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To cite this article: N Nadiarti *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **763** 012031

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Ecosystems Approach to Fisheries Management (EAFM) assessment for grouper and snapper fisheries in Bontang, East Kalimantan, Indonesia

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Abstract. Groupers and snappers are two demersal fish groups that are currently experiencing heavy fishing pressure both for the live reef fish trade and as fresh or processed fisheries commodities across the Coral Triangle. The purpose of this study was to assess the status of grouper and snapper fisheries in the Bontang region, East Kalimantan, Indonesia using Ecosystems Approach to Fisheries Management (EAFM) indicators. The assessment followed the Indonesian EAFM Assessment Guidelines methodology, with 6 Domains (Fisheries Resources, Habitat and Ecosystems, Fishing Technology, Social, Economy, and Governance) and 32 indicators. Data were collected through a desk study and site visits including key informant interviews, direct observation and secondary data collection. With the exception of the Social Domain, at least one indicator in each Domain was in the Very Poor category, and three indicators were in the Poor category. Management policies and actions are needed to maintain the overall Good status and address the issues threatening sustainability.

1. Introduction

The Coral Triangle, including the Indonesia Seas Large Marine Ecosystem (ISLME) has been recognized as a globally important area due to its mega biodiversity, productivity and fisheries production, as well as its contribution to global climate regulation [1]. Threats to the fisheries resources within this region include increasing fishing pressure (Illegal, Unreported and Unregulated (IUU) fishing, destructive fishing); pollution and habitat degradation of coastal and marine environments (including coral reefs, mangrove forests and seagrass beds); conflicts between user groups; and global climate change [1]. Two high value demersal fish groups are groupers (Serranidae) and snappers (Lutjanidae). Prized for the live reef fish trade as well as in the form of fresh or processed fisheries commodities, Indonesia is one of the most important sources of high value groupers and snappers worldwide [2,3].

From a global perspective, the exploitation of many grouper and snapper stocks is considered unsustainable, due to direct threats such as destructive fishing and overfishing [4,5]. A recent worldwide review of the conservation status of groupers based on IUCN Red List criteria [4] placed most larger grouper species in one of the threatened categories, with most smaller species classified as



Least Concern globally, although some local or regional stocks could be at risk. Groupers and snappers are currently experiencing heavy fishing pressure across the Coral Triangle, including in Indonesia [6–8]. Ensuring the sustainability of grouper and snapper fisheries is considered a matter of importance from local to global levels [3]. Snapper and grouper fisheries in Indonesia are generally both multi-species and multi-gear in nature [6–8]. While groupers exported in the live reef fish trade mostly belong to just 12 species [2], many more species are caught and traded as fresh fish or other commodities [6].

To address such complex issues in these and other fisheries, Indonesia has adopted a policy of implementing an ecosystems approach to fisheries management (EAFM) within the framework of the Fisheries Management Areas (FMAs) established under Ministerial Regulation 18/PERMEN-KP/2014. The first step towards implementing EAFM is to have reliable data on the current status of a fishery. The Indonesian Ministry for Marine Affairs and Fisheries (MMAF) has adopted an EAFM status assessment methodology [9,10]. The Bontang region in East Kalimantan, Indonesia is a major hub for the grouper and snapper fisheries in FMA 713 [11]. The purpose of this study was to assess the status of grouper and snapper fisheries in the Bontang region using the Indonesian Ecosystems Approach to Fisheries Management (EAFM) status assessment methodology.

2. Methods

2.1. Study time and site and data scope

The EAFM assessment took place from December 2019 to April 2020. Field observations took place in Bontang City, East Kalimantan Province, Indonesia. Secondary data were collected in both Bontang and the provincial capital Samarinda. Additional data and information were collected through a literature search. The assessment was validated through a focus group discussion with representative stakeholders from the city, provincial and national levels held in Samarinda.

