American Journal of Humanities and Social Sciences Research (AJHSSR)
e-ISSN: 2378-703X
Volume-4, Issue-1-pp-413-421
www.ajhssr.com
Research Paper Open Access

Sustainability Status of Ecological Dimensions in Development of Redi in Buton Regency Southeast Sulawesi

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Abstract: *Redi (Mini Purse Seine) is active of fishing gear and the ship as driven for the net to catch the schooling fish target. In conducting the operational of fishing gear, there are many problems that occurred on ecology, economy, social, published, institutional, and technology. This study aimed to determine the sustainability status of Redi based on ecological dimension using RAPFISH approach in Buton Regency, Southeast Sulawesi. The method in this research was a case study with RAPFISH (Rapid Appraisal of fisheries) approach which is a ordination technique of multi-discipline and non-parametric. This technique was used to evaluate and determine the fisheries status, in the case of Redi sustainability. The results of the study showed that the of use index values for sustainability status of ecological dimension was in the category "enough (quite) sustainable" with the sustainability index value of 50,29 %. The results of the analysis leverage to 8 (eight) ecological dimension attribute indicates that there were 3 (three) sensitive attributes that most influence on the sustainability status of ecological dimensions. In an effort to improve the performance of redi fishing gear in a sustainable manner, we need concrete strategies through improved performance the sensitive attributes based on the priority scale.*

Keywords: *RAPFISH, Redi sustainability, the ecological dimension*

I. INTRODUCTION

A mini purse seine is an active fishing gear used to capture small groups of pelagic fish such as cobs, flying fish, *julung*, baby tuna, skipjack and others. Purse Seine is also called "trawl ring". This naming is based on the function of the ring strap or its wrinkle . The existence of the wrinkle rope will change the condition of the net from extending to pouch-shaped at the end of each arrest. Basically, capturing fish using purse seine is an attempt to encircle a group of fish with a net, after which the bottom net is pursed, thus the fish are collected in the pocket. In other words by reducing the scope of movement of fish. The fish cannot escape and can be caught finally. The function of net mesh and nets is as a barrier wall, and not as a fishing rod. The local name of fishing gear in Buton Regency is redi fishing gear.

At present, the government has treated strict supervision of fishing gear throughout the Indonesian region. The government affirms this through the Minister of Maritime Affairs and Fisheries Regulation No. 2/2015 concerning the Prohibition of Using Trawl and Seine Nets Fishing Equipment. The government has also carried out a moratorium on the increase in the number of fishing vessels, especially mini ships. This arrangement is intended so that the use of fishing gear that causes conflict between fishermen and threatens the continuation of the fish population and habitat will immediately be stopped.

Recently, one of the cases of fishing gearbanned by the government is *cantrang* fishing gear. After going through a long evaluation, it is finally determined that this fishing gear would be prohibited in Indonesia. Because in its operation is very damaging to fish resources and their habitat environment.

The redi cases in Buton Regency have similarities with the *cantrang* cases that have been discussed a lot lately. The problem aspects that arise from this redi case were social, ecological, economic, social, technical and institutional aspects. One aspect that researchers examine in this regard was the ecological aspect. The attributes included in this aspect were the pressure of fishing activities, changes in the fish environment, changes in species of fish caught in redi, discard and bycatch (proportion of fish discarded), changes in fish size captured by redi, changes in fishing groundfish, and size status of fish redi catch.

Some several previous studies showed that there was a decrease in the number and quality of fish caught due to a decrease in fish resource stocks. This is related to the symptoms of overfishing and overcapacity. Overcapacity was an effort carried out in waters that exceed the capacity or capacity of the waters.

Whereas overfishing is interpreted as over-exploiting fish from the amount needed to maintain fish stocks in water (Amiruddin et al, 2013). Effort or catch effort was a trip when going to sea and returning to basecamp. A trip was very dependent on the increase of the ship annually. The higher the increase, the greater the pressure of capture on fish resources. This condition will have an impact on the existence of fish resource stocks in water.

Darsono (2007), observed the characteristics of overfishing along the coast of West Java. The indication can be seen from the smaller catch fish, certain types of fish were increasingly difficult to obtain. This is allegedly due to the dense number of boats and limited fishing catches. This opinion is also supported by Purnomo's (2003) research, that the North Coast of Central Java is quite severe experiencing overfishing. This is evidenced by the change in the size of the fishing gear from 2.5 cm to only 1.7 cm or 1.8 cm at this time. In addition, the distance taken by fishermen to catch fish was also farther away. In the past, fishermen generally only searched for fish around the Java Sea, but now there were quite a lot of fishermen who sail to the Makassar Strait. Whereas in the Straits of Malacca, Sumino (2002) explained that the fish catch in 1997 showed that the length of some demersal fish tended to be smaller compared to the trawl catch in 1985. This could be an indicator that the pressure of capture of demersal fish in the Strait Malacca was already high. Hariati (2006), explained the development of small palagis fishing businesses by ring trawlers in the Malacca Strait, that the catching rates of small pelagic fish in the period of 2003 - 2004 and 2004 - 2005 were 710.9 kg/day and 521 kg/day respectively, declined from the small pelagic fish catch rate in the 1996 period of 1997 were 935.9 kg/day and 1831.7 kg/day, respectively. So it is recommended that the number of ring trawlers operating in the waters of the Malacca Strait is not added.

