.

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6- If applicable, you are requested to use citations published in EJAR related to your work.

If any of the above criteria are not complete or there is an unjustified delay in the response of the corresponding author, we regret that we will be forced to reject your paper.
I hope these criteria and timeline would suit your agenda.

Looking forward that you would confirm your acceptance of the above to proceed with the reviewing and publication process.

We thank you once again for your interest to submit your work to EJAR.
* Please cc in your reply the following emails:

fatma_abdelrazek@hotmail.com;cassiopea23@yahoo.com;marwa_ismaiel@ymail.com;mahmoud_ejar@yahoo.com;salah_niof@yahoo.com

Best Regards.
Sincerely,

Marwa Ismaiel
Editorial Office of EJAR

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Cc: fatma_abdelrazek@hotmail.com, Elzahrae Elmasry <cassiopea23@yahoo.com>, marwa_ismaiel@ymail.com, mahmoud_ejar@yahoo.com, salah_niof@yahoo.com
Bcc: Dian Wijayanto <dianwijayanto@gmail.com>

Dear Dr. Marwa Ismaiel

Thank You for your good response. I agree to follow all the publishing processes in your journal. Thank You very much!

Best regards
Dian Wijayanto
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Ms. Ref. No.: EJAR-D-19-00210
Title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Egyptian Journal of Aquatic Research

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Egyptian Journal of Aquatic Research

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Cc: fatma_abdelrazek@hotmail.com, cassiopea23@yahoo.com, marwa_ismaiel@ymail.com, mahmoud_ejar@yahoo.com, salah_niof@yahoo.com

Journal title: Egyptian Journal of Aquatic Research
Corresponding author: Dr. Dian Wijayanto
Article title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Manuscript number: EJAR-D-19-00210

Dear Dr. Dian Wijayanto

Please suggest more international reviewers with their names, contacts and affiliations (not from your home country).

With kind regards

Sincerely

Mahmoud Attallah
Editorial Office of EJAR

Dian Wijayanto <dianwijayanto@gmail.com> Mon, Sep 23, 2019 at 4:55 PM
To: Elzahrae Elmasry <cassiopea23@yahoo.com>
Cc: dianwijayanto <dianwijayanto@yahoo.com>, fatma_abdelrazek@hotmail.com, Elzahrae Elmasry <cassiopea23@yahoo.com>, marwa_ismaiel@ymail.com, mahmoud_ejar@yahoo.com, salah_niof@yahoo.com

Dear Editor of EJAR

We are very appreciate for your good respon. I suggest additional reviewers as follows:
(1) Prof. Matsuishi Tkashi Fritz. Expertise: fisheries management. email: phocoena@fish.hokudai.ac.jp. Institution: Hokkaido University, Japan
(2) Dr Kaoru Kakinuma. Expertise: fisheries policy. email: kaoru.kakinuma.a1@tohoku.ac.jp. Institution: Tohoku University, Japan
(3) Dr. Michael Abbey. Expertise: fisheries policy. email: michael.abbey@noaa.gov. Institution: NOAA, USA.
Thank You very much!

Best regards
Dian Wijayanto

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3 messages

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To: dianwijayanto@gmail.com, dianwijayanto@yahoo.com
Cc: fatma_abdelrazek@hotmail.com, cassiopea23@yahoo.com, marwa_ismaiel@ymail.com, mahmoud_ejar@yahoo.com, salah_niof@yahoo.com

Journal title: Egyptian Journal of Aquatic Research
Corresponding author: Dr. Dian Wijayanto
Article title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Manuscript number: EJAR-D-19-00210

Dear dr. Dian,

Good day to you,

Please note that the reviewers completed the review of your manuscript and advised its acceptance after revision.
The current status of your manuscript is: pending for payment (300 USD).

You are requested to make the fee transfer via the western union or MoneyGram services to the following receiver:
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Address: 16 Ameer Elbehar st., Bolkly, Alexandria, Egypt
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And please send a scanned copy of the transaction having the MTCN number, the sender's full name and the country from where the money was sent.
I shall wait for your confirmation about payment so that I would be able to send you the reviewers' comments to proceed further with the reviewing process.

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Sincerely,

Elzahrae Elmasry
Editorial Office of EJAR

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Cc: dianwijayanto <dianwijayanto@yahoo.com>, fatma_abdelrazek@hotmail.com, Elzahrae Elmasry <cassiopea23@yahoo.com>, marwa_ismaiel@ymail.com, mahmoud_ejar@yahoo.com, salah_niof@yahoo.com

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Editorial Office of EJAR

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Dian Wijayanto <dianwijayanto@gmail.com> Wed, Oct 16, 2019 at 1:35 PM
To: Elzahrae Elmasry <cassiopea23@yahoo.com>

Cc: dianwijayanto <dianwijayanto@yahoo.com>, fatma_abdelrazek@hotmail.com, Elzahrae Elmasry <cassiopea23@yahoo.com>, marwa_ismaiel@ymail.com, mahmoud_ejar@yahoo.com, salah_niof@yahoo.com
Bcc: Dian Wijayanto <dianwijayanto@gmail.com>

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I have paid the publication charge of EJAR using Western Union (No. MTCN 923-510-1407) as You requested. I sent the scan file of money transfer on this email. Please check. I am waiting for good news from You. Thank You very much!

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Ms. Ref. No.: EJAR-D-19-00210
Title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Egyptian Journal of Aquatic Research

Dear Dian,

The reviewers have commented on your above paper. They indicated that it is acceptable for publication after minor revision.

I invite you to revise and resubmit your manuscript.

Please carefully address the issues raised in the comments.

If you are submitting a revised manuscript, please also:

a) outline each change made (point by point) as raised in the reviewer comments

AND/OR

b) provide a suitable rebuttal to each reviewer comment not addressed

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I look forward to receiving your revised manuscript.

Yours sincerely,

Fatma Aly Abd El Razek
Editor in Chief
Egyptian Journal of Aquatic Research

Reviewers' comments:

Reviewer #1: It is a very nice paper which shows differences in use of two fishing gears. However, they have interviewed fishermen, but nothing about them. Such interviews should be detailed and the use of this new methodology name local ecological knowledge (LEK) is not clearly explain. I suggest the authors to read and cite these papers. Test of significance were not applied to show significant differences between curves (ANCOVA, for instance). Non parametric tests (Kruskal-Wallis for instance) should be to show the annual differences for catches. Vernacular names together with names of authors who firstly described the species should be added for each species. Photos of the most abundant species should be added together with those of fishing gears, why not also photos of study site?

Reviewer #2: Abstract: should include brief methodologies

Keywords: should order alphabetically.

Introduction:
1. More literature review on fishing gears
2. More information on fishing ground

Methodology:
1. is the questionnaire also considering the fishing ground of purse seine and danish seine?
2. What are the variable of the fishermen operational cost?

Result and Discussion: need additional citation for discussion

****

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Ms. Ref. No.: EJAR-D-19-00210R1
Title: Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia
Egyptian Journal of Aquatic Research

Dear Dian,

I am pleased to inform you that your paper "Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia" has been accepted for publication in Egyptian Journal of Aquatic Research.

