TAC-STUDY IN TEGAL WATERS AND ITS ADJACENT AREAS BASED ON CAPTURE PRODUCT AND RELATION TO SOCIO-ECONOMIC ASPECTS TOWARDS RESPONSIBLE FISHERIES

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ABSTRACT

There is a high level of fishery resources exploitation in dense coastal waters region such as North Coast of Java. This is because of the increasing numbers of traditional fishing gears was concentrated on the territory. For the past ten years, the rate of resource utilization in Tegal waters and its surrounding has reached its peak and serious problems occurred that relates to the lack of resources capacity. Appropriate measures should therefore be taken in order to avoid further problems. The study aims to examine the potential and rate of the fishery resources in Tegal waters and its surrounding waters. The study used Surplus Production by Schaefer (1954). Materials used were catch data, data of the development of fishing gears for the past five years (1998-2002), data on genus composition and numbers of catches the Fish Landing Place. The level of fishery resources utilization has reached the maximum value. Fishing effort in Tegal waters and its surrounding has exceed the sustainability of the resources, so this situation needs better maintenance and control to minimize exploitation pressure of fishery resources on coastal area. The government as a policy maker (by rule or law), on fisheries management for coastal fisheries must apply precautionary approach by focusing on biological and economics aspects of the resources.

Keywords: fisheries product, TAC, Community Based Management

INTRODUCTION

Monetary crisis occurred since the mid of 1997 is still continuing and slowing down national economic growth. In this situation, fishery sector is expected to contribute and speed up macro economic growth. Utilization of fisheries resources has become a new development paradigm in global era and should be implemented rationally and continuously. This policy is very realistic as shown by the fact that fisheries resources, especially marine fish is considerably large and exploitable.

Indonesia, with a total area of 5.8 million km^2, has a great deal marine resources, both in terms of amount and diversity. Sustainable yield of Indonesian marine fisheries resource is estimated 6.25 million ton/year, which consists of resources in Indonesia territorial waters around 4.40 million ton/year and ZEEI water around 1.86 million/year. Marine fisheries utilization in Central Java has been conducted from year to year through various development activities. According to Central Java Fisheries and Marine Agency (2002), from 1996 until 2000 fishery production in Central Java has increased by 2.07% per year in average, from 347,936.80 ton in 1996 become 374,786.30 ton in 2000. But the increase was mainly due to the increase of freshwater fishery production by 9.97% per year in average, from 63,635.20 ton in 1996 became 92,003.20 ton in 2000. Whereas marine fishery production has decreased 0.92% per year in average, from 284,304.60 ton in year 1996 became 271,833.30 ton in 2000.

In utilizing marine fisheries resources, fishing has a certain characteristic in common fishery business such as the high uncertainty. This is mainly caused by highly spatial and temporal variation of fish resources. Moreover, when the exploitation rate is higher than the sustainable yield, catch will decrease and overfishing will occur. Decreasing trend in the catch is caused by among others: incompatibility between potential and fishing effort, habitat destruction, and use of unfriendly fishing gear and lack of fishing infrastructure.

Recently, exploitation of marine fisheries resources in the north coastal waters of Central Java has been suspected to exceed the optimum level. According to National Commission for Assessment on Marine Fisheries Resources Stock (1998) and Merta et al. (1999), level of marine fisheries exploitation in Java Sea has reached 130%. Result of previous study showed that level of exploitation of marine fish resource in Java Sea water has been much higher, reaching 149% (Dwiponggo, 1990). Result of study on Resource and Ecological Assessment in Tegal Waters and its surrounds clearly indicated that sustainability of capture fisheries has been threatened by overfishing. It could be understood since the captured fish tend to decrease and their size is getting smaller from year to year (Coastal Community Development and Fisheries Resources Management Project Central Java, 1999). Some of the above conditions are caused by overexploitation relating to uncontrolled fishing efforts. Initially, catch will increases with the increase in fishing efforts, but at a certain point, resource recovery (reproduction and growth) could not compete with fishing effort and higher exploitation rate will lead to decrease in catch. Therefore, rationalization of fishing efforts should be conducted through marine fisheries resource management by determining Total Allowable Catch (TAC), so as to maintain fish resource sustainability and hence guarantee the continuation of fishing activity. Information on TAC is really needed as a database in marine fisheries resource exploitation. Project Administration Memorandum (PAM) – ADB point 3 concerning Project Components/Outputs of Coastal Fisheries Resource Management Program stated among others: “coastal fishing areas are covered and total allowable catch is determined” and “coastal fisheries resource management plans are developed”. Furthermore, enclosure of Decree of the Minister of Agriculture No. 995/Kpts/K.210/9/99 concerning fish resource potencies and Total Allowable Catch in Indonesian fisheries area, has determined value of TAC in relation to reasonable fisheries resource management. Study on the potential and marine fisheries resource exploitation level has also been conducted by National Commission for Assessment on Marine Fisheries Resource in 2001.

