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Is it Drivers of Fishing Affecting Participation in Fisheries Management? A Logit Examination of Lake Tanganyika Fishery

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Abstract **-**Despite the plethora of examples of declining fish stocks, there has still been no clear explanation for causes of overcapacity and ineffective fisher participation in co-management, leading to overfishing on Lake Tanganyika in Zambia. Using a Binary Logistic Regression Model, predictor independent variables were regressed against a binary dependent variable with the implicit aim of investigating socio-economic factors capable of influencing a person's choice to become a fisher and a fisher's choice to participate in fisheries management. Data was collected using structured and semi-structured interviews, and focus group discussions. Analyses were run using SPSS computer software, and Classical Content Analysis. Results revealed that some human dimensions are critically important for policy crafting to avoid blanket strategies. The implied message centred on careful articulation of policy and strategies around entry into fishing and participation in management of fisheries if sufficient compliance with regulations is to be achieved. The study recommends improved application of existing and new socio-economic knowledge due to its potential to inform debate around fisheries in ways that can help to achieve greater balance of conflicting concerns pertaining to recruitment into the fishery and its management.

Keywords- *Co-management; Fisher; Participation; Sustainability; Tanganyika*

I. INTRODUCTION

Lake Tanganyika fisheries resources play a vital role in the economy, peoples' wellbeing and nutrition in the four riparian countries of Burundi, Democratic Republic of Congo, Tanzania and Zambia [1]. The fisheries provide a direct source of income and livelihood for more than 44,000 fishermen including a wide range of various operational groups, but the indirect influences of the lake fishery reach about ten million people in the catchment and trade area in Eastern Africa [1].

The Tanganyika fishery is one of the most productive [2] with its fish stocks being among the most important natural resources in Zambia. The fishery is making contribution to supplies of food, employment, income and well-being of lake riparian communities [3]. However, although fishing has intensified, catch levels have progressively declined as revealed by declining annual fish consumption per person from 14 kg in 1964 to 11.4 kg in the 1970s, 8 kg in the 1990s to 6.4 kg in 2003 and 6 kg in 2011 [4;5]. Over-exploitation of fish stocks could be attributed to common-property of and free access to the resources dictated by socio-economic circumstances of the resource users. As a consequence overfishing by the local fleets has led to rare appearance of valuable species [4] and existence of resource use conflicts. Besides impacting biodiversity by altering population and community structures of fish stocks and food webs, overfishing and fishing with destructive methods, perpetuated by ever growing numbers of fishers, have negative repercussions on the socio-economic circumstances of riparian communities through loss of livelihoods. It has been proven through research that decreased catches, lower profitability and lost markets have forced the industrial sector of the lake to refrain from further investments or to partly stop operations [1].

Zambia adopted co-management in the 1990s based on the hypothesis that if local people whose daily lives were affected by management activities when involved in decision-making, efforts to improve fish stocks on Lake Tanganyika would be achieved. Fisheries co-management was known to have potential to improve the sustainability and efficiency of fisheries management [6]. Nonetheless, attempting to improve fish stocks on Lake Tanganyika was an enormous task given our incomplete understanding of drivers of fishing and socio-economic factors undermining behavioural responses of resource users towards co-management.

II. LITERATURE SURVEY

Lake Tanganyika is one of Zambia's major fisheries. Officially this fishery is state property. In practice it is a common resource, open to all with or without a fishing license. There has also been no set limit to the numbers of fishing licenses to be issued. Rather, the fishery has been "open access", free to all entrants. This has had potential to constitute overcapacity. Studies conducted on the lake fishery have reported decline of fish catches by more than 50% in the last 25 years or so due to decrease in primary productivity and over fishing [7]. In order to increase annual catch and per capita fish production, management of capture fisheries must change to support such an increase. Co-management was increasingly seen as an alternative to centralised fisheries management, because ideally, it integrates biological, social and human aspects of fisheries [8]. [9], emphasizes that most individuals affected by the management arrangements need to be included in the group that makes and can change the arrangements. In Zambia, co-management was introduced as a necessary condition for successful implementation of management measures with a view to improve the fisheries stocks through community participation of individual fishers, the definitive stakeholders.

