



DOI: 10.22144/ctu.jen.2018.025

The fishing effort and stock biomass of trawl fishery in the South - East offshore waters of Vietnam

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Article info.

Received 02 Aug 2017

Revised 26 Nov 2017

Accepted 20 Jul 2018

Keywords

Fishing effort, Kobe Plot, South – East Offshore Waters, stock biomass, trawler

ABSTRACT

The data of the project: "Research on fluctuations and distributions of fishing effort in the South-East offshore waters of Vietnam" was used to analyze fishing effort and stock biomass status of trawler activities in the South-East offshore waters. The results showed that fishing effort and stock biomass of trawlers group over 250 hp power were overfished maximum sustainable level. The trawlers from 90 to 249 hp showed two different periods: The stage before 2010, stock biomass was overfished but fishing effort was not overfished. Otherwise, the stage after 2010, both fishing effort and stock biomass were overfished maximum sustainable level and trended to increase rapidly. For trawlers group under 90 hp, fishing effort had not been overfished but stock biomass crossed the threshold. In general, fishing status of all of trawls trend to deeply overfish both sides of fishing effort and stock biomass, the reducing number of trawler is recommended to remain sustainable stock biomass in the South-East offshore waters. Kobe Plot chart was used to assess fishing effort and stock biomass actuality in the survey years compared to maximum sustainable threshold and its fluctuation trend. There are important results for reference point to support managers issue decisions for fishing effort controlling to maintain and develop marine fish resource in the South - East offshore waters.

Cited as: Hung, D.X., 2018. The fishing effort and stock biomass of trawl fishery in the South - East offshore waters of Vietnam. Can Tho University Journal of Science. 54(5): 59-64.

1 INTRODUCTION

South - East Sea of Vietnam is considered as the main fishing ground of the whole nation, where most of the fishing activities are carried out in all year round. The trawlers in the coastal provinces of the South-East and surrounding areas are large - scale fishery, and impact strongly to the bottom fisheries resources in this area (Nguyen Van Khang, 2011). The assessment of current fishing effort and maximum sustainable yield in the South East offshore waters of Vietnam has been implemented by the project of "Research on fluctuations and distribution of fishing effort in the Southeast

offshore waters" in 2013 by Bui Van Tung. Bui Van Tung (2014) concluded that fishing effort of trawl fishery in the South - East offshore waters exceeded 56.3% of allowable yield. However, this conclusion is unspecific, it has not been showed the particular status of fishing effort and stock biomass. In the present situation, the fishing activities in the particular fishing ground should be considered in two aspects: the fishing effort and stock biomass. These two values indicate situation of fishing ground. In some cases, the fishing effort has not crossed the maximum sustainable fishing effort (f_{MSY}), but the biomass has exceeded the sustainable biomass because using unit to calculate fishing

effort in the particular study may not reflect the extent of impact on the fisheries resources rightly.

To assess the fisheries status, diagrammatizing the fishing effort and the biomass affected by that fishing effort was presented at the Regional Fisheries Management Organizations (RFMOs) tuna conference in Kobe (Japan), and the Kobe Plot software for two-sided analysis of resource - fishing was released (Victor Restrepo, 2011). This software was being widely used to describe the visually fishing effort and stock biomass status at the time of survey compared to maximum sustainable value. Kobe Plot was released three versions in the years of 2011, 2012 and 2014. The design and function are further improved according to request by worldwide users in the 3th version (Tom *et al.*, 2015). Kobe Plot was used to assess demersal fisheries status in Mediterranean and the Black Sea, the conclusion indicated that management strategy evaluation applied on hake showed that moving to maximum sustainable yield (MSY) will result in considerable

fluctuation in catches in the short-term though they will increase and stabilise over the longer-term (Scarcella *et al.*, 2014). In 2013, Scientific, Technical and Economic Committee for Fisheries (STECF) of European Commission has planed management for the Greek bottom trawlers, Kobe Plot was used to assess biomass dynamic model in the scientific report (STECF, 2013).

In this study, Kobe Plot software was used to evaluate and visually show the relation and current status of the stock biomass and fishing effort of trawl fishery in South East offshore waters of Vietnam in the period of 2008 - 2012.