2.2. EAFM Assessment methodology: Domains, indicators and criteria

The assessment was carried out in accordance with Regulation of Director General for Capture Fisheries of MMAF No. 18/KEP-DJPT/2014 on Technical Guidelines for Assessment of Indicators for Ecosystem Approach to Fisheries Management as set out in the MMAF EAFM Assessment Guidelines [9,10]. The EAFM assessment was based on 6 Domains (Fisheries Resources, Habitat and Ecosystems, Fishing Technology, Social, Economy, and Governance) with 32 weighted indicators, some of which have more than one criterion, each of which could take a value from 1 to 3 based on quantitative and/or qualitative data (Table 1).

Table 1. EAFM Indicators, Evaluation Criteria and Weights for the six Domains

Indicators	Criterion/Criteria
Domain 1 – Fisheries Resources	
a. Basic CPUE	Rate of decline
b. Size trends in target species catch	Trend direction
c. Proportion of juvenile fish captured	Proportion (%)
d. Species composition of the catch	Proportion of total catch volume
e. “Range Collapse”	Change in abundance and fishing grounds
f. Bycatch of or other threats posed to ETP* species by the fishery	ETP species caught
Domain 2 - Habitat and Ecosystems	
a. Water Quality	Level of pollution
b. Status of Seagrass ecosystems	Species richness and Percentage cover
c. Status of Mangrove ecosystems	Density and Percentage cover
d. Status of coral reef ecosystems	Diversity and Percentage cover
e. Special habitats	Sites known and managed

Indicators	Criterion/Criteria
f. Climate change impacts on habitat condition/ resources	Availability of data and strategies for adaptation/mitigation
Domain 3 - Fishing Technology	
a. Destructive and illegal fishing	Frequency of infractions (per year)
b. Modification of fishing gear and ancillary equipment	Percentage of target species caught < Lm (length at first maturity)
c. Fishing capacity and effort	Fishing capacity ratio
d. Catch selectivity	Prevalence of non-selective fishing gear
e. Compatibility between fishing vessel function/size and legal documents	% sampled vessels not carrying complete and accurate legal documents
f. Certification of fishing vessel crew in accordance with regulations	Percentage of crew with appropriate certificates
Domain 4 - Social Domain	
a. Stakeholder participation in fisheries management	Percentage of stakeholders involved
b. Conflict in fisheries	Number of instances/year
c. Utilization of local knowledge in fishery resources management	Includes traditional ecological knowledge/TEK)
Domain 5 – Economic Domain	
a. Asset ownership of fishing households/units	Trend direction
b. Fishing household income	Compare to regional minimum wage
c. Savings ratio of fishing households	Compare to borrowing interest rate
Domain 6 Institutional Domain	
a. Compliance with fisheries regulations and responsible fishery principles.	Prevalence of infractions per year
b. Comprehensiveness of fishery management rules and regulations	Number of Domains covered
c. Demersal fishery decision taking mechanisms	Presence and effectiveness
d. Fishery management plan (RPP)	Presence and level of implementation
e. Synergy between fisheries management policies and institutions	Conflicts, communication, synergy
f. Stakeholder capacity building	Presence and effectiveness

The values obtained for each criterion were entered into a standard EAFM Excel worksheet to calculate the Bontang grouper and snapper fishery status, overall and by Domain, based on a 5 point colour-coded scale: Very Poor (1-20, Red); Poor (21-40, Orange); Average (41-60, Yellow); Good (61-80, Pale Green) and Excellent (81-100, Dark Green). The assessment results and other data obtained were further analysed in order to formulate recommendations for action.

3. Results and Discussion

3.1. Aggregate EAFM assessment results

Bontang City has several major industries including fossil fuel extraction and fertiliser production companies. The area has naturally rich marine fisheries with extensive mangroves, seagrass beds and coral reefs [12,13]. The fisheries are mostly small-scale, typically using small boats below 5GT. Comparing local and provincial fisheries data indicates that fluctuations in landings in Bontang appear to reflect changes in landing sites by fishermen in neighbouring districts rather than substantial changes in fisheries production which has remained relatively stable except for an increase in snapper volume. While almost all snappers and some groupers are sold as fresh (dead) fish, Bontang is a centre for the live reef food fish trade (LRFT) in East Kalimantan, especially for groupers, with several traders buying live fish from fishermen, both market-sized fish and juveniles for growout.

