Analysis of Environmentally Friendly Skipjack Tuna Fishing Gears In West Band Sea, Indonesia

Muslim Tadjuddah

1Department of Fisheries Capture, Fisheries and Marine Sciences Faculty, University of Halu Oleo, Kendari, Southeast Sulawesi Province, Indonesia.

Received 18 December 2016; Accepted 12 February 2017; Available online 20 February 2017

ABSTRACT

Background: Selection of a superior and environmentally friendly of fishing technology in the region waters dependent on natural factors. Choosing the right fishing technology, effective, efficient, economical and sustainable and does not damage the ecosystem is a must this time, but it is quite difficult because of the many factors that influence it so difficult making the right decision. Objective: This study aims to determine the skipjack tuna fishing gear selected with criteria based on biological, technical, social, economic and environmental friendliness aspects, to analysis of environmentally friendly skipjack tuna fishing gears, to achieve these objectives used multi-criteria analysis approach (MCA) with the scoring method used to establish priorities skipjack tuna fishing gears elected environmentally friendly. Results: Based on the analysis of biological aspects indicate that pole and line fishing gear is ranks first priority, hand line and purse seine fishing gears are on the second and third priorities. Social aspects indicate that fishing gear which ranks the first is pole and line, the second is hand line and the third is purse seine. Aspects economic indicate pole and line is first priority, the second hand line and the third is purse seine fishing gears. Technical aspects of fishing gear that is hand line first priority, secondly pole and line and the third is purse seine fishing gear. After analyzing of the fifth aspect, showing that the hand line fishing gear is a gear of the most superior in comparison to purse seine and pole and line in exploiting the potential skipjack tuna. The advantage of hand line fishing gear, especially in the economic and technical aspect. While the second seeded namely pole and line fishing gear with an edge on the biological, social and environmental friendliness aspects, while purse seine ranked third. Conclusion: Value functions from the fifth aspect analysis (biology, economy, technical, social and environmentally friendly aspect) of the fishing gears that first priority to be developed is hand line and pole and line fishing gear, the second priority is purse seine fishing gear. Pole and line and hand line fishing gear can be developed simultaneously, because pole and line fishing gear excelled in the biological and social aspects while hand line fishing gear excel on technical and economic aspects in explore the potential skipjack tuna in the western Banda Sea. As for the environmental friendliness aspect both of these fishing gear has the advantage almost same. Based on value of the aspect of environmental friendliness, pole and line and hand line fishing gear can be grouped into a less friendly to the environment while the purse seine and can be grouped into fishing gear which is not environmentally friendly.

KEYWORDS: Fishing gears, pole and line, purse seine, hand line, west banda sea

INTRODUCTION

Choosing the appropriate fishing technologies, effective, efficient, economical and sustainable and does not damage the ecosystem is a necessity today, but it is quite difficult because of the many factors that influence it so that complicates the decision-making right. Choosing fishing technology ahead of a fishing gear in waters heavily dependent on natural factors, such as: 1) type and abundance of fish.2) spread of fish resources, 3) acreage,
location and physical state of the fishing environment. According to [2], fishing technology environmentally-friendly is fishing gear that does not impact the environment, does not damage the seabed (benthic disturbance), possible loss of small fishing gear, as well as its contribution to lower pollution meanwhile [6] suggests that the development of fisheries activities is generally done to increase the production and productivity of fisheries itself, by increasing the income of farmers and fishermen, increasing gross domestic product (GDP), foreign exchange, improving nutrition and employment.

In relation to supply protein for the people of Indonesia, the absolute requirement that must be met by a unit of fishing to be developed is to have productivity per fisherman per year is quite high, but still can be accounted biologically and economically. On other hand an analysis to assess level of environment friendliness and to determine the superior fishing gears as well sustainable exploitation in skipjack tuna on-site research has not been done location research. Whereas according to [15] in order to optimize utilization of fish resources sector in water area required a consideration of the type of fishing gear to be used and should not damage the marine resources and ecosystems. Destructive fishing gears should be limited and replaced with fishing gear more environmentally friendly. In West Banda Sea the skipjack tuna caught using fishing gear: pole and line, purse seine and hand line.