Thank you for submitting your work to Egyptian Journal of Aquatic Research.

Yours sincerely,

Fatma Aly Abd El Razek
Editor in Chief
Egyptian Journal of Aquatic Research

Reviewer #1: Although the authors have not totally followed my instructions, especially LEK study, very important for this category of paper, this latter was considerably improved and I believe that it is at present worthy for publication in the review.

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Publication of your article [EJAR_367] in The Egyptian Journal of Aquatic Research is on hold due to file problems

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Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia

Dian Wijayanto[1*], Indradi Setiyanto[1], Hendrik Anggi Setyawan[1]

[1]*Department of Capture Fisheries , Faculty of Fisheries and Marine Science, University of Diponegoro, Semarang, Indonesia*

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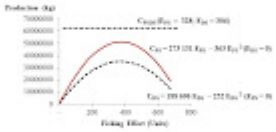

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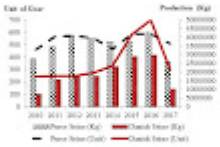

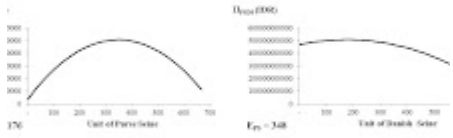

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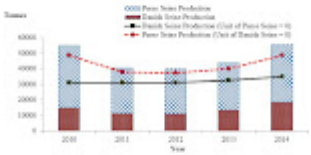

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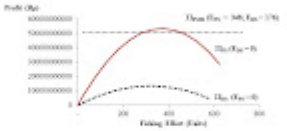

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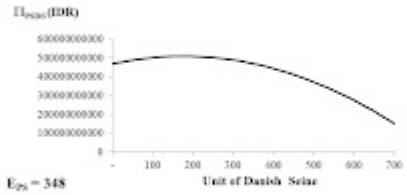

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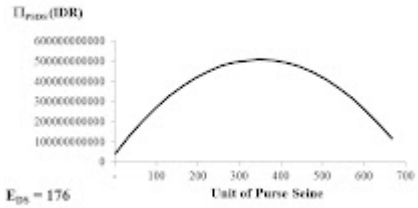

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Abstract: The characteristic of fisheries in Indonesia is multi-gears, including in Rembang Regency. Rembang Regency had fishery production of 36,243 tons in 2017 and very dependent on purse seine and Danish seine. Although they have different fishing operation, but types of fish caught by purse seine and Danish seine are partly of the same species. The interrelation of fish species caught shows the risk of interrelation between purse seine and Danish seine, i.e. negative externalities. The purpose of this research was to make the model of relationship between Danish seine and purse seine fisheries in Rembang Regency with a bio-economic approach. We have modified Gordon-Schaefer model to be a multi-gears model. We also did optimization of production and profit. This research have proven that Danish seine fishing efforts have a negative impact on the production of purse seine fisheries, and vice versa. The combination of 328 units of purse seine and 304 units of Danish seine will produce optimal aggregate production. While the combination of 176 units of Danish seine and 348 units of purse seine will generate an aggregate profit of IDR 510 billion per year as the win-win solution for both Danish seine and purse seine fisheries.

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3. Regarding suggestions for using ANCOVA and non-parametric tests, we did not do that because we put more emphasis on simulation models. Without being tested by ANCOVA or non-parametric tests, it has been seen that different scenarios produce different production and profits.
4. We have followed up on suggestions for vernacular names and names of authors.
5. Suggestions for adding photos have been followed up, but only photos of vessel. Adding more photographs of fish, fishing port and fishing gear will become too many photos in the manuscript.

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Bio-economic model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia

Abstract

The characteristic of fisheries in Indonesia is multi-gears fisheries, including in Rembang Regency. Rembang Regency had fishery production of 36,243 tons in 2017 and very dependent on purse seine and Danish seine fisheries. Although they have different fishing operation, but types of fish caught by purse seine and Danish seine are partly of the same species. The interrelation of fish species caught shows the risk of interrelation between purse seine and Danish seine (negative externalities) which can encourage overfishing. The purpose of this research was to make the model of relationship between Danish seine and purse seine fisheries in Rembang Regency with a bio-economic approach. We have modified Gordon-Schaefer model (single gear) to be a multi-gears model that can explain the reciprocal relationship between Danish seine and purse seine fisheries, and also did optimization of production and profit. This research have proven that Danish seine fishing efforts have a negative impact on the production of purse seine fisheries, and vice versa. The combination of 328 units of purse seine and 304 units of Danish seine will produce optimal aggregate production (62,286 tons per year). While the combination of 176 units of Danish seine and 348 units of purse seine will generate an aggregate profit of IDR 510 billion per year as the win-win solution for both Danish seine and purse seine fisheries. The highest aggregate profit will occurred at 370 units of purse seine fisheries and 0 units of Danish seine which generated a profit of IDR 535 billion per year.

Keywords: bio-economic, Danish seine, profit maximization, purse seine

Introduction

Indonesia is the second largest capture fisheries producer in the world (FAO, 2014) and has the second longest coastline in the world, i.e. 54,716 km (CEA, 2018). Therefore, fisheries development in Indonesia has a strategic role. The pattern of capture fisheries in Indonesia is multi species and multi gears. It is estimated that Indonesia has 8500 fish species (Kep No. 67 / KEP-BKIPM / 2015) and there are 67 types of fishing gear in Indonesia which are grouped into 12 types of fishing gear classifications (BBPPI, 2013). So, there are several types of fish and fishing gears that are operated in each of fishing grounds in Indonesia. Therefore, there is an inter-relation between several fishing gears.

Rembang Regency is one of the coastal regency in Indonesia with capture fisheries production of 36,243 tons in 2017 (DKP Kabupaten Rembang, 2017) and has a coastline length of 63 Km (BPS Kabupaten Rembang, 2018). Rembang Regency is very dependent on purse seine and Danish seine fisheries as the backbone of capture fisheries in Rembang Regency. In 2017, purse seine production in Rembang Regency was 72.07% and Danish seine production was 27.89% of Rembang Regency marine fisheries production (DKP Kabupaten Rembang, 2017). Both of these fishing gears have a greater fishing power than other fishing gears in Rembang Regency, i.e. gill net, fishing line, trammel net and traps.

Purse seine capture fish schools that are drawn to fish-attracting devices. The target of purse seine fisheries is pelagic fish, including skipjack, yellowfin tuna, and frigate (CEA, 2018). The use of drifting fish aggregating devices in purse seine operation since the early 1990s (Fonteneau, et al, 2013). Purse seine operation has three steps, i.e. setting, immersing and hauling. The Danish seine was invented by the Danish fisherman (in 1848) and then became one of the most important fishing gears used in Denmark. Danish seining consists of three main steps, i.e. setting, collecting and closing phase (Herrmann, et al, 2016). Purse

seine and Danish seine are active fishing gear, that is, actively searching the target fish location.