2 MATERIALS AND METHODS

2.1 Study data

This article used data from the Project of "Research on fluctuations and distributions of fishing effort in the South - East Offshore Waters of Vietnam" (Bui Van Tung, 2013).

Table 1: Fishing effort (boat-day) of the trawl fishery by standard fleet

Trawler Group (hp)	Year				
	2008	2009	2010	2011	2012
≥ 250	4,160	4,811	5,252	5,408	5,622
150 – 249	292	283	483	867	1,037
90 – 149	194	190	320	382	378
50 – 89	199	82	204	217	237

(Bui Van Tung, 2014)

Table 2: Catch per unit effort (kg/boat-day) of trawlers from 2008 to 2012

Trawler Group (hp)	Year				
	2008	2009	2010	2011	2012
≥ 250	158.0	166.2	135.5	84.2	75.5
150 – 249	44.9	57.5	79.9	82.6	84.5
90 – 149	37.5	44.4	67.1	54.3	54.4
50 – 89	29.3	14.1	31.4	22.7	23.6

(Bui Van Tung, 2013)

Table 3: Maximum sustainable yield and the fishing effort of the trawl fishery

Trawler group (hp)	F _{MSY} (Boat-day)	MSY (tons)
≥ 250	3,600	664,005
150 – 249	593	122,491
90 – 149	336	44,614
50 – 89	486	27,996

(Bui Van Tung, 2011)

2.2 Study region

The study region is in South-East offshore waters, from 6°00 N to 11°30 N and from 105°00 E to the

outside border of Economic Exclusive Zone of Vietnam.

The provinces involved in the survey are Binh Thuan, Ba Ria – Vung Tau, Ho Chi Minh (Can Gio), Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Bac Lieu and Ca Mau.

2.3 Data analysis

2.3.1 Fishing effort and biomass

The ratio of biomass at surveyed year and sustainable biomass ($\frac{SB}{SB_{msy}}$) is replaced by the rate of catch per unit effort (CPUE) at the surveyed year

and the CPUE corresponding to the maximum sustainable fishing effort ($\frac{CPUE}{CPUE_{msy}}$) and indicated on the OX axis of the Kobe Plot diagram. Assuming fishing capacity of the fishing fleets does not change according to the surveyed year. The CPUE corresponding to the maximum sustainable fishing effort is calculated by the formula:

$$CPUE_{MSY} = \frac{MSY}{F_{MSY}}$$

The rate of fishing effort at the surveyed year and the maximum sustainable fishing effort calculated as $\frac{F}{F_{msy}}$ and also expressed on the OY axis of the Kobe Plot chart.

The hypothesis in this study is the bottom fish stock biomass status only is affected by fishing effort of trawl group predominantly.

This study assumes that, in the same time, the number of trawlers going out the area is equal to the number of trawlers getting in the area.

2.3.2 Kobe Plot software

The Kobe Plot chart (Victor Restrepo, 2011) consists of two axes of which the X axis represents mature fish biomass, related to sustainable biomass (B_{msy}), and the Y axis represents the mortality due to fishing associated with maximum sustainable fishing effort (F_{msy}). The chart allows for assessment both fishing effort and the biomass. A value less than 1.0 on the X axis means that the biomass is smaller than the sustainable biomass, i.e. the fisheries resource has been overfished. And, a value above 1.0 on the Y axis means that the fishing mortality is higher than the maximum sustainable fishing effort, i.e. it is overfishing.

The status of fishing effort and stock biomass is expressed in terms of the rate of the fishing effort at surveyed year compared to the maximum sustainable fishing effort and the rate of CPUE at the surveyed year compared to the CPUE corresponding to the maximum sustainable fishing effort (called maximum sustainable fishing productivity) on the Kobe Plot chart. This chart includes the OY axis representing $\frac{F}{F_{msy}}$ and the OX axis representing $\frac{CPUE}{CPUE_{msy}}$ with each axis value ranging from 0 to 2,