Based on this background, for guidance in the development of skipjack tuna fishing gear unit by which environmentally friendly and sustainable required an information as the basis for stakeholders in taking a decision. This study aims to determine the skipjack tuna fishing gear selected with criteria based on biological, technical, social, economic and environmental friendliness aspects, to analysis of environmentally friendly skipjack tuna fishing gears. The benefits of this research are expected (1) to provide information about level of environmentally friendly fishing gears by which superior and sustainable exploitation of resources of skipjack tuna in the study site, (2) as material information to the parties in determining the policy on the use of tuna at the sites. Both as a reference for further research in the development of science and technology in the field of management of tuna fisheries in the western Banda Sea.

**Methodology:**

The study was conducted during three months from March - May 2015. Data collection was carried out on two sample locations, firstly: In Kendari ocean fishing port for sampling purse seine and pole and line fishing gears and Langara Bajo village in island Wawonii designated as the location to get data hand line fishing gear.

Data collection was conducted using survey and direct observation in the study site focused on the centers of skipjack tuna fishery activities. Data was obtained through interviews with fishermen and direct observation of fishing units in the field by using a questionnaire, which has been prepared in accordance with the purposes of analysis and research purposes. The number of samples was observed 20% of the population of fishermen catching skipjack tuna in the research sites.

Object of research is a unit of fishing the dominant catch of skipjack tuna and still active at the time, respondents were collected by purposive sampling that is by ensuring obtaining a representative sample of the population to be studied [12] by way of each sample fishermen were given a brief understanding the questions that will be given in the questionnaire to the perception of any questions. The number of respondents overall were 30 people: 10 fisherman purse seiner, 10 fisherman pole and line and 10 fisherman hand line. To strengthen the information about the general skipjack tuna fisheries in the study site were collected secondary data obtained from the Central statistics agency of Southeast Sulawesi Province, Department of Fisheries and Marine Resources Konawe Islands regency and literature review of the research that has been done.

A multi criteria analysis (MCA) with the scoring method used to assign priority tuna fishing unit selected. Scoring method can be used to study the criteria that have different units. Scoring is given to the lowest to highest value. For the highest score given order of priority 1, and vice versa. In assessing all the criteria the exchange rate, so that all have the same standard value. Type of fishing gear that received the highest score means better than the other, and vice versa. Standardization with value function can be performed by using formula of [4] as follows:

\[
SV_{ij} = \frac{X_{ij} - \text{Min}X_j}{\text{Max}X_j - \text{Min}X_j}
\]

**Information:**

\(SV_{ij}\): the value of standardized indicators for - \(j\) fishing gear - \(i\) or fish resources-\(i\)

\(X_{ij}\): value of indicator- \(j\) for fishing gear -\(i\),fish-\(i\)

\(\text{Min}X_i\): minimum value of criteria -\(j\)

\(\text{Max}X_j\): maximum value of criteria \(j\)

Based on the indicators measured made composite index. Each variable in each of the indicators is assumed to have the same weight (\(W=1\)) so that the final scores for each indicator are:
\[ \text{NK}_i = \sum_{y=1}^{m} \text{SV}_y \]

Information:
- NKI : composite values for the indicator j
- SVyi : the value of all standardization variable y in the domain of the i
- m : the number of variables in the domain of the i

Data collection of fishing gear selection is done to get the type of fishing gear that has the performance was good in review of aspects of biological, technical, social, economic and environmental friendliness. In determining the selection of fishing gear technology in the utilization of skipjack tuna in the Western Banda Sea, survey data is evaluated through a multi criteria analysis (MCA) as follows:

Biological aspects of emphasis on four criteria: composition of the catch (X1), size of the catch (X2), condition of the catch (X3). Technical aspects, is analyzed to determine the effectiveness of the fishing gear used, include: size of the boat or ship (X1), fuel consumption per day (X2), use of fishing gear (X3), material fishing gear and production of catch per day (X4). Social aspects include: number of fishermen who absorbed per unit of fishing gear (X1), materials for the manufacture of fishing gear easily available or not (X2). Economic aspect, this analysis is intended to look at the feasibility of each gear skipjack: profit per year (X1), revenue cost ratio (X2), and the break-even point (kg) (X3).

Aspects of environmental friendliness, assesses the environmental friendliness based on standards of environmental friendliness fishing gear according to [6] and [9] that the fishing gear is said to be environmentally friendly if they meet nine criteria include: having a high selectivity (X1), does not damage the habitat (X2), producing fish of high quality (X3), does not harm the fishermen (X4), production is not harmful to consumers (X5), by-catch low (X6), low impacts to biodiversity (X7), does not harm the fish are protected (X8), acceptable socially (X9). Priority of each criterion fishing unit is determined based on the highest scoring, meaning that the higher the value of the scoring of the criteria of a gear then the greater priority, with the highest score is 4 and the lowest is 1. Assessment is based on the results of questionnaires and interviews with the respondents.