Purse seine and Danish seine have different fishing operation patterns. Purse seine has pelagic fish as target. While Danish seine chose demersal fish as target (BBPPI, 2013; Anggawangsa, et al, 2014). Danish seine ('cantrang') in Indonesia has been modified by fishermen so that its characteristic is similar to trawl and can be categorized as mini trawl (Adhawati, et al, 2017; Wijayanto, et al, 2019). Although the pattern of fishing operation is different, the types of fish caught by purse seine and Danish seine are partly the same type. Several aquatic animals that catched both by purse seine and Danish seine include (DKP Kabupaten Rembang, 2017): *Restrelliger brachysoma* Bleeker (short mackerel), *Selaroides leptolepis* Cuvier (yellowstripe scad), *Loligo* sp (squid), *Leiognathus equulus* Forsskal (common ponyfish), *Trichiurus* spp (largehead hairtail), *Netuma thalassina* Ruppell (giant catfish), *Lutjanus* spp (red snapper), *Sphyraena barracuda* Edwards (great barracuda), *Megalaspis cordyla* Linnaeus (torpedo scad) and *Abalistes stellaris* Bloch and Schneider (starry triggerfish).

The fishing operations for Danish seine and purse seine fisheries from Rembang Regency fishermen are on FMA of 712 or Java Sea. The potential of fish resources in FMA of 712 is 981,680 tons per year. Demersal and small pelagic fish resources are the biggest potential of FMA of 712 (33% and 31%). While the potential of large pelagic fish resources is 11%, the rest is a combination of reef fish, shrimp, lobster, mud crab, blue crab and squid (Keputusan Menteri KP No. 79/2016)

Many types of fish are caught different by Danish seine and purse seine, but possibly that fish catch have interaction because they live in the same ecological area, including food chain relationship. Lotka and Volterra are the pioneer scientists who develop of inter-species relationship models through their studies in 1925 and 1926. Several researchers also conducted multi-species bio-economic studies that explain the relationships between species. Kar and Pahar (2007) made a predator-prey model in a reserved marine environment. Verma, et al (2004) made predator-prey model in two different cases of aquatic environments (open access and reserved area). Das, et al (2009) developed a predatory model that follows the logistic growth model. Rojas-Palma, et al (2012) made predator-prey model in the case of open access where prey growth is influenced by the Allee-effect (low population density) and predators are general. Toaha and Azis (2018) developed a modified predator-prey model from the Leslie-Gower model. Singh and Weninger (2008) and Kasperski (2011) used a combination of multi-species and multi-gears. Smith, et al (2016) developed a model of 3 species to optimize fish harvest with several alternative scenarios.

In this research, the characteristic of multi species was ignored, and we used single stock assumption follow the Gordon-Schaefer Model. The linkage of the types of fish caught shows the risk of inter-relation between purse seine and Danish seine fisheries, i.e. technological (negative) externalities. The competition of fishermen to catch fish encourages overfishing. In the world, overfishing is getting higher, that is around 31.4% in 2013 (FAO, 2016).

In the case of Danish seine and purse seine fisheries in Rembang Regency, the two fishing gears have a mutually influential relationship. Therefore it is necessary to manage Danish seine and purse seine capture fisheries. The bio-economic model can be used to develop fisheries management of Danish seine and purse seine in Rembang Regency. Several researchers have conducted multi-gears bio-economic studies, including Campbell and Kennedy (2010), Kasperski (2011), Hammarlund, et al (2018), and Wijayanto, et al (2019). The purpose of this study was to analys the interrelationship of Danish seine and purse seine fisheries in Rembang Regency with a bio-economic approach. The results of this study can be

used to develop alternative policies in the fisheries management of Danish seine and purse seine in Rembang Regency.

Research Methods

3.1. Research Location

The main location of our research were at 'Tasik Agung' fishing port and also 'Pandangan', 'Karang Anyar' and 'Sarang' fish landing places (Figure 1). Tasik Agung' fishing port is fishing base of Danish seine fisheries. 'Pandangan', 'Karang Anyar' and 'Sarang' fish landing places are main fishing base of purse seine fisheries.

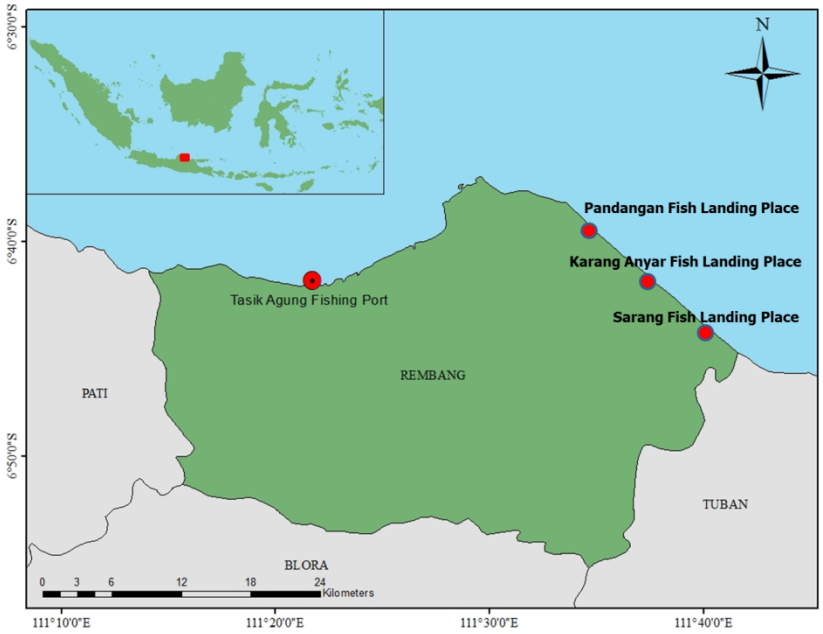


Figure 1. The Research Location

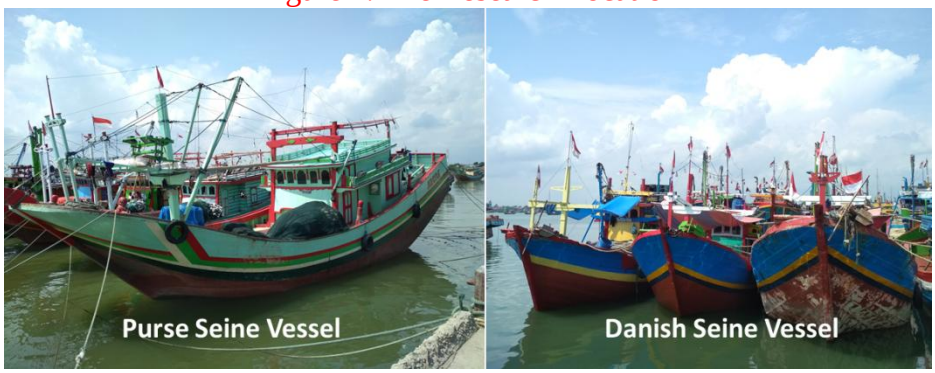


Figure 2. Purse Seine Vessel and Danish Seine Vessel

3.2. The Collecting Data

This research used statistical data on capture fisheries in Rembang Regency issued by the Maritime and Fisheries Office (government agency, namely 'Dinas Kelautan dan Perikanan' or DKP) of Rembang Regency, i.e. production and fishing gears, both purse seine and Danish seine in 2010-2017. We were also survey and interview to purse seine fishermen (30 respondents) and Danish seine fishermen (30 respondents). We collected information about costs of capture fisheries business, and price of fish. The survey was conducted in April-May 2019.