The aggregate scores placed the grouper and snapper fisheries in Bontang in the Good condition (Figure 1), with some indicators differing between grouper and snapper fisheries. The numeric values show that most Domains were barely above the minimum (60) for this category (with Fisheries

Resources in the Average category for snappers), and therefore require efforts to maintain an overall rating of Good with substantial improvements required to reach the Excellent category. The exception was the Economic Domain (77), close to the lower boundary of the Excellent category (80-100). Within each Domain there were some indicators in the Poor or Very Poor category which should be priorities for action.

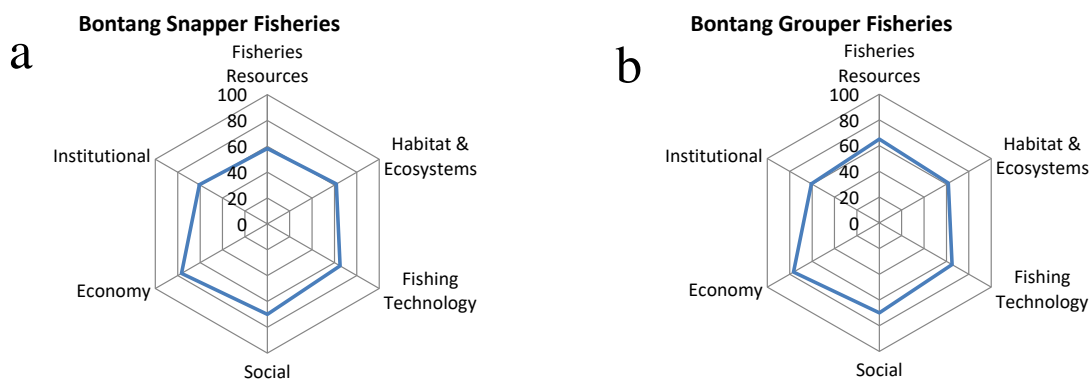


Figure 1. Aggregate EAFM results for grouper and snapper fisheries in Bontang presented as spider diagrams: a. Snappers; b. Groupers

3.2. Domain 1 – Fisheries Resources

The grouper and snapper stocks around Bontang appear to be in a reasonably good condition, with an overall Domain score of 58 (Average) for snappers and 65 (Good) for groupers. However, the indicators reveal that depletion has occurred and that the resources may decline further without action (Table 2). All field survey respondents agreed on the decline in mean size, while the majority considered these fishes harder to catch compared to the past, taking longer and/or going further afield to maintain catch volume. This was offset to some extent by higher prices for fish. Snappers were more likely to be caught as juveniles than groupers, and fisheries targeting snappers had higher bycatch that those targeting groupers. According to respondents, the capture of endangered, threatened and protected (ETP) species was rare in grouper and snapper fisheries; however, any turtles caught were generally released alive.

Table 2. Domain 1 indicator values for Bontang snapper (S) and grouper (G) fisheries

Indicator	Level
a. Basic CPUE	3 S&G
b. Size trends	1 S&G
c. Juvenile fish captured	3 S 4 G
d. Species composition	3 S 5 G
e. “Range Collapse”	2 S&G
f. ETP species	3 S&G

One species of particular concern is the mangrove red snapper or mangrove jack *Lutjanus argentimaculatus* (Indonesian name *kakap merah bakau* or *kakap bakau*), which reaches sexual maturity at a total length (TL) of around 51 cm [11] to 57 cm [14]. The survey found strong indications of juvenile habitat inshore, particularly associated with mangrove/seagrass areas, and considerable capture of juveniles in these habitats by gears not covered in the stock assessment by [11]. In particular, juvenile *L. argentimaculatus* observed in fisheries catch (e.g. *belat* fish trap catch at the Tanjung Limau Fish Landing Site in Bontang), on fish stalls, fish markets and in barbecued fish restaurants ranged from 10 cm to around 30-35 cm. Similar sized juveniles of several other grouper and snapper species were also observed.

Some live juvenile groupers from several fishing gears were sold to live reef food fish (LRFT) traders for grow-out. As suggested by [4], increased production and use of hatchery-bred fish rather than juvenile groupers from the wild should be encouraged. In this respect, we recommend the revitalisation of the Bontang hatchery, through a partnership between East Kalimantan and Bontang City line agencies supported by central government (MMAF) and the private sector (e.g. through corporate social responsibility programs, known as CSR).