forming four distinct parts: the part of $\frac{F}{F_{msy}}$ and $\frac{CPUE}{CPUE_{msy}}$ values from 0 to 1, it indicates that not exceed the fishing effort threshold but exceed the stock biomass threshold; Area with $\frac{F}{F_{msy}}$ values from 0 to 1 and $\frac{CPUE}{CPUE_{msy}}$ values from 1 to 2, it indicates that the fishing effort and stock biomass have not crossed the threshold; the part of $\frac{F}{F_{msy}}$ and $\frac{CPUE}{CPUE_{msy}}$ values range from 1 to 2 to exceed the fishing effort threshold but not to exceed the stock biomass level and the $\frac{F}{F_{msy}}$ value ranging from 1 to 2 and $\frac{CPUE}{CPUE_{msy}}$ values ranging from 0 to 1 denote the threshold of both fishing effort and stock biomass.

Kobe Plot software's input data is an Excel file with the format "CSV (MS-DOS)" consisting of three columns in strict order: year column, $\frac{CPUE}{CPUE_{msy}}$ column and $\frac{F}{F_{msy}}$ column.

Kobe Plot software (version 3.0) works based on the R programming language.

The data is processed on Excel software before running on Kobe Plot software.

3 RESULTS AND DISCUSSION

3.1 Trawlers group over 250 hp

The chart showed that the trawlers group of over 250 hp was in part 4 of the diagram, it means that the trawlers group was overfished both stock biomass and fishing effort. In particular, CPUE in surveyed years was less than CPUE of maximum sustainable fishing effort. From 2009 to 2012, overfished level of stock biomass and fishing effort steadily increased (Figure 1). According to Bui Van Tung (2014), the fishing effort of over 250 hp trawler fleet in South-East waters exceeded f_{msy} . In this result, status of stock biomass and fishing effort were showed clearly in the diagram, but the stock biomass (SSB) did not appear visually in the results of Bui Van Tung (2014). Nguyen Van Khang (2011) also concluded that trawl fisheries of South East Waters overfished. In this study, for trawlers group of over 250 hp, trawl one - boat and two - boat groups were not separated, so fishing effort of one - boat group may be different of two - boat group.

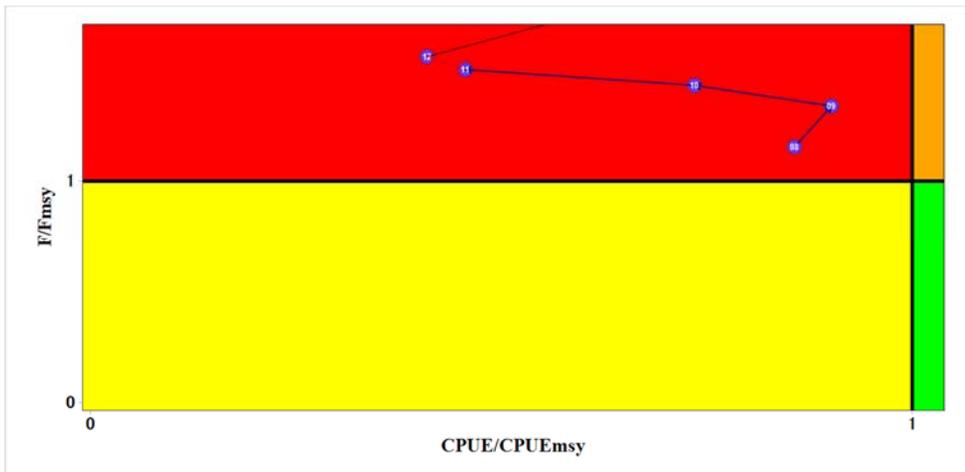


Fig. 1: Fishing effort and correspond stock biomass of trawlers group over 250 hp

3.2 Trawlers group from 150 to 249 hp

There was a difference of fishing operation status of trawlers group of 150 - 249 hp between 2008 - 2010 and 2011 - 2012. From 2008 to 2010, the fishing status of this trawl group was just over the stock biomass level and conversely, fishing effort has not ex-

ceeded the sustainable level yet. However, the fishing effort also increased rapidly in these years. In 2011, the fishing effort and stock biomass both overfished (Figure 2). For this trawler group, Bui Van Tung (2014) also showed that the fishing effort of 2012 exceeded f_{MSY} 334 boat - days, matched with this result, but it did not indicate biomass status and by group year too.