Considering the matters above, study on the resources and TAC in Tegal waters is necessary to assess the potential and level of fisheries resource exploitation in this area. Since Tegal waters is an open coastal area that needs specific management acts, location of this study was expanded to cover fishing ground in Brebes District, Tegal City, Tegal District, Pemalang District, Pekalongan District, Pekalongan City, Batang District, Kendal District, and Semarang City. In addition, this study used Maximum Allowable Fishing Gear (MAF) as alternative method in controlling aquatic resources exploitation.

MATERIALS AND METHODS

Generally, fishery business could be defined as an activity to manage and exploit fish and aquatic resources to add supply of energy, material and technology and/or other material, which is directed to get biomass for human needs. Fishery resources are recognized as renewable resources, which mean that they can be renewed naturally, so they will be useless if we do not utilize them. But it does not mean that the resource is not unlimited in terms of their amount and capacity to regenerate. Fish resources and its environment, in normal condition, are recoverable and renewable, but they are not unlimited and could not be kept in their natural condition continuously. So, when we exploit them irrespective of ecological principle, for example over the sustainable potential or environment capacity, negative impact on fishing continuation may occur.

Fisheries resource is a common property and open access resource, so anyone could exploit it. Consequently, when the optimum exploitation level is exceeded, adverse impact for the next fisheries resource users and beneficiaries will happen in due course. The basic concept in describing the dynamic of an exploited aquatic resource is stock. A stock is a sub cluster of species that is generally considered as basic taxonomy unit. The ability to separate different species is required for identifying stock.Stock assessment is aimed at giving suggestion on optimum level of aquatic biological resources exploitation. Biological resource is limited but renewable and fish stock assessment could be used to estimate exploitation level that ensures long-term maximum fishing catch. At certain level, catch increases with fishing effort, but after that, resource replenishment (reproduction and growth of body) could not compete with fishing effort thus the greater increase of exploitation level will lead to decrease of catch.

Irrational and uncontrolled resources exploitation will cause stock to decrease, decline in fish population, capital over-accumulation, and decrease in CPUE and low profit in fishing industry. Fishery development, in relation to fishery resources exploitation is based on a concept of maximum yield that assures sustainable effort (MSY: maximum sustainable yield and MEY: maximum economic yield) to get optimum economic profit, whether for fisheries community or government, now or in the future, in accordance with national objective. This could be achieved through sustainable development program and integrated management system on fisheries resources.

In relation to fishery development, assessment of exploitable fish resources is very important since they are limited. It means that fishery development could not be accelerated without considering their capacity. In case of capture fisheries, control on effort is necessary and it should refer to the result of Total Allowable Catch (TAC), fish resource potential and allocation of number of fishing boat/vessel that are allowed operating in each water area. This concept of sustainable fishery development is important to assure fishery resource sustainability.

This study used the following approaches:
a. Descriptive Analysis
b. Mathematical Analysis

Descriptive analysis approach is used to describe and analyze data on general condition, marine fisheries activity and development of fishing in study area. Whereas mathematical analysis approach is used to analyze level of fish resource exploitation based on sustainable potential and fishing effort in study area.

The main data in this study were secondary data collected from fish landing place (fishery port, PPI, etc.) that spread along Central Java north coast. Besides that, primary data were also collected in each study area to crosscheck and back up the secondary data.

Secondary data collected in this study were catch landed in study area. The data were supplemented by data on production per fishing trip, both monthly and yearly during the last five years. Whereas the primary data were on marine fisheries activity conducted by fisherman including average production per fishing trip, fishing gear used, fishing method, fish species, fishing ground and other data related to fish resource conservation (spawning area, rearing and nursery ground).
The secondary data are collected from Central Java Fisheries and Marine Agency, District/City Fisheries and Marine Agency/Office, and other related institutions. The primary data were collected by interview with fishermen (especially captain and other related key person) in each study area, using questionnaire.

Mathematical approach uses *surplus production model* by Schaefer (1954) based on Catch per Unit Effort/CPUE and Maximum Sustainable Yield/MSY. Generally, CPUE and C/F, where C is catch and F is effort could be used as a relative abundance index. Surplus Production method is based on assumption that CPUE is a function of effort. Surplus Production model uses CPUE as input. Usually the data is an annual data series obtained from commercial fishery catch. The model is based on assumption that fish biomass in the sea is proportional to the CPUE. Estimation on fishing catch is derived by multiplying effort with CPUE.

The main objective of Schaefer model is to determine the change in the abundance of fish that subject to exploitation and to determine the maximum catch without changing the sustainability of the resource. One of the models is based on the achievement of MSY level. Both approaches could be used as a basis in calculating TAC. Alternative approach such as the use of number of fishing power for each fishing gear could be used to control fishing level in each district/city.