A study from 2014-2019 carried out stock assessments on specific fisheries targeting deeper water demersal fishes (mainly snappers and groupers) in several FMAs across Indonesia, including FMA 713 [11]. These data indicate that many Indonesian grouper and snapper stocks can be considered overfished or at high risk of overfishing, with large numbers of juveniles caught, low spawning potential ratios (SPR) with few “mega-spawners”, and overall declining trends in stock condition. In general, our primary data support this national assessment at the local level in Bontang.

3.3. Domain 2 – Habitat and Ecosystems

The overall score (62) was just over the minimum score of 61 for the Good category. There were risk factors associated with all six indicators in Table 3. With respect to water quality, Regulation of the Minister for the Environment No. 51/2004 provides three standards: ports, marine tourism, and marine life; the Very Poor condition based on standard criteria is unsurprising in view of the level and type of industrial activity in the area.

Table 3. Domain 2 indicator values for Bontang snapper and grouper fisheries

Indicator	Level
a. Water Quality	1
b. Seagrass ecosystems	3
c. Mangrove ecosystems	4
d. Coral reef ecosystems	3
e. Special habitats	3
f. Climate change impacts	2

Reported water quality issues include heat pollution from the cooling water of industrial plants [15,16], fertiliser spills and sedimentation. Parameters reported as exceeding national standards for marine life and/or tourism include nutrients (nitrogen and phosphorus), heavy metals (Pb, Cu) and total suspended solids (TSS) with hydrogen sulphide (H₂S) exceeding limits for port areas [16–21]. These issues will be difficult to address, but it appears that the seagrass and mangrove ecosystems play an important role in the reduction and mitigation of local pollution, in addition to their role as “blue carbon” ecosystems in mitigating anthropogenic global warming [22–24]. This makes the protection and (where necessary) rehabilitation of these ecosystems a priority for sustainable fisheries in the area.

Most Bontang grouper and snapper fishermen operate one-day fishing trips, relatively close to shore. Therefore fishing grounds are likely to be affected by water quality issues. Furthermore, important grouper and snapper nursery and feeding grounds are clearly within the coastal areas chronically or occasionally affected by the water quality issues outlined above. High concentrations of heavy metals, especially lead, (Pb) have been detected in the flesh of snappers caught in Bontang [20]. Field observations showed that Bontang mangroves trap large volumes of plastic waste and other marine debris, and indicate that plastic pollution (including macro and micro plastics) is an issue in Bontang.

Despite significant degradation and loss of coastal ecosystem fish habitat, Bontang still has productive coastal ecosystems as reported in a coastal database project in 2015 [12,13] as well as research articles and theses. Coral cover on the coral reefs of Bontang is reported as low and declining, but the taxonomic diversity of scleractinian corals is high [12,13,25,26], which indicates potential for natural and/or assisted recovery if local impacts can be reduced.

Extensive seagrass beds are found around the small islands and sandbanks of Bontang [12,13], as well as the coastal mangrove forests (observation and respondents). Ten seagrass species (*Cymodocea rotundata*, *C. serrulata*, *Enhalus acoroides*, *Halodule pinifolia*, *H. uninervis*, *Halophila decipiens*, *H. minor*, *H. ovalis*, *Syringodium isoetifolium*, and *Thalassia hemprichii*) are reported from Bontang seagrass meadows, with *E. acoroides* was present and dominant at all sites [12,19]. Mean reported seagrass cover was 48.5% with an average of 3.7 species per site.

Mangrove forests in Bontang are extensive and largely dominated by the genus *Rhizophora*; other genera reported include *Avicennia*, *Bruguiera*, *Sonneratia*, *Nypa* (*N. fruticans*), *Xylocarpus*, *Acanthus*, and *Excoecaria* [12]. Density was generally in the high category, while evidence of considerable loss and degradation placed cover in the medium category [12,27]. Some mangroves areas are being promoted as tourism attractions (primary data; [28–30]). These include areas previously within the Bontang City conservation area (annulled by UU 23/2014), most of which are expected to be within the new provincial protected area awaiting ministerial approval. A small proportion of Bontang mangrove forests are within the Kutai National Park.

