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Multi-stakeholder perspectives on the use and influence of “grey” scientific information in fisheries management

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Abstract

Scientific information on the shrimp and groundfish resources of the Brazil-Guianas Continental Shelf has been produced by the United Nations Food and Agriculture Organization (FAO) and the Caribbean Regional Fisheries Mechanism (CRFM), in collaboration with the national governments exploiting the resources, since the early 1970s. In spite of the availability of such information, largely as grey literature, there is limited evidence as to the extent it is being used in fisheries management in Trinidad and Tobago. The flow of information between multiple stakeholders — fishing industry, scientists, fisheries managers, policy makers and fisheries advisory bodies — was studied based on responses to a survey of key individuals to document each of their roles in the creation, distribution, and use of fisheries information. Content analysis of responses was completed to determine the opportunities and barriers for using scientific information in fisheries management.

Saliency, credibility, and legitimacy of the information were shadowed by barriers that decreased these attributes. Knowledge about the fishery has increased and technical capabilities have been strengthened through research. At the same time, advances in digital technology have made information more accessible. Yet, the high technical content of fisheries information reduced its

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usefulness to some stakeholders and formal systems do not exist for distributing or measuring the use and influence of such information in decision making. Communication strategies to promote awareness of the scientific information and aligning scientific information with fisheries policy could increase its use and influence. Institutional support for partnerships and education to encourage stakeholder involvement could also facilitate increased influence of scientific information.

Keywords: scientific information use and influence, information management, fisheries management, shrimp and groundfish fisheries, Brazil-Guianas continental shelf, grey literature

1. Introduction

Scientific attention on living marine resources including fisheries and the potential biological, social and economic consequences of overfishing [1] has resulted in national, regional and international governmental agencies producing countless technical reports. Fisheries scientific information is broad and multidisciplinary [2] and is often intended to inform fisheries policy decisions to mitigate or reverse declining trends. These reports are often produced as grey literature [3] outside of the networks of mainstream commercial and academic publishers. Like most other environmental reports [4], fisheries reports are often authored by scientific and technical experts and sometimes rigorously refereed; however, they can remain largely unknown because of how they were released or communicated. Similarly, problems of awareness generally prevail as for other environmental information [5, 6], despite most new information now being digitally produced and arguably easier to access. Multiple stakeholders, including policy and decision makers, resource users and the general public need to be aware of important scientific and technical assessment reports to make informed decisions [7, 8, 9, 10]. Investigating how marine environmental organizations produce, distribute and use information reveals the flow of scientific information to relevant policy decisions and offers insights for enhancing the use of science in natural resource management [11, 12, 13].

This study examined information use and its influence in managing the national shrimp and groundfish fishery of Trinidad and Tobago in the Brazil-Guianas Continental Shelf [14]. Scientific information on the status of this fishery has been published by regional fisheries scientific Working Groups under the UN Food and Agriculture Organization (FAO) / Western Central Atlantic Fisheries Commission (WECAFC) since the early 1970s [15] and the Caribbean Regional Fisheries Mechanism (CRFM) since the early 2000s [16]. FAO and CRFM fisheries reports to date are available as grey literature in hard copy and by open access on the Web. However, the use and influence of such pertinent information in developing national fisheries policy is unclear. This study describes the pathway of information (access and use) in national fisheries management based on responses to a survey of the main stakeholder groups directly involved in the production of fisheries information or affected by the process. The study was

conducted within the context of information management, and fisheries management and policy, to address three broad research questions:

1. What is the role of the stakeholders (fishing industry, scientists, fisheries managers, policy makers and fisheries advisory bodies) in the production, distribution and use of scientific fisheries information?
2. How is this information, published as grey literature, being used for decision making in the management of the fishery?
3. What are the opportunities and barriers for using this information for decision making?

Increased understanding about information pathways can be very beneficial to organizations involved in policy development, funding and coordinating scientific research, through facilitating data collection, analysis and information dissemination.

2.0 National institutional arrangements and mechanisms for fisheries management on the Brazil-Guianas Continental Shelf

The Brazil-Guianas region in northeast South America [17, 18] encompasses the marine area between the mouth of the Amazon River in Brazil to the Gulf of Paria, shared by Trinidad and Tobago and Venezuela in the northwest (Fig. 1). The Brazil-Guianas Shelf ecosystem is considered to be within the Caribbean Large Marine Ecosystem for the Latin America and Caribbean region [19, 20]. Coastal fisheries on the shelf are dominated by shrimp and groundfish species, shared by neighbouring countries and exploited by different fleets and gear including demersal trawl, gillnets, lines and fish traps [17].

Fisheries management in Trinidad and Tobago is the responsibility of the Ministry of Agriculture, Land and Marine Resources (MALMR). The national government interacts with the FAO and CRFM in implementing programmes for ongoing national, bi-lateral and regional initiatives for sustainable development of the fisheries sector and including joint assessment and management-oriented research on fisheries resources with neighbouring countries [19]. The FAO provides financial and technical support for the Working Group on Shrimp and Groundfish Resources of the Brazil-Guianas Continental Shelf, a sub-regional working group under the WECAFC [21], a regional fishery body established in 1973. Members of the Working Group are Trinidad and Tobago, Venezuela, Suriname, Guyana, French Guiana and Brazil. The CRFM formed a similar Shrimp and Groundfish Working Group in 2003, comprising the member states of the Caribbean Community and Common Market (CARICOM) exploiting these resources on the shelf (Guyana, Suriname and Trinidad and Tobago) [22]. Trinidad and Tobago is a participating member of both the CRFM and the FAO/WECAFC Working Groups. The formal Working Groups comprise the technical staff of the FAO/CRFM, technical consultants hired by

FAO/CRFM and national scientists. Industry representatives, including relevant NGOs, fisheries managers and policy makers, are invited to attend Working Group meetings [23]. The Terms of Reference of the FAO and of the CRFM Shrimp and Groundfish Working Groups [24] were developed by the fisheries advisory bodies in association with the member governments.

2.1 Fisheries scientific information for the Brazil-Guianas Region

Research and assessment of the resources of the region date back to when the WECAFC was established (e.g., [25]). Scientific information has been produced in annual regional scientific meetings of the CRFM Working Group since 2004 (e.g., [26]) and of the FAO/WECAFC ad hoc Working Group between 1996 and 2000 (e.g., [27]). National assessments and joint assessment and management-oriented research were completed within the context of the FAO Code of Conduct for Responsible Fisheries [28].