RESULTS AND DISCUSSION

Physical Characteristic

As stated before, this study covers area along the western part of Central Java north coast, namely: Brebes District, Tegal District, Tegal City, Pemalang District, Pekalongan District, Pekalongan City, Batang District, Kendal District and Semarang City. Geographically, Central Java Province faces to Java Sea in the north and Indian Ocean in the south. The length of Central Java north coast is around 453.9 km from westernmost of Brebes District to easternmost of Rembang District. Physiographically, Central Java north coast is alluvial plain zone that stretch from Brebes District until Rembang District, and only a little part that included in quarter volcano zone and Java middle depression, namely Pekalongan District, Tegal District, Batang District, Jepara District, Pati District, and Rembang District. The alluvial plain is started form western part of Brebes until Demak and become narrow along the Jepara coast due to the existence of Muria Mountain.

Central Java north coast area lies between $108^0$41'37.7'' – $111^0$15''E and $6^0$44'56.6'' – $7^0$00'S. Morphologically, this area consists of lowland plain (western Central Java north coast) and hill (eastern and southern) and valley that stretch from the west to the east (south coast). Generally, Brebes coast until Semarang coast is a sloping coast that consists of clay and sandy clay, whereas coast and bottom of sea in Jepara, especially, much constructed of coral reef and coral fragment, sediment, sand, and clay. The coast and sea bottom of Brebes District until Semarang City is composed of alluvial sediment in form of smooth clay until lump that have not become lithium and come from rivers emptying into the coasts. Commonly, bottom of sea is relatively sloping with 5 m, 10 m, 15 m up to 20 m depth.

Indonesia is affected by west and east monsoon, so the dominant wind direction is from the east to the west and affects variation of meteorology and oceanographic factors happens there. In Indonesia, including in Java Sea and Hindia Ocean, the west monsoon occurs between October and March, whereas the east monsoon occurs between April and September. There is interchange I season between west and east monsoon and interchange II season between east and west monsoon and both seasons occur in relatively short term.

The wind along Java north coast predominantly blows from northwest. It is caused by distortion of wind direction from the west that continuously goes to the north due to terrestrial vegetation tenacity, and goes to Demak and Jepara coast and ended at the northernmost of Jepara. This distortion will affect coastal wave direction and then it could be used as guidance or prediction of coastal abrasion or sedimentation process. The wind speed during west season is around 0.01 – 14 m/s when a little storm happens. Length of the west season will determine perfection of mixing process in coastal area. It determines length of fertility and primary productivity in the next east season. The mixing process will be affected by the size and height of wave, where the wave determined by wind speed. If the wind speed and wave height become significant, then the mixing process will reach deeper water. Although west season period in Central Java south coast usually endure more slowly than period in Central Java north coast, the effect is not as great as in north coast. Nevertheless, at certain months the wind lows fast from the west and northwest that highly threaten shipping and fishing operation.

Central Java north coast water is affected by Java Sea with the low level of salinity, especially during the west season. The fish resources that found much in this area is small pelagic and demersal fish. The dominant ecosystem in Central Java north coast is swamp, mangrove, seabed, delta, sandy coast and coral reef.

Description of Capture Fisheries

According to Central Java Marine and Fisheries Agency 2003, number of fishermen in Central Java currently is 107,936 consists of owner (12,881) and labor (90,603). The fishermen mostly found in Kendal District (13,376 = 12.39%), Pekalongan City (13,010 = 12.05%) and Pati District (11,649 = 10.79%), whereas the number of trader in Central Java entirely was 3,561 people.

The development of fishery household in study area was followed by growth of fishing fleet. In terms of type of fishing fleet, outboard motor boat outnumbered motorized boat and un-motorized vessel. The existing data (Central Java Fisheries and Marine Agency, 2003) shows that number of fishing fleet in Central Java totally reached 23,203 units that consists of 1,829 un-motorized vessel and 18,484 outboard motor boat and 2,889 motorized boat (<5 – 10 GT, 10 – 30 GT and > 30GT).

The increase in fishing fleet was followed by fishing gear. Until last year, total number of fishing gear in Central Java was 44,493 units (Central Java Fisheries and Marine Agencies, 2003). Generally, the number of fishing gear has increased especially in Tegal District, Tegal City, Pemalang District, and Pekalongan District, whereas in Semarang City, it tends to decrease or stable. The most fishing gears that fishers use are Payang, Dogol (purse seine), Jaring Klitik drift gillet), Jaring Insang Tetap (set gillnet) and Trammel Net.