There are substantial efforts for mangrove rehabilitation by multiple stakeholders (e.g. government agencies, corporate CSR programs, and community groups) and mangrove products are being developed as alternative or additional livelihood options. Coordination among all the agencies and civil society stakeholders with rights, responsibilities or vested interests in mangrove ecosystems has not always been optimal. The community nursery and the methods developed in Bontang (ensuring appropriate species are used, effective planting techniques and post-planting monitoring/care) have become a resource for mangrove restoration throughout East Kalimantan, winning awards from local to national level. However, the rate of mangrove deforestation is greater than the rate of rehabilitation, and several respondents mentioned plans to change the designation of some areas to enable expansion of industrial development into both primary and restored mangrove forests. Furthermore, once replanted mangroves have become established, there is a need for ongoing management (e.g. selective thinning) which is not being met, at least in part due to current regulations forbidding the cutting of mangroves. This lack of management is resulting in overly dense pole-like stands with many bare or dead lower branches and limited value as wildlife habitat.

With respect to special habitats, no data were available on spawning aggregation sites (SPAGS). However, the mangrove forests (and adjoining seagrass beds) are important nursery and feeding grounds for both snappers and groupers. The snappers in *belat* trap catches included species known to use mangroves as important nursery and/or feeding habitat such as *Lutjanus fulviflamma* [31] and *Lutjanus argentimaculatus* [32].

No specific studies on the impacts of climate change on the fish, fish habitat and fisheries of interest in the study area were found. With regards to actual impact, bleaching (and other climate change impacts) have been recorded at several sites in the Makassar Strait and at similar latitudes within Indonesia [33–35] and at least one site in East Kalimantan experienced coral bleaching in 2016 [36]. In addition to coral bleaching, inputs from some respondents indicated there may also be impacts related to sea surface level rise and increasing severity of tropical storms.

3.4. Domain 3 – Fishing Technology

Despite the overall Good rating (65), only two indicators were above average (Table 4). The destructive and illegal fishing indicator had a Very Poor score. There was widespread agreement between respondents that illegal and destructive practices by locals (including use of explosives, poisons and minitrawls called *dogol*) and non-locals (including *cantrang* trawlers from Java) had increased significantly since 2014, with some kind of infraction occurring at least once most days. This increase was widely blamed on ineffective surveillance and enforcement since the implementation of UU 23/2014 had greatly reduced capacity at the local level. Only one out of three community coast watch groups (*Pokwasmas*) was still functioning, and was unable to function as effectively as previously.

Fish landing records from Bontang City Fisheries Department for the year 2019 show that groupers and snappers landed were caught using many fishing gears (*dogol* mini trawls, set gillnets, trammel nets, mobile and fixed lift nets, floating and bottom longlines, trolling lines, handlines, *belat* fixed fish trap, fish traps/pots). The records also show increases over time in both the number and the fishing capacity of vessels and gear used, but in 2019 the fleet was still dominated by small outboard vessels and vessels with inboard motors under 5 GT. Handlines were the only gear used by vessels over 10 GT landing groupers and snappers in Bontang.

Table 4. Domain 3 indicator values for Bontang snapper (S) and grouper (G) fisheries

Indicator	Level
a. Destructive/illegal fishing	1
b. Modification of fishing and ancillary gear	3
c. Fishing capacity and effort	3
d. Catch selectivity	3
e. Fishing vessel documents	5
f. Crew certification	5

One concern regarding the LRFT is the feed (“trash fish”) given to fish being held or grown out, which include juveniles and fish caught through destructive fishing methods. Furthermore, some LRFT fishermen use poisons such as potassium cyanide. Some buyers only buy fish they feel sure are caught using non-destructive methods (e.g. hook and line or traps), and invest in training for the fishermen they buy from. Others are not so scrupulous, and protect their businesses from the higher risk of mortality by only paying for fish that survive in the holding cages for a certain period of time.