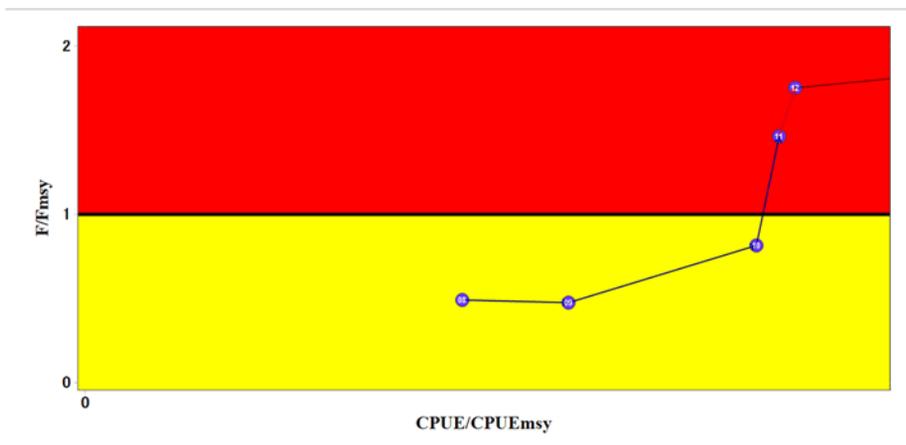


Fig. 2: Fishing effort and correspond stock biomass of trawlers group from 150 to 249 hp

3.3 Trawler group from 90 to 149 hp

For trawlers group of 90 to 149 hp, there is a similar situation with the group of 150 - 249 hp. However, in 2011 and 2012, almost the fishing mortality and fishing effort was unchanged. The sustainable crossing level was not far from the reference point. In

2012, overfishing situation occurred and the resource biomass has exceeded the allowable limit (Figure 3). For this trawler group, fishing effort and stock biomass status were also described more specifically than that of Bui Van Tung (2014). The fishing effort by year of trawler from 90 - 149 hp is raising sharply but the stock biomass has been declining seriously from 2010.

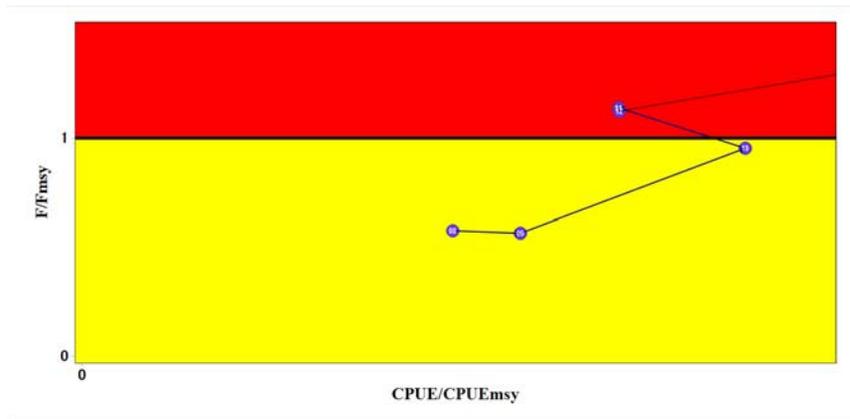


Fig.3: Fishing effort and the stock biomass of trawlers group of 90 to 149 hp

3.4 Trawlers group from 50 to 89 hp

For the trawlers group of 50 - 89 hp, the fishing effort did not exceed allowable fishing level but in terms of stock biomass crossed the sustainable in the period of 2008 - 2012. In conclusion of Bui Van Tung, the trawlers group exceeded f_{MSY} 189 boat - days in 2012, comparing to this result, the exceedance was indicated for stock biomass but not for fishing effort. So, the fishing effort of trawls group of under 89 hp should be cut down necessarily to ensure resource development.

There was strong variation in stock biomass in terms of CPUE and fishing effort between 2009 and other years (Figure 4). The conclusion of Bui Van Tung (2014) and Nguyen Van Khang (2011) is only in the status of fishing effort without the correlation presentation between fishing effort and stock biomass, so overfishing means that stock biomass is

over the sustainable level also. The Kobe Plot diagram illustrated both the resource biomass and the fishing effort status.