3.3. The Research Model

We developed our bio-economic model based on the Gordon-Schaefer model. One of the assumptions of the Gordon-Schaefer model is single gear, and we modified to a multi-

gears model in case of Danish seine and purse seine. If both Danish seine and purse seine fisheries production are affected by the effort of Danish seine and purse seine, then the equation is as follows (modified from Wijayanto, et al, 2019):

$C_{PS} = a.E_{PS} - b.\ E_{PS}^2 - e.E_{DS}$ (1)

$C_{DS} = f.E_{DS} - g.\ E_{DS}^2 - h.E_{PS}$ (2)

C_{PS} is purse seine production (kg), C_{DS} is Danish seine production (kg), E_{PS} is purse seine effort (unit), and E_{DS} is Danish seine effort (unit). While a, b, e, f, g and h is a constant. Equation (1) can be modified become equation (3):

$E_{DS} = {}^{a}/_{e}\ E_{PS} - {}^{b}/_{e}E_{PS}^2 - {}^{1}/_{e}C_{PS}$ (3)

If equation (3) is embedded in equation (1), then the maximization ($dC_{DS} / dE_{DS} = 0$) can generate equation (4):

$E_{DS}^* = f/2g$ (4)

E_{DS}^* is the number of Danish seine (unit) that produce maximum production if the number of purse seine (unit) is equal to zero. Equation (4) is identical to the C_{MSY} (production at maximum sustainable yield) in the Gordon-Schaefer model. Likewise, the process of maximization in purse seine will produce equation (5).

$E_{PS}^* = a/2b$ (5)

E_{PS}^* is the number of purse seine (unit) that produce maximum production if the number of Danish seine (unit) is equal to zero. If C_{PS} in equation (1) and C_{DS} in equation (2) are combined into C_{PSDS} (kg), then equation (6) is produced. The optimization process of equation (6), i.e. $dC_{PSDS}/dE_{PS} = 0$ and $dC_{PSDS}/dE_{DS} = 0$, could generate equation (7) and (8):

$C_{PSDS} = C_{PS} + C_{DS} = (a-h).E_{PS} - b.\ E_{PS}^2 + (f- e).E_{DS} - g.\ E_{DS}^2$ (6)

$E_{PS}^{**} = a-h\ /\ 2.b$ (7)

$E_{DS}^{**} = f-e\ /\ 2.g$ (8)

E_{PS}^{**} is the number of purse seine (unit) that produce maximum production if there is a Danish seine and purse seine reciprocal relationship. E_{DS}^{**} is the number of Danish seine (unit) that produce maximum production if there is a reciprocal relationship between the Danish seine and purse seine. If equations (7) and (8) are included in equation (5) can generate equation (9), i.e. C_{PSDS}^{**} as maximum production of combined Danish seine and purse seine:

$$C_{PSDS}^{**} = \frac{a^2-2.a.h+h^2}{4.b} + \frac{e^2-2.e.f+ef^2}{4.g} \quad (9)$$

Then, we did the profit maximization. If each of fishing gears does not influence each other (or one of the gears is zero), then the profit equation uses equations (10) and (11).

$\Pi_{DS} = C_{DS}.p_{DS} - E_{DS}.c_{DS}$ (10)

$\Pi_{PS} = C_{PS}.p_{PS} - E_{PS}.c_{PS}$ (11)

Π_{PS} is the profit of a purse seine if the number of Danish seine is equal to zero (IDR per year). Π_{DS} is profit of Danish seine if the number of purse seine is equal to zero (IDR per year). Notation p_{PS} is the price of fish caught by purse seine (IDR per kg, and p_{DS} is the price of fish caught by Danish seine (IDR per kg). Notation c_{PS} is the cost of purse seine (IDR per unit per year), and c_{DS} is the cost of Danish seine (IDR per unit per year). The cost components include fuel, consumption, asset depreciation, asset maintenance, licences, retribution or tax and remuneration, with standardized units in IDR per year. Purse seine and Danish seine catch several types of fish (multi species), but our model used the assumption of single species and single price. We used proportional average fish prices as a single price.

$p_{PS} = \sum_i^n p_i.s_i$ (12)

$p_{DS} = \sum_j^m p_j.s_j$ (13)

Notation p_i is the price of fish (IDR per kg) of the type i caught by purse seine, while n is the number of fish species caught by purse seine. Notation s_i is the biomass proportion of type i fish compared to the total biomass of purse seine fish catch (%). Notation p_j is the price

of fish (IDR per kg) of type j caught by Danish seine, while m is the number of species of fish caught by Danish seine. Notation of s_j is the biomass proportion of fish type j compared to the total biomass of fish caught by Danish seine (%).

The combination Π_{DS} in equation (10) and Π_{PS} in equation (11) produces equation (14), i.e. Π_{PSDS} as follows:

$$\Pi_{PSDS} = p_{DS}.f.E_{DS} - p_{DS}.g.E_{DS}^2 - p_{DS}.h.E_{PS} - E_{DS}.c_{DS} + p_{PS}.a.E_{PS} - p_{PS}.b.E_{PS}^2 - p_{PS}.e.E_{DS} - E_{PS}.c_{PS} \quad (14)$$

Π_{PSDS} is the aggregate profit of purse seine and Danish seine fisheries business if the two fishing gear have an interrelated relationship (IDR). The process of maximizing profits used d $d\Pi_{PSDS} / dE_{DS} = 0$ and $d\Pi_{PSDS} / dE_{PS} = 0$ that generate equations (15) and (16):

$$E_{DS}*** = (p_{DS}.f - c_{DS} - p_{PS}.e) / (2.p_{DS}.g) \quad (15)$$

$$E_{PS}*** = (p_{PS}.a - c_{PS} - p_{DS}.h) / (2.p_{PS}.b) \quad (16)$$

$E_{PS}***$ is the number of purse seine (unit) that produce maximum profit (Π_{PSDS}) if there is a reciprocal relationship between Danish seine and purse seine. $E_{DS}***$ is the maximum number of Danish seine (unit) that produce maximum profit (Π_{PSDS}) if there is a reciprocal relationship between Danish seine and purse seine.