According to the government policy on fishery development in Central Java during 1999/2000 until 2003/2004, projection on average production increase from 1999 to 2004 is 2.05% and from 2000 to 2004 is 2.13%. Whereas projection on the average product value from 1999 to 2004 is 6.24% and from 2000 to 2004 is 6.25%. The achievement on marine fisheries production in Central Java during Pelita VI (1994 – 1998) was 98.77% of the target, whereas the product value was 120.63%. Marine fishery production in study area from 1997 up to 2001 fluctuated but tended to decrease especially in Semarang City, Kendal District, Batang District, and Pemalang District, whereas in other district/city was relatively stable, except in Tegal City which tended to increase. The highest production is in Pekalongan City due to the high fishing catch landed by purse seines fleets in Pelabuhan Perikanan Nusantara Pekalongan (PPNP), Tegal City, and Batang District, and the lowest production was in Semarang City.

Although marine fishery production decreased the product value tended to increase from year to year which may be caused by the increase in selling price. The highest product value was in Pekalongan City where the pelagic fish caught by purse seine was main product. The condition was also found in Tegal City and Batang District where many purseseiner landed their catches.

Potential and Distribution of Fish Resource

Basically, fishery resource in Central Java is of great potential. Some fishery resources have high export value, such as tuna, skipjack, pomfret, grouper, eel, shrimps (penaeids and lobster), and seaweeds etc. Exploitation of fishery resources could support and develop economic, but up to now, it has not yet been exploited optimally. The existing problem is due to lack of information on potential and distribution of fishery resource, location of exploitation and fishing ground.

Fishery resource potential in Central Java is mainly from Java Sea and Indonesia Ocean. Both areas have a different marine resource characteristic. Java Sea is dominated by small pelagic fishery resource such as scads, mackerel, and little tuna, and demersal fish such as ponyfish etc, whereas Indonesia Ocean is dominated by big pelagic fishery resource such as skipjack, tuna, hairtail, sailfish and shrimp. Besides that, Indonesia Ocean water area also has resource potency such as shrimp, coral fish and eel that is quite potential and has not been optimally exploited yet. Fish resource potency spread out in water around Central Java is estimated 1,513,765 ton/year including Java Sea around 847,515 ton/year and Hindia Ocean around 666,240 ton/year (Central Java Fisheries and Marine Agency, 2003).

Fish resource potential and level of exploitation in Central Java varies according to area. Some groups of fish are big pelagic, small pelagic, demersal, coral fish, ornamental fish, shrimp, crustacean, shells, sea cucumber, etc. Shrimps as a top export commodity has been exploited close to its existing capacity, whereas big pelagic and demersal fish has not been depleted yet. In addition, the potential of small pelagic varies with area.

According to Central Java Marine and Fisheries Agency, 2003, number of fisher in Central Java up to know is 107,936, which consists of owner (12,881) and labor (90,603). The fishers, mostly, found in Kendal District (13,376 = 12.39%), Pekalongan City (13,010 = 12.05%) and Pati District (11,649 = 10.79%), whereas number of trader in Central Java entirely is 3,561 peoples. Growth of fishery household in study area is followed by growth of fishing fleet. Up in relation to type of fishing fleet, outboard motor boat is more than motorized boat and un-motorized vessel. The existing data (Central Java Fisheries and Marine Agency, 2003) shows that number of fishing fleet in Central Java totally reaches 23,203 units consists of 1,829 un-motorized vessel and 18,484 outboard motor boat and 2,889 motorized boat (<5 – 10 GT, 10 – 30 GT and > 30GT).

Development of fishing fleet is followed by increase of fishing gear. Up to now, totally, number of fishing gear in Central Java is 44,493 units (Central Java Fisheries and Marine Agencys, 2003). Generally, number of fishing gear has increased especially in Tegal District, Tegal City, Pemalang District, and Pekalongan District, whereas in Semarang City, it tends to decrease or stable. The most fishing gears that fishers use are purse seine, gill net, set gill net and trammel net.

According to operational policy of fishery development in Central Java during 1999/2000 until 2003/2004, projection on average production increase from 1999 to 2004 is 2.05% and from 2000 to 2004 is 2.13%. Whereas projection on the average product value from 1999 to 2004 is 6.24% and from 2000 to 2004 is 6.25%. Achievement of marine fisheries production in Central Java during Five-year development plan (Pelita VI) (1994 – 1998) was 98.77% out of the target, whereas the product value was 120.63%.

Marine fishery production in study area from 1997 up to 2001 fluctuated but tends to decrease especially in Semarang City, Kendal District, Batang District, and Pemalang District. Whereas in other District/city is relatively stable, hence in Tegal City it tends to increase. Successively, the highest production is in Pekalongan City due to the high fishing catch landed by Purse Seines fleets in Pelabuhan Perikanan Nusantara Pekalongan (PPNP), Tegal City, and Batang District. The lowest production is in Semarang City.

