RISK ANALYSIS APPROACH OF TRAWLER (SIENE NETS FISHING BOAT) IN NORTH COAST OF EAST JAVA

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Abstract

Fisheries management is needed because the characteristics of fisheries resources have high value and are sensitive to management, and there are 4 (four) basic components in management that must be considered, including: (1) resource sustainability; (2) economic sustainability; (3) social community (labor); and (4) environment, especially ecosystems. In the management of long-term oriented fisheries resources, prioritizing caution in making decisions and policies Fisheries management aims to maximize production without damaging existing resources or the environment. Fisheries management consists of several elements, namely: assessment of resources, decision makers, selection of strategies, alternative management, supervision. So that a manager needs to assess risks and vulnerabilities in discussing regulations, protecting fisheries resources and the environment. Based on Kepmen KP No.6 / 2010 cantrang and dogol are classified as Boat or vessel seine nets. With the issuance of the Regulation of Prohibition Number 2 / PERMEN-KP / 2015, cantrang fishing gear is prohibited. Data retrieval in October 2017 - April 2017 at 3 locations for Fish Landing Centers (Pasuruan, Probolinggi and Gersik). Data taken from the catch includes type, size and food to estimate the bottom conditions of the waters. Based on the scale scale level matrix analysis that trawl, has a probability and impact that causes a very large risk of fisheries resources. The highest alternative is to reduce the risk of handling species, size and fishing gear

Key word : Siene net, pelagic fish ,demersal fish

INTRODUCTION

Fisheries management, is needed because the characteristics of fisheries resources have high value and are sensitive to management, and there are four basic components in management that must be considered, including: (1) resource sustainability; (2) economic sustainability; (3) social community (labor); and (4) environment, especially ecosystems. Sustainability is the goal of managing fisheries resources. The definition of sustainability is to meet the needs of the present generation without sacrificing the needs of future generations, so the objectives of management are: first, to prevent biological and commercial extinction, secondly optimize the benefits derived from fisheries in an unlimited period. Failure in fisheries management can be caused by erroneous scientific information, poor management decisions, inability of decision makers to act, errors in managing, uncertainty in fisheries substantially control of arrests experiencing major difficulties and economic factors. [1][2][3], So that a manager needs knowledge about risk and vulnerability in discussing regulations, protecting fish resources and their environment.

Fish resources that the occurrence of crisis conditions in fisheries, because fisheries resources are open accses and cammon property, and are not obedient in carrying out fisheries management, lack of supervision and monitoring of law enforcement/government, capitalism production, fishermen, excess fishing. Although there has been a ban on limiting the catch but with no information on the process and place for recruitment, spawning and the lack of linkages between ecosystems and fish resources. While the theory used today only

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sees the number of catches based on Maximum sustainable yield (MSY). [4][5][6][7] So that in order to maintain and reduce damage to fisheries resources a proper plan.

Risk assessment has become very important knowledge in management planning [8][9][10][11][12][13]. Risk assessment is needed to calculate from various information related to different fisheries resources, local knowledge including scientific data and analysis. The stages in the analysis of risk risk management strategy concepts as shown in Figure 1. Definition of risk assessment as a process of obtaining qualitative or quantitative measures of risk level, or probability of adverse events, loss of expected benefits from resources and risk analysis as an analysis of benefit flows under uncertainty , including the probability of an event and some measures of the severity of a situation [14][15][16][17].

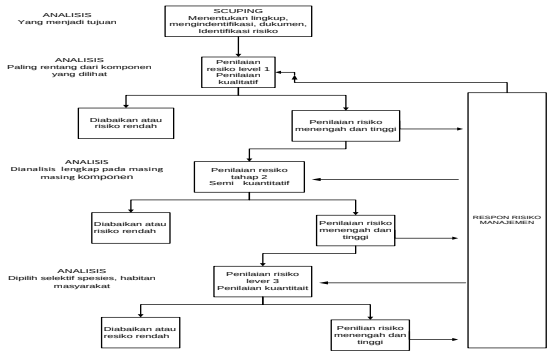

Figure 1 Diagram of management risk analysis (based on [17])