The commercially important species of penaeid shrimp (*Farfantepenaeus brasiliensis* (pink spotted shrimp), *F. subtilis* (southern brown shrimp), *F. notialis* (southern pink shrimp), *Litopenaeus schmitti* (southern white shrimp), *Xiphopenaeus kroyerii* (Atlantic seabob)) [29-33] and some of the most dominant and commercially important species of demersal fish (groundfish) (whitemouth croaker: *Micropogonias furnieri*; weakfish: *Macrodon ancylodon*, *Cynoscion jamaicensis*; lane snapper: *Lutjanus synagris*) [34-37] on the continental shelf have been assessed and technical reports have been written and published. Results of biological and bio-economic assessments of these species show that they are currently fully to over-fished. Overall recommendations [38, 39] were made to reduce fishing effort, improve and enhance data collection systems and continue fisheries assessments.

Member countries of the FAO/WECAFC Working Group held national consultations to present the results of scientific assessments to multiple stakeholders in 2000 and to initiate their participation in the management of these fisheries [40]. A regional meeting of senior decision-makers (fisheries Ministers and managers) was held in 2001 to inform them on the status of shrimp and groundfish resources and to identify an appropriate strategy for implementing effective co-operation in research and management [41]. In 2002, a regional meeting of fishing industry stakeholders initiated regional co-operation at the level of the fishing industry [42]. Between 2002 and 2005, ad hoc bilateral meetings of the FAO/WECAFC Working Group were held to continue joint assessments [36] and from 2003 onward the CRFM Working Group continued assessments. The CRFM is the successor to the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP) supported activities of the FAO/WECAFC since 1991.

2.2 Global perspective of the use and influence of scientific information

Consideration of inherent characteristics of information can be the starting point for measuring its use by multiple stakeholder groups. Challenges faced in the use and influence of information

have been identified in previous studies [10, 12, 43-45]. In policy and decision making, ‘useful’ information satisfies a demand of the decision maker [4, 8, 10, 12, 45-48] and is salient, credible and legitimate to the audience to which the publications are directed [10, 45]. Saliency of information deals with its relevance to the needs of decision makers and other stakeholders, credibility involves its scientific adequacy in the eyes of the stakeholders, and legitimacy reflects the perception that its production was unbiased and included the views and values of multiple stakeholders [49]. In the eyes of multiple stakeholders, information is useful if it meets the thresholds of saliency, credibility and legitimacy required for each stakeholder group [43]. Similarly, for information to positively influence policy making, it must establish a balance in tradeoffs for the same attributes.

The frequent disconnect between science and decision-making arising from the nature of the information and knowledge produced by scientists, and information needed and used by decision-makers, has resulted in a call for more communication between policy makers and scientists [10, 43, 50, 51]. Aspects of communication and organizational culture have been identified as important determinants of whether scientific information is used or not used in natural resource management, including addressing high profile global issues such as climate change [10, 52]. Scientists who consider priority stakeholder needs in their choice of research questions increase the likelihood of use of their findings in policy making. Policy-makers also respond more readily to research that obviously affects their constituents’ or clients’ needs. For the Caribbean region, Berkes, Mahon, McConney, Pollnac and Pomeroy [53] provide guidelines to assist managers and scientists to prepare information to meet the needs of all stakeholders.

The process by which marine environmental information is produced may be as or even more important than the final report in determining its level of usefulness [4, 8]. Institutional constraints can influence the roles and expectations of scientists, managers, and policy makers in fisheries management [10]. If there is no demand for research from stakeholders, little uptake of scientific advice into management will occur, however well the information is communicated. Since personalities are also linked to information use, elements of successful personal relationships, such as mutual trust, respect and reciprocity, are critical prerequisites in information use and influence within and between sectors. Increasing social capital and longevity of professional relationships can promote effective communication of information [12, 54].

3.0 Methods

3.1 Research Context

Based on knowledge of the fisheries and their management [15, 25, 26, 28, 30-32] five stakeholder groups involved in sharing fisheries information were identified: scientists, managers, policy makers, fishing industry and fisheries advisory bodies. The population size for scientists, managers, policy makers and advisory bodies was based on the authorship of the

publications of the FAO/WECAFC and CRFM Working Groups, and the list of participants at the Working Group meetings and stakeholder consultations [25, 26, 28, 34, 35, 40, 41]. Twenty-one individuals were identified including current and past members of both Working Groups, between 1996 and 2008 (three national scientists in the FAO/WECAFC Working Group, and later two scientists in the CRFM Working Group); five fisheries managers and three policy makers involved in fisheries management; four fishermen/owners; and six technical and administrative staff with the fisheries advisory bodies.

The 21 individuals were invited to participate in the study survey which was administered by email coupled with telephone/internet contact where necessary. Responses were received from 19, of which 13 were from Trinidad and Tobago and 6 from the fisheries advisory bodies (Table 1). The participants from Trinidad and Tobago included scientists, senior administrators in the Ministry of Agriculture and its fisheries department and key fishermen/vessel owners. The participants from the FAO and CRFM included all of the senior staff directly responsible for the Working Groups. Responses from scientists, fisheries managers and policy makers in Trinidad and Tobago represented an estimated 96% of the key stakeholders within these groups. The four fishermen/vessel owners historically represented the views of the estimated 137 individuals in the trawl fishery (artisanal, semi-industrial and industrial fleets).

3.2 Data collection

Semi-structured questionnaires were developed to survey the participants in each of the five stakeholder groups. The survey was carried out in a three-month period from May to July 2009. The questionnaires were based on knowledge of the scientific information on the shrimp and groundfish produced by Trinidad and Tobago in collaboration with the FAO and CRFM. Each questionnaire had four main sections in which the respondents were asked to define their role as a stakeholder, to indicate their awareness of the scientific information and to describe their role in the production, distribution and use of that information (Table 2).

3.3 Data analysis

Each completed questionnaire was assigned a pseudonym to maintain anonymity and responses were categorised by stakeholder group and by question. The responses were entered into an Excel spreadsheet that provided a matrix of data for inter- and intra-stakeholder group comparisons and contrasts. A description of the production and distribution of information was obtained from each category of stakeholder (see Section 4.1). The views of the five stakeholder groups revealed the information flow process from five key perspectives.