Although marine fishery production has decrease, the product value tends to increase from year to year. It may be caused by the increase of selling price. The highest product value is in Pekalongan City where the pelagic fish caught by purse seine becomes main product. The condition also happens in Tegal City and Batang District where many purse seines landed their catch.

Fish resource potential in study area is dominated by small pelagic fish group, especially scad (*Decapterus sp*, *Selar spp*), Bali sardinella (*Sardinella lemuru*), Fringescale sardinella (*Sardinella fimbriata*), chubb mackerel (*Rastrelliger spp*), and anchovy (*Stophorus spp*). Some of demersal fish are mostly Ponyfish (*Leiognathidae*), yellowtail goatfish (*Mullidae*), black pomfret (*Formio niger*), hairtail (*Trichiurus spp*), fork-tailed threadfin bream (*Nemipteridae*) and sting ray (*Triginidae*).

Monthly data of fish production in all districts/cities in study area during the last 5 (five) years since 1998 until 2002 shows that fishing was conducted along the year. The crowded season is during August and December, and the peak is in November.

As in other area, there are four seasons in Java Sea namely: West Monsoon (December – February), Transition I Season (March – May), East Monsoon (June – August) and Transition II Season (September – November). The fish production in study area during the last five years since 1998 until 2002 shows that the highest production was reached in Transition II season (September – November) but it started to decline when approaching West Monsoon, whereas the lowest production is reached in Transition I Season and start to increase in East Season.

Level of Fish Resource Exploitation

Theoretically, level of fish resource exploitation in an area is determined by resource stock in the area and fishing effort to catch fish. Fish resource productivity will be determined by catch per Unit Effort (CPUE).

Estimation of potential and level of fish resource exploitation in study area is conducted using Surplus Production model developed by Schaefer (Spare et al, 1992), which is by doing analysis on relationship between effort and CPUE. Based on the analysis, we will get value of stock and sustainable potential.

The use of this model is aimed to determine optimum effort level, namely an effort to catch maximum sustainable fishing catch without affecting long-term stock that usually we know as Maximum Sustainable Yield (MSY). Based on revaluation of fish resource potential conducted by national Commission for Stock Assessment in 1997, the sustainable fish resource potential in Java Sea is 843,515 ton/year. Whereas Decree of the Minister of Agriculture no. 995/KPts/IK.210/9/99 states that potential of small pelagic and demersal fish in Java Se and Sunda Straits is 771,200 ton/year and the Total Allowable Catch (TAC) is 616,960 ton.

Based on the data, if we estimate that the potential of Central Java is 1/3 of the total potential of Java Sea and Sunda Straits, then marine fish resource potential in Central Java according to National Commission for Stock Assessment is 281,172 ton/year and the TAC is 224,938 ton. Central Java marine fishery production in average since 1997 until 1999 has reached 274,478 ton/year (97.62% of its sustainable potential). But the exploitation has exceeded the TAC by 49,540 ton (22.02%). When compared to Decree of the Minister of Agriculture no. 995/KPts/IK.210/9/99 in which potential of Central Java is 1/3 of total potential in Java Sea and Sunda Straits that is 257,067 ton/year and the TAC is 205,653 ton, the exploitation has exceeded the TAC by 68,825 ton (33.47%).

Calculation of MSY and Optimum Effort, 1997 – 2001

Based on data series during the last five year since 1997 – 2001 (Fisheries and Marine Agency of Central Java, 2003), calculation on marine fishery resource potential and exploitation level in study area was made, both for each district/city and entire study area. Considering fishing fleets operate in study area use several fishing gears, then standardization of fishing gear with purse seine has been conducted in this calculation, since the CPUE for Purse Seine is the highest or the most effective among the other fishing gears.

Graph on relationship between production and number of fishing efforts in each district/city shows that production per number of fishing trips operates during 1997 until 2001 has slightly decreased. This condition indicates that the level of fishing efforts has affected production, especially in Brebes District and Pekalongan City. Moreover, trend of production increase due to increase of fishing efforts has not been found in most other districts/cities and entire study area. The result indicated that increased fishing efforts from year to year have decreased the production.

Based on the calculation on the potential and exploitation level for entire study area we found that value of MSY is 142,873 ton/year and the optimum effort is 190,026 trips/year. It means that annual production is 164,536 ton in average, produced from 150,321 trips of fishing effort. The value has not exceeded sustainable potential and optimum effort, in other words fish resource in study area has not been overfished yet.