Increases in gear diversity and gear modification have been reported [37]. Modifications in Bontang include the modification of fixed lift nets (*bagan*) to catch demersal species, as well as small mesh sizes in several gears. While overall more than 50% of reported grouper and snapper production comes from relatively selective gears, a large number of juveniles are caught by unselective gears, including the *belat* fixed fish traps as well as the modified lift nets (*bagan*). In both these gears, release of juveniles in live condition should be possible, but it seems that this very rarely if ever happens.

The size of vessels sampled in Bontang under the five year stock assessment on demersal stocks mentioned earlier [11] is similar to that observed in the field (mostly < 5 GT, a few 5-10 GT or larger vessels), and close to the average for FMA 713, which is characterised by a large fleet of small fishing vessels. This size factor means that requirements regarding vessel documents and crew certification are minimal, mostly limited to simple registration and obtaining a fisherman’s identity card. As these cards bring several benefits (such as the right to subsidised fuel) with very little effort, it is not surprising that compliance was high. For the few larger vessels compliance was low, mostly due to procedural difficulties and poor coordination between levels and sectors within the district and provincial governments.

3.5. Domain 4 – Social

The Social Domain score (70) was well within the Good category with no indicators in Poor or Very Poor categories (Table 5). Addressing the issues raised under Domain 6 should improve stakeholder participation, which appears to have reduced since law UU No 23/2014 on Regional Autonomy transferred jurisdiction over waters 0-4 NM from shore from city/district to provincial governments.

Table 5. Domain 4 indicator values for Bontang snapper and grouper fisheries

Indicator	Level
a. Stakeholder participation	3
b. Conflict in fisheries	3
c. Use of local knowledge	4

Strong support from the City Government has enabled the Fisheries Service to retain some manpower and other capabilities, including with respect to enabling stakeholder participation. One example was the collaboration between fishers, outreach officers and the Fisheries Service in data collection. Another was the way in which the award-winning Tanjung Limau fisheries landing site (PPI) was organised with contributions from several agencies to provide appropriate services for fishers and traders.

A study spanning three years (2008-2010) found that the majority of local fishermen in the East Kalimantan region resented the (legal or illegal) activities of fishers from further afield, with 89% citing some aspect of resource use conflict as the main problem facing fisheries in the area [38]. Similar resentment was expressed by respondents, particularly with respect to minitrawls (*cantrang*) from Java. While the conflicts within the fishing communities of Bontang (e.g. between destructive fishers and hook and line fishers) are moderated by ties of kinship, ethnicity and neighbourhood, there is significant amount of covert resentment with potential for conflict. With respect to local knowledge, as in much of East Kalimantan [39] the fishing communities in Bontang are predominantly of non-indigenous ethnic groups. Long-standing place-specific traditions were not found. One example of applied local knowledge is the mangrove nursery and skilled services in mangrove restoration.

3.6. Domain 5 – Economy

The Economic Domain had the highest score (77), although there is still room for improvement, especially with respect to savings (Table 6) and financial management more generally. A study on fishing communities in East Kalimantan [39] found that while Bajo fishers were present, a considerable proportion of fishing communities in East Kalimantan were of Bugis ethnic origin, some established since the eighteenth century and others newly arrived or transient. The traditional patron (*punggawa*)/client (*sawi*) system was prevalent, and few fisher families had any savings. The *sawi* depended on the *punggawa* for loans both for operational costs and family emergencies; in return, they sold their catch to the *punggawa*, often at rates below market price, but could generally make a good income. The field data were mostly consonant with [39]. All respondents earned more than the regional minimum wage (UMR) and nearly all had increased their assets over recent years. Although there were systems in place for contributions to cooperatives for some fishermen, the savings ratio was extremely low for almost all households. The main economic challenges for most fishing households were managing household finances and small business planning and management.

Table 6. Domain 5 indicator values for Bontang snapper and grouper fisheries

Indicator	Level
a. Asset ownership	5
b. Fishing household income	5
c. Savings ratio	1

3.7. Domain 6 – Institutional Domain. The Institutional Domain had the lowest possible score (61) qualifying for the Good category, with only one indicator (stakeholder capacity building efforts and effectiveness) achieving an above average score (Table 7). Two indicators scored as Very Poor and one as Poor. The two indicators scored as Average reached cumulative scores from multiple criteria above the minimum value for this category, enabling the overall Good score.