The sustainability status of the Redi fishing gear is the place or position of the Redi fishing gear in a sustainability group, in relation to other groups in the larger group. In ecology, sustainability *(English: sustainability)*, comes from the word 'sustain' which means' continues' and ability 'which means' ability'; that is a biological system that was still capable of sustaining biodiversity and unlimited productivity. A fish resource and its habitat that is exploited with environmentally friendly technology and causes the system to be healthy and long-lived were examples of sustainable biological systems.

The objectives of this study were : (1) to Identify the ecological attributes affected by the redi operation; (2) to determine the determinant variables for the sustainability of redi fishing gear.

II. MATERIALS AND METHODS

The collected data for this study were consisted of attributes which constructed the five dimensions of sustainability of the fisheries, e.g. ecology, technology, economy, institutional, and social. The data were collected from Buton Regency waters, Southeast Sulawesi (Figure 1) over a period of 12 months, from January 2017 to January 2018. Some data were obtained from the owners of redi (industries), the personal owners of redi, the owner of FADs, redi fishermen, and who used redi in Buton waters. The fishing fleets operated redi, which mainly caught scads (*Decapterus russelli),* Indian mackerels (*Rastrelliger kanagurta*), selar (*Selaroides leptolepsis*), and cob (*Auxis thazard*). The fishing grounds were located 1-7 miles from fishing base, reachable within 1-8 hours. Secondary data were obtained from the Central Bureau of Statistic (of Buton Regency and City), the local Marine and Fisheries Agency, scientific research journals, and research reports. The sustainability status of the redi-based fisheries was assessed by applying RAPFISH which had been developed by [12]. The analysis was carried through three steps, i.e. (1) determination of sustainability attributes of the fisheries and the assessment criterion, (2) assessment of fisheries attributes, (3) analysis of ordinal scores of each sustainability dimension using multi-dimensional scaling (MDS) approach. The third step yielded attributes sensitiveness, i.e. changes in value of root mean square (DRMS). The increase of changes in the value meant more sensitivity, vice versa. Attributes with high sensitivity were considered significant factors that must be carefully managed, e.g. [12,5,16]

Figure 1. Research location in Buton Regency, Southeast Sulawesi

III. RESULTS AND DISCUSSIONS

3.1. Affected ecology dimensions by using Redi

Conditions of each redi sustainability attributes

Status of caught fish size

In this study, the dominant catch of redi fishing equipment were cob fish and *Decapterus spp*. While other catches were *skipjack*, baby tuna, *rastrelliger*, etc. According to the local fishermen, sailing fish escaped throughout the year. Capturing peak season usually occurred in August-December which characterized by increasing fish production both in quantity and type compared to other months. The peak season for *Decapterus spp* in Buton Regency occurred in August-November (east wind season), medium season in December-Marc, and least in April-June. Most of the *Decapterus spp*was obtained in the spring are higher than *D. ruselli* and could reach 28 cm long, while *D. macrosoma* and *D. lajang* could reach 23 and 27 cm long respectively.