Problem definition

Fishing is fundamentally a productive activity rated in most countries as important to local communities. Fishing in Zambia is dominated by artisanal fishers [2]. Their numbers on the Zambian portion of Lake Tanganyika have increased with corresponding increases in operational fishing gear according to the 2011 frame survey report [10] and subsequent catch assessment surveys. These increases were compounded by

introduction of various innovative harvest technologies in the presence of ready market outlets and the absence of legal restrictions besides population growth. Over-fishing and destructive fishing techniques that caused habitat destruction were of particular concern among the artisans inter alia inadequate management.

This study endeavored to understand two things: 1) despite notable progressive decline in fish catches, fisheries remain a fairly attractive mode of employment for Tanganyika-basin inhabitants and beyond; 2) although fisher committees were reported to exist at various fishing villages on Lake Tanganyika fishery, their participation in resource management remained modest. The study therefore was aimed at investigating key drivers of fishing and socio-economic factors influencing a fisher household's choice to participate in fisheries co-management on Lake Tanganyika in Zambia. The reasons for high participation in fishing were a useful ingredient to reducing depletion of the fisheries resources and consequently the potential threats to the livelihoods of people involved in the fisheries sector. The factors influencing choice to participate in fisheries management gave an insight on society's perceptions in as far as participation was concerned. Nonetheless, both aspects were meant to contribute to a process for explicitly including the human dimension into fisheries management advice and in the decision-making process.

Methodology/approach

The study was conducted in the two Lake Tanganyika districts of Mpulungu and Nsama that are divided into four strata between the two districts but also shared among six Chiefs namely; Tafuna, Chitimbwa, Nsama, Zombe, Teleka and Chomba Wakasaba. The study adopted a case study design [11] because this approach has the potential to deal with simple through complex situations while taking into consideration how phenomena such as overcapacity and co-management are influenced by the context within which they are situated. The 379 fisher and 189 non-fisher respondents were sampled for the face-to-face interviews. A random sampling technique was used to select the sample. Besides, 36 key informants and six focus groups of up to 14 individuals each were purposively sampled from preexisting groups in an emergent-systematic design.

Push factors influencing decision to start fishing on the lake were used as a proxy for overcapitalization that hugely contributes toward stock overexploitation. Socio-economic factors that may potentially influence choice to participate in management were sought in social, economic, cultural and political aspects. Interview schedules were the main tool of data collection while classical content analysis, and descriptive statistics and logistic regression analysis (using SPSS-version 20 and Microsoft Excel) were the main analytical techniques. Classical content analysis was used to examine the discussions for meaning and particular implication. Descriptive statistics were used for summarizing and presenting data from the survey. Descriptive analysis for the parameters included frequency counts and percentages, which provided a distribution of respondents across the parameters. A logit regression model was used to identify parameters that influence a person's choice to become a fisher and a fisher's choice to participate in fisheries co-management on Lake Tanganyika. In this model, socio-economic characteristics of the respondents were independent variables while 'being a fisher' and 'participation' were the dependent variables. The logit model was used, according to [12], to examine socio-economic and socio-cultural factors influencing the afore-stated choices. Since the aim was to interpret the dependent variable as the likelihood of making a choice, a dichotomous logistic regression model technique was found appropriate in regressing 'being a fisher' and 'participation' on a set of independent variables.

The equation used to estimate the parameters was specified as $Y_i = \text{Ln}(P/1-P_i) = f(X_i)$, where Y_i = the dependent variable, i.e. being a fisher or participation in management; X_i is a vector of socio-economic parameters assuming values from 1 to 12. The model was evaluated using bi-variate correlation analysis to address possible multicollinearity among the independent variables. Variables that were highly correlated to the others were dropped from the model.

III. RESULTS AND DISCUSSION

Drivers of fishing

Table 1 presents results of the regression, which shows that eight out of eleven variables significantly affected the respondent's choice to become a fisher on Lake Tanganyika. Education level, gender, age, landownership, residence, relative is/was a fisher, family size were significant at $p<0.05$ while access to credit was significant at $p<0.1$. Gender, age, landownership, family size, residence, relative is/was a fisher and access to credit were positively related to becoming a fisher. This suggests that these are the key socio-economic factors influencing choice to become a fisher on the Zambian side of Lake Tanganyika. Literacy level was negatively associated to becoming a fisher.