One of the roles of fisheries management which is a conceptual step focuses on maintaining and reducing damage and not on resource management. Increasingly recognizing and understanding the phenomenon of change and damage to fisheries resources, it can better address these resources. Attitudes and responsiveness based on good understanding and understanding can optimize the condition of fish resources

MATERIAL AND METHOD

Data collection locations for motorized trawl fishing catches are in Probolinggo, Pasuruan and Gersik. Observations conducted in the study identified the types of catches, the length of fish, and biology. The method of analysis of trawler catches is composition analysis, diversity, uniformity, One Way ANOVA, and level of environmental friendliness. The composition can be known how much the diversity of the catch from motorized trawl fishing gear. The data used in this analysis is the amount of weight in each fish species that has been identified and data on the total weight of the fish caught when recording field data. Analysis of diversity or diversity of catches is used to make it easier to analyze the number of individuals - each form of fish genus in a community According to [18], this can facilitate the analysis of information on the number of individual species in a fish resource community. The uniformity index describes the balance of the ecosystem.

The eco-friendly level analysis refers to the analysis method according to the weighting criteria based on 9 criteria for environmentally friendly fishing gear in accordance [19] First, measure the Fork Length (FL) sample of the dominant fish, which is as many as 5 types of fish. Furthermore, the length of fish is adjusted to the Length at first maturity (Lm) of fish from the results of studies conducted by previous researchers. If the length of the sample fish is more or equal to the Length at first maturity (Lm), the fish is considered suitable for catching, whereas if the length of the fish is less than the Length at first maturity (Lm) then the fish is not suitable for capture. Proper catching fish and not worth catching is calculated in proportion.

The risk analysis theory approach uses modifications based on [20][21]. (Figure 2). namely (1). risk context (defining undesirable things in avoiding an event in each component in the ecosystem), (2) Establish

the context (3) Identify the risk, hazards, and effects (ie impacts) (4) In risk assessment (i.e. doing analysis risk) there are 3 steps, namely (a) determining the possibility (Table 1). (b) determine the consequences (Table 2) and (3) give a score on the impact or risk. (Table 3).

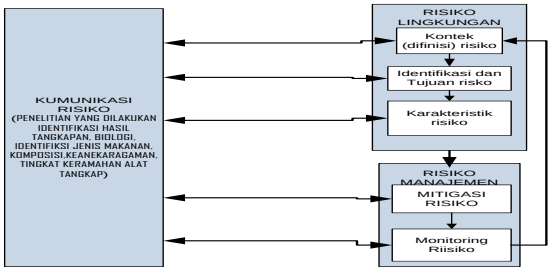

Figure 2 Modified risk analysis scheme

Table 1. Table of possibilities or probability of occurrence

Description		Information
Rare .	Certainly	Occurs in ordinary conditions (81 - 99%)
Possible	Most likely	Impact that will occur (61-80%)
Unlikely	Possible	Can happen but not expected (41 - 60%)
Occasional	Small possibility	Maybe on an important occasion (20 - 40%)
Likely	The possibility is very small	Can occur in important events (less than 20%)

Table 2 impact ranking table

Impact	Possibility of environmental conditions
Ignored (N)	Less than 20 %
Low (L)	21 – 40 %
Moderate (M)	41 – 60 %
Height (H)	61 – 80%
Extreme (E)	81 – 99 %

N = ignored, L = low, M = is H = high E = extreme

Table 3 Scoring

No	Topic	Probability (P)	Impact (D)

explanation of the scale of P and D, values 1 – 5

After all the steps above are completed, the most recent step is to combine all of these steps to analyze risk management, while the risk management approach approaches the model as in Table 4.