Nevertheless, if the 142,873 ton/year of MSY is compared to assessment result of National Commission for Stock Assessment and Decree of the Minister of Agriculture no. 995/KPts/IK.210/9/99, with assumption that sustainable potential and TAC in entire study area is half of Central Java north coast, then sustainable potential in study area is higher and means that its exploitation level has exceeded the determined sustainable potential and TAC. (Note: for Central Java north coast, according to Decree of the Minister of Agriculture the sustainable potential is 128,534 ton/year and TAC is 102,827 ton, whereas according to National Commission for Stock Assessment the sustainable potential is 140,586 ton/year and TAC is 102,469 ton).

Calculation of MSY and Optimum Effort based on Total Effort and CPUE during 1997 until 2001

Calculation of CPUE and efforts during five years since 1997 until 2001 has resulted in estimation of MSY and optimum effort both for each district/city and entire study area. Based on the calculation, we estimate MSY and determine the MSY that has been or will be reached in certain level of fishing effort. Graph on relationship between total effort and CPUE for each district/city generally shows a negative relation between effort and CPUE, except for Kendal District. Graph for study area shows that y/f has decreased in line with increase of fishing effort although the slope is relatively small. Hence, result of calculation for study area shows that CPUE has not exceeded the MSY by 49,792 ton/trip, but the fishing effort during 1999 until 2000 has exceeded the optimum level.

Calculation of MSY and Optimum Effort based on the Dominant Fish during 1997 until 2001

Fish resource in the study area is dominated by small pelagic fish especially scads, trevallies, sardinella, chubb mackerel, anchovy, fringescale sardinella, Eastern little tuna and ochre-banded goatfish. Some of demersal fish are mostly ponyfish, croakers, pomfret, Indian halibut, hairtail and rays. Calculation on estimation of MSY and effort based on dominant fish production and fishing effort for each district/city during five years later since 1997 until 2001 shows that fish production in Brebes District has exceeded the MSY and the fishing effort has also exceeded the optimum effort. A similar condition has happened in Pekalongan City, Batang District, Semarang City and study area. Whereas in Tegal District, Tegal City, Pemalang District, Pekalongan District and Kendal District, both production and fishing effort has not exceeded the MSY and the optimum effort. Nevertheless, for the certain periods overfishing tended to happen occur with the increase in fishing effort.

Sustainable potential in study area is 21,627.59 ton/year which could be achieved with 34,484 trip/year of optimum effort. Therefore, the average annual production and fishing effort has exceeded the value. But it is much lower than sustainable potential and TAC determined by National Commission for Stock Assessment and Decree of the Minister of Agriculture.

Calculation of MSY and Optimum Effort based on Total Effort and CPUE of Dominant Fish in 1997 until 2001

Based on the dominant fish production and number of fishing effort above and considering CPUE we know that all district/city is faced with decrease of fish stock abundance with increase of fishing effort, especially in Semarang City and study area. Whereas in Brebes District, Tegal District, Tegal City, Pekalongan District, Pekalongan City, Batang District and Kendal District there is no indication of the decrease of stock abundance. But, in certain years, it is found that number of fishing effort has increased form year to year and has been followed by decrease of dominant fish production.

Result of field observation shows that catch along the year was almost stable without difference on the amount and economic value. A problem that fishermen often face during their fishing operation is difficulties in catching more fish than previous years. Besides that, in fact, size of fish is smaller and fish price has decreased constantly.

Recently, many fishermen have changed their fishing gear to catch pelagic fish into fishing gear to catch demersal fish due to lack of the pelagic fish. The bottom fishing gear used by fishers generally are environmental unfriendly fishing gear. This trend is supported by many arad and cantrang (some kind of modified trawl) with small mesh size and limited fishing ground.

Calculation of MSY and Optimum Effort in 1998 until 2002

Data on production and fishing effort during the last five year since 1998 until 2002 shows that calculation on sustainable potential and optimum effort in Brebes District, Pekalongan City, Batang District and Semarang City tends to exceed. Whereas tendency for other districts/cities and study area could not be found yet, but they have exceeded sustainable potential and optimum effort for several years.

Result of calculation of sustainable potential and optimum effort for all study area shows MSY is amounting to 467,789.72 ton/year that generated from 348,294.57 optimum efforts. With this MSY, the TAC is 374,232 ton, so it has far surpassed the MSY and TAC determined by Decree of the Minister of Agriculture and National Commission for Stock Assessment.

Calculation of MSY and Optimum Effort based on Total Effort and CPUE in 1998 until 2002

Data on fishing effort and fish production landed in all districts/cities during the last five years since 1998 until 2002 shows that fish production in study area tends to decrease in line with increase of fishing effort. Moreover, production per unit effort during the five years has decreased sharply. It indicates that increase of fishing effort did not increase fish production.

Calculation on MSY and optimum efforts based on total effort and CPUE shows that in Brebes District, Tegal City, Pekalongan District, Batang District and Semarang City and study area, the sustainable exploitation level has been exceed due to fishing effort. The decrease has not been found yet in Tegal District, Pekalongan City, Pemalang District and Kendal District. It means that increase of effort has not affected stock abundance and average fishing catch per unit effort is still indicating an increase.