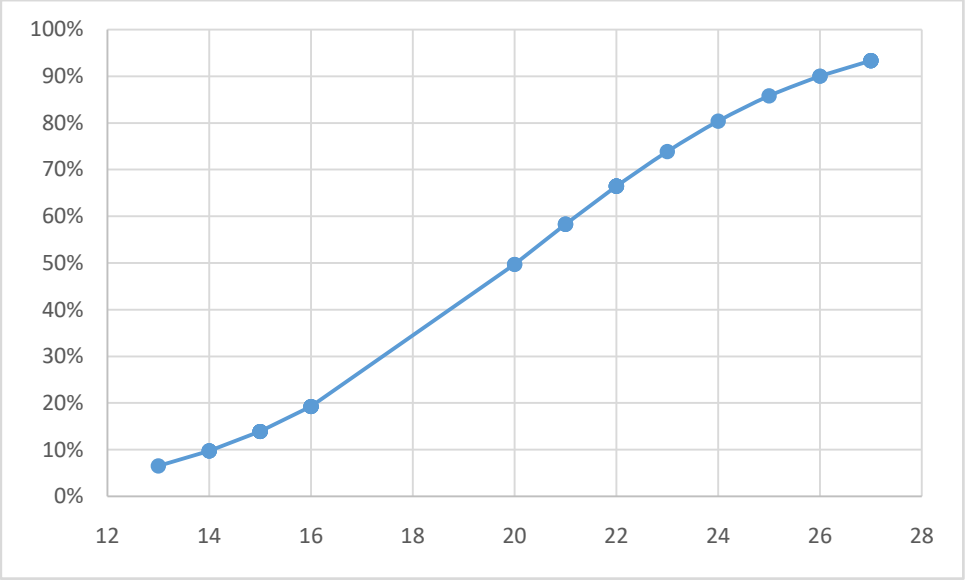

Figure 2. Graphic of First Time Caught Size with Forking Branch Length

Description: Lc 50% is at a value of 20 cm

Other studies had shown maturity of fish gonad was obtained at the size of Lm = 17.6 cm. The maximum length of 35.0 cm TL for males / unsexed, and the length generally ranges from 25.0 cm TL for males/ unsexsed (Masuda, 1993). The existence of *Decapterus spp.* was usually in the form of schooling (Smith-Vaniz, 1995, Kuiter and Tonozuka, 2001 and Mundy, B.C., 2005). Sometimes they were seen in small groups along the reef slopes bordering deep waters in zooplankton chases. Adults ate small invertebrates (Fischer, 1990).

Distributions of Fish

The environment of *Decapterus spp*. habitat was usually found in rocky seas with a depth range of 20 - 214 m (Mundy, 2005). Research conducted by Myers (year) explained that it was usually found in a range of 30-70 m. The location of the coordinates usually in the tropics at latitude and longitude 39 ° N -34 ° S, 180 ° W-180 ° E. Research conducted by Smith-Vaniz(1995) had shown that the distribution of these fish in the world includes the Indo-Pacific and Southeast Atlantic: from Knysna to Christmas, South Africa to Australia, including the Persian Gulf and the Red Sea, and in the Central Pacific Islands from Korea South to the Gulf of California to Peru, including the Galapagos Islands. Meanwhile, the distribution in southern Western Australia and South Australia was incorrect.

The definition of migration distance showed the smaller or narrower size of the caught fish, the more effective the management effort, along with the risk or threat to the sustainability of the fishery business in the area or unit of analysis is getting smaller. Fishing by using redi in Buton Regency was not only in the local waters but to the border of Wakatobi Regency. However, it was only one company made an arrest on the route. The migration path from Decapterus spp. and cobs was seasonal. The migration path had almost never changed, according to the results of interviews with many redi fishermen. The distance of migration from the species of caught target by redi, among others are Decapterus spp. and cobs, which had been known to have close life cycles and located in FADs around the waters of Buton Regency. So the migration distance was between 1-2 jurisdictions (zero score).

According to the LIPI Center for Research on Oceanology (1998), generally *D. macrosoma* could reach 40 cm which generally 25 cm in length, and *D. russelli* reached 40 cm in length which generally 20-25 cm in length. Furthermore, Nontji (2002) said that in the east wind season, namely in June-September the migration pattern of flying fish into the Java Sea from the Makassar Strait and Flores Sea followed the current pattern and salinity distribution pattern. It was alleged that the pattern of the east season currents carried flying fish into the waters of Buton Regency.

Change in species of caught fish by redi

The species of caught fish attribute describes continual fishing beyond the sustainable level, which can lead to depletion. In this case, the reduction in the number of species of fish caught could be an indication of the extinction of existing fish species. Based on observations in the field and data from the Buton District Fisheries Service in the last ten years, the total catches of redi were no more than 10 species (zero score), while the total catches from activities purse seine fisheries harvested more than 10 species.

Discard and bycatch (Proportion of discarded fish)

Bycatch is accidentally unwanted fish capturing due to the limitations of fishing gear to select the catches. Bycatch is also a target species with too small in size or low quality, besides non-target species which are often accidentally caught such as seabirds, marine mammals, and turtles. The important category in bycatch is discarding the discarded individual target species as the size is too small. Size limitation can be seen as an effort to prevent the capture of fries; although in reality there are accidentally caught and killed then thrown away. Lost or discarded fishing gear still can be used to catch fish for years, without supervised or recognized by anyone. This type of "killing" is called as ghost fishing. Drifting fish nets tend to be accumulated in one area due to the carrying tides. The fishing gear which is released and sunk to the bottom of the sea still can continue to kill waters seabed animals.

Impact of discard catch and ghost fishing. The formation of oxygen-free layer (anoxia) on the seabed due to a discard catch causes seabirds or carcasses gather in the fishing area. Bycatch tends to cause remarkable species population damage to species with low reproductive rate and limited spreading ability species are unable to recolonize areas that have been depleted. The dissipation of apex predators. Overfishing tends to trigger apex predators.