Table 4. The final results of management risk analysis

No	Resource	Possible Risk			Impact of Risk			Alternative risk reduction		
		1	2	3	1	2	3	1	2	3

Ket: 1= Low, 2 = Moderate; 3 = High

RESULT AND DISCUSSION

Types of fish caught and fishing gear

Based on identification of forms and methods of operation in 3 sampling locations. The form and method of operation are similar, known as cantrang, at PPP Mayangan Also called jonggrang fishing gear. According to the National Standardization Agency (2006) [22], cantrang fishing gear is a pocket fishing device without an outer board, with a rope that operates on the bottom of the water by circling the hordes of fish, and hauling from the boat. Cantrang is one of the basic fishing tools of trawl nets which are widely used by small and medium scale fishermen, with fishing areas in the entire territory of Indonesian waters. Cantrang is included in the classification of boat seines.

According to Kepmen KP. No. 06 (2010) [23] concerning fishing gear in the fisheries management area of the Republic of Indonesia, according to its type consisting of 10 (ten) groups namely surrounding nets, seine nets, trawls, dredges , lift nets, falling gears, gillnets and entangling nets, traps, hooks and lines. Cantrang belongs to the second group, namely seine nets. According [24][25], concerning the prohibition on the use of trawlers and seine nets in the Fisheries Management Areas of the Republic of Indonesia, trawl fishing and trawl fishing are prohibited from being used throughout the Fisheries Management Areas of the Republic of Indonesia. This prohibition is due to the

fact that trawl fishing gear and trawl nets have caused a decline in fish resources.

The trawl catch species in PPI Campurejo consists of 33 species, namely bulu ayam (*Coilia dussumieri),* gulamah (*Johnius carouna*), manyung (*Netuma thalassina*), bilis kuning (*Setipinna tenuifilis*), kaca (*Kurtus indicus*), layur (*Trichiurus lepturus*), bawal hitam (*Pampus argenteus*), bawal putih *(Parastromateus niger*), solok (*Thryssa hamiltonii*), tonang (*Congresox talabonoides*), belut laut (*Cirrhimuraena chinensis*), lidah lumpur (*Cynoglossus bilineatus*), lidah (*Zebrias altipinnis*), kerapu macan (*Cephalopholis argus*), teri trasak (*Thryssa baelama*), pari (*Dasyatis brevicaudata*), bidang (*Scatophagus argus*), selar (*Alepes vari*), ketang-ketang (Drepane punctate), tembang (*Sardinella gibbosa*), barakuda (*Sphyraena putnamae*), buntal (*Legocephalus spadiceus*), buntal hijau (Dichotomyctere nigroviridis), jangki tompel (*Lutjanus johnii*), peperek (Eubleekeria jonesi), sotong (*Sepia recurvirostra*), udang putih (*Panaeus merguiensis*), udang windu (*Panaeus monodon*), rajungan batik (*Portunus pelagicus*), rajungan gerbong (Charybdis feriatus), rajungan mata panjang (*Podophthalmus vigil*),rajungan mata tiga (*Portunus sanguinolentus*) dan keong macan (*Babylonia areolata*)

The catch in Lekok District consists of 24 species. that is Peperek (*Leiognathus splendens*) (Cuvier, 1892), Kuniran(*Upeneus moluccensis*) (Bleeker, 1855) , Kurisi (*Nemipterus nematopus*) (Bleeker, 1854), Beloso (*Saurida argentea*) (Macleay, 1881), Barakuda (*Spyraena putnamae*) (Jordan & Seale, 1905), Kerong – kerong (*Terapon theraps*) (Cuvier, 1829), Bawal hitam (*Parastromateus niger*) (Bloch, 1795), Gulamah (*Pennahia anea*) (Bloch, 1793), Swanggi (*Priacanthus tayenus*) (Richardson, 1846), Buntal (*Lagocephalus guentheri*) (Miranda Riberio, 1915), Layur (*Trichiurus lepturus*) (Linnaeus, 1758), Ayam – ayam (*Abalistes stellaris*) (Bloch & Schneider, 1801), Selar kuning (*Selaroide leptolepis*) (Cuvier, 1833), Sebelah (*Psettodes erumei*) (Bloch & Schneider, 1801), Pari (*Dasyati zugei*) (Muller & Henle, 1841), Lidah Zebra (*Zebrias zebra*) (Bloch, 1787), Kerapu lumpur (*Epinephelus coioides*) (Hamilton, 1822), Ketang – ketang (*Drepane punctata*) (Linnaeus, 1758), Cumi – cumi (*Photololigo duvaucelii*) (Valenciennes, 1842). Sotong (*Sepia officinalis*) (Linnaeus, 1758), Gurita (*Octopus alpheus*) (Norman, 1993), Udang (*Penaeus merguiensis*) (de Man, 1888), Rajungan (*Portunus pelagicus*) (Linnaeus, 1758), Lidah (*Cynoglosus macrolepidotus*) (Bleeker, 1851).