Based on calculation and discussion, it is found that fish resources exploitation in study area has reached more than optimum exploitation and fishing effort should not be increased, whether in form of fishing gear or fishing fleet increase. But it is still possible if fishing ground is expanded and fishing operation is extended to farther area. This condition needs control both on number of fishing gear and fishing fleet by bordering their number in line with the generated optimum fishing effort. The next, in relation to fishery resources management effort, we should control the TAC as determined, and regulate and limit fishing effort adjust to the number of optimum fishing effort, so MAF could be generated.

Capacity of Habitat and Fish Resource Sustainability

Fish resource sustainability highly depends on habitat capacity and affected external pressure faced by the ecosystem. In coastal area there are three important habitats for fish, i.e. coral reef, seabed and mangrove in coastal area. They are essential habitat for several fish as spawning ground, nursery ground, and feeding ground. Habitat in the study area, especially the middle area (Pemalang until Batang Districts) supported by coral reef, seabed and mangrove, although recent data collected from many sources show that their condition tends to become worse.

Some coral reef ecosystems are found among others in Pemalang reef, Sugali reef, Karang Jeruk, and Bapang reef. Coral reef is a good habitat for important economic fish such as grouper, red snapper, rabbitfish, some ornamental fish etc, whether as spawning ground, feeding ground and living ground. In the coastal area, mangrove forest could be found in the same condition as in the past before brackish water culture was conducted along the Central Java north coast. Few good mangroves were also found in those areas, except in some areas around estuary such as Tegalsari, Muarareja, Mintaragen, Kaligung, Ketiwon, Ulujami and Kendal coasts. Predominant mangrove species is *Rhizophora sp*.

Seabed also found in study area although the condition is not same as in the past, especially in area starting from tidal area until 20 m seaward in unpolluted waters. The existing seabed is *Enhallus*. Result of study conducted by PT. SWAKON (1999) shows that several fish and shrimp larva had been found in several coral reef, seabed and mangrove ecosystem.

Result of some observations indicated that there were larvae of at least 29 fish species. Several larvae have important economic value among others anchovy (*Stolephorus indicus, Thryssa purava*), mullet (*Mugillidae*), groupers (*Serranidae*), red snapper (*Lutjanisdae*) and rabbitfish (*Siganidae*). Based on result of sampling during September – October, some dominant species has been found are anchovy (*Stolephorus indicus*, *Thryssa purava*), mullet (*Mugil spp*), glassy fish (*Ambassis spp*), mullet (*Liza macrolepsis*), and ponyfish (*Leiognathus speindens*). Although in relatively slight, some important economic fish such as groupers (*Seranid*), red snapper (*Lutjanid*) and rabbitfish (*Siganid*) also used these waters as nursery ground.

Based on measurement on standard length, where the standard length is < 5 mm, *Ambassis spp* is the most abundant species found in coastal area, so it is guessed that the area used as nursery ground for the fish. This is also the case of *Pseudogobbius sp, Stolephorus indicus* and *Tryssa purava*. Distribution of *Stolephorus* is only up to river border. Only individuals more that 20 mm could reach canal. *Mugil cephalus*, *Liza macrolepsis*, *Oryzias latipes* are mostly found in canal and their size is more that 10.0 mm. The presence of these species in canal and river indicated that these fish are a brackish water inhabitant.

Rationalization of Fish Resource Exploitation

Result of the last five-year data analysis whether based on Central Java statistical data since 1997 until 2001 or data collected form all PPI in study area since 1998 until 2002 showed that exploitation level of fish resource has surpassed MSY. Besides that, CPUE tends to decrease with time which indicates that fish resource potential has decreased and fishing rate has exceeded fish resource growth rate.

Fishery resource in north coast Central Java waters especially in study area has been depleted. This condition is supported with result of REA I that indicate overfishing and coral reef habitat destruction in Karang Jeruk. So, it could be stated that fish resource potential in this area has decreased.

Several causes of fish resource depletion in the study area are:

1. Increase in the number of fishing gears is followed by decrease in catch, which indicates overfishing. The increased number of fishing fleet, especially in the small ones (< 30 GT) was stimulated by fishery regulation in Decree of Minister of Agriculture No. 508/Kpts/PL 810/1996 on Procurement of Fishery Boat. In addition, environmental unfriendly fishing gears such as Cotok/Arad (modified trawl), Garuk Kerang (clam scraper), poison, explosive material, unselective fishing gears and other <1 inch-mesh sized fishing gears are not banned factually.
2. Pollution whether caused by industrial or household waste. In this case, Rokhmin Dahuri (2002) suggested that high polluted coastal area are West Java, East Java, Central Java, DKI, Riau, Lampung, South Kalimantan, Aceh, West Sumatra and Jambi.
3. Physical habitat destruction of coral reef, seabed and mangrove, sedimentation and environment pollution.