Table 1: Results of the logit regression model

Variable	X_i	Coefficient	P>|z|
Constant		7.473	
Education level	X_1	-3.453	0.000*
Gender	X_2	1.602	0.000*
Age	X_3	1.863	0.005*
Marital status	X_4	-0.069	0.903
Family size	X_5	1.223	0.047*
Landownership	X_6	1.555	0.000*
Residence	X_7	2.492	0.000*
Other IGAs	X_8	-0.332	0.293
Relative is/was a fisher	X_9	2.037	0.000*
Access to credit	X_{10}	0.895	0.056**
Fish catches	X_{11}	-0.658	0.125

**Statistically significant at p-value p<0.05; **statistically significant at p-value p<0.1*

Education level and choice to become a fisher

Of the interviewed respondents, 54.6% supported the fact that fishing accommodates even those that had never gone to school claiming that fishing was easy to learn. Most fishers tended to have low levels of formal education. In this study, 58.1% of the respondents only went as far as primary school level, 19.5% having no education at all. Therefore the lower the education levels of people in the riparian communities, the more these people will recruit as fishers. Consequently, lack of education especially among men in fishing communities poses significant constraints on sustainability in artisanal fisheries.

This was more so because higher levels of educational attainment discouraged most people from taking up fishing as an occupation.

Gender and choice to become a fisher

Gender is defined as a social construct that ascribes different qualities and rights to women and men regardless of individual competence or desires. Out of the 379 fishers interviewed for the study, 98.2% were male, with only 1.8% female headed households. The differences in gender between fishers and non-fishers was statistically significant at $p<0.05$. Based on this study, it can be inferred that fishing was a male dominated occupation. In addition, traditional and cultural fevers the notion that females should not engage in fishing activities. Therefore this implies that if more male children are born, all other factors held constant, the probability of recruiting as fishers is high. The women are either full-time housewives or are engaged in other support activities like agriculture and vending.

Age and choice to become a fisher

The age of respondents increased from the 15-25 age bracket to 26-35, accounting for 15% and 32%, respectively. Age range then gradually dropped through 36-45, 46-55 to >55 age brackets accounting for 29%, 15% and 10%, respectively. The positive coefficient of age (Table 1) implies that a person would take up fishing at a younger age. With the majority of the fishers falling in the 26-35 age bracket implies that fishing demands active and physically fit workers to operate fishing units. The relatively lower percentage of fishers in the other age brackets appears to suggest that those people were not so attracted to fishing. Like was assumed, at younger age most people went out fishing all by themselves compared to the older ones that normally assigned such responsibilities to their most energetic dependents' or employees.

Family size and choice to become a fisher

The minimum and maximum household family sizes were between one and twenty one members, respectively, with the mean at about 6 members. Household family size was found to be positively influencing people to join fishing. The more children one has, especially males, the higher the probability that the number of fishers will increase in the fishery. The reason for this push was sought in poverty. Most huge families were known for having difficulties in managing to support all the children and hence the often early engagement of most children in fishing. The larger the size of the family of the person, the higher the quantity of fish they would catch because household members constitute a significant proportion of the labour force in fishing. On the other hand, although the person's household members may not be involved directly in fishing activities, they would actively engage in fish retailing, processing, etc.

Landownership and choice to become a fisher

Landownership mainly for purposes of agriculture in the near vicinities around Lake Tanganyika involves small portions averaging 0.5ha. However, most of the portions of land was steep, rocky and sandy - not suitable for crop agriculture. However, some people were engaged in off season farming, whilst those who were unable to support their families, often times would be hired as crew members on fishing vessels to gain experience and eventually start-up as fishers by purchasing of traditional fishing units (such as gill nets).

Residence and choice to become a fisher

Results of the study showed positive correlation between residence and choice to become a fisher, implying that a person living in the fishery area would be more influenced by daily activities to engage into fishing compared to someone who just visits. Such activities would become a part of their lives in ways that engaging in them would possess reasonably understood risks. Most young ones born and bred in the fishing villages felt fishing was all that they could do best and so they got engaged involved in the activity by circumstance – not necessarily as a career because no one pursues it as such. Those that undergo technical training target employment as fisheries staff in the Department of Fisheries, and commercial companies dealing in fish.