The catches at the Mayangan PPP consist of 23 species including swanggi, kurisi, peperek, beloso, kapasan, biji nangka, marmoyo, barakuda, buntal, pari hidung runcing, rajungan, cumi-cumi, gulamah, kakap merah, kerong-kerong, bawal hitam, ikan lidah, layur, hiu pasir, kapas-kapas, udang tiger, kerapu, dan ikan lompa. The areas of the three data collection locations concluded that there were different species caught

Based on the type of catch has a probability of occurring in any area and any results. This is evidenced by the variety of catches. The trawler catch species obtained 4 categories namely small pelagic fish, demersal fish, soft-bodied animals and hard-skinned animals. Species that dominate each area of land also differ. catches in the main port, which are demersal fish of 19 species. In Lekok PP, the species that dominates the catch are demersal fish with 18 species. Motorized trawler catches in PPI Campurejo gresik consist of 33. Base fish are 15 species, surface fish are 10 species, hard-skinned animals are 7 species and soft-skinned animals are 1 species. On the other hand, in each region different types are caught. For example, someone was caught in a gresik fishing area but was not caught in the Lekok area. This is evidenced by the ikan marmoyo, kakap merah and ikan kerapu found in Probolinggo not found in Lekok Pasuruan ikan ayam ayam dan ikan sebelah found in Lekok Pasuruan are not found in Mayangan Probolinggo. Based on this, the risk assessment has extreme values for all types. (table 5). And it will happen

Catch Composition Analysis

During data collecting in Gresik, 33 species of fish were caught. The highest percentage is dominated by 5 species of fish, is: ikan gulamah (*Johnius carouna*), udang

putih (*Panaeus merguiensis)*, ikan bilis kuning (*Setipinna tenuifilis)*, ikan manyung (*Netuma thalassina)* dan ikan bulu ayam (*Coilia dussumieri)*. While for the catch with the least percentage is ikan kerapu macan (*Epinephelus longispinis)* The composition of pelagic fish is 36.42% with a total species of fish of 10 species, the composition of demersal fish is 38.76% with a total species of fish of 15 species and hard-skinned animals and soft-skinned animals of 24.82% with a total species of 8 species. Extend the majority of probolinggo species that dominate the catch, is ikan swanggi (*Priacanthus tayenus*), kurisi (*Nemipterus nematophorus*), dan peperek (*Photopectoralis bindus*)

The trawler catches in Jatirejo Village, Lekok Subdistrict are dominated by three species, the most species being ikan peperek (*Leiognathus splendens)*. The second most species is from the soft-skinned animal category, is cumi – cumi (*Photololigo duvaucelii*). Then the third species is ikan kuniran (*Uppeneus moluccensis*) The fewest catches are udang putih (Penaeus merguiensis) weight 18,1 Kg and rajunganThe catch in Lekok sub-district consists of 24 demersal fish species, which are as many as 18 species. Whereas in major PP, there are 23 species. The species that dominates the catch is demersal fish of 19 species. The percentage of catches in Mayangan Pelagis is small (0.04%) Demeral (97.60%) Soft-skinned animals (1.27) Soft-skinned animals (1.10%) and from 23 species. The species that dominates the catch is demersal fish of 19 species.