Based on result of the conducted study and the previous study, some of these rationalization efforts could be implemented as follows:

1. Fishing gear rationalization by reducing the fishing gear as MAF principle and increasing the fishing operation into more expanded fishing ground and allocating the fishing effort to the underfished area such as south coast of Central Java.
2. Restocking and conservation of fish by settling artificial coral reef as fish habitat to substitute the broken coral.
3. Prohibiting use of destructive fishing gear (environmental unfriendly and unselective gears).
4. Rehabilitation of mangrove forest along the all-coastal area that ecologically possible. Elimination of coastal pollution, among others by enforcing and increasing control on industrial waste disposal to apply Law on Living Environment.
5. Coastal community empowerment in fishing arrangement toward responsible fisheries through formation and strengthening of CBFRM groups. IEC should be developed in CBFRM activities in order to increase fisher awareness and appreciation in keeping coastal fishery resource.

6. In order to reduce pressure on fish resource, business diversification into fish (aqua) culture or agribusiness could be conducted.

All people expect that fish resource could be conserved. Some development of capture fisheries in north coast should be directed to gillnet, trammel net, purse seine, and Danish seine, whereas in coral area should be directed to passive fishing gear such as traps, fyke net and hook and line.

CONCLUSION AND RECOMMENDATION

Based on results of study, it could be concluded as follows:

1. Capture fisheries production in study area fluctuated every year, but tended to decrease during the last five years since 1997 until 2001 and since 1998 until 2002.
2. Fishing effort increased during the last five years since 1997 until 2001 and since 1998 until 2002, both in terms of number of fishing fleet and fishing trip with their various fishing gears.
3. Relationship between production and fishing effort shows that level of exploitation in study area has exceeded the MSY and optimum effort. The CPUE and effort values indicated decrease of fish stock abundance. Production and fishing effort of predominant fish were also in similar condition.
4. The average production has exceeded the real TAC. The calculated MSY and TAC was much more than those determined in Decision of the Minister of Agriculture (MSY=128,535 ton/year and TAC =102,827 ton) and National Commission for Stock Assessment (MSY=140,586 ton/year and TAC =112,469 ton),
5. Decrease of fish resource potential in study area is caused by increase of fishing effort and physical habitat destruction due to use of environment unfriendly fishing gears, waters pollution, and the poor monitoring on law enforcement.

Unmanaged fish resource exploitation may cause pressure on the existing potential so the resource availability would much decrease and it is possible to disappear.

Fish resource exploitation and management should be based on rational, responsible and environment perspective management principle. This principle more guarantees fish resource sustainability so it could be exploited continuously and sustainable.

Fishery development in Central Java should be not only focused to increase production, but should be able to keep fish resource and its environment sustainability in line with code of conduct for Responsible Fisheries, MEY and MSY by considering socio-economic value maximally.

In order to maintain coastal resources and manage fish resource, then participation of people in CBFRM could be increased actively and participatory. Besides that, legal and constitutional aspects in fishery resource management need to be socialized for law enforcement that sides with common fisher community.

REFFERENCES

Dahuri, R., 2000. *Perencanaan Pengelolaan Sumberdaya Pesisir dan Laut Indonesia.* Semiloka Pemberdayaan Pesisir, 9-20 Mei 2000, Cilacap.

_____, J. Rais, S.P. Ginting, dan J. Sitepu, 1996. *Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu*. Penerbit Pradnya Paramita, Jakarta.

Dinas Perikanan dan Kelautan Provinsi Jawa Tengah, 1998-2002. *Perikanan Jawa Tengah dalam Angka.* Subdin Program Dinas Perikanan dan Kelautan Provinsi Jawa Tengah, Semarang.

Gulland, J.A., 1969. *Fish Stock Assesment*. FAO-United Nation, Rome.

Komisi Nasional Pengkajian Stok Sumber Daya Ikan Laut, 1998. *Potensi dan Penyebaran Sumber Daya Ikan Laut di Perairan Indonesia.* Komnas Pengkajian Stok Sumber Daya Ikan Laut, Jakarta.

Merta, I.G.S., J. Widodo, dan S. Nurhakim, 1999. *Sumberdya Ikan Pelagis.* Buku II. Dit. Jen. Tan., Jakarta.

Schaefer, M., 1954. *Some Aspects of Population Important to the Management of the Commercial Marine Fishes.* Bull. I-ATTC/Bol.CIAT, 1(2):27-56.

Sparre, P. and S.C. Venema, 1992. *Introduction to Tropical Fish Stock Assesment.* Part 1. Manual. FAO Fish. Tech. Pap., (360/1):376.