Table 7. Domain 6 indicator values for Bontang snapper and grouper fisheries

Indicator	Level
a. Level of compliance with fisheries regulations/responsible fishery principles	1
b. Comprehensiveness of fishery management rules and regulations	3
c. Demersal fishery decision taking mechanisms	3

- d. Fishery management plan (RPP)
 e. Synergy between fisheries management policies and institutions
 f. Stakeholder capacity

2
1
5

Infractions included fishing gear and fishing lane infractions as well as infractions associated with vessel registration and documents. The latter were rare in Bontang and mainly due to (sometimes insurmountable) obstacles to compliance and perverse incentives. All fishers interviewed would be glad to comply with administrative regulations, so long as the procedures were not too difficult or expensive. With respect to fishing gear infractions, especially the use of destructive fishing methods, the issues are complex, involving social, political and economic dynamics at multiple levels. However, past experience shows that improving surveillance and enforcement capacity and effort should reduce the frequency and severity of these infractions. With respect to fishing lane infractions, especially with regards to fishermen from outside East Kalimantan but also some local fishers, underlying issues include lack of clarity in and/or socialisation of marine spatial planning and lack of enforcement.

Decision-making systems and procedures existed but, based on the interviews and FGD they do not always function effectively and not all decisions are implemented fully or effectively. A fisheries management plan (RPP) for FMA 713 has been drawn up. At the time of the assessment implementation was still in a preparatory phase, including the launch of harvest strategies for both snappers and groupers. As the standard criterion choices would be no RPP or RPP implementation underway, albeit partially, an intermediate score was given. Anticipated regulations regarding the proposed provincial level MPA and the implementation of the RPP are expected to make a substantial contribution to this Domain. Furthermore, there were signs of a desire to improve communications and synergy both during field interviews and at the FGD. It can be hoped that the recent rise in on-line communication will facilitate ongoing communication and improve or build synergy in many aspect pertinent to achieving ecologically and socio-economically sustainable fisheries.

Appropriate capacity building, well-delivered and used effectively included the alternative livelihoods training and capacity building in mangrove nursery and restoration management (led by the Forestry Service). The fish catch sampling program organised by The Nature Conservancy (TNC) is another example which should be continued, expanded and replicated, and contributions have also been made by corporate CSR programs. The maximum score does not imply that there is no more to be done, as this is an area where Bontang can continue to improve and invest in human resources, both in the community and in government institutions.

4. Conclusion

Overall, the Grouper and Snapper fisheries in Bontang had an EAFM assessment score in the Good status category; however, in five of the six Domains at least one indicator was in the Very Poor category. Without appropriate management interventions, it is extremely likely that the grouper and snapper stocks and habitat condition will continue to decline, with negative impacts on the indicators and, more importantly, the ecosystems and the livelihoods of the coastal communities in the area. The issues raised and actions identified to address indicators/criteria in each domain showed a high degree of overlap. Proposed actions and policies designed to improve the economic and ecological sustainability of the grouper and snapper fisheries were grouped under five broad themes: co-management; sustainable and appropriate fisheries data; socio-economic welfare and gender; research to underpin targeted interventions; and administrative support for responsible fishing. While the industrial nature of the Bontang City economy poses intrinsic challenges, adopting holistic, ecosystem-based approaches to fisheries resource management, in particular with respect to the signature mangrove habitats, could enable Bontang to become a model for sustainable “Blue Economy” oriented development.

Acknowledgments

This study was implemented under the ISLME project funded by the Global Environment Fund

through the Food & Agriculture Organization of the United Nations (GEF/FAO Project no: GCP/RAS/289/GFF). The authors also wish to thank the Indonesian Ministry of Marine Affairs and Fisheries (Directorate General of Capture Fisheries) for their support The Faculty of Fisheries and Marine Science of Universitas Mulawarman, and all the respondents and related stakeholders who participated in the field assessment and FGD are thanked for their cooperation and inputs.

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