The conclusion is that the trawler catches consist of 4 categories of small pelagic, demersal fish, soft-bodied animals and hard-skinned animals wherever the fishing area. the catch composition is based on number and type has something that is certain to happen because the trawl is operated in any dominant area, the type of each area is different. Based on these differences and certain occurrences, the risk assessment has an extreme value (table 5). The existence of various types in the waters can show that these waters have high diversity and good resources, but if in the wrong management, the sustainability of demersal fish resources will be exhausted.

Based on the analysis of the diversity level for the three regions ranging from 2.33 to 2.76. This value ranges from $1 \leq H' \leq 3$ = Diversity is currently being spread, community stability is sufficient. The diversity of fish in a waters illustrates the existence of fish wealth in these waters which means wealth when the location is a moderate condition. Based on this value, the probability of occurrence Most likely the consequences caused by trawl fishing gear (table 5) high species diversity show a better balance of ecosystems. Conversely, low diversity (a small number of species) indicates a stressed ecosystem or a damaged ecosystem, which may be caused by the change in the watershed ecosystem due to trawl fishing, natural disasters, pollution. The trawl catch is very varied, but in each region the variation is different. So that it influences the diversity of fish resources so that in these conditions the diversity is 61-80%, so it has a high risk (Table 5).

The results of the level of uniformity analysis of the uniformity index value with a value of 0.67 - 0.87, the value is at $0.6 \leq E \leq 1$ so that it shows high uniformity, stable community then high uniformity value. This can be interpreted that the high spread and stability of the community are also classified as stable. If the smaller the value of security (E) then the uniformity of a population and the spread of individuals who dominate small populations, if the value is greater then the uniformity of a population where the type and number of individuals each type is evenly distributed. The uniformity index value is also influenced by environmental conditions, the more evenly distributed individuals between species, the better functioning of the ecosystem. Ardani and Organsastra (2009) stated that the index of fish species uniformity ranged from 0 - 1. The criteria for the uniformity of fish species were that if the E value approached 0 then the individual distribution between species was not the same and there were a certain group of abundant individuals. Conversely, if the value of E approaches 1, the spread of individuals between types is relatively the same. That is, the distribution of individuals or between fish species in the Lekok sub-district is relatively similar and there is no abundant group of individuals or species. Based on this, the probability Most likely the consequences caused by trawl fishing gear (Table 5), while the impact that is caused is likely to occur in these environmental conditions with uniformity 60 - 80% so that the impact caused by motorized trawlers is high (table 5)

Environmental Friendly Level

In the analysis of the level of environmental friendliness to determine the level of environmental friendliness in the trawl device. This is to realize sustainable fisheries and responsible use of fish resources. Catching units can be said to be environmentally friendly if they have fulfilled environmental friendliness factors. The environmental friendliness factor used is the comparison of the main and side catches, the length of fish that is worth catching and the level of utilization of the main and side catch fish. The results of the assessment of the level of environmental friendliness can be seen in Table 6.

Table 6. Assessment of Environmental Friendly Levels

No	Observation	Rating (%)	Criteria	Score
1	Main Catch (%)			
		81-100	Very Environmentally Friendly	4
		61-80	Environmentally friendly	3
		41-60	Less Environmentally Friendly	2
		0-40	Not Friendly Environment	1
2	Utilization of by-catch(%)			
		81-100	Very Environmentally Friendly	4
		61-80	Environmentally friendly	3
		41-60	Less Environmentally Friendly	2
		0-40	Not Friendly Environment	1
3	Length at first maturity (%)			
		81-100	Very Environmentally Friendly	4
		61-80	Environmentally friendly	3
		41-60	Less Environmentally Friendly	2
		0-40	Not Friendly Environment	1

Penarikan kesimpulan:
If total score 3 until 5 : Not Friendly Environment
If total score 6 until 8 : Less Environmentally Friendly
If total score 9 until 11 : Environmentaly Friendly
If total score 12 : Very Environmentaly Friendly