If equation (14) is optimized but in condition of $E_{DS} = 0$, then $C_{DS} = 0$ and the constants f, g and h are also zero, so that equation (17) is identical to E_{MEY} in the Gordon-Schaefer model. Similarly, the optimization of equation (14) with $E_{PS} = 0$ will produce equation (18):

$$E_{PS}**** = (p_{PS}.a - c_{PS}) / (2.p_{PS}.b) \quad (17)$$

$$E_{DS}**** = (p_{DS}.e - c_{DS}) / (2.p_{DS}.f) \quad (18)$$

$E_{PS}****$ is the number of purse seine (unit) that produce maximum profit of purse seine (Π_{PS}) if $E_{DS} = 0$ and $C_{DS} = 0$. $E_{DS}****$ is the number of Danish seine (unit) that produce maximum profit of Danish seine (Π_{DS}) if $E_{PS} = 0$ and $C_{PS} = 0$

Result and Discussion

The progress of Danish seine and purse seine fisheries can be seen in Figure 3. Purse seine fisheries are concentrated in the Fish Landing Place of Sarang, Pandangan and Kragan, and also in Coastal Fishing Port of Tasikagung. Purse seine vessels based in Rembang Regency have a length of 10.0-16.5 m, use 2 engines (60-190 HP), and lamps of 7000-18000 watts, i.e. mercury and halogen lamp (Wiyono and Hufiadi, 2014). Whereas Danish seine fisheries are concentrated in Coastal Fishing Port of Tasikagung. 'Cantrang' in Indonesia is a Danish seine that has been modified, therefore similar to trawl (CEA, 2018).

Fishing ground of Danish seine and purse seine from Rembang Regency in Java Sea, where include in Fisheries Management Area (FMA) of 712. This is consistent with the results of interviews with respondents. Minister of Maritime and Fisheries Affair in 2015 had banned trawl and seine net operations (including Danish seine) through Ministerial Regulation No. 2/2015 because it is considered not environmentally friendly. However, the policy experienced pros and cons. Danish seine fishermen protest the ban of Danish seine operation (CEA, 2018), including Danish seine fishermen from Rembang Regency.

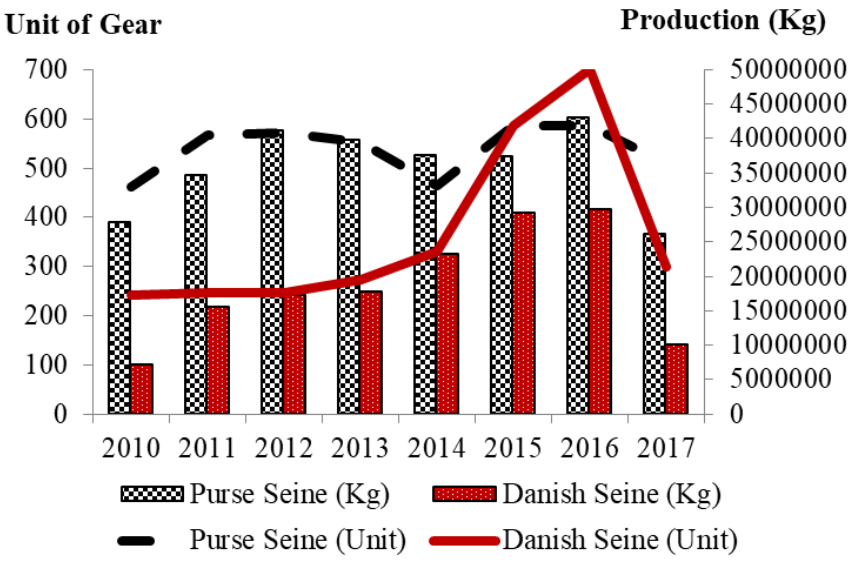


Figure 3. The Progress of Purse Seine and Danish Seine in Rembang Regency

4.1. Costs and Revenue

Based on the interviews results, an average of costs, fish prices and revenues of Danish seine and purse seine fisheries could be seen in Table 1. The size of Danish seine vessels in Rembang Regency is 50 to 80 GT (gross tons) with an investment cost of IDR 700 million to 850 million (an average of IDR. 765 million). While the size of purse seine vessels in Rembang Regency is 25 to 30 GT (an average of 29 GT) with an investment cost of IDR. 500 million to 650 million (an average of IDR. 580 million). All costs including investment costs were then converted into units of IDR per trip in the bioeconomic analysis (using equations 10 to 18). The average fish price of purse seine fishing gear is higher than Danish seine. Fish caught by Danish seine has a lower price because the partial of fish is under size and the fish is destroy (Wijayanto, et al, 2019).

Table 1. Average Costs, Revenues and Fish Prices

Income, Fish Price and Cost	Danish Seine	Purse Seine
Gross Income (IDR per trip)	154,844,625	42,662,746
Harvest (tons per trip)	30	4
Fish price (IDR per kg)	5,161	10,666
Trip per years	8	32
Total cost per trip (IDR per trip)	139,311,835	35,158,334
Vessel depreciation (IDR per trip)	6,379,167	1,209,077
Main machine depreciation (IDR per trip)	658,750	327,009
Supporting machine depreciation (IDR per trip)	447,500	40,402
Fishing gear depreciation (IDR per trip)	486,875	1,399,554
Fishing aids depreciation (IDR per trip)	402,500	98,438
Vessel maintenance (IDR per trip)	5,815,625	181,052
Machine maintenance (IDR per trip)	2,097,500	181,845
Fishing gear maintenance (IDR per trip)	931,250	1,016,865
Fishing aids maintenance (IDR per trip)	245,000	86,409
Diesel fuel (IDR per trip)	16,347,500	3,412,500
Oil (IDR per trip)	1,125,000	1,660,714
Consumption of crews (IDR per trip)	51,300,000	8,232,143

Income, Fish Price and Cost	Danish Seine	Purse Seine
Licences and administration (IDR per trip)	2,296,875	500,496
Harvest tax (IDR per trip)	7,742,231	2,133,137
Profit sharing for crews (IDR per trip)	43,036,063	14,678,694

Notes: assuming the economic life for vessel of 15 years, machine of 10 years, and fishing gear of 5 years.

4.2. The Relationship of Danish Seine and Purse Seine

In this research, we made simulation using equations (1) and (2). To simplify the linearization process, so equation (1) were divided by E_{PS} and equation (2) is divided by E_{DS} can produced equation (20) and (22):

$$C_{PS} / E_{PS} = 273\,131 - 363\,E_{PS} - 35\,319\,(E_{DS} / E_{PS}) \quad (19)$$

$$C_{PS} = 273\,131\,E_{PS} - 363\,E_{PS}^2 - 35\,319\,E_{DS} \quad (20)$$

$$C_{DS} / E_{DS} = 188\,696 - 252\,E_{DS} - 35\,211\,E_{PS} / E_{DS} \quad (21)$$

$$C_{DS} = 188\,696\,E_{DS} - 252\,E_{DS}^2 - 35\,211\,E_{PS} \quad (22)$$

Based on equations (20) and (22), it is evident that the fishing effort of Danish seine influences (decreases) the production of purse seine fisheries, and vice versa. Several research results also showed that Danish seine (including mini trawl) and trawl influencing the productivity of other fishing gear (Adhawati, et al, 2017; Hammarlund, et al, 2018; Wijayanto, et al, 2019). That conditions need to be considered by the government to manage Danish seine and purse seine fisheries for the fishermen welfare in Rembang Regency, as well as the wider area. The study of Hammarlund et al (2018) also proved that two fishing gear with the same target can cause negative externalities. It is proven that a multi-gears bio-economic study is needed for the purposes of optimizing production and economy.