In this study, trawlers of less than 90 hp exhibited biomass excess even when the fishing effort was still within acceptable limits. However, fishing effort unit (boat – day) should be considered in this study, it does not show the intensity of fishing, technological factors, scale of fishery. Moreover, in the South East offshore waters, there is a lot of fisheries which catching in the same fishing ground, therefore, the reduction of the bottom fish biomass was not only effected by trawlers, also other fisheries (trap, bottom gillnet, etc) and other engine capacity trawlers group.

Moreover, division of the power group as this study may be affected to assess impact of each trawlers group to stock biomass, because many trawlers groups be able to catch same fishing group.

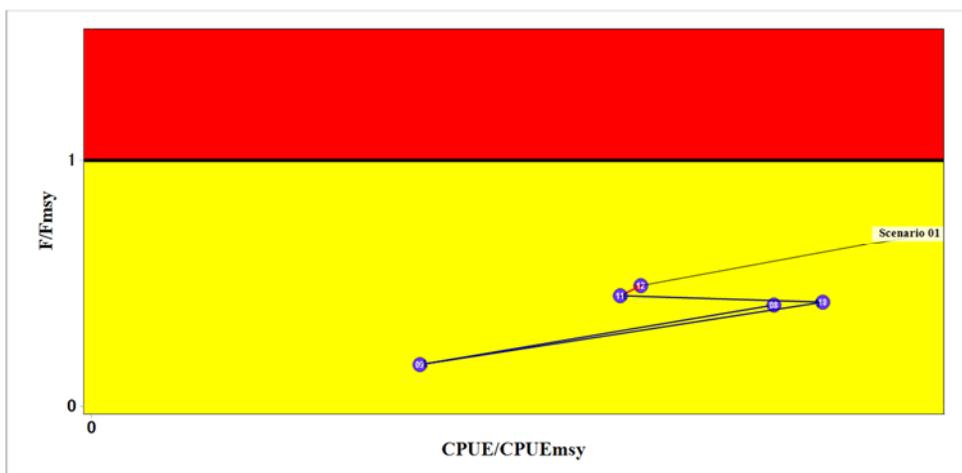


Fig. 4: Fishing effort and the stock biomass of trawlers group of 50 hp to 89 hp

Using the Kobe Plot chart, it is possible to assess both the fishing effort and the stock biomass status of the trawl fishery. The chart also predicts the trend

of fishing activity of the trawl fishery in the following years. In this trawlers group, the result indicated that the fishing effort increases continually and the

resource has trend of development. The trawlers group should be studied more cautiously to affirm fishing effort level suitable with sustainable stock biomass.

4 CONCLUSIONS AND RECOMMENDATIONS

In general, the fishing effort and the corresponding resource of the trawlers in the South East offshore Waters of Vietnam are overfished. However, specific consideration in each fleet manifests different levels. With trawlers group of over 250 hp, the fishing overfished both of fishing effort and stock biomass. For trawlers of 90 hp - 249 hp, at the first stage stock biomass exceeded the sustainable level but the fishing capacity had not exceeded yet the allowable catch level but after 2010 both fishing effort and stock biomass exceeded the sustainable level. Particularly, for the trawlers group with the capacity of less than 90 hp, the status of the stock biomass exceeded the threshold and tends to recover but the fishing effort had not exceeded the level yet. However, the fishing effort tends to increase strongly in the following years, more studies need conducting to identify sustainable fishing effort for each trawlers group to ensure resource recovery.

The results assessed the stock biomass status and fishing effort in the South East offshore waters in the period of 2008-2012 by Kobe Plot diagram as a management tool for fisheries managers. However, it is necessary to study the new data from 2013 to 2017 to provide timely basis for making appropriate management decisions.

The division of trawler capacity groups, will have problems like biomass (fishing grounds) that will not correlate with the power group because of the

fishing status of erroneous fishing area and the fishing grounds.

The activity of other fisheries also impacts on fishing ground of bottom trawl fishery in the South-East offshore waters, therefore, to make a base for cutting down number of trawlers, the other fisheries also should be studied as a recommendation in this report.

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