Based on the assessment of the level of environmental friendliness by using a score, the main catch factor gets a value of 4, the length of the catchable fish gets a value of 1 and the utilization rate of the catch gets value 3. The total score is 8, and the value 8 is in range 6 - 8 meaning that it can be said that the trawl fishing gear that is operated is less environmentally friendly. This is also supported by other factors in accordance with the international standards of the CCRF (Code of Conduct for Respnsible Fisheries) based on FAO (1995) and the Ministry of Fisheries in 2006 which are said to be environmentally friendly if they fulfill 9 criteria including having high selectivity, not damaging the ecosystem, producing high quality fish, no harm to fishermen, safe products for consumers, low By-catch, low impact on biodiversity, not catching protected and socially acceptable fish. It is indicated constructively that trawl nets in all three sampling areas are not environmentally friendly because the operation uses the help of a board for the opening of both parts of the wing. This board can cause friction to the coral so that the coral becomes damaged. In addition, it is further strengthened by the assessment of the score above that the fishing gear caught fish - fish that are not yet worth catching. This is what makes trawl pull as a less environmentally friendly fishing gear. Based on this, the probability of occurrence in trawler catches is fixed because it occurs in extraordinary conditions (81-99%) (table 1 and table (5), the consequences and possibilities that occur in the condition of the catchment area are 81-99% so that the impact which is concluded Extreme (E) (table 7).

Table 6 Description of possible risks for managing trawlers

Topic	Description				
	Definitly	Large	Happen	Small	Very Small
Catches					
Small pelagic	E				
Large pelagic	E				
soft-skinned animals	E				
Hard-skinned animals	E				
Catch	E				
Animal Diversity		H			
Uniformity		H			
Environmental friendly	E				

N: ignored, L = low, M = medium H = high E = extreme

Based on an analysis of the possibility of risk, a scoring was carried out to see the extent of the opportunities and possible impacts of problems on COB fisheries resources (Table 6). The table is given a score of 1 (one) if it only gives a small effect, given a score of 5 if it has a large influence on both opportunities (P) and Impact (D). Opportunities arising from motorized trawl trawlers that have the greatest risk of risk are catches and environmental levels because: (1) all types of fish resources are caught, (2) there are variations in biomass of species caught between one species and species another 3) The average length of fish caught is less than the length of the gonad ripe, so it does not meet the length of the fish that is worth catching. The resulting impact has a great value for all.

Table 7 scoring topics on the possibility of what happened and the consequences or effects

Topic	Scoring	
	P	D
Small pelagic	5	4
Large pelagic	5	4
soft-skinned animals	5	4
Hard-skinned animals	5	4
Composition of catches	3	4
Animal Diversity	3	4
Uniformity	3	4
Environmental Friendly	5	4

Based on these scores (table 7) in the risk scale scale matrix (Figure 3), it can be seen that trawling fisheries management has a probability value and the impact that causes damage to fisheries resources is very worrying that this seems to be close to the red condition. If this condition continues, then the condition of demersal fish resources that have a large variety of compositions will not achieve sustainable resource management goals. Because in the management of sustainability there are ecosystem interactions, as well as social and economic problems. Many obstacles are encountered in the presence of sustainable fish, including deficiency data, especially with regard to catch data, overcapacity, ecosystem capture effects, such as loss of ecosystems, and frequent social and ecological problems.

Figure 3 Scale of risk matrix that occurs in the management of motorized drag fishing gear

The first step in a risk assessment is to identify the most important hazards. The most important danger in managing trawl nets is the fishing gear itself. So that risk management requires criteria and identification of hazards. Risk analysis is based on the ability to measure the probability of a particular event and its consequences. But basically for the biological nature it is usually very difficult to measure these factors precisely. Thus, risk analysis in biological systems is often carried out using broad qualitative categories, by assessing probabilities and consequences from low to high.