Result:
Fishing gears of skipjack options:
Analysis skipjack tuna fishing gear selection is performed to determine priorities fishing gear, superior and sustainable eligible to be developed in the utilization of skipjack. The third fishing gears is analyzed based on the reviews aspects of biological, technical, social, economic and environmental friendliness.

Assessment of biology aspects:
Analysis of the biological aspects is done to see if the type of fishing gear that is used to exploit skipjack tuna in western Banda Sea can damage the resource or not. Assessment biology aspects focused on three criteria, namely the composition of catches, fish size and condition of the catch. Overall data obtained from observations and interviews with fishermen skipjack tuna research location. Results scoring and standardization of the biological function, value of the third aspect of fishing gears unit can be presented in Table 1. Each criterion is given the priority order and the order of priority for each of these criteria has a different value.

<table>
<thead>
<tr>
<th>Fishing gear Unit</th>
<th>Assessment criteria</th>
<th>V(A)</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole and Line</td>
<td>X1 0.25 X2 1 X3 0.16</td>
<td>1.41</td>
<td>0.47</td>
<td>1</td>
</tr>
<tr>
<td>Purse seine</td>
<td>&gt;3 minor damage</td>
<td>0.51</td>
<td>0.17</td>
<td>3</td>
</tr>
<tr>
<td>Hand line</td>
<td>X1 0.125 X2 0.714 X3 0.16</td>
<td>0.999</td>
<td>0.333</td>
<td>2</td>
</tr>
</tbody>
</table>

Information:
- X1 = Composition of the catch
- X2 = Size of the catch (cm)
- X3 = Condition of the catch
- V(A) = Function of the value of alternative A, the number of V_i(X_i)
- UP = Priorities in order
Based on the scoring result of the analysis of biological aspects indicate that the fishing gear pole and line ranks first priority of the next gear hand line and purse seine are on the second and third priorities with the composition of the catch pole and line and hand line only skipjack tuna only, while the catch purse seine more than two fish species.

Viewed from size criteria catches indicate pole and line and hand line fishing gear capable to catching skipjack tuna with large size namely more than 41-50 cm and more than 50 cm while purse seine relatively small size of less than 30 cm to 30-40 cm. From these results indicate pole and line, hand line fishing gear is more superior when compared with purse seine.

Criteria condition of fish caught by pole and line and hand line fishing gear has same condition, namely in fresh fish conditions, meanwhile for purse seine catches damaged condition. After standardization based on the overall function of the values obtained indicate that pole and line fishing gear is occupies the first priority, second hand line and the third purse seine.

**Assessment of technical aspects:**

Analysis on the technical aspect in determining choice of skipjack tuna fishing gear is related to the technical operation of the fishing gear, technical aspects examined whether effective or not. The criteria used boat or vessel size, fuel consumption per trip, duration of use of fishing gear, fishing gear materials, production per trip, easy to using fishing gear. Value of the skipjack tuna fishing unit can be seen in Table 2.

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th>Fishing gear</th>
<th>Unit</th>
<th>V(A)1</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole and Line</td>
<td>V1 X1</td>
<td>1</td>
<td>0.25</td>
<td>0.33</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>V2 X2</td>
<td>2</td>
<td>0.25</td>
<td>0.33</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>V3 X3</td>
<td>3</td>
<td>0.25</td>
<td>0.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>V4 X4</td>
<td>4</td>
<td>1</td>
<td>0.375</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>V5 X5</td>
<td>5</td>
<td>1</td>
<td>0.375</td>
<td>4</td>
</tr>
<tr>
<td>Hand line</td>
<td>V1 X1</td>
<td>1</td>
<td>0.25</td>
<td>0.33</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>V2 X2</td>
<td>2</td>
<td>0.25</td>
<td>0.33</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>V3 X3</td>
<td>3</td>
<td>0.25</td>
<td>0.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>V4 X4</td>
<td>4</td>
<td>1</td>
<td>0.375</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>V5 X5</td>
<td>5</td>
<td>1</td>
<td>0.375</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fishing gear Unit</th>
<th>Assessment criteria</th>
<th>Unit</th>
<th>X1</th>
<th>X2</th>
<th>V(A)1</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole and Line</td>
<td>V1X1</td>
<td>0.33</td>
<td>1</td>
<td>3</td>
<td>1.33</td>
<td>0.665</td>
<td>1</td>
</tr>
<tr>
<td>Purse seine</td>
<td>V2X2</td>
<td>0.125</td>
<td>2</td>
<td>4</td>
<td>0.455</td>
<td>0.2275</td>
<td>3</td>
</tr>
<tr>
<td>Hand line</td>
<td>V3X3</td>
<td>0.25</td>
<td>3</td>
<td>7</td>
<td>1.25</td>
<td>0.625</td>
<td>2</td>
</tr>
</tbody>
</table>