Relative was/is a fisherman and choice to become a fisher

The study revealed that 58.8% of the fishers interviewed were motivated to become fishers by a relative who was or is a fisher. The results of the model were expected because a person would be mentored and/or trained in fishing by such a relative in the course of providing family labour. Some respondents claimed they were motivated by the economic successes of their relatives who were involved in fishing.

Access to credit and choice to become a fisher

The positive correlation in the model results suggests that access to credit in form of bank loans or other financial support resulted in many more people taking up fishing as a source of livelihood. This was confirmed from indication by most non-fishers (78.3%) that they would invest in fishing if they had acquired sufficient start-up capital from a lending institution. It was revealed that most companies that buy fish in bulk have come up with small loan schemes where fishers can access credit for gear replacement and operation costs. These schemes have included providing fuels to fishers. Banks have rarely given out loans to fishers due to a history of migration and difficult in being identified with a particular locality. Experience has it that fishers have in the past proven difficult when it came to recoveries. With the current demand for substantial collateral in order to qualify for a bank loan, some people opt to go into fishing so that they could access easy loans from companies that would buy their catch. Most of such loans are paid back in form of fish catch itself. These deals are in the favor of the buyers who tie fishers to them through a series of loans for constant supply, at pre-determined prices.

Drivers of participation in management

Table 2: Results of the logit regression model

Variable	X_i	Coefficient	P>|z|
Constant		0.412	
Gender of household head	X_1	2.084	0.027*
Age of household head	X_2	-0.479	0.000*
Years of fishing	X_3	0.115	0.315
Literacy level	X_4	0.326	0.359
Ethnic group	X_5	0.153	0.041*
IGAs/dependence on fishery	X_6	-1.078	0.001*
Family size	X_7	-0.136	0.001*
Advice on management	X_8	0.161	0.605
Fish catch status	X_9	-0.145	0.725

Awareness of law	X_{10}	-0.642	0.027*
Regulatory pressure	X_{11}	0.769	0.005*
Involvement in decision	X_{12}	0.889	0.020*

** Statistically significant at p-value p<0.05*

Table 2 presents results of the regression and shows that eight out of twelve variables significantly affected the fisher's choice to participate in the management of Lake Tanganyika. Gender of household head, age of household head, ethnic group, alternative income generating activities (IGA), family size, awareness of provisions of law, regulatory pressure and involvement in decision making were significant at $p<0.05$. Gender of household head, ethnic group, and regulatory pressure were positively related to participation in fisheries management. This suggests that these are the key socio-economic factors influencing participation of fishers in fisheries management activities in Lake Tanganyika, on the Zambian side. Age, other IGAs, family size, awareness of provisions of law and involvement in decision were negatively associated to participation in fisheries management.

Gender and choice to participate

Gender concerns were revealed in the many gender stereotypes within the fishery sector despite providing livelihood to both men and women. Fishing was understood to be predominantly men's work. This perception affects the way the fishing industry is supported [13]. In most instances, females dominate the fish marketing system i.e. wholesaling, processing and retailing. Fish processing usually constituted the main occupation among women with others constituting secondary jobs. It was found that gender of the household head was positively correlated to choice to participate in management. This implies that most female headed households would make a choice to participate in management of the lake fishery with a view to sustain their livelihoods. Contrarily to their male counterparts, the female household heads rarely undertake migrations in pursuit of fish for processing. For this reason, females would participate in the management of the fishery adjacent to their residence because they will be assured that the catch would be landed within their reach or they can easily fish too. However, women's low presence in the organizational base needs to be recognized and enhanced. For instance, [13] note that women are the main agents in fish processing and trading and they claim that women are concerned with the day-to-day management of the home and therefore some of the critical changes brought about by poor fisheries management affect them more than their male counterparts. In spite of high illiteracy levels cited as a key influencing factor in determining women's roles in the society, key informants pointed out that women must be present in sufficient numbers and must occupy some important decision-making positions in order to press for action in line with their interests.

Age and choice to participate

It was found that the age of a fisher was negatively correlated to choice to participate in the management of the fishery. This was contrary to the expectation that the older the person, the more likely that they would participate in management. This therefore implies that the younger age bracket (15-35 years) is better placed to make choices to participate than the older ones. On the contrary, [14] found that the variable of age had the highest probability of fishers less than 35 years being less likely to adopt conservation measures, while fishers older than 35 were more likely to adopt conservation measures in selected states in Nigeria. Therefore based on findings of this study, attention needs to be paid to younger age groups because they would constitute discreet stakeholder interests. These younger age groups are more likely to make significant contributions to family food supply by occasional fishing and therefore the need to take onboard their concerns that have more often been overlooked.