The text of responses to each question was coded in the Excel matrices based on observed themes for information use and influence. These coded responses were used in a second round of coding of the complete survey responses using the qualitative research software NVivo8 [55],

designed for analysis of non-numerical and unstructured data. This content analysis followed the methodology of coding for qualitative data analysis [56-59]. Through coding, the opportunities for and the barriers to current use of information were revealed. These opportunities and barriers were then categorized under the three attributes of information: salience, credibility and legitimacy. The coded responses were also used to develop a diagram outlining the flow of information among the five types of stakeholders (see Section 4.4). Limited quantitative analysis of responses was performed and the information flow diagram was reexamined and modified based on the stakeholder responses to the questions on production, distribution and use of information in Table 2. Direct responses from stakeholders are presented in Section 4.0 and are referenced by the stakeholder group name followed by a unique identifying number.

4.0 Results

4.1 Role of stakeholders in the production, distribution and use of fisheries information

The role that each stakeholder played in the production, distribution, and use of information shows FAO, CRFM and scientists taking lead roles in the production and distribution phases (Table 3). Responses showed that scientists, fisheries managers and members of the fisheries advisory bodies operated in their positions between 15 to 25 years, the members of the fishing industry operated for 14 to 40 years in the fishery, and policy makers between 2 and 14 years. Table 3 shows longevity in terms of the median number of years participants worked in their unique stakeholder roles.

The production and distribution of fisheries information by the FAO and the CRFM followed the same general pathways (Fig. 2). Production of information began with collaboration between the fishing industry and scientists in data collection. Scientists decided which resources were assessed based on available information and requested technical assistance from the FAO and CRFM for data analysis. Stock assessments were completed at Working Group Meetings by scientists, FAO and CRFM and final reports were submitted to managers and policy makers (Fig. 2). Responses showed that all final technical reports were deposited in the library of the fisheries administration and entered into the institutional library cataloguing system for use by managers, policy makers and the general public (Fig. 2).

Dissemination of information by the FAO and CRFM occurred through hardcopy, by electronic mail and digital format on the Web. Scientists stated that in response to requests for scientific information, they directed the general public to the library and they produced summaries for the fishing industry and policy makers, and results were presented at multi-stakeholder meetings (Table 3). Information was used mainly by fisheries managers and policy makers to draft management regulations, develop fisheries policy, develop fishing agreements among stakeholders in the fishing industry and guide regional maritime delimitation discussions.

4.2 Opportunities for and barriers to the use and influence of fisheries information

Based on stakeholder responses, the opportunities and barriers to the use and influence of fisheries technical reports are presented under the three main attributes of information defined in Section 2.3: salience, credibility and legitimacy (Table 4). Overall, individual members within each stakeholder group held the same general views on the survey questions, and there was no notable “intra-stakeholder group” divergence of opinions; however, some “inter-stakeholder group” differences were noted. The following section shows overall statistics from the 19 survey responses with direct quotes for illustration.

4.2.1 Salience of information

On the whole, the opportunities for salience (Table 4) contributed a median value of 69% (Fig. 3). The basic opportunity for salience was the production of information. Seventy-six percent of responses, mainly the scientists, managers and the fishery advisory bodies, agreed that the technical reports of the FAO and CRFM Shrimp and Groundfish Working Groups had increased the regional knowledge base for the fishery over the period 1992 to 2008:

“Publications of FAO or CRFM shrimp and groundfish Working Groups are perhaps the most comprehensive reports of the resources in this region” (Fisheries Manager 1).

“Participating countries were able to create new information at Working Group meetings and were able to return home with new sources of information for fisheries management. ... the aim is also to create a body of literature on the subject” (Fisheries Advisory Body 2).

Responses showed that fisheries managers, scientists and fisheries advisory bodies made efforts to make information available and accessible to users. The fisheries library was a repository of the hardcopy of technical reports and summaries while placing digital versions of the information on the internet made it more accessible to a wide range of users (Fig. 3).

“Since the FAO and CRFM are leading fisheries advisory bodies which support fisheries management work in Trinidad and Tobago and the Caribbean, the library maintains and aggressively builds a collection of the reports generated by these agencies” (Fisheries Manager 1).

“The published reports are placed in the public domain with the intention to promote decision making based on scientific information and to influence and enable decision makers to make decisions on fisheries management” (Fisheries Advisory Body 1).

Overall, responses describing barriers to the salience of the information (Table 4) had a median value of 38% (Fig. 3). Salience was reduced due to the highly technical nature of the information which limited its use by decision makers, resource users and wider audiences. This view was

articulated in 90% of the responses, including both technical and non-technical groups. Fisheries managers and the fishing industry stressed the need for summaries of results that could appeal to all users.

“It [scientific information] helps in the sense that it attempts to provide a knowledge (science) based foundation for action in interaction with policy makers, politicians, the fishing industry, other users (‘impactors’) of aquatic resources. However the information has to be distilled, summarized, simplified in interaction with these” (Fisheries Manager 1).

“Most FAO and CFRM scientific reports are not designed for the Fishing Industry, or even Fisheries Managers or Policy Makers in the Caribbean. The reports are too full of jargon and too long” (Fisheries Manager 2).

“There is need for technical documents but it is also important to produce summaries of the findings in a manner that would appeal to fisherfolk and primary stakeholders. Very often the information does not get to the fisherfolk because it is not presented in a manner that would allow for easy reading and understanding by these stakeholder groups” (Fisheries Manager 3).

“...most times I think that I am not qualified to understand them” (Fishing Industry 4).

Salience was also reduced by absence of an established distribution mechanism for the FAO and CRFM publications and the lack of a formal system to promote awareness of the publications. These barriers were stated by 67% of stakeholders (Table 4). The FAO participants noted that the increased reliance on the electronic media to distribute reports may have prevented the local fishing industry from accessing information since the latter have limited accessibility to computer resources and the Internet or are not yet technologically equipped or literate. A review of the Ministry of Agriculture Web site showed that digital versions of the reports were not posted and the FAO and CRFM Web sites were the only sites at which the digital versions could be publicly accessed.

“There is no formal framework for systematic information dissemination to stakeholders to promote awareness of any technical report. From time to time technical reports are shared with related agencies. It is also in the interest of these agencies (FAO and CRFM) to use their own mechanisms to promote and distribute their documents” (Fisheries Manager 1).

While national scientists had benefited from capacity building in the years leading to the formation of Working Groups, the social capital involved in the assessment and management of the resources was still small and the longevity of professional relationships was vulnerable to loss of institutional memory over time which encouraged participants from outside of the government structure to attend meetings and a move towards a more “individualized participation.”