Purse seine productivity is influenced by factors of production, including time of trip, supplies and ice that will affect the operating costs of fishing (Wiyono and Hufiadi, 2014). Purse seine is also a productive fishing gear to catch tuna and other large pelagic fish, thus providing greater profit compared to pole and line, hand line and troll line fisheries, both in MSY (maximum sustainable yield) and MEY (maximum economic yield) conditions (Natsir, 2018). Purse seine is also proven to be an effective fishing gear to catch small pelagic fish compared to trawl and drift net (FAO, 2001).

By using equations (20) and (22), it can be simulated the production of purse seine and Danish seine, including if it is assumed that $E_{DS} = 0$ or $E_{PS} = 0$. The simulation showed that if $E_{DS} = 0$, it will make increased C_{PS}, and vice versa. However, the combination of E_{DS} and E_{PS} tends to produce higher amounts of C_{DS} and C_{PS} in aggregate production. That is due to a part of fish caught by purse seine and Danish seine is different types of fish. Simulation results from equations (20) and (22) can be seen in Table 2 and Figure 4.

Table 2. The Aggregate Production Simulation of Purse Seine and Danish Seine

Years	Unit of Purse Seine (E_{PS})	Unit of Danish Seine (E_{DS})	Production of Purse Seine (kg)	Production of Danish Seine (kg)	Production of Purse Seine (kg) if $E_{DS} = 0$	Production of Danish Seine (kg) if $E_{PS} = 0$	$C_{PS} + C_{DS}$ (kg)
A	B	C	D C_{PS} (E_{PS}, E_{DS})	E C_{DS} (E_{PS}, E_{DS})	F	G	H = D + E
2010	461	243	40 170 037	14 722 220	48 752 543	30 954 393	54 892 257
2011	568	246	29 313 614	11 150 612	38 002 077	31 150 339	40 464 226
2012	572	246	28 750 523	11 009 769	37 438 986	31 150 339	39 760 292
2013	553	272	30 403 437	13 186 728	40 010 193	32 658 293	43 590 165

Years	Unit of Purse Seine (E_{PS})	Unit of Danish Seine (E_{DS})	Production of Purse Seine (kg)	Production of Danish Seine (kg)	Production of Purse Seine (kg) if $E_{DS} = 0$	Production of Danish Seine (kg) if $E_{PS} = 0$	$C_{PS} + C_{DS}$ (kg)
2014	464	331	36 873 833	18 477 035	48 564 407	34 814 840	55 350 868

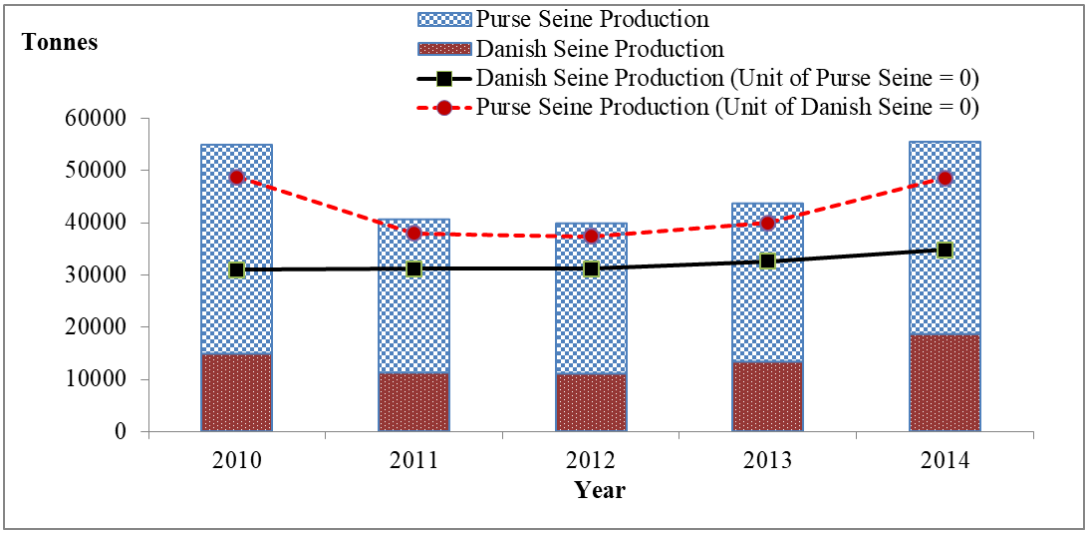


Figure 4. The Simulation of Purse Seine and Danish Seine Production

4.3. The Optimization of Production

By using equations (4), (5), (20) and (22), it can be estimated that the optimal fishing effort per fishing gear. The simulation result showed that when $E_{PS} = 376$ units can produce a maximum C_{PS}, which is 51,367 tons per year if it is assumed to be $E_{DS} = 0$. While the optimal E_{DS} at 374 units that can produce an optimal C_{DS}, which is 35,280 tons per year if $E_{PS} = 0$. By using equations (6), (7), (8) and (9), we can estimate the optimal combination of E_{PS} and E_{DS} that produce optimal C_{PS} and C_{DS} in aggregate, namely $E_{PS} = 328$ units and $E_{DS} = 304$ units which will produce an aggregate production of 62,286 tons per year. Simulation of purse seine and Danish seine production can be seen in Table 3 and Figure 5.

Table 3. The Aggregate Production Optimization Simulation

	E_{PS} (units)	E_{DS} (units)	C_{PS} (tonnes)	C_{DS} (tonnes)	$C_{PS} + C_{DS}$ (tonnes)
Scenario 1	0	374	0	35 280	35 280
Scenario 2	376	0	51 367	0	51 367
Scenario 3	328	304	39 779	22 507	62 286