Ethnic group and choice to participate

The lakeshore communities are socio-culturally heterogeneous. Of the surveyed population, the majority of the fishers were those of the Lungu (44%) and Thabwa (25%) tribes. The remaining 31% of the respondents formed smaller proportions that included the Bemba, Namwanga, Mambwe and other ethnic groups combined. The Lungu and the Thabwa tribes share the lake's coastline on the Zambian water front as indigenous settlers while the other tribes are considered migrants. The Thabwa dominate stratum IV under Chiefs Nsama, Teleka and Chomba Wakasaba whereas the Lungu dominate strata I to III under Tafuna, Zombe and Chitimbwa. In this study therefore, ethnic group was used as proxy for understanding migrants' contribution to the management of the lake fishery. It was revealed that the influx of outsiders to the fishery had caused substantial changes to the social structures of the two tribal communities of Lungu and Thabwa. Chiefs and village heads impact on the management of the fishery through powers entrusted in them to supervise assignments within their jurisdiction with full support of their subjects. [15] noted that a large proportion of the natural resource collaboration and negotiation failures involving tribes likely breakdown because of a mutual lack of understanding about fundamental values or beliefs that drive perspectives about natural resources. However, [9] revealed successful co-management despite marked differences in ethnicity and fishing gear in the village of San Salvador in Zambales, in the Philippines.

Alternative IGAs and choice to participate

The study showed that 44.6% of the fisher households got their income from fishing alone, 39.1% from fishing and farming, 12.9% from fishing and small scale businesses, and 3.4% from fishing and wage employment. This implies that full-time fisheries employment, as a primary source of income, does not preclude involvement in other forms of work. Fishing was supplemented by secondary involvements in farming, business and employment. Indicative information on net monthly incomes fluctuated between 'good' and 'poor' fishing periods but generally, the study revealed that gear owners earn substantially more than their crew counterparts.

Alternative IGAs and choice to participate shows negative correlation with participation in management. This implies that households with IGAs other than fishing would worry less about management compared to those that are dependent on fishing. Most fishers and their families are dependent on the fishery for their incomes and livelihood compared to the other sources such as farming, business and employment. However, as fishing effort becomes greater, competition is growing and this is consequently limiting profits for many. Regardless of the declining fish catch trend, extremely strong majorities of fishers indicate a wish to continue with their fishing while noting substantial year-to-year, season-to-season and area-to-area fluctuations, often associated with dramatic shifts in the relative abundance of clupeids and *Lates spp*. Despite the sector's minimal contribution to the country's GDP, [16]

argues that artisanal fishing provides a safety-net function to thousands of households.

Family size and choice to participate

Household family size was found to significantly influence choice to participate in fisheries management at $p<0.05$. Family size shows negative correlation with participation. This implies that larger families have more need for the resource, hence a higher probability of not participating in fisheries management activities compared to smaller families. This could be attributed to the fact that larger families were more dependent (45%) on the resource and would venture more into fishing, with difficult to observe management measures such as lunar breaks, closed areas and use of recommended fishing gear. Huge family sizes resulted partly from early marriages and the effects of HIV/AIDS leading to extended families. Other reasons were sought in having larger families that would contribute labour to income generating endeavours. Under such circumstances, larger families needed to be supported by programmes that advocated for alternative livelihoods.

Awareness of provisions and choice to participate

Fishers in many places consider themselves to be relatively powerless in relation to other stakeholders in the fishing industry because of insufficient awareness of policy provisions [17]. Findings of this study revealed that awareness of provisions of law and other matters pertaining to fisheries was negatively correlated to choice to participate in management. This implies that the more unaware the fishers are of the provisions, the more they are marginalized and their local efforts undermined. [18] emphasizes that an essential component of policy involves public awareness campaigns in the villages, in fishing camps and on the islands. For instance, such campaigns are proving to be successful, in the sense that illegal fishing methods and fishing when and where it is prohibited are almost unanimously identified as the main issues to be tackled in the fisheries of Lake Mweru-Luapula [18]. [19] also cite success with awareness rising as an important crosscutting issue for fisheries co-management. There are many ways to raise people's awareness for active participation in resource management - meetings, workshops at different levels, a series of training sessions, traditional festivals and other annual events. Further awareness could be possible via communication through leaflets, banners, radio, television broadcasts and newspaper articles.