Apex predators are usually the biggest fish as the target of human catches. Increasing number of human catches of large predatory fish in the sea will increase population growth of small fish, so there will be an ecosystem imbalance. Effects to the ecosystem. From the various impacts above, complexity could be seen from prey to predator species. If predatory species were targeted because of the absence or declined of economical fish that occur continuously, the balance of ecosystem will be disrupted. So it would cause broken food chain. Those impacts made us as the writers would like to give suggestions. Avoiding discard catch, it should use the fishing gear with high selectivity and level of friendliness to the environment which not damaging the ecosystem in the sea. Meanwhile avoiding the ghost fishing, the used fishing gear has a marker monitor and made from biodegradable materials.

The attribute of discarded by catch showed the efficiency level of the using of fisheries resources. The fewer bycatch and thrown away caught fish meant the more efficiently use or utilization of fisheries resources. Furthermore, these implications had more guaranteed sustainability of fisheries in the analyzed area or unit. Based on the results of observations and interviews, the bycatch was almost nothing wasted. Because fishermen with redi gathered the netted caught fish and used as side income or for daily needs.

Changes in the size of caught fish by redi

The size of the caught fish attribute described the unchanged size of fish capturing during the last 10 years indicated enough time for fish to grow mature before being caught. This showed a threat for the sustainability of fisheries in small areas. Based on direct observation, the size of fish caught varies depending on the time of the season. Changes in the size of fish and species in the last year would describe the effects of ecological changes. If the size of the fish got smaller, then it can be said that the aquatic environment and small pelagic fishery resources are damaged (degradation), as well as the changes in the type of caught fishes are getting smaller from time to time. Those conditions could be categorized as growth overfishing which occurred when the fish stocks captured were smaller on average than the size that was supposed to produce at the maximum level (Fauzi, 2005).

Generally fishes are caught when they have reached a certain body size, and small size fishes are not caught by nets or released by fishermen. Overfished of the caught fishes based on body size usually causes the remaining fishes with farther from the stage of sexual maturity, so it will make the population hard to restore the population. This will cause lesser next catch, so regulations are loosened to maintain fishermen's income.

Population decline occurred when overfishing affecting the balance of the ecosystem, i.e. eliminating certain trophic level, so the trophic level above it does not get prey. Another example is excessive tuna fishing which caused increasing of a population of small fish such as anchovy. In Peru, the declined of catch fell in the 1970s due to El Niño overfishing (Peruvian Anchovy Case, Peru-fishing, 2012). Anchovy was once the main natural resource for Peru with more than 10 million metric tons of catch per year, but after 1971 the population continuously declined to 4 million metric tons per year only. On the Island of Newfoundland, Canada, cod fish populations occurred drastically decline (Kunzig, 1995). In 1992, Canada issued a moratorium that banned fishing at the area until indefinite time (Kurlansky and Mark, 1997)

Various deep sea demersal fish such as *Hoplostethus atlanticus*, *Dissostichus eleginoides*, and *Anoplopoma fimbria* are in a threatened condition due to overfishing. Deep sea fish is a type of fish with very slow growth and reproductive rate. This type of fish has reached the stage of sexual maturity at the age of 30 or 40 years. Deep sea fish are also in international waters which are not protected by the regulations of any country. Deep sea fish were increasingly targeted since the discovery of cooling technology that can be brought to the high seas (Floyd and Mark, 2007).

Changes of fishing ground fish

Changes of fishing ground fish which occurred last 10 years indicated the condition had been occurred. This occurrence was in almost all places at several sub-districts from the results of the interview which stated the same thing that the fishing ground had undergone real change. Many factors affect changes in fishing ground in a waters location. The factors could be changes in temperature, salinity, primary productivity, or human factors due to excessive capture pressure etc.

Fishing ground is an area where population of all organisms is utilized as a fishery producer. Environmental conditions apparently could affect fishing grounds. Some factors which affect environmental conditions include water temperature, gram level (salinity), pH, brightness (transparency), water movement, water depth, watershed topography, existing building forms from the waters (bottom properties), dissolved oxygen content, and food.

Fishing ground is characterized by the existence of a mass distribution of water as a result of the presence of accumulation area of ocean streams. The distribution of this mass of water will bring and cause living organisms. Fluctuations in environmental conditions actually affect many things including distribution, migration, growth, and migration from many aquatic organisms, also with fish. Marine animals included fish like to inhabit the environment and sometimes live in a permanent place, sometimes just passing through, or inhabiting a place for short periods of time as well as continuing to move or migrate. When the animals are present or settled in a place, this makes easier for them to be caught by using fishing equipment.

Good fishing ground characteristics had inhabit fish (such as sub-population, age, size, duration / duration of life and growth rate), quantity of individual fish (such as sub-population size, number of fish coming to fishing ground, number of fish hordes and the level of individual density in groups). In addition to the characteristics of fishing ground such as: location / position, area, and depth), time (such as: season and resident time). The area with optimum physical factors caused species of fish could adapt easily due to the relatively small fluctuations occurrence. Upwelling area from deep waters is rich in nutrients which move up to the Euphotic area with a lot quantity of phytoplankton, where the results of the photosynthesis process could be consumed by other aquatic animals. The point area and Upwelling peak were the combination of thermoclines in shallow waters, and then the optimum range of temperature for fish species is the limiting factor in a narrow area.