Based on the results of scoring and standardize the function values based on the technical aspects of fishing gear that is hand line first priority, secondly pole and line and the third is purse seine fishing gear. This shows that pole and line most effectively to using the material of fishing gears and most efficient for catching skipjack tuna in west Banda Sea.

**Assessment of social aspects:**

Analysis on the social aspect in determination of fishing gear skipjack tuna selection in this study was associated with several factors, including, total employment of fishermen in each fishing unit, procurement of fishing gear does not complicate or materials to make fishing gear readily available and among fishermen skipjack itself there is a conflict or not. Value of the skipjack tuna fishing unit can be seen in Table 3. Each criterion is given the priority order and the order of priority for each of these criteria has a different value.

<table>
<thead>
<tr>
<th>Fishing gear Unit</th>
<th>Assessment criteria</th>
<th>Unit</th>
<th>X1</th>
<th>X2</th>
<th>V(A)1</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole and Line</td>
<td>V1X1</td>
<td>0.33</td>
<td>1</td>
<td>3</td>
<td>1.33</td>
<td>0.665</td>
<td>1</td>
</tr>
<tr>
<td>Purse seine</td>
<td>V2X2</td>
<td>0.125</td>
<td>2</td>
<td>4</td>
<td>0.455</td>
<td>0.2275</td>
<td>3</td>
</tr>
<tr>
<td>Hand line</td>
<td>V3X3</td>
<td>0.25</td>
<td>3</td>
<td>7</td>
<td>1.25</td>
<td>0.625</td>
<td>2</td>
</tr>
</tbody>
</table>

Information :

X1 = Number of employment fishermen in the unit of fishing gears (Person)
X2 = Procurement fishing gear does not complicate (1) is very difficult to find, (2) hard to get, (3) readily available, (4) very easily
V(A) = Function of the value of alternative A, the number of V(Xi)
UP = Priorities in order
Based on the results of scoring and standardize the function values based on the social aspects, pole and line and hand line occupies the first and second priority while purse seine occupy the third priority.

**Assessment economics aspects:**

Analysis economic aspect in determining choice of skipjack tuna fishing gear was associated with several factors, including value of investments, operating costs per trip, fishing equipment maintenance costs and gross revenue per trip. All this data is obtained based on interviews with skipjack tuna fishing gears. Value of the skipjack tuna fishing unit can be seen in Table 4. Each criterion is given priority order and the order of priority for each of these criteria has a different value.

**Table 4**: Results of scoring and standardize aspect economic of value functions skipjack tuna fishing gears in west of Banda Sea

<table>
<thead>
<tr>
<th>Fishing gear</th>
<th>Unit</th>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole and Line</td>
<td>V1X1 0.333333</td>
<td>V2X2 0.333333</td>
</tr>
<tr>
<td>Purse seine</td>
<td>0.33 1</td>
<td>0.33 1</td>
</tr>
<tr>
<td>Hand line</td>
<td>3 1</td>
<td>3 1</td>
</tr>
</tbody>
</table>

Information:

- **X1** = Profit per year
- **X2** = Variable cost per trip
- **X3** = Maintenance cost of fishing gears
- **X4** = Pendapatan kotor per trip revenue cost ratio
- **V(A)** = Function of the value of alternative A, the number of V1(Xi)
- **UP** = Priorities in order

Based on the results of scoring and standardize the function values: hand line fishing gear occupies the first priority while pole and line the second priority and purse seine occupy the third priority.

**Analysis of environmental friendliness:**

Aspect in determining the choice of tuna fishing gear used nine criteria fishing gear belonging environmentally friendly fishing gear. The value of the tuna fishing gears unit can be seen in Table 5. Each criterion is given the priority order and the order of priority for each of these criteria has a different value.

**Table 5**: Results of scoring and standardize aspect environmental friendliness of value functions skipjack tuna fishing gears in west of Banda Sea

<table>
<thead>
<tr>
<th>Fishing gear</th>
<th>Unit</th>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole and line</td>
<td>V1X1 4</td>
<td>V2X2 4</td>
</tr>
<tr>
<td>Purse seine</td>
<td>0.5 0.125</td>
<td>0.1667 0.063</td>
</tr>
<tr>
<td>Hand line</td>
<td>0.25 0.25</td>
<td>0.5 0.063</td>
</tr>
</tbody>
</table>

Information:

- **X1** = Fishing gears having a high selectivity
- **X2** = Does not damage the habitat
- **X3** = Producing fish of high quality
- **X4** = Does not harm the fishermen
- **X5** = Production is not harmful to consumers
- **X6** = by-catch is low
- **X7** = Low impacts to biodiversity
- **X8** = Does not harm the fish are protected
- **X9** = Acceptable socially
- **V(A)** = Function of the value of alternative A, the number of V1(Xi)
- **UP** = Priorities in order

Based on the results of scoring and standardization functions based on the value of the aspect of environmental friendliness, pole and line and hand line fishing gear can be grouped into a less friendly to the environment while the purse seine and can be grouped into fishing gear which is not environmentally friendly.
In determining the selection of skipjack tuna fishing gear, criteria used is fishing gear unit that scored the highest of the biological aspects, technical, social, economic and environmental friendliness, in other words the priority of fishing gear is a gear that should be developed. Based on the results of scoring and standardization value functions from the fifth aspect analysis of fishing gears pole and line, hand line and purse seine as shown in Table 7.

<table>
<thead>
<tr>
<th>No</th>
<th>Category</th>
<th>Fishing gears</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not Environmental friendly (Total &lt; 3)</td>
<td>Purse seine</td>
</tr>
<tr>
<td>2</td>
<td>Less Environmental friendly (3 ≤ Total ≤ 6)</td>
<td>Pole and line Hand line</td>
</tr>
<tr>
<td>3</td>
<td>Environmental friendly (Total &gt; 6)</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7: Total standardization aspects of biological, technical, social, economic and environmental friendliness of value functions skipjack tuna fishing gears in west of Banda Sea

<table>
<thead>
<tr>
<th>Fishing gear</th>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V(A)1</td>
</tr>
<tr>
<td>Pole and Line</td>
<td>1.41</td>
</tr>
<tr>
<td>Purse seine</td>
<td>0.51</td>
</tr>
<tr>
<td>Hand line</td>
<td>0.999</td>
</tr>
</tbody>
</table>

Information:
V(A1) = Biological aspects
V(A2) = Technical aspects
V(A3) = Social aspects
V(A4) = Economic aspects
V(A5) = Environmental friendliness aspects

Based on the results of total standardization aspects of biological, technical, social, economic and environmental friendliness unit skipjack tuna fishing in west of the Sea Banda then that becomes, the first priority is hand line fishing gear, pole and line on the second priority and Purse seine fishing gear is the third.

Discussion:
Biological aspects:
Based on the analysis of biological aspects criteria are: the composition of the catch, the size of the catch, and the condition of the catch (Table 1) pole and line fishing gear is superior to hand line and purse seine. Based on the composition of the catch, size of the catch pole and line fishing gear better than hand line and purse seine. This is because the pole and line catch of skipjack tuna with a uniform size and tend to be larger, based on field observations and interviews with fishermen skipjack obtained information, the catch pole and line with a size of more than 50 cm while the gear hand line tends to be more smaller than size 50 cm, as well as in purse seine, but the purse seine tend to catch with a smaller size that is 30 cm.

It is closely related to the selectivity of purse seine fishing gear, where pole and line and hand line has a high selectivity when compared with purse seine [3]. Based on the condition of the fish, fishing gear pole and line and hand line has the same advantages that the condition of the catch while appliance catches of purse seine catches already damaged so that if sold in the market have a lower selling price. On the whole of the assessment criteria of this biological aspect that has been standardized by the function value, the obtained results of pole and line fishing gear is superior compared to hand line and purse seine fishing gear.