Regulatory pressure and choice to participate

Penalties for breach of the Fisheries Regulations are found in the Fisheries Act. Upon conviction, these range from fines to imprisonment or both, depending on the gravity of the offence. Findings of this study revealed that regulatory pressure/punishment significantly contributes to choice of a fisher to participate in fishery management. The positive correlation between punishment and choice to participate implies that the greater the risk of getting apprehended and fined, the more a fisher would choose to participate in management of the fishery. The implication of this is according to [14] who noted that a robust regulatory framework and an enhanced mechanism for implementation and enforcement have to be accorded priority as means of enhancing fisheries resources conservation measures adoption amongst the artisanal fishers. They argue that it is imperative as the persuasive approach alone may never bring willingness for self-compliance to adoption measures to the desired significant threshold. Most respondents gave their reason for being culprits in line with findings by [20] on the Zambezi system saying 'we have to eat', 'certain times mesh sizes on a net no longer catch fish' 'some local leaders also break rules and regulations' and 'DoF does not patrol.'

Involvement in decision making and choice to participate

It was found that the involvement of a fisher in decision was positively correlated to choice to participate in the management of the fishery. This implies that the more the fishers are involved in the decision making process, the more they would not feel ignored and act contrary to the provisions of law pertaining to fisheries. This agrees with [1], who reported that management in partnership may enhance the precautionary principles too if the stakeholders can agree on the common objectives, and the communities' social ruling is strong enough to support the conservation ethics.

Like most fishery areas, the management approach of Lake Tanganyika was established in the classic top-down model and features a high degree of state control over all aspects of fisheries - policy definitions to regulation enforcement. Although fisher committees are reported to exist at various fishing villages, *de facto* local community participation in resource management decision-making remains poor. However, the fact that artisanal and traditional fisher groups reject the proposition that decision pertaining to fishing rules should only be decided by Government is eagerness to embrace management responsibilities more directly. This debunks Hardin's statement that centralized government and private property were the only institutional arrangement that could function to prevent the overexploitation of common-pool resources. [17] argue that if representation is inadequate and there are large differences in power, inequitable decisions are likely. This works to the detriment of the co-management institution, especially if those who are dissatisfied do not comply with the decisions that are made. This emphasizes the role of local stakeholders, the fishers, in the development and critic of fisheries management policy.

CONCLUSION

Although income prospects may not be spectacular, the fisheries of Lake Tanganyika have remained a fairly attractive mode of employment for most basin inhabitants with small landholdings, large families, poor access to micro-credit facilities, relatives who are fishers, and low educational levels. On the other hand, although fisher committees are reported to exist at village level, *de facto* local community participation in resource management was found to be significantly influenced by gender, age, ethnic group, alternative IGAs, family size, awareness of provisions of law, regulatory pressure and involvement in decision making.

Generally most riparian community dwellers engage in fishing as their principal job, though they are commonly involved in secondary occupations in subsistence crop farming. In order for people to appreciate involvement in other IGAs, the following are proposed to constitute incentive or motivation not to indulge in fishing: scaling up of non-fishing activity rate through capacity building; provision of activity specific loans; market provision for alternative products; and improved infrastructure to support proposed innovations. Besides making revenue for the government, there should be a limit on how many fishers to license annually in order to control recruitment into the lake fishery. The low participation, of especially women, in the management of fisheries has been recognized and needs to be enhanced. The more unaware the fishers are of the provisions of law and other relevant matters pertaining to their fishery, the more they are prone to marginalization and

their local efforts undermined. Therefore, an essential component of policy should involve public awareness campaigns in all the fishing villages to address issues of major management/conservation concerns. While the persuasive approach could be an effective tool in facilitating willingness for self-compliance, a robust regulatory framework and an enhanced mechanism for implementation and enforcement have to be given priority as means of enhancing fisheries resource conservation. For the purpose of effectiveness, an alternative enforcement scheme that favours active involvement of fishers and local communities should be involved in surveillance and control activities.

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