Risk is mathematically the result of vulnerability in capabilities multiplied by threats. From this understanding in analyzing risks, three things are considered to be threats, vulnerabilities and capabilities that exist. In this problem, ability is the nature of fish that can grow. Whereas those that include vulnerability are basic waters ecosystems as fishing ground trawls (environment, temperature, chlorophyll, mangrove forests, coastal areas), economics (fishermen's income), social (education, regulatory institutions). Based on this understanding, risk assessment is carried out for possible impacts and risk reduction alternatives (Table 8)

The highest alternatives for risk reduction are species, mesh size and fishing gear. This is caused by various problems, for example, the tool will be related to regulations, awareness of fishermen, restrictions on operations. So that the impact and possibility of the risks that occur also have a high chance. So that it is related to biology (fish, both size and type), fishing gear, and how to plot it. So the manager of fisheries in a sustainable manner needs to protect the structure of the ecosystem and function while considering the current and future needs of the community as part of the marine ecosystem. Sustainable fishing tools can also directly contribute to the maintenance or recovery of a resource. If the catch is not carried out well on the results of catch species whether protected or not, endangered, or threatened with extinction, it will require economic costs for high fisheries.

Table 8. Assessing the possibilities, impact, and alternative risks for seine net fisheries management

No	Topic	Possible Risk			Impact Risk			Alternative risk reduction		
		1	2	3	1	2	3	1	2	3
1	Small pelagic			V			V			V
2	Large pelagic			V			V			V
3	soft-skinned animals			V			V			V
4	Hard-skinned animals			V			V			
5	Composition of catches		V				V		V	
6	Animal Diversity		V				V		V	
7	Uniformity		V				V			
8	Environmental Friendly			V			V			V

Ex: 1= Low; 2= Moderate; 3= High

CONCLUSION

- Trawl fishing gears have the risk and risk of being dangerous
- Management of sustainable fisheries resources requires a risk analysis approach
- The magnitude of the assessment of the possibility of opportunities and impacts depends on the condition of the problem.
- Possibilities, opportunities and impacts that have high scores compared to others in the management of trawl fishing gear related to biology (catches) and fishing gear
- Biggest risk reduction alternative on catches and fishing gear
- Biology, fishing gear, methods of management provide opportunities for possibilities and high risk impacts

REFERENCE

[1] Maunder, M. N., Sibert, J. R. Fonteneau, A., Hampton, J., Kleiber, P., and Harley, S. J. 2006. Interpreting catch per unit effort data to assess the status of individual stocks and communities. e ICES Journal of Marine Science, 63: 1373 -1385

[2] Costello Christopher, Steven D. Gaines, John Lynham.2008. Can Catch Shares Prevent Fisheries Collapse? Science 321, 1678

[3] Hilborn Ray, 2010. Pretty Good Yield and exploited fishes. Fisheries Research 32: 193 – 196

[4] Chung-Ling Chen, 2010. Factors influencing participation of 'top-down but voluntary' fishery management—Empirical evidence fromTaiwan. Marine Policy34 :50–155

[5] Castro Maricela delaTorre Lars Lindstro¨m., 2010. Fishing institutions: Addressing regulative, normative and cultural – cognitive Elements to enhance fisheries management. Marine Policy34: 77–84

[6] Matsuda Hiroyuki, Mitsutaku Makino, and Koji Kotani. 2008. Optimal Fishing Policies That Maximize Suistainable Ecosystem Services. Fisheries for Global Wefare and Environment, 5th World Fisheries Congress 2008,pp. 359-369

[7] Lelono T.D. 2008. Kajian awal analisis risiko bencana kawasan pesisir selatan jawa timur (studi kasus Kab.malang). Proseding Bali scientific meeting Balai riset dan observasi kelautan (BROK. Pusat riset teknologi kelautan. Badan riset kelautan dan perikanan. F3 – 8

[8] Cortes Enric, Elizabeth N. Brooks, and Kyle W. Shertzer, (2015) Risk assessment of cartilaginous fish populations ICES Journal of Marine Science (2015), 72(3), 1057–1068. doi:10.1093/icesjms/fsu157

[9] Gibbs, M. T., and Browman, H. I. Risk assessment and risk management: a primer for marine scientists.(2015) ICES Journal of Marine Science (2015), 72(3), 992–996. doi:10.1093/icesjms/fsu232

[10] Gaichas, S. K., Link, J. S., and Hare, J. A.(2014) A risk-based approach to evaluating northeast US fish community vulnerability to climate change. – ICES Journal of Marine Science, 71: 2323–2342

[11] Jørgensen, L. L., Planque, B., Thangstad, T. H., and Certain, G. (2016). Vulnerability of mega benthic species to trawling in the Barents Sea. – ICES Journal of Marine Science, 73: 184 –197.