Technical Aspects:
After standardization of the values function of the of technical aspects that include size of the boat, fuel consumption per day, duration of use of fishing gear, fishing gear and material production per day. (Table 2) pole and line fishing gear topped the list while the hand line fishing gear and finished second, while the purse seine in third place. In terms of productivity, pole and line is lower than purse seine but purse seine using the fuel which is much larger than the hand line fishing gear. Regarding [7], that the technical factors of production which significantly toward affect production catches mini purse seine fishing gear among others: the amount of labor, fuel amount, fishing days , high nets and long nets.

Based on experience following the third trip of this fishing gear and interviews with fishermen catching skipjack tuna showed the peak season is in August-September each year. The calculations show another advantage of fishing gear pole and line, that criteria of duration of use of fishing gear, fishing equipment pole and line can
be used up to two years, as well as in purse seine but the purse seine had a lower score at criteria material or material from fishing gear so that when combined with pole and line fishing gear seen this better performance of the purse seine. While the duration of use of hand line for only one year, this is what causes the value of score hand line lower than the second fishing gear above.

Criteria such as size boat used to catch skipjack tuna, purse seine has a size relatively larger than the boat which is used for pole and line fishing gear, while fishing gear hand line boats are relatively small with a size less than 5 GT, the overall assessment of the technical aspects of standardization with the values function, the results obtained pole and line fishing gear is superior compared to hand line and purse seine fishing gear.

Social Aspects:
According to [6] in the Asian Productivity Organization Development stated that a sustainable fishery business social factors should be an important concern. Based on the analysis of the social aspects (Table 3) which includes: the number of fishermen who absorbed per unit of fishing gear, fishing gear ease of getting material and conflicts between fishermen. According to [6] stated that a sustainable fishery activities of social factors must be the paramount concern. Based on the standardization of the values function found pole and line fishing gear ranks first, and the second ranks is hand line fishing gear.

The advantages of pole and line and hand line fishing gear is never a conflict, so that the scoring of value function these types fishing gear more higher than purse seine. Based on interviews with purse seine fisherman, fishing equipment is ever there are conflicts with other fishermen that use FADs caused by the seizure of the fishing area, but the conflicts that have occurred have been completed by a group of fishermen with village officials facilitated. So based on the social aspects that have been standardized by the value function, pole and line and hand line fishing gear is more superior if compared with purse seine fishing gear.

Economic Aspect:
Based on the analysis of economic aspects with the criteria of the investment value of each unit of fishing gear, gains per year, focused on the study this aspect in terms of feasibility in exploiting skipjack tuna with different fishing gear. From Table 4, it looks fishing gear hand line is ranked first, pole and line fishing gear is the second and the purse seine ranks third. The results of the analysis criteria on aspects of economic feasibility was conducted to determine the business profits earned skipjack tuna fishermen. The analysis showed the biggest gains received by hand line fishermen while pole and line and purse seine fishermen benefits should be divided by the boat owners and the entire crew of the boat. In accordance [8] stating that analysis of the profit is the ratio between the total revenue with total costs.

From this information it can be concluded that in order to take advantage of pole and line fishing gear exploitation of skipjack tuna with a number or a larger size but are generally in the review of the feasibility, hand line fishing gear get better returns from pole and line and purse seine fishing gear, so that hand line fishing gear is reasonable to be developed when viewed from the aspect of economy.

Based on the economic aspects that have been standardized by the value function, hand line fishing gear is superior compared to pole and line fishing gear but the pole and line is more superior from purse seine fishing gear.

Aspects of environmental friendliness:
Based on criteria analysis aspects of environmental friendliness among other things: selectivity of fishing gear, rate of habitat destruction operation impact unit fishing equipment, quality of the fish, level of security or a danger to consumers from consumption of catches, by catch of units of fishing gear, impact of biodiversity of the operation of fishing gear, operating hazards fishing gear unit to the protected fish, fishing gear acceptable investment criteria-cost, profitable culturally appropriate and in accordance with existing regulations (Table 5). Pole and line and hand line fishing gear included in the class that are less environmentally friendly while purse seine fishing gear classified into environmentally unfriendly.

Based on the study of various aspects of environmental friendliness showed less environmentally friendly purse seine fishing gear cause catches of skipjack tuna with relatively smaller size and quality of the catch is not good so if traded will get relatively lower prices.

Purse seine classified into fishing gear which is not environmentally friendly due can cause habitat destruction on a large area, as a result of the operation will affect a broad for biodiversity if the mesh size is not set to be dangerous for immature fish, especially fish which protect. This is according to [5] that purse seine catches tend to capture the relatively smaller compared with pole and line fishing gear. This is also supported by opinion [1] states that purse seine fishing gear including fishing gear that are less environmentally friendly.

In relation to the level of less environmentally friendly fishing gear hand line, [14] stating that catch of small fish is more dangerous than catching fish that have not spawned, because the quantity of fish taken more numerous with the same weight, and also fish more little easier to catch, if fishing in phases prior to spawning, the fish did
not have a chance to spawn, while not all the fish that spawn can be captured and fish generally have a chance to spawn at least once during their lifetime.

Research on fishing gear featured in a water area should not only be seen from one or two aspects but on the various aspects that influence it. Likewise, in the determination of gear featured on skipjack tuna fishing activities in the west of the Banda Sea, by analyzing all aspects: biological aspects, technical, social, economic and environmental friendliness.

After analyzing of the five aspects, results obtained that hand line fishing gear is the gear most superior in comparison with pole and line and purse seine fishing gear in exploiting the skipjack tuna potential. The advantages of hand line fishing gear mainly on technical and economic aspects while the second seeded namely pole and line fishing gear with excellence on the biological aspects, social and environmental friendliness while purse seine fishing gear ranks last.

Advantages of hand line fishing gear from the technical and economic aspects, but based on the analysis of fishing gear has operating costs that are much lower, maintenance costs are also lower and earn a profit far better than either of the other woods fishing gear. Excellence pole and line can be seen from each aspect, among other aspects of biology, pole and line fishing gear is better in terms of the composition of the catch. The technical aspects, production pole and line is better than hand line and purse seine fishing gear, aspects of environmental friendliness is better in terms of selectivity and catch, while the purse seine is better only in terms of revenue cost ratio. As for social aspect, hand line fishing gear and more in terms of purse seine never conflict. Analysis of the combined aspect is intended to assess the advantages of fishing gear as a whole, results of this analysis is one indicator of how sustainability of utilization of skipjack tuna in west of Banda Sea

**Conclusion:**

Based on the analysis of biological aspects indicate that pole and line fishing gear is ranks first priority, hand line and purse seine fishing gears are on the second and third priorities. Social aspects indicate that fishing gear which ranks the first is pole and line, the second is hand line and the third is purse seine. Aspects economic indicate pole and line is first priority, the second hand line and the third is purse seine fishing gears. Technical aspects of fishing gear that is hand line first priority, secondly pole and line and the third is purse seine fishing gear.

Based on value of the aspect of environmental friendliness, pole and line and hand line fishing gear can be grouped into a less friendly to the environment while the purse seine and can be grouped into fishing gear which is not environmentally friendly. Value functions from the fifth aspect analysis (biology, economy, technical, social and environmentally friendly aspect) of the fishing gears that first priority to be developed is hand line and pole and line fishing gear, the second priority is purse seine fishing gear. Pole and line and hand line fishing gear can be developed simultaneously, because pole and line fishing gear excelled is the biological and social aspects while hand line fishing gear excels on technical and economic aspects in explore the potential of skipjack tuna in the western Banda Sea. As for the environmental friendliness aspect both of these fishing gear has the advantage almost same. Although results of the analysis show that hand line and pole and line fishing gear is a fishing gears that should be developed simultaneously in exploiting skipjack tuna however purse seine fishing gear are slowly starting to be reduced

**ACKNOWLEDGEMENTS**

We would like to thank Directorate of Research and Community Service, Ministry of Research and Higher Education (Kemenristek-DIKTI- RI) who fund this research with SKIM MP3Ei PERPRIMNAS fiscal year 2015. This article was presented on poster in International Conference on Small Islands Research in Tropical Regions - The Spermonde Archipelago and other Case Studies (SIRTRE), held on 15-16 September 2015 in Makassar, South Sulawesi, Indonesia

**REFERENCES**

5. CRITC COREMAP- LIPI. 2006. Baseline Ekologi Study. 2006 Wakatobi Regency – Southeast Sulawesi Province [In Bahasa Indonesia]
15. Wiyono, E.S., 2011. Superior Fishing Gears in Bangka Belitung Province Buletin PSP ISSN: 0251-286X Volume XIX No. 3 Edisi Desember 2011 Hal 229-238. [In Bahasa Indonesia]