“Scientists from a public service background are more inclined to share information as opposed to scientists from a university or other research oriented organization. Maintaining institutional memory within the Working Groups became a concern as well, in terms of continuity of work started” (Fisheries Advisory Body 5).

4.2.2 Credibility of Information

Median responses for opportunities favouring credibility were 52% and 62% for barriers lowering credibility (Figure 3). Seventy-one percent of responses, mainly fisheries managers and the fishery advisory bodies, acknowledged the high technical competencies of the Working Groups (Table 4).

“[Working Group is] ...the provider of information, guidance and advice on the status of the fishery to promote sustainability and best practices” (Fisheries Manager 3).

“Publications under my charge are intended to advise about research and resource assessment issues, and to advise about options for improving the scientific foundation required for generating management advice” (Fisheries Advisory Body 6).

While information was used for fisheries management, fisheries managers and policy makers stated that production of information was also a means of maintaining institutional credibility.

“...to demonstrate that the national fisheries authority is responding in a positive way to concerns from the industry about the status of fish stocks, environmental impacts of demersal shrimp trawling, and levels of bycatch and discards” (Fisheries Manager 3).

“...The statistics are used in report preparations and to highlight trade data (import and export figures) and local production and methods of fish catch” (Policy Maker 1).

Credibility was reduced by the inability of the information to be framed for policy making or within policies that had a direct impact on the fishing industry or existing government agendas. This was a major barrier identified in 62% of the responses (Table 4) due mainly to the fisheries managers and policy makers who wanted reports identifying issues and recommendations in a form for a policy statement.

“...usually it is the recommendations that are considered in respect of the reports ...It depends on whether there are plans to implement policy changes” (Fisheries Manager 1).

“...policy makers at the level of the administrative and political directorate do not request such technical information but are guided by the recommendations derived from such information [stock assessments]” (Fisheries Manager 3).

The fishery advisory bodies were of the view that the demand for information was not strong within the Caribbean region. Alternatively, fishermen believed that the fishing industry had a low priority with the government.

“Management decisions, when taken, are not normally referenced to scientific or other reports. Fisheries governance in the region is not proactive and thus there is no systematic use of scientific information in decision making. Decision makers do not demand regular, scientific information on their fisheries from their managers and so there is no culture/tradition in this regard” (Fisheries Advisory Body 1).

“Information, no matter how much is produced, is not being used because fishing is not important to politicians” (Fishing Industry 3).

Members of the fishing industry also questioned the credibility of Working Group technical publications since they saw the FAO and CRFM as “external bodies” directly involved in the production of scientific information instead of the local fisheries administration. In spite of their support for data collection and attendance at stakeholder meetings, fishermen felt that there was insufficient feedback of results to them and they did not see real changes in fisheries management based on the content of these report.

I assume it [data collection] is to understand how we shrimp [i.e., fish] but they never give feedback (Fishing Industry 5).

We have been involved in extensive data collection, responded to surveys.....but hardly anything is done afterwards (Fishing Industry 6).

Thirty-three percent of the responses, including all fishermen, show that the fishing industry viewed the information as irrelevant to their livelihood as the assessments did not address the real issues affecting them and as a result they were not motivated to change their fishing practices (Table 4). Likewise, in spite of all the technical information that is available, policy makers still used fisheries statistics, such as trade data, and not biological data to determine the health of the fishery.

“Too much information is being prepared but the fishing industry only want[s] to know the main points. Fishermen need the basics, i.e., ice, fuel, space to fish, money at the end of the day. Only when they have these basic necessities, then they will be prepared to listen to [and] accept scientific information. Only then they will be able to understand what sustainability means” (Fishing Industry 3).

“I have a lot of information from the meetings with fisheries staff to present results. But the information is in my head only. Even knowing this, I have not changed my way of fishing” (Fishing Industry 1).

The lack of a formal means of monitoring report distribution and use, both in hardcopy and digital version, by clients and the general public, lowered the credibility of the information (Table 4). The FAO and the CRFM also did not monitor usage of the documents and did not track downloads from its Web site. In contrast, scientists stated that they often gauged usage of FAO and CRFM publications through informal and infrequent analysis of the bibliographies of other relevant agency reports.

“Documentation and sharing are mainly personal and depend on the good will ... or professionalism (efficiency) of staff who receive the reports to share with others quickly (especially if it is in hard copy only). There is no efficient documentation system. Technical and scientific reports are mostly used by technical staff” (Fisheries Manager 2).

“..... There is also a greater need for internal sessions for information sharing with fisheries managers. The documents should not only occupy the shelves in the libraries but should be actively used as reference documents in internal discussions at meetings designed to share this information...” (Fisheries Manager 3).

4.2.3 Legitimacy of Information

The median response for opportunities for legitimacy was 61% and for barriers was 38% (Fig. 3). Fishery managers supported the work of the FAO and CRFM and they used the recommendations in reports to provide technical and financial support for fisheries management (Table 4). The fisheries advisory bodies facilitated production of information as independent agencies; however, legitimacy was reduced by the limited involvement of certain stakeholders in co-production of knowledge. While the information was created and available on one hand, on the other, 86% of responses stated that the production of information was not in response to a request for information and 90% showed that there was a limited involvement of all stakeholders (Table 4).

“The process [production of fisheries assessments] is therefore internally driven by the [FAO or CRFM] secretariat, and also internally driven at the national level by the scientists. Managers have yet to play a more active role” (Scientist 1).

“The managers plenary in the Working Group Meetings comprised mainly scientists, a small number of fishery managers, and no policy makers. The degree of success for information to be transferred to the fishery managers and policy makers was therefore reduced. The turnover rate of personnel in fisheries departments is quite high and common to most countries in the Working Group” (Fisheries Advisory Body, 2009).

“...motivated officers and involvement in FAO, CRFAMP, CRFM and other external funded projects, and scientific Working Groups were the main impetus for producing information” (Scientist 1).

All of the stakeholders (19 in total) identified the lack of formal systems to disseminate information as a major barrier to communication, one that prevented wider audiences from benefiting from the available new knowledge (Table 4). The lack of transparency of distribution of the information to all stakeholders was highlighted, but was a cause for great concern by fishermen. The participating fishermen represented stakeholder interests in advisory groups and encouraged other fishermen to attend meetings and cooperate with the fisheries administration; however, they felt that they were either not directly involved or were not consulted enough. Fishermen in the end had little confidence in the management role of the fisheries administration, especially with regard to monitoring illegal fishing activities.