Pressure on fishing activities

Pressures in this area were quite high. This could be seen from the increasing fleet development. As illustrated in the introduction of this study. Whereas other indicator, such the size of caught fish slightly decreased if compared to 10 years ago. Current fishing produces are relatively small in size compared to the average size of the fish which usually used to be caught. The pressure of water users or the intensity level of water use by various activities would directly affect the waters ecological conditions of the FADs installation. The higher level of utilization (pressure) of the water would cause the decreasing quality of the waters. These water pressures could be in the form of the use of the sea as a marine cultivation area, routes of sea transportation traffic, landfills, solid fishing areas and so on.

Overfishing was a type of overexploitation to the fish populations that reach dangerous levels. The loss of natural resources, the slow rate of populations' growth, and the low level of biomass were the result of overfishing which has been exemplified from the excessive hunting of shark fins that disturbing overall marine ecosystem (Scales and Helen, 2007). The ability of the fisheries business towards recovery from falling catches in quantity due to this depends on the resilience of the fish ecosystem to the decline of the population. Changes in species composition within an ecosystem can occur after overfishing where energy in the ecosystem flows to

uncaptured species. The indirectly impact of overfishing is reducing the income of fishermen so they tend to switch professions. At the East China Sea, fishermen switched professions from capture fisheries to aquaculture, fish processing, and marine tourism after the declined of the local catch (China Daily, 2006).

Exploitation status of fish resources

The attribute of exploitation status described the higher the level of exploitation of fisheries resources in a waters region will increase the risk or threat level to the sustainability of fisheries in the waters. So far, fishermen in Buton Regency had used most part of the watershed of the fishing area. According to the results of an evaluation which conducted by the Center for Capture Fisheries Research, BRKP (2007) concluded that the Banda Sea waters (WPP 714) had a potential of 165,944 tons, JTB was 132,755 tons and utilization rates were 0.44%.

The classification as overfishing has not occurred yet. For this reason, the level of utilization of fish resources could be qualified under exploited. This attribute was given a zero score.

Redi's sustainability status in the ecological dimension

Marques (2008) explained that ecological indicators were usually used to provide synoptic information about the state of the ecosystem. The application of ecological indicators was not freed from criticism, therefore, as the principle that evaluation of environmental quality always should be done through a combination of several ecological indicators, which can provide complementary information. In Figure 4 shows a graph of ordination of the ecological dimension.

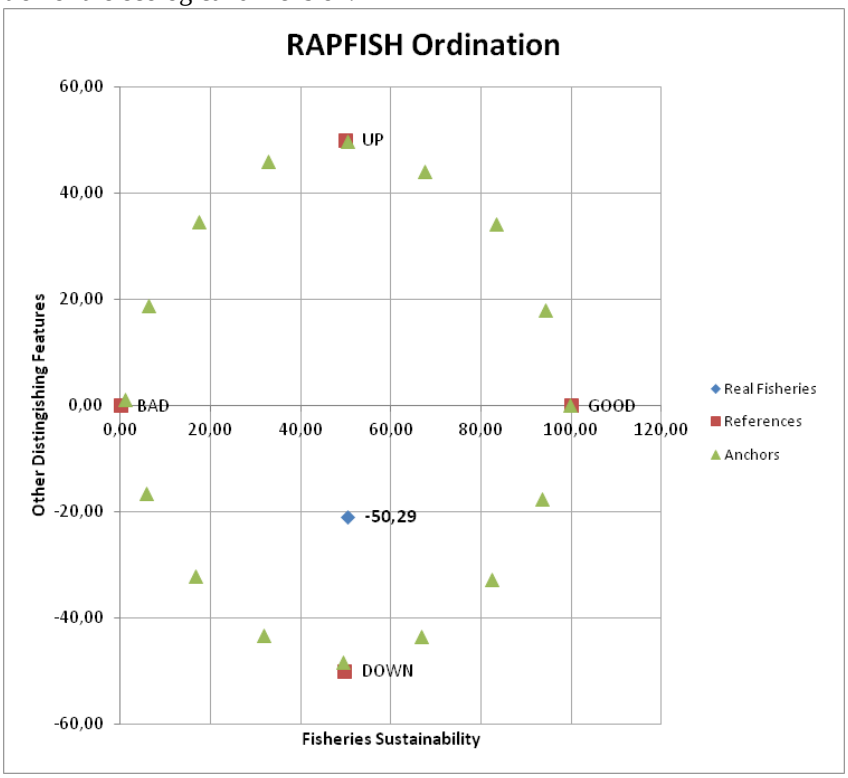

Figure 4. Level of sustainability of ecological dimension

The results of RapfishRedi analysis of the ecological dimension (ecological sustainability) obtained 50.29% of sustainability index or classified as sustainable (> 50%). This value described the condition of Redi fisheries was not experiencing pressure from ecological aspects. This could happen due to the intensity of fish resources use was generally still far from the bottom of the waters, far from the coast and its fishing activities were still far from the location of the reef as the habitat of the fishes. Odum (1993) concluded that ecology is a study of the structure and function of ecosystems or nature and humans as a part. Thus, the impact resulting from human activities will have an impact on the structure and function of the ecosystem.

The results of RapfishRedi analysis could be accepted that obtained results of the validation test by the Monte Carlo value of 45.37% which indicated a very small difference in the difference of 0.56% or less than 1%. This value indicated the effect of the error or the impact of the error in giving a score was relatively small. So, the RapfishRedi model for the ecological dimension was stated as sufficient to predict the sustainability

index value. According to Kavanagh and Pitcher (2004), Monte Carlo analysis could be used as a simulation method to evaluate the impact of random errors in statistical analysis which performed on all dimensions. The same thing was also stated by Fauzi (2005) that Monte Carlo analysis could be the indicator of error which caused by giving scoring on each attribute, variations in giving multidimensional scoring due to different opinions, repeated data analysis processes, and errors in inputting data or lost data.

The accuracy test results (goodness of fit) also indicated the sustainability index estimation model could be used, where the value of Squared Correlation (R2) is 0.9526245 or approached to 1. The R-square value approaches to 1 means that the data is mapped perfectly. This value described more than 95.2 6% model of the expectation sustainable indexcould be explained as well, as remaining 5.48% was explained by other factors. Kavanagh (2001) mentioned the value of Squared Correlation (R2) of more than 80% indicated the sustainability index estimation model is good and adequate to be use. The result of inaccuracy (a lack of fit measure) or stress value is 0.13 or approached to 0 (zero). The stress value approached to zero, so the output produced was more similar to the actual situation or the lower the stress value,the model is better or suitable to be used. On the other hand, the higher the stress value, the lesser model suitability. Kavanagh (2001) explained the stress value that can be tolerated was<20%, thus the model could be well received with a stress value of 13%. Aside from sustainability index obtaining, RapfishRedi analysis also produced output in the form of leverage of attributes. Leverage attributes are attributes which give the highest percentage value in the sustainability of a management dimension. In Figure 6, the example shows the values of the ecological dimension sustainability attributes.

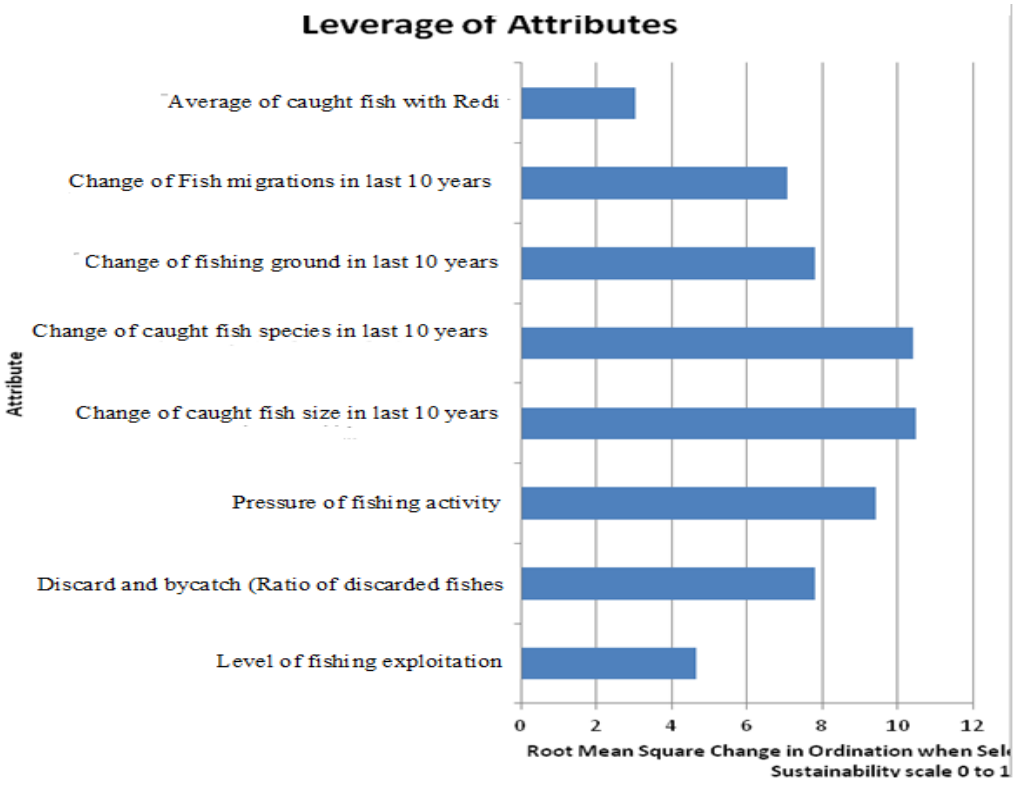

Figure 5. Leverage attributes of ecological dimension sustainability

Leverage Attributes

The result of RapfishRedi analysis for leverage attributes showed that generally sustainability attribute could be divided into three groups, i.e. group with the most influential on sustainability of ecological dimension, i.e.; (1) change of caught fish size in last 10 years (RMS =10.49%); (2) change of caught fish species in last 10 years (RMS =10.39%); and (3) pressure of fishing activity (RMS =9.40%). Meanwhile group with moderately influence consisted of three attributes, ie; (1) discard and bycatch (ratio discarded fish) with (RMS =7.82%); (2) change of fishing ground in last 30 years (RMS = 7.79%); (3) change of fish properties in last 10 years (RMS = 7.07%). The last is third group has the least influence which consisted of two attributes i.e., (1) level of fishing exploitation (RMS = 4.66%). Kavanagh and Pitcher (2004) explained that RMS value showed

the importance of each attribute to the status sensitivity of sustainability. In other words, the higher RMS value would make bigger influence or role of the attribute to the sensitivity of sustainability.

IV. CONCLUSION AND SUGGESTIONS

Conclusion

This research had shown that generally index of Redi sustainability in Buton Regency was 50.29% or classified as sustainable (>50%). Sensitivity analysis showed the group with the most influential on sustainability of elcological dimension, i.e; (1) change of caught fish in last 10 years; (2) change of caught fish species in last 10 years; and (3) pressures of fishing activity. Sustainability of Redi in Buton Regency based on ecological dimension was moderately sustainable.

Suggestion

Based on the research which had been done, it is suggested to study RAPFISH with measurable and well-methodical evaluation techniques, so the given result can be more detailed. It is necessary to study further from field experiences about researched attributes so the variable of problem and its derivatives can be known exactly

REFERENCES

[1] Amiruddin W, Setiyanto I, dan Hadi S.E, Analysis of the Profitability of the Transition of fishing business to be rental business of marine tourism ship in the islands, 2017 Undip Journal.

[2] Anonim, 2008, Database of Marine and Fisheries Development 2008, Bappenas Jakarta.

[3] Alder J .et.al. 2000. How Good is Good? A Rapid Appraisal Techniques for Evaluation of The Sustainability Status of Fisheries of The North Atlantic. In Paul amd Pitcher (eds). Metohds for Evaluation The Impact of Fisheries on The North Atlantic Ecosystem. Fisheries Center Research Report,200 Vol (8) No.2.

[4] Darsono,2007,www.tempointeractive.com/hg/nusa/jawamadura/2007/06/06/brk,2007

[5] Fauzi dan Anna. 2005. Modeling of Fisheries and Marine Resources. Jakarta: PT. Gramedia Pustaka Utama. 343 page

[6] Fauzi Akhmad, 2005, http://www.kompas.com/kompas-cetak/0307/30/bahari /459117.htm : "Turning the Tide" Fisheries Economics Policy
Fauzi, A. dan Anna, S. (2002). Evaluation of the sustainability status of fisheries development: Application of rapfish approach (Case study of DKI Jakarta coastal waters). Coastal and Ocean Journal, 4(2), 36-49.

[7] Fauzi, A..2005.Modeling of fishery resources. Publisher of Gramedia Pustaka Utama:343 hal

[8] Fischer, W., I. Sousa, C. Silva, A. de Freitas, J.M. Poutiers, W. Schneider, T.C. Borges, J.P. Feral and A. Massinga, 1990. Fichas FAO de identificaçao de espécies para actividades de pesca. Guia de campo das espécies comerciais marinhas e de águas salobras de Moçambique. Publicaçao preparada em collaboraçao com o Instituto de Investigaçao Pesquiera de Moçambique, com financiamento do Projecto PNUD/FAO MOZ/86/030 e de NORAD. Roma, FAO. 1990. 424 p.

[9] Foreign Assistance Legislation for Fiscal Year 1982. Committee on Foreign Affairs. 1981. Peru - Fishing". Federal Research Division of the U.S. Library of Congress. Diakses tanggal 2012-05-01.

[10] Fish recruitment". The Scottish Government. Accessed date : 16 October 2013.

[11] Floyd, Mark (2007). "Long-term deep-sea fish are threatened by technology and overfishing ". AAAS. /2018/03/03 : 2012-05-01.

[12] Hariati Tuti, 2006, Catches and Catching Efforts of Small Pelagic Fish Caught on Trawl in the Malacca Strait. Year of 2003 – 2004 th, Indonesian Fisheries Research Journal, Vol. 12 No.2 / 2006.

[13] http://kendaripos.co.id/fisherman in Buton Island protest the activity of redi ship.Accessed date/2018/03/03

[14] Kavanagh, P. 2001. Rapid Appraisal of Fisheries (RAPFISH) Project. University of British Columbia, Fisheries Centre

[15] Kavanagh and Pitcher. 2004. Implementing Microsoft Exel Sofware For Rapfish : A Technique For The Rapid Appraisal of Fisheries Status. Canada. Fisheries Center, University British Columbia. 75 page.

[16] Kusbimanto, I.W., S.R.P. Sitorus, Machfud, P.I.F. Poerwo, dan M. Yani. 2013. Analysis of the sustainability of the development of urban transport infrastructure in the Mamminasata Metropolitan, South of Sulawesi Province. Bridge Road Journal. 30(1): 1-15

[17] Marques SC, UM Azeiteiro, SM Leandro, H Queiroga, ALnPrimo, F Martinho, I Viegas dan MA Pardal. 2008. Predicting Zooplankton Response to Environmental Changes in Atemperate Estuarine Ecosystem. J.Marine Biology. p.155:531-541

[18] Odum EP. 1993. Dasar-dasar Ekologi: Volume ke 3. Universitas Gadjah Mada Press. Translate from : Fundamentals of Ecology.
[19] Pitcher, T.J. and D.B Preikshot. 2001. Rapfish: A Rapid Appraisal Technique to Evaluate the Sustainability Status of Fisheries. Fisheries Research. Vol 49(3): 255-270.
[20] Thamrin, S. H. Sutjahjo, C. Herison, dan S. Biham. .2007. Sustainability Analysis of the West Kalimantan-Malaysia Border Area for the Development of Agropolitan Areas: Case Study of the Bengkayang District (Near the Bengkayang Regency Border). Agro Economic Journal. 25 (2): 103-124.
[21] Purnomo, 2003, www2.kompas.com/kompas-cetak/0311/11/jateng/683007.htm - 40k:
[22] Severe, Overfishing in North coastal Javadi Pantai Utara Jateng
[23] Sumiono Bambang, 2002, Capture Rate and Density of Demersal Fish Stock in Malacca Strait, Indonesian Fisheries Research Journal, Vol. 8 No.1 / 2002.
[24] Tajerin, Manadiyanto, dan Adi Pranowo Sapto, 2003, Analysis of Profitability and Distribution of Income of Fishing Business Using Mini Ring Trawlers in Tuban Regency, East Java, Indonesian Fisheries Research Journal,Vol.9 No. 6 / 2003.
[25] Kuiter, R.H. and T. Tonozuka, 2001. Pictorial guide to Indonesian reef fishes. Part 1. Eels- Snappers, Muraenidae - Lutjanidae. Zoonetics, Australia. 1-302.
[26] Masuda, H. and G.R. Allen, 1993. Meeresfische der Welt - Groß-Indopazifische Region. Tetra Verlag, Herrenteich, Melle. 528 p.
[27] Mundy, B.C., 2005. Checklist of the fishes of the Hawaiian Archipelago. Bishop Mus. Bull. Zool. (6):1-704.
[28] Myers, R.F., 1999. Micronesian reef fishes: a comprehensive guide to the coral reef fishes of Micronesia, 3rd revised and expanded edition. Coral Graphics, Barrigada, Guam. 330 p.
[29] Smith-Vaniz, W.F., 1995. Carangidae. Jureles, pámpanos, cojinúas, zapateros, cocineros, casabes, macarelas, chicharros, jorobados, medregales, pez pilota. p. 940-986. In W. Fischer, F. Krupp, W. Schneider, C. Sommer, K.E. Carpenter and V. Niem (eds.) Guia FAO para Identification de Especies para lo Fines de la Pesca. Pacifico Centro-Oriental. 3 Vols. FAO, Rome.
[30] Peruvian Anchovy Case: Anchovy Depletion and Trade". Trade and Environment Database. 1999. Accessed date : 2012-01-05.
[31] Peru-Fishing ". Divisi Research Federal Libarary Kongres AS. Accessed date : 2012-05-01.
[32] Pauly, Daniel (1983). Some simple methods for valuing tropical fish stocks. Technical paper FAO Fisheries 234. ISBN 92-5-101333-0. Accessed date : 2012-05-01.
[33] Kunzig, R (April 1995). "Twilight of the Cod". Findout: 52. Accessed date : 2012-05-01.
[34] Kurlansky, Mark (1997). "11-12". Cod: Fish Biography that Changed the World. New York: Walker. ISBN 0-8027-1326-2.
[35] Scales, Helen (29 Maret 2007). "Shark Declines Threaten Shellfish Stocks, Study Says". National Geographic News. Accessed date : 2012-05-01.
[36] Pollution, overfishing destroying E. China Sea fishery". China Dailiy. 2006-08-16.
[37] Widodo Johanes dan Suadi, 2008, Management of Marine Fisheries Resource, Gadjah Mada University.