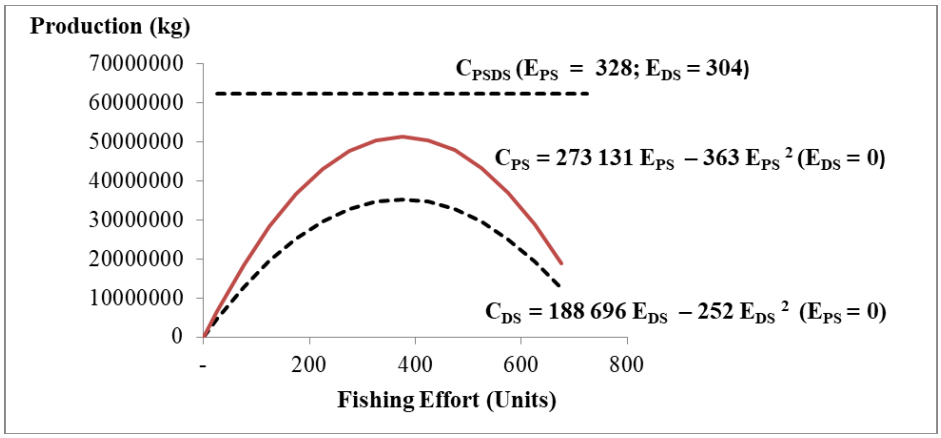


Figure 5. The Optimization Simulation of Purse Seine and Danish Seine Production

The combination of purse seine and Danish seine in scenario 3 generate optimal production, because catches of purse seine and Danish seine are partly different. Elimination of one fishing gear (purse seine or Danish seine) will eliminate the production of certain types of fish. The most of aquatic animal catches from purse seine in Rembang Regency are *Decapterus macrosoma* Bleeker (shortfin scad), *Sardinella fimbriata* Valenciennes (fringescale sardinella), *Auxis thazard* Lacepède (frigate tuna), *Restrelliger brachysoma* Bleeker, *Selaroides leptolepis* Cuvier and *Loligo* sp (dominated by pelagic resources). *Decapterus macrosoma* Bleeker and *Sardinella fimbriata* Valenciennes are not caught by Danish seine. While *Restrelliger brachysoma* Bleeker, *Selaroides leptolepis* Cuvier and *Loligo* sp are also caught by Danish seine. The main catches of Danish seine are *Priacanthus tayenus* Richardson (purple-spotted bigeye), *Nemipterus hexodon* Quoy and Gaimard (ornate threadfin bream), *Lutjanus* spp, *Saurida tumbil* Bloch (greater lizardfish), *Leiognathus equulus* Forsskal, *Gerres* sp, *Caranx tille* Cuvier (tille trevally), *Netuma thalassina* Ruppel, *Gymnara* sp, grouper fish, *Selar crumenophthalmus* Bloch (bigeye scad), *Megalaspis cordyla* Linnaeus and *Trichiurus sp*. So the Danish seine catches are dominated by demersal fish. However, *Leiognathus equulus* Forsskal, stingray, *Selar crumenophthalmus* Bloch and *Trichiurus sp* are also caught by purse seine (Anggawangsa, et al, 2014; DKP Kabupaten Rembang, 2017).

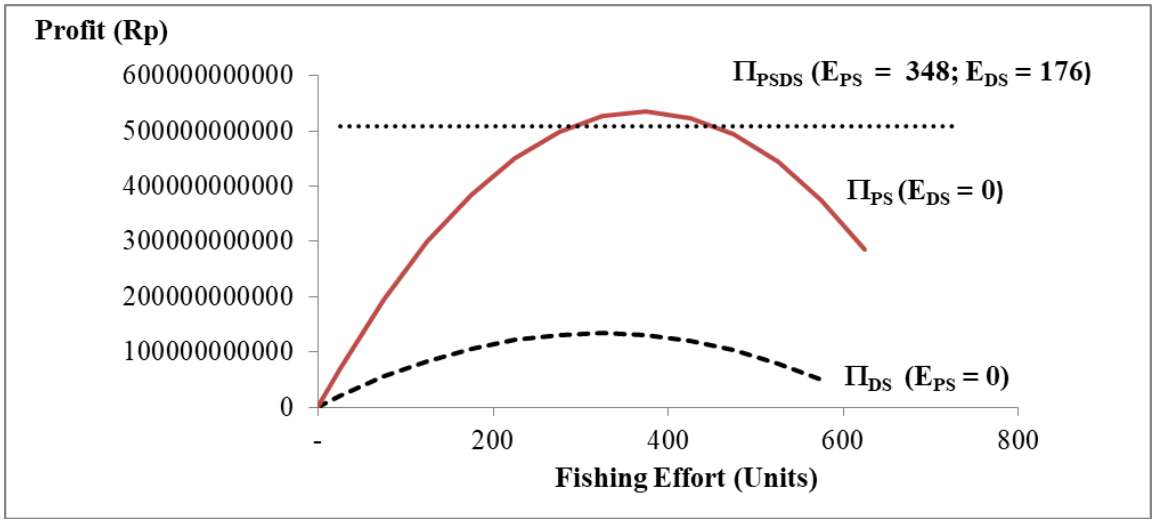
The fish resources caught in Java Sea have links between one type of fish and another. The relationship can be in the form of predator-prey, food and space competition and mutually beneficial relationships. Carnivorous fish will eat smaller fish. Large pelagic fish are generally carnivores (Anggawangsa, et al., 2014). Even some types of fish are cannibal, which is to eat a smaller type of fish, including *Trichiurus sp* (Bittar, et al, 2012). *Trichiurus sp* is known as fish that have a very broad geographical distribution, i.e. tropical waters (including Indonesia) and sub-tropical (Hsu, et al, 2009). *Selaroides leptolepis* Cuvier is small pelagic fish which live in groups, can reach an individual length of 20 cm and is indicated to have been overfishing in sea-waters of Banten, that is also part of FMA of 712 (Mayalibit, et al, 2014). Likewise, anchovies in the Malacca Strait bordering the Java Sea have also been overfishing (Tambun, et al, 2018). It is recommended to catch fish that can be caught larger than 11.9 cm in length (Sala, et al, 2018). While *Restrelliger brachysoma* Bleeker in the Java Sea is partly native to the Java Sea, i.e. partly comes from the South China Sea. *Restrelliger brachysoma* Bleeker from the South China Sea migrates to the Java Sea, but is not found in sea-waters of Banyuwangi or the eastern end of the Java Sea (Indaryanto, et al, 2015). Squid include positive photo taxis that is attracted to the light used in purse seine operations. *Leiognathus equulus* Forsskal live in groups in sandy or muddy sand at a depth of 10-50 m. *Leiognathus equulus* Forsskal has high growth and recruitment. The main food of *Leiognathus equulus* Forsskal is copepod (zooplankton) and phytoplankton (Prihatiningsih, et al, 2014).

4.4. The Optimization of Profit

We used equations (10), (11), (12), (13), (14), (15), (16), (17) and (18) to develop scenarios for optimizing the profitability of Danish seine and purse seine fisheries businesses. The simulation results can be seen in Table 4 and Figure 6. The simulation showed that $E_{DS} = 0$ will produce greater aggregate profit than $E_{PS} = 0$. This happens because the value of production and fish price of Danish seine is small compared to the fish price of purse seine.

In the case of the Tegal region (a distance of 277 km from Rembang Regency), the Danish seine operation has a negative impact on gill net production. The average of gill net production loss was 3,814 tonnes per year. The loss production of gill net can be replaced by

Danish seine production, but the loss value of gill net production (in IDR) is greater than Danish seine production value (Wijayanto, et al, 2019).



Note: Assuming fish price that caught by Danish seine is IDR 5,161per kg, and by purse seine of IDR 10,666 per kg, and also cost per trip of Danish seine is IDR. 139,311,835 and purse seine of IDR. 35,158,334.

Figure 6. The Profit Simulation of Purse Seine and Danish Seine

Table 4. The Aggregate Profit Optimization Simulation of Purse Seine and Danish Seine

	E_{PS} (units)	E_{DS} (units)	Π_{PS} (IDR Billions)	Π_{DS} (IDR Billions)	$\Pi_{PS} + \Pi_{DS}$ (IDR Billions)
Scenario 4	0	320	0	134	134
Scenario 5	370	0	427	0	535
Scenario 6	348	176	469	40	510

The combination of purse seine and Danish seine fisheries that produce maximum aggregate profit occurs if E_{DS} = 176 units E_{PS} = 348 units as win-win solution. To clarify, a simulation of E_{DS} and E_{PS} is conducted, with two scenarios, i.e. the first scenario E_{DS} fixed at 176 units, while the second scenario E_{PS} fixed at 348 units.

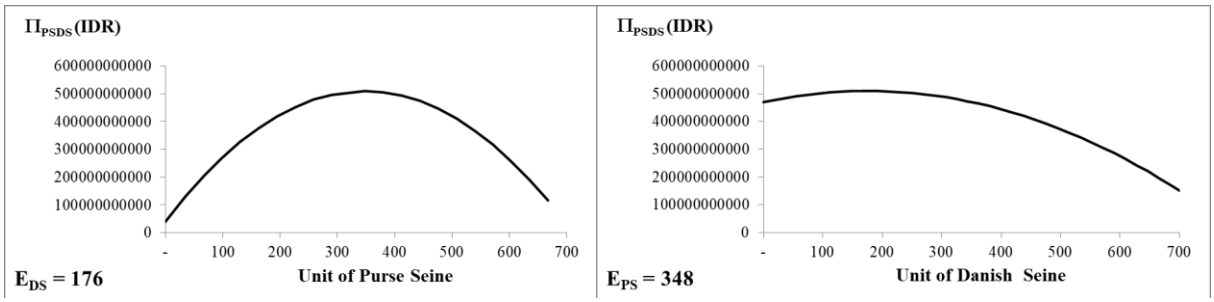


Figure 7. The Simulation of Two Optimization Profit Scenario

4.5. The Alternative Policy of Danish Seine and Purse Seine

Based on several simulations in scenarios 1 to 6, it can be seen the consequences in Danish seine and purse seine management. We can use the game theory approach. In the case of Danish seine and purse seine fisheries, it is similar to the game theory model of 'prisoner's dilemma', so there needs to be cooperation to optimize production and profits among actors,

both Danish seine and purse seine fishermen. Collaborative fisheries cooperation between actors has been proven to be able to optimize the benefits of each actor, including through fishing quotas (Campbell and Kennedy, 2010).

If the Rembang Regency government select control toward purse seine for the optimizing Danish seine fisheries, then purse seine fishermen will feel disadvantaged. Based on the characteristics of purse seine and Danish seine, the government tends not to take this scenario, because the Danish seine is considered controversial (not environmentally friendly). Several disadvantages of trawl (including modified Danish seine) are seafloor pressure, fuel use, and bycatch (Hammarlund, et al, 2018). Increased selectivity of fishing gear can affect the condition of fish resource stocks, both in quantity and distribution of age composition of fish (Prellezo, et al, 2017). FAO (2001) also suggests the need for trawling restrictions (licensing). In this study, it is evident that the results of the simulation of a decrease in fishing effort (especially modified Danish seine) can produce greater economic benefits.

If the Rembang Regency government prefer to control Danish seine fisheries for the purpose of optimizing purse seine fisheries, then Danish seine fishermen will have feel disadvantaged. In reality, Danish seine fisheries absorb workers not only fishermen, but also transportation service providers, transport workers, supply of Danish seine fisheries inputs and the fish processing industry. Whereas if the government does not regulate Danish seine fisheries and purse seine, then both parties do not get optimal benefits.

Therefore, it is recommended that the Rembang Regency government and the Indonesia government be able to use the optimization of a combination of Danish seine and purse seine fisheries. If government of Rembang Regency want to optimize aggregate production, then can use the combination of E_{DS} = 304 units and E_{PS} = 328 units. However, if government want to optimize aggregate profits, so can use the combination of E_{DS} = 176 units and E_{PS} = 348 units.

Policies to increase production related to improving food safety can be invalid in the medium and long term, although in the short term it can increase production. That is because overfishing can reduce production and increase business uncertainty in the medium and long term, which in turn will reduce income and food security (Maouel, et al, 2014). According to Kompas, et al (2007), a combination of policies is needed. Each alternative fish resources management policy has weaknesses. MEY as a target will not be optimal without the support of appropriate instruments (input control). TACs (total allowable catches) and ITQs (Individual Transfer Quotas) as input control cannot be optimized without an output target. Limiting the number of units will encourage fishermen to reproduce other fishing gears. Therefore, a combination of policies is needed.

Conclusion

This research proven that fishing effort of Danish seine has negative effect to purse seine production, and vice versa. The purse seine fisheries production function follows the equation: C_{PS} = 273 131 E_{PS} - 363 E_{PS}^2 – 35 319 E_{DS}, while the Danish seine fisheries production function follows the equation: C_{DS} = 188 696 E_{DS} - 252 E_{DS}^2 – 35 211 E_{PS}. The combination of E_{PS} = 328 units and E_{DS} = 304 units will produces an optimal aggregate of C_{PS} and C_{DS}, that is 62,286 tons per year. While the combination of E_{DS} = 176 units and E_{PS} = 348 units produces an optimal aggregate profit in win-win solution, that is IDR 510 billion per year, although this value is smaller than the optimization of the benefits of purse seine fisheries at E_{PS} = 370, E_{DS} = 0 and C_{DS} = 0 that produces profit of IDR 535 billion per year.

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Bio-economic Model of Danish Seine and Purse Seine Fisheries in Rembang Regency, Indonesia

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***Detailed Response to Reviewers**

Response to Reviewer 1:

1. The interview results of have been explained in the manuscript (see table 1).
2. Regarding suggestions for using LEK, we need to explain that our goal in conducting interviews was to obtain data on fishing costs and fish prices of purse seine and danish seine fisheries. Therefore we do not use the LEK method, but we will consider it for our further research.
3. Regarding suggestions for using ANCOVA and non-parametric tests, we did not do that because we put more emphasis on simulation models. Without being tested by ANCOVA or non-parametric tests, it has been seen that different scenarios produce different production and profits.
4. We have followed up on suggestions for vernacular names and names of authors.
5. Suggestions for adding photos have been followed up, but only photos of vessel. Adding more photographs of fish, fishing port and fishing gear will become too many photos in the manuscript.

Response to Reviewer 2:

1. Suggestions for adding methodology to abstract have been followed up.
2. Suggestions for sorting keywords in alphabetical order have been followed up
3. Suggestions for adding to the fishing ground and fishing gears literature on the introduction have been followed up
4. The questionnaire also covers the fishing ground area and has been explained in the results and discussion part
5. Operating costs can be seen in table 1.
6. Suggestions for adding citation to the discussion have been followed up.