[12] Kenny Andrew J., Neil Campbell, Mariano Koen-Alonso, Pierre Pepin, Daniela Diz,2018., Delivering sustainable fisheries through adoption of a risk-based framework as part of an ecosystem approach to fisheries management. Marine Policy 93 (2018) 232–240

[13] Taranger, G. L., Karlsen, Ø., Bannister, R. J., Glover, K. A., Husa, V., Karlsbakk, E., Kvamme,B. O., Boxaspen, K. K., Bjørn, P. A., Finstad, B., Madhun, A. S., Morton, H. C., and Sva sand, T. (2015 Risk assessment of the environmental impact of Norwegian Atlantic salmon farming. ICES Journal of Marine Science (2015), 72(3), 997–1021. doi:10.1093/icesjms/fsu132

[14] Burgman, M. A., Ferson, S., and Akc¸ akaya, H. R. 1993. Risk Assessment in Conservation Biology. Chapman and Hall, London

[15] Francis, R. I. C. C., and Shotton, R. 1997. "Risk" in fisheries management: a review. Canadian Journal of Fisheries and Aquatic Sciences, 54: 1699–1715

[16] Restrepo, V. R., Thompson, G. G., Mace, P. M., Gabriel, W. L., Low, L. L., MacCall, A. D., Methot, R. D1998. Technical guidance on the use of precautionary approaches to implementing National standard 1 of the Magnuson–Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/ SPO 31. 54 pp

[17] Hobday, A. J., A. Smith, H. Webb, R. Daley, S. Wayte, C. Bulman, J.

Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, T. Walker. (2007) Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra

[18] Odum, E.P., 1971. *Fundamental of ecology*.,W.E.Sounders, Philadelphia. 567
pp

[19] FAO. 1995. *The Ecosystem Approach to Fisheries. Food and Agriculture Organization of The United Nations. Code of Conduct for Responsible Fisheries. Rome*. 41 hlm.

[20] Carey J. M., Burgman M. A. & Chee Y. E. (2004) *Risk Assessment and the Concept of Ecosystem Condition in Park Management.* Parks Victoria Technical Series No. 13. Parks Victoria, Melbourne. 96 hal

[21] Campbell, M. L., and C. Gallagher. 2007. Assessing the relative effects of fishing on the New Zealand marine environment through risk analysis. ICES J. Mar. Sci. 64:256-270.

[22] SNI. 2006. Bentuk Baku Kontruksi Pukat Tarik Cantrang. Badan Standardisasi Nasional. SNI 01-7236-2006. Jakarta

[23] Keputusan Menteri Kelautan dan Perikanan Republik Indonesia. Nomor 6/Kepmen-KP/2010. Alat Penangkapan Ikan di Wilayah Pengelolaan Perikanan Negara Republik Indonesia

[24] Surat Edaran Menteri Kelautan dan Perikanan Republik Indoneia. Nomor 72/MEN-KP/II/2016. Batasan Penggunaan Alat Penangkapan Ikan Cantrang di Wilayah Pengelolaan Perikanan Negara Republik Indonesia.

[25] Peraturan Menteri Kelautan dan Perikanan Republik Indonesia. Nomor 2/Permen-KP/2015. Larangan Penggunaan Alat Penangkapan Ikan Pukat Hela (*Trawls*) dan Pukat Tarik (*Seine Nets*) di Wilayah Pengelolaan Perikanan Negara Republik Indonesia