“The involvement of fishermen has always been on an individual basis and instead there should be a collective response from fishermen. This way we will feel that the overall views of the industry are incorporated and then the reports will be more acceptable. We also tend to believe that the information collected by the fisheries division is not correct because they are not keeping enough tabs on the fishery and still target only industrial and not artisanal fishermen” (Fishing Industry 3).

“To a very little extent and spasmodically...there was never any organized system of making these available to me” (Fishing Industry 4).

The fisheries advisory bodies noted that explicit mechanisms at regional or national levels for measuring information use did not exist except for feedback received from scientists and managers at FAO and CRFM meetings (Table 4). The FAO participants stated that when they officially submitted a print copy of the report to the Permanent Secretary of the Ministry of Agriculture, it was accompanied by a covering letter highlighting the main results and recommendations and at the same time requested the recipient to report on follow-up actions taken. The fisheries managers were also invited to attend the final plenary session of the Working Group meetings and were given an opportunity to provide feedback on the assessment reports before they were finalised by scientists and the fishery advisory bodies. Both the CRFM and FAO stated that usually very few responses are received from the managers and policy makers, in participating countries including Trinidad and Tobago, on actions taken to implement the recommendations and on outcomes.

4.3 Information flow

The flow of fisheries information among stakeholders is represented in the diagram in Fig. 4 by arrows which indicate one way or two-way flow of information and indicate a strong or established pathway (wide arrow) or a weak or infrequent pathway (narrow arrow). The movement of fisheries technical information as determined in this Caribbean study contained gaps in the information flow among stakeholders involved in fisheries management. The strongest flow of information is the two-way communication between the fishery advisory bodies

and the scientists. A strong one-way flow of information in the form of primary fisheries data occurs between the fishing industry and the scientists, yet a weak flow of information in the form of results from scientists and fishery managers goes back to the fishing industry. Communication between the fisheries advisory body and fisheries managers and the policy makers encompassed dissemination of final reports and announcements of meetings. Direct communication between the policy makers and scientists, and between the policy makers and the fishing industry does not occur. Scientific information produced by the Working Groups, published as technical reports, circulates mainly at the levels of the scientists and managers. The exchange of information is strong between the scientists and fishery managers since scientists communicate results to their managers. The primary objective of publishing scientific information was to inform the policy makers and an apparent linear flow of information from scientists to policy makers was noted.

5.0 Discussion and conclusions

Based on responses in this study, the fisheries technical reports did not meet the thresholds of salience, credibility and legitimacy to make them useful to all stakeholders. Tradeoffs among the three attributes in terms of opportunities and barriers were also not balanced and fisheries managers, policy makers, and the fishing industry did not benefit fully from the production of the grey scientific information. Limited communication of information both in terms of content and the mechanisms involved and limited involvement of all stakeholders prevented the information from being fully utilised. The opportunities and barriers to the use and influence of information mainly resulted from the organizational structure and culture for fisheries and information management in Trinidad and Tobago. The overall fisheries assessment process followed by the FAO/WECAFC and CRFM Working Groups also played a role in creating some of the opportunities and barriers. The fact that the technical reports are so-called grey literature did not impede their salience or credibility to all five stakeholder groups. In this study, the fact that FAO and CRFM reports are grey literature, rather than primary publications, did not emerge as being important in terms of the credibility of the information. In general, participants viewed scientific information produced by the Working Groups as simply available information. It was likely that the term “grey literature” was unknown or had little meaning for the stakeholders and therefore any publishing differences between grey and primary literature were not considered relevant as stakeholders were mostly interested with fisheries scientific information as a whole. Scientists responded to requests for information from a wide range of stakeholders, within and outside of their organizations; however, these requests sought existing scientific information, not expectations for the “creation” of new information. In general, there was little demand for scientific information.

According to Chakalall et al. [23], the recommendations or the status of the fish stocks given in the scientific reports of the FAO Working Group [37, 41] often had no clear link to management action and any existing plans were too broadly stated. A review of the literature showed no

current management plans for the shrimp and groundfish fishery that can be referenced and suggested scientists used broad policy directions for the agriculture sector [60, 61] to determine the objectives for management and decide on which species were to be assessed. This scenario existed when the FAO/WECAFC and CFRAMP developed the Working Group agenda in the early 1990s. Scientists and the Working Group, therefore, decided on the focus of fisheries assessments and what policy makers needed; but they were limited in presenting a clear process linking the status of resources to policy goals and specific actions to be taken. The limited guidance reduced the usefulness of the reports to fisheries managers, policy makers and the fishing industry and a wider range of stakeholders. The facilitating role of the FAO and CFRM appeared to encourage fisheries managers and policy makers to support further research and generation of technical reports. Many fisheries managers said that they operated in technical roles before entering administration and this may have influenced their support for production of technical information. The longevity of professional relationships also seemed to facilitate information flow and the progress of work among most of the stakeholder groups with the exception of the policy makers. Policy makers often changed with political administrations and had general responsibility for the total agriculture sector in which the fisheries sector contributed less than 0.01% of agriculture GDP [61]. This situation may have influenced the gap in communication from the policy makers to other stakeholders in the fisheries sector.

Within the organizational structure of the fisheries administration and the Working Group there were no well established links between the research effort and alternative audiences to encourage multi-stakeholder participation. The low credibility and legitimacy of the technical reports to the fishing industry, claims of political persuasion and bias, and minimal trust in the fishery advisory bodies were influenced by the industry's limited involvement in the flow of information. The fisheries administration historically interacted with fishermen on an individual rather than on a collective basis due to the absence of effective fishermen groups [62]. The general mistrust of government by the fishing industry is common across the region and previous studies considered this to be a roadblock to effective fisheries management in Caribbean states [63, 64]. This underappreciated role of the human factor in fisheries information use and influence is by no means unique to the Caribbean region or this industry. Audiences often view environmental assessments that they have participated in as most legitimate [46]. In the shrimp and groundfish study, the FAO and CFRAMP/CFRM considered the fisheries assessment reports to be the final product for the policy makers while placing less attention on the needs of other stakeholders such as the fishing communities, managers and other stakeholders within the Ministry, and the general public as targets for information dissemination as well. Therefore, no initiatives were taken to determine how to use the results after assessments were completed. An evaluation of CRFAMP concluded that it had achieved its goal in enhancing the region's capability to perform fisheries stock assessments, had contributed to the creation of a body of knowledge in technical reports on the status of fish and shrimp resources and engendered regional co-operation among fisheries management units [65, 66]. However, although fisheries management capabilities were improved, fisheries management measures in the region have not. The FAO in particular was

aware of the need to reach and engage other stakeholders who could use their positions to increase awareness at the level of policy makers.

“In future, greater efforts will be made to make policy-makers, stakeholders and the public more aware of work of this nature. This will require specialist publications that convey the key messages and target different audiences...not necessarily in science...Our strategy was probably too focused on scientists and their managers and neglected the wider, but still very relevant and influential audiences” (Fisheries Advisory Body 2).

The objective of this study was to gain initial understanding of the influence of information, published largely as grey literature, in management of the shrimp and groundfish resources. Only Trinidad and Tobago was selected from the six members of the Working groups to participate in the study. To build a larger picture of the role of information within the Shrimp and Groundfish industry, stakeholders in all six countries of the Working Group should be surveyed. It is known that the countries of the Brazil-Guianas are committed to adopting the FAO Code of Conduct for Responsible Fisheries [28] and the ecosystem based approach to fisheries management (EBFM) [37]. This commitment may be a positive indication of the potential for increased use and influence of fisheries information arising out of the WECAFC Working Group. Given the experience of the Shrimp and Groundfish Working Group, scientists, managers, policy makers and fishery advisory bodies must consider how fisheries information use and influence can be realistically improved and what their future roles and responsibilities would entail.

6.0 Recommendations

The ultimate metric of useful information is whether the information is actually being used [10]. Clearly, the use and influence of scientific information in some fields of endeavour are very complex matters that are not yet well understood. Nonetheless, the results of this Caribbean fisheries information study point to the following general recommendations for increasing information use and influence:

1. Scientific information often needs to be translated so that all stakeholders will benefit, particularly groups that have difficulty understanding technical language. Document production can utilize communication strategies to increase the usefulness of the information by all stakeholders. Effective communication of information to the non-technical stakeholders will occur when the right balance of details, in a non-technical manner, are presented through regular and formal information distribution systems, accompanied by methods to receive feedback. Special versions of scientific reports, in the form of short briefing documents and media presentations, could be prepared for non-technical audiences as opposed to versions simply adapted for various individuals or agencies. The main advantage of such publications is the common message developed for target audiences ranging from politicians and senior government officials to the fishing communities with different levels of literacy.

2. Formal arrangements and mechanisms for stakeholder involvement in the production of information could be established. Increased involvement of multiple stakeholders will tend to raise the credibility of government publications. The focus of governmental and intergovernmental scientific working groups can include education and enhancing strategies to communicate fisheries scientific information. This focus could involve partnerships among the main stakeholder groups — scientists, managers, policy makers, fishing industry and fishery advisory groups — in preparation of specialist publications which tailor scientific information to reach non-technical audiences.
3. Through regular receipt of information from a fisheries administration, via a formal mechanism, the credibility of the information to all stakeholders will likely increase. Information sharing among stakeholders is one means of accounting for funds spent on research. Furthermore, networking may generate additional research and enable effective uptake of new information at national, regional or international levels.
4. Library facilities providing access to both print and digital copies of information should be supported at the national level. To foster wide dissemination of scientific information, formal systems for distribution of information through library networks and other institutional channels of communication should be maintained. Institutional Web sites can be kept current with technical scientific reports, summaries and statistics for public retrieval. Web sites should be designed to be easily searched by all levels of fishing community with access to the internet. With suitable software applications, the usage of documents posted on Web sites can be monitored.
5. The role(s) of scientific information in decision making needs to be considered in related government policy. Much of this information is published as grey literature. The benefits of many scientific studies would increase through clearer links to national policy issues. To be relevant to policy issues affecting fishing communities, research needs to be framed so that policy makers and other stakeholders can understand the findings and thereby increase the potential of science to guide decision making.
6. Education can be a key to facilitate effective communication both within government organizations, and between such organizations and other stakeholders. To increase the involvement of public groups and empower them to request and use relevant information to improve their livelihoods, government organizations should place an emphasis on educational programmes that will enhance skills to access and use information resources. Increased appreciation of the importance of scientific information, primary or grey, can facilitate a change in current perceptions of stakeholders regarding information use.
7. Additional methods to measure the use and influence of scientific information in decision making by a range of stakeholders are needed. In the process of producing information, indicators to evaluate the usage of publications, e.g., web tracking facility, should be

included. Data arising from such measurement will serve as an important assessment of the update of scientific information, whether primary or grey.

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Fig. 1. Map of the Brazil-Guianas Continental Shelf and countries comprising the FAO/WECAFC Working Group

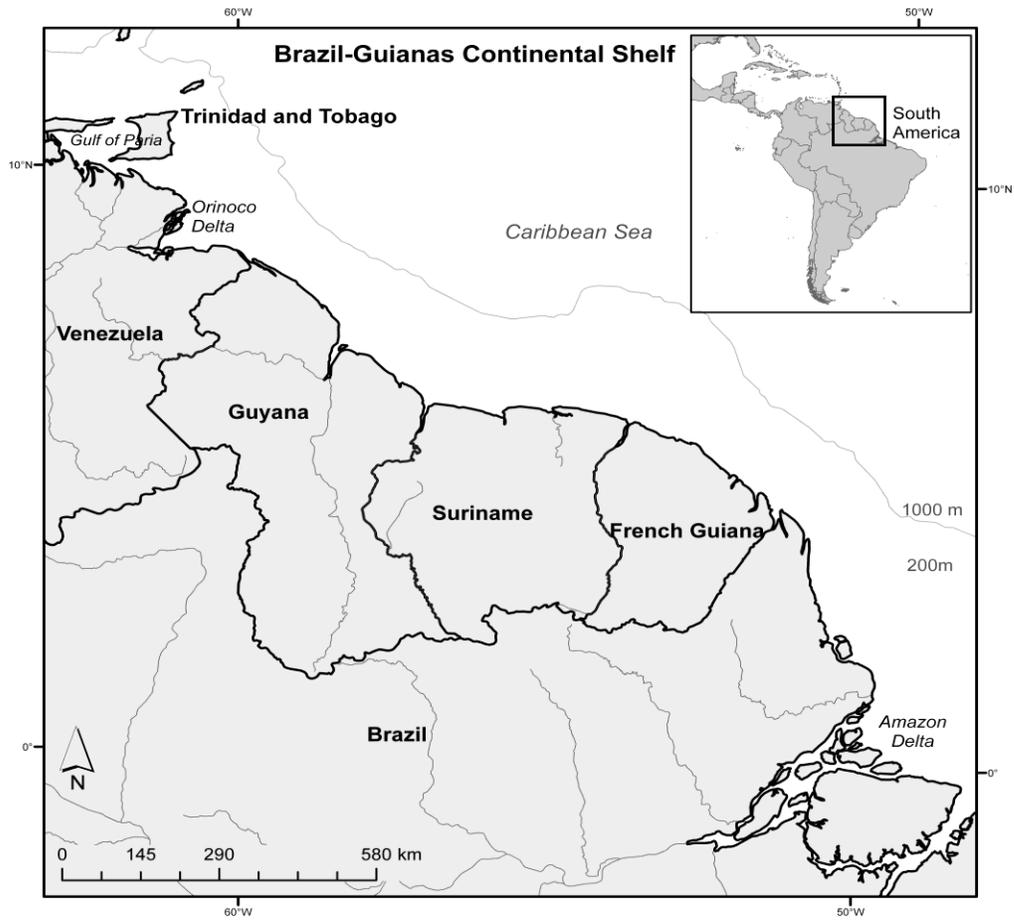


Fig. 2. Overview of the main activities in the production and use of Working Group reports on the shrimp and groundfish fishery

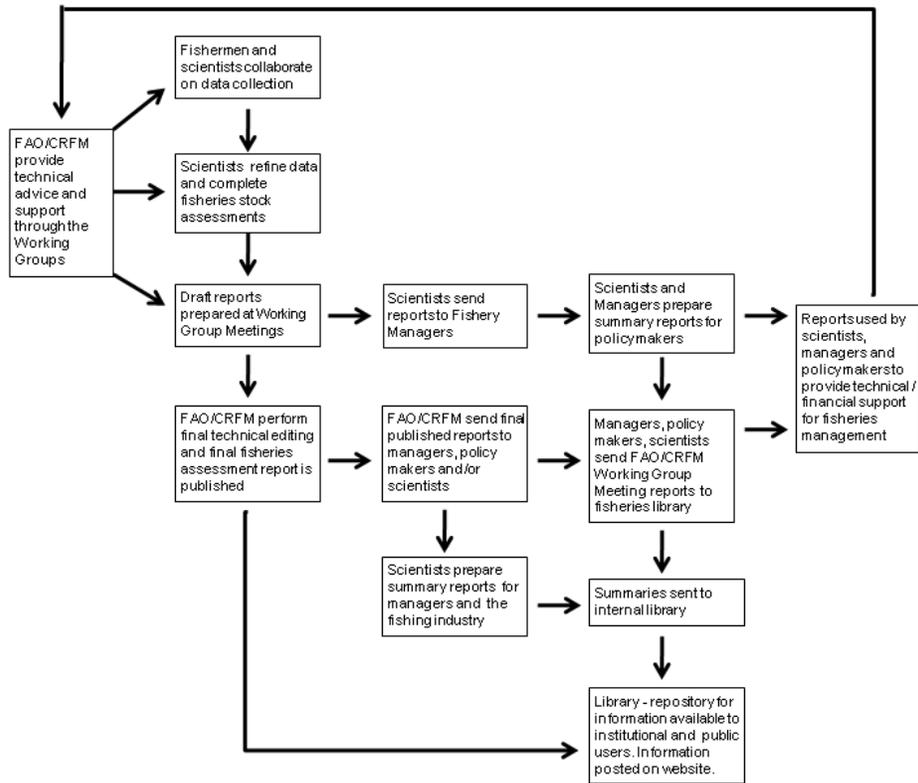


Fig. 3. Opportunities and barriers related to three attributes of fisheries information, represented by median percentage responses

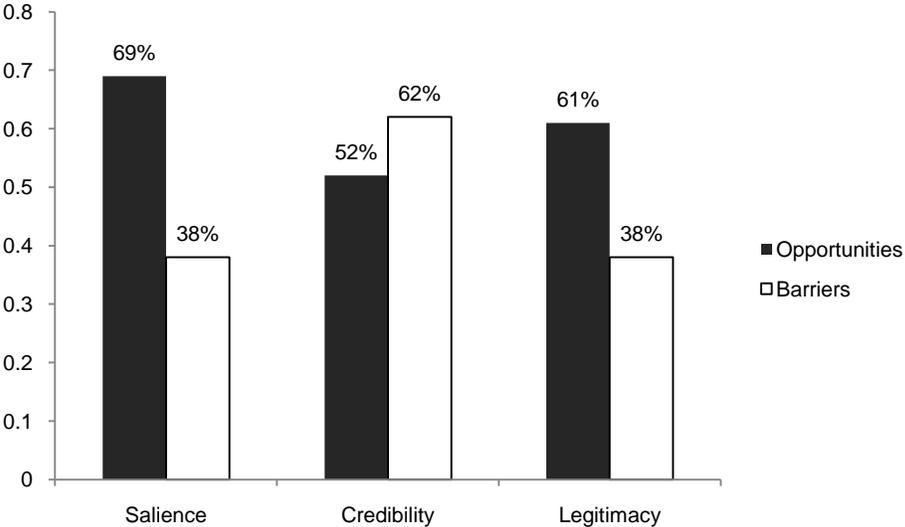


Fig. 4. Fisheries information flow between the stakeholders (Based on results in Tabl

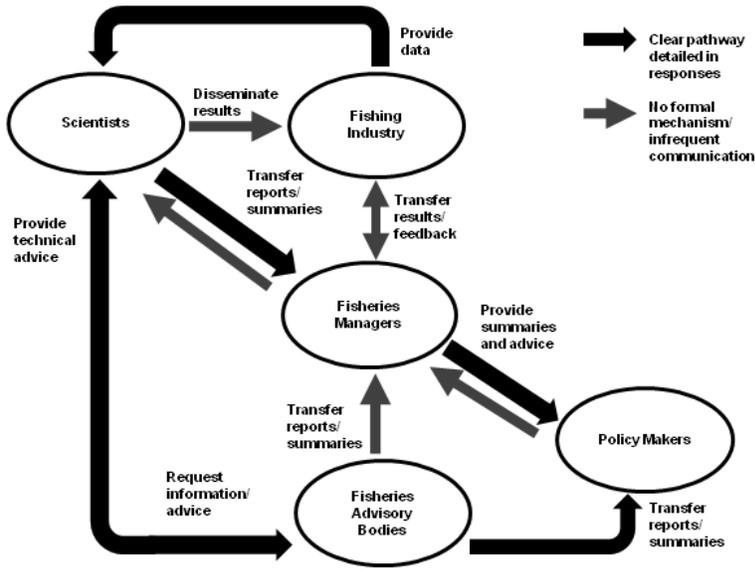


Table 1. Survey responses by each stakeholder group

Stakeholder Group	Organization	Number of Questionnaires Sent	Number of Completed Questionnaires
Fisheries Advisory Bodies	Food and Agriculture Organization (FAO)	3	3
	Caribbean Regional Fisheries Mechanism (CRFM)	3	3
Trinidad and Tobago			
Fishing Industry	Artisanal and Semi-industrial fishery	2	2
	Industrial fishery	2	2
Policy Makers	Ministry of Agriculture, Land & Marine Resources	3	2
Fisheries Managers	Ministry of Agriculture, Land & Marine Resources	5	5
Scientists	Ministry of Agriculture, Land & Marine Resources	2	1
	Institute of Marine Affairs (IMA)	1	1
	TOTAL	21	19

Table 2: Overview of the questions directed at each stakeholder regarding the production, distribution and use of scientific fisheries information

Main Survey Question	Fishing Industry	Scientists	Fisheries Manager and Policy Makers	Fishery Advisory Bodies
What is your role as a stakeholder in the shrimp and groundfish fishery in Trinidad and Tobago?	<ul style="list-style-type: none"> - Describe your role in the fishing industry and experience. - What is your awareness of the FAO and/or CRFM publications? 	<ul style="list-style-type: none"> - <i>What is your role and experience with the FAO and CRFM Working Groups and fisheries administration?</i> 	<ul style="list-style-type: none"> - <i>What is your role and experience with the fisheries administration?</i> - What is your awareness of the FAO and CRFM publications? 	<ul style="list-style-type: none"> - <i>What is your role and experience with the FAO and CRFM?</i>
<i>What is your role in the production of fisheries information by the Working Groups?</i>	<ul style="list-style-type: none"> - Describe your role in the creation of information. - What are your views on the purpose of FAO or CRFM publications? 	<ul style="list-style-type: none"> - What drives the generation of fisheries scientific information? - Who requests the information? - What is the intended purpose of FAO or CRFM publications? - What is the process of production of fisheries information? 		
What is your role in the distribution of fisheries information produced under the Working Groups?	<ul style="list-style-type: none"> - Describe your role in the distribution of reports. - What is your awareness of the use of reports for management? 	<ul style="list-style-type: none"> - What is your role in the distribution of scientific information to stakeholders? - What mechanism(s) are used to distribute information within and outside your agency? - What <i>factors affect distribution?</i> - How is information received by the organization? 		
<i>What is your role in assessing the use of fisheries information produced by the Working Groups?</i>		<ul style="list-style-type: none"> - What are the mechanisms for tracking evidence of the use of the fisheries publications? - What are the methods of awareness promotion? - <i>Is the fisheries scientific information useful for management and policy?</i> 		

Table 3: Role of stakeholders in the production, distribution and use of fisheries information

Stakeholder	Number of years (median)	Production	Distribution	Use
Fishing Industry	36	Provide scientists with fish landings data.		
Scientists	15	Request technical assistance and advice from FAO and CRFM (sampling plans, data collection, monitoring and verification). Attend Working Group Meetings and complete fisheries stock assessments.	Send final reports to fisheries managers and the library. Complete summary reports for managers and fishing industry. Attend multi-stakeholder meetings.	Justify further research and future participation in scientific Working Groups.
Fisheries Managers	15		Attend multi-stakeholder meetings Prepare summary reports for policy makers	Update current fisheries information. Guide management measures and bilateral fishing negotiations. Support regional fisheries management initiatives such as the FAO and CRFM. Respond to pressures by national fishermen and environmental groups for information on the impacts of trawling.
Policy Makers	8			Use summaries in administrative reports.
Fisheries Advisory Bodies	11	Provide technical advice and support to the Working Groups. Hire technical consultants to assist national scientists in data collection and analysis. Conduct technical and editorial review of assessments.	<u>FAO</u> - mail one printed copy to each of the Working Group participants, Minister of Agriculture, relevant government agencies, universities, research institutes. - place digital versions of reports on Web site. <u>CRFM</u> - mail one print copy to each scientists and fisheries manager attending meetings. - present copy to fishing industry and managers at the Caribbean Fisheries Forum - send copy to policy makers through the CRFM Ministerial Council. - place digital versions of reports on Web site.	

Table 4: Summary of opportunities for and barriers to the use and influence of fisheries information. (Number in parentheses is the percentage of participants expressing these views)

Information Attribute	Opportunities	Barriers
Salience of information (Contribution to knowledge, availability and accessibility of information)	Best available scientific information for the shrimp and groundfish resources in the region. (76%)	Information too technical and not suitable for wider audiences. (90%)
	Hardcopies accessible in libraries and on request. (71%)	Limited/no formal awareness promotion of scientific information. (67%)
	Production of information involved capacity building for national scientists. (67%)	Loss of staff and institutional knowledge due to turnover. (28%)
	Increased availability of reports in digital format, and increased open access on the internet and institutional websites. (57%)	Limited access to computers and digital information within the fishing communities. (38%) Latest information not available in a timely manner on MALMR Web site. (23%)
Credibility of information	Information used by government for satisfying regional and international obligations. (71%)	Scientific information not framed for policy and management purposes (62%) No institutional culture for proactive use of information. (38%) Fishing industry not receptive to the information – no relevance to livelihood. (33%)
	Use of information by external agencies promotes credibility of reports. (33%)	No formal systems for measuring use of information. (71%) No formal system to measure accessibility of reports by stakeholders and general public. (62%)
Legitimacy	Formal technical Working Groups made up of experienced scientists, staff of fisheries advisory bodies, technical consultants. (71%) <ul style="list-style-type: none">• funding and production of information drives further research and increases available scientific data.	Limited involvement of all relevant stakeholders in the creation of reports. (90%) No formal request for scientific information from stakeholders. (86%)
	Fisheries advisory bodies are independent agencies which facilitate production of information. (61%)	Perception that national agencies are not in control of information production. (29%) Low public confidence in national entities and personalities involved in information production. (29%) Lack of national political will to use scientific information for fisheries management. (38%)
	Individual role of stakeholders in distribution and FAO and CRFM protocols ensures that published reports are sent to key stakeholders (48%).	No formal mechanisms for dissemination of information to wider audiences. (100%) No formal means of national feedback to fisheries advisory bodies on the use of information. (29%)