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Fishermen's Perceptions and Attitudes toward Risk Diving and Management Issues in Small-Scale Fisheries

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Small-scale fishermen work in a high risk environment, but other variables could exert pressure and increase their likelihood of accidents, such is the case of diving. The paper addresses issues associated with fishermen perception and attitudes toward risk about risk, and strategies developed to face economic, environmental and management policies stress. Surveys and focus groups were undertaken in a Yucatan fishing village. Decompression sickness was identified as the main health problem among divers. Carbon monoxide poisoning is not completely understood because knowledge gap of fishermen. Management policies and increase in fishing population are stress factors with fishermen had to deal. Fishermen expressed their concern regarding to preserve marine resources promotions, generating initiatives; however they recognize that success only can be possible if divers along the Yucatan coast contribute with resource sustainability. Factors that can contribute to reduce risk vulnerability on divers and actions to improve fisheries management are discussed.

Key Words: risk perception; artisanal fisheries; fishermen health; diving behavior

Introduction

Fisheries support livelihood of millions of people around the world. The Food and Agricultural Organization (FAO) reports that over 54 million people worldwide work in the fisheries (FAO, 2014). However, fishing has one of the highest occupational risks among professions and has been widely reported as the occupation with the highest rates of mortality and morbidity (Eurostat, 2004; CDC, 2010; Bureau of Labor Statistics, 2011; Salas, et al. 2011). Technology innovation in this field (such as better ships and improved fishing gear) has allowed an increase in fishing performance and industry productivity, nevertheless working conditions continue to be hazardous and the risk of injury and death remain stagnant (Bokea & Ikeara, 2000; Valdemarsen, 2001; Salas, et al. 2007).

Small-scale fishers have adopted diving as a fishing method especially in the context of small-scale fisheries (SSF) (Béné & Tewfik, 2001; Ekpanyaskul, 2012; Huchim, et al. 2012; Naranjo, 2014). Diving in fisheries involves the use of breathing compressed gas at increased barometric pressure, known as *hookah*, allowing divers to modify their fishing behavior by extending the time spent underwater (Figure 1). The system allows them access to deeper and more diverse fishing grounds and also to work at night (Naranjo, 2014). This technique is the widely used across Central and South America because it is cost effective, for example in the lobster and sea cucumber fisheries of Nicaragua, Galapagos, Costa Rica and Mexico (Huchim, et al. 2012; Naranjo, 2014).

Breathing compressed gas under increase pressure has been reported to cause decompression sickness (DCS) and/or arterial gas embolism (AGE) (Denoble, et al. 2008; Denoble, et al. 2011). DCS has historically been reported in recreational divers with a prevalence ranging from 7 to 35 injuries per 10,000 divers (Buzzacott, 2012). The incidence of DCS, the severity, the amount of deaths and the socioeconomic burden are significantly higher in coastal fishing communities from developing countries than in recreational divers (Doolette, 1999; Liu, et al. 2013).

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The increase in incidence of DCS among fishermen divers is not completely understood, but possible predictors could be correlated to market demands, overfishing leading to a scarcity of marine resources, the cost of living and debts, risk taking behavior among fishermen, and a complete lack of knowledge about safety (Johannes & Djohani, 1997; Huchim, 2015).

Risk can be defined as the potential occurrence of not expected event of loss or injury; occurrence of risk is measured based on probability and vulnerability given the level of exposure (Francis & Shotton, 1997; Cardona & Darío, 2001). Fisheries worldwide are threatened by overfishing and fishermen must deal every day with dwindling marine resources, fishing regulations, market demands and the constant risk of injury (Charles, 1998; Seijo, 2008; Salas, et al. 2011; Cinner, 2015). Attitudes in fisheries like target species chosen, allocation of fishing effort, gear type and fishing method, security, and trip characteristics will be defined by the risk perception of fishermen (Mistaien & Strand, 2000; Eggert & Martinsson, 2004).

Risk perception is associated to different factors, Weber & Milliman (1997) refer to risk preferences as being attracted or repelled by risk, while other authors classify the risk attitudes of fishermen as risk seekers, neutral and averse (Bockstael & Opaluch, 1983; Seijo, et al. 1998; Eggert & Tveterás, 2004; McConell & Price, 2006). Eggert & Lokina, (2007) and Naranjo (2014) describe artisanal fishermen as risk seekers, which could be related to the lack of job opportunities and target species scarcity, as mentioned by Cinner, et al. (2015) and Salas, et al. (2011a). The SSF in Yucatan harvest the Caribbean spiny lobster (*Panulirus argus*), an important species that generates a substantial amount of revenue for hundreds of families (Huchim, 2015). However, the Mexican Institute of Social Security (IMSS) reports that DCS is the most prevalent health condition that fishermen are treated for; hence, DCS is the main cause of hospitalization related to fishing activity.

On the other hand overfishing has been linked to an increase of DCS (Huchim, et al. 2015). Predictor of a decrease in fish population in the region are the relative free access to catch, inefficiency of regulators, and an increase in fishing effort (Fraga, et al. 2008; DOF, 2012; Ríos-Lara, et al. 2012). A decrease in lobster catches as well as other species could further stimulate a change in the fishing behavior of divers. It is here contended that fishermen might be willing to take more risk in order to maintain a level of catch that provides a stable income; they usually develop strategies to face the dwindling marine resources while simultaneously try to mitigate risk of diving.

The aim of this study was to understand the decision making in a high risk activity and how to deal with sustainability fisheries or process associated to reduce risk conditions for fisheries.

Figure 1. The diving hookah system

Objective

1. Understand how artisanal divers perceived risk and how they refer to their attitude towards risk-taking behavior while fishing.
2. Comprehend fishermen coping strategies developed when faced with economic stress and dwindling marine resources.

Methods

Focus groups (FG) and surveys were conducted in a fishing village (Rio Lagartos) located in the eastern coast of Yucatan, Mexico. Each fisherman diver gave consent prior to the start of this study. Audio from the interviews carried out during focus groups were digitally recorded; no incentives were given to the fishermen. Published protocol was followed and used the recommended implementation tools defined by Betts et al. (1996)

The following topics were used during FG: Health problems associated with diving, access to health services and treatment, demand of lobster and possible link to fishermen's health, and fishermen participation in conservation efforts.

Three FG's comprised of 6 fishermen each participated in the study. FGs were conducted in January 2014. In order to encourage active participation FG´s were conducted at the fishing cooperatives facilities. Fishermen were advised that they were free to leave the group at any moment. The question guide used in the study was previously validated in a pilot study among similar subjects. These questions were calibrated before being used on subjects (Corbin & Strauss, 1990). Sessions were directed at understanding fishermen perception on their health as it relates to their diving technique and health care. Questions were also directed at issues related to conservation and the problems with management regulation in the lobster fisheries, and the activities that the fishermen promote to keep lobster fisheries viable (Table 1).

Table 1. Question guide for the Focus Groups

1.	How long have you been fishing and used diving as a fishing method?
2.	In your opinion, are there any risks associated with your fishing activity?
3.	How are the health issues you mentioned related with lobster fishing or diving?
4.	Do you have access to health insurance? How would you get medical treatment in case of a fishing related accident?
5.	Is working in and under ocean related with higher risk of injury?
6.	How do you think supply and demand of lobster are related to your health or relate to the risk of repetitive injury?
7.	Do you carry out activities for marine resources conservation purposes?

The entire FG was recorded in its entirety and demographic information pertaining to each subject was recorded. Additional notes regarding non-verbal cues between participants during the meetings were also recorded. A field expert with experience in qualitative research who had a rapport with the subjects led the FG. Sessions lasted fifty minutes long. Each FG was completed in one single meeting after all topics were thoroughly covered and no new data were provided. Audio and video recordings were made of the FG and these were transcribed *verbatim.*

The research staff created an open and comfortable environment for the participants of the FGs to promote free discussion. An honest, open, and judgment-free discussion was encouraged in order to acquire true insight into the issues to stimulate ideas. Previous work in the area developed by the research team helped to ensure trust in participants, and to offer feedback for the correct interpretation of the ideas expressed in the sessions.

The constant comparative method, drawn from grounded theory, was used for data analysis (Corbin & Strauss, 2008). This method consists of comparing new data with previous recorded data (Glaser & Strauss, 1967; Dillon, 2012). Based on best practice and recommendations made by Keim, et al. (1999), FG transcripts and observation notes of non-verbal language were coded and grouped into categories. The presence of the research team in the site of study started two years before the present study; this rapport helped the fishermen community feel free to express their perceptions and opinions.

A socio-demographic questionnaire to gather more information from all participants was used before start the FG. The questionnaire used in the survey contain 50 questions, applied to a total of 192

fishermen, which helped to obtain sociodemographic data, including age, scholarship, fishing history, and technology employed in the lobster fishery. Previously, the survey was validated in a similar community to secure the comprehension of questions by fishermen (Arribas, 2006). An Excel® database was used to capture the information and for the descriptive analysis.

Results

Socio-demographic profile

A total of 192 local fishermen were interviewed, most of them (56.7%) were born in the study site, while the rest arrived from near villages and also from other states of Mexico. The average age was 40.39±9.4 years and ranged from 18 to 67; the average years of fishing experience was 23±9.7 years. Elementary school (63.5%) was the main scholarship among fishermen and less than 5% had some grade in school. The income of fishermen is variable and according to testimonies is approximately US$312.6 per month but they often had to invest in fishing equipment, reaching debts of US$462.3±1024.6 before the fishing season started. All the fishermen use technology in their boats in order to have more chances for better catches and therefore better incomes. For example, the size of the boat, all made of fiberglass, is important to keep bigger iceboxes inside, and many of the fishermen bought new ones because the previous size could not contain all of the sea cucumber catch. The outboard engine has been changed for engines with more power but also producing less pollution. GPS is an important tool to save time looking for fishing sites and for return to the same site in the near future. The hookah system as a diving fishing art allowed them to spend more time underwater and dive in deeper waters.

Focus groups

All participants were male and affiliated to a fishing cooperative. The age of fishermen ranged from 29 to 52 years, approximately half of them had about 20 year of fishing experience and all of them had at least one DCS event (Table 2). Fishing is the main economic activity for people living in the community of Rio Lagartos, although livestock and commercial business provide other sources of revenue. Fishermen employing the HDS located onboard the vessel to dive for crustaceans, mollusk, and fish. The lobster season is an eight-month period (July to February), the octopus season comprises five months (August to December) and a recently sea cucumber fishery operates in a period of two months (December and February). Fishermen began using diving as a fishing method at the age of 15 years old, working as apprentice to relatives or friends during fishing journeys and getting involved with diving in a stepwise process. When fishermen feel ready to dive, they look for a job as diver in other boats or get their own boat and diving equipment to get independence.

Results were grouped in sections and will be explained in sequence before getting into the discussion and conclusions.

Table 2. Socio-demographic information of the participants of FG's.

	Mean	Range	Level of Education	%
Age (years)	40	29-52	Elementary incomplete	28
Fishing Experience (years)	22	6-36	Elementary complete	50
Children	2	1-4	Secondary school	22

Health Problems Associated Whith Diving

All fishermen recognized DCS as the main health problem associated to diving in artisanal fisheries; and a fisherman also report his concern regarding to carbon monoxide poisoning (COP) through their hookah. Fishermen recognized both health problems were caused by spending long periods of time underwater, the time spent seems to be correlated to the target species. For example, the longer periods underwater were utilized during the sea cucumber fishing season (one month) in order to maximize profit in such a short fishing season (race for the catch).

Some of the participants stated that, when fishing yields decreased, they have to spend more time in a trip in order to adjust for losses or expenses acquired, "*Sometimes after diving all day without good catches, suddenly I find a cave with fish or lobster, and well, I have to stay the necessary time to catch the most I can to have a profitable day*".

Fishermen recognized that having more divers in the crew could reduce time underwater and hence the

risk, however, the distribution of work entails the distribution of revenues, as one fishermen said,

Today I just earned US$20, taking three more divers with me, would reduce my income to US$5 per trip"; *"There are days with high catches and days with low catches, and if every day you had to pay for gasoline. The share among divers of the crew, it is not profitable at all*.

Another factor associated with DCS, is rapid ascent that are common when the air supply is interrupted due to a rupture in the air hose or a mechanical failure of the air compressor as one participant state, "*Usually you go up to the surface slowly, but when you don't have air, you have to ascend as quickly as you can to avoid drowning*".

Fisherman stated they are aware that a slower ascent could reduce their probability of getting DCS. The way the equipment is operated demand skilled crew to help divers especially under risky conditions.

Fishermen associate symptoms like itching and joint pain with single DCS event, and chronic pain in joints, bones and lungs with repetitive events, "*Once you have DCS you will never be the same person, you always feel pain, not too strong, but the pain is there all the time*".

Another fisherman stated that some diseases like diabetes, cholesterol and being overweight could increase the severity of DCS. When fishermen were asked how the self-care related to chronic diseases could be mitigated, they stated that everyone needs to take care of himself.

Poisoning can also occur, as one stated, if the equipment does not provide enough air and the oil leaks through the system or air contaminants from the engine enters to the storage tank. Fishermen asserted that structural modifications to the hookah system were not possible, and the only thing to do as prevention actions is repairing the equipment when it is smoking. They also believe that sanitary napkins can filter oil leaking to purify the air.

Weather conditions can also affect fishing activities and contribute to risky behavior. During presence of the meteorological events fishing is restricted and fishermen remain at port from few days to a whole month until weather conditions amend. These conditions impact fishing effort and hence incomes, and to people whose fishing is the main or only economic activity, they will spend more time fishing and diving to compensate the loss of income due the inclement weather.

Logisitics and Infrastructure in Fishing Communities

According to fishermen the hyperbaric oxygen therapy is only the treatment for DCS and could help to those divers with COP, but is only applied on a hyperbaric chamber (HC). The nearest HC from the community of Rio Lagartos is 40 miles away and this distance is recognized as a barrier. Ground transportation is the only way to get treatment but even if they manage to get there, as fishermen indicated, there is no guarantee for treatment,

This time when the sea cucumber fishery opened, I had DCS, so I went to the HC, but when I arrived to the clinic, there was a line of about 30 people waiting for treatment, I had to go back home with pain relief pills and wait four days more to finally get into the HC.

During the high peaks of DCS cases the fishermen are triaged, those with severe injury are treated first and those with milder damage were sent back home with pain relief pills until space were available. The increase of DCS cases during the sea cucumber fishing season is attributed to additional participants arriving from rural and urban areas to join in the fishing activity because of the high value of the target species. Many of these people had no previous experience diving, it is evidence the lack of skills and knowledge about the required steps to avoid accidents while diving; in some cases some people do not know how to swim properly, but the use of *hookah* allow them access to the resources.

Even though the relevance of having rapid access to a HC, fishermen state that having an HC in the community is difficult because the costs of maintenance, gas supplies, personnel salaries, and trained personnel.

Can Environmental And Market Conditions Have An Impact In Fishermen Health?

Fishermen agreed that underwater environment can affect their operations and furthermore, can be associated with health problems. For instance, if they cannot find catches close to the shore, they must move further from the coast into deeper waters with expectation of catches, although that cannot always occur, "*Last Sunday I went over 15 miles and nothing, today I was fishing over 15 miles (27 km) and fished nothing*".

Another reason to dive far from the coast and in deeper waters is to catch bigger fishes and lobsters, in order to comply with management regulations defined by the fishing cooperative and management plans.

Water currents as environmental factor can also be a risk issue because of the induced physical stress in fishermen when swimming against it. There is a perception that currents could be correlated to the number of DCS injuries, especially during the sea cucumber fishery.

According to the FG participants, fishing market plays an important role on the activity. The prices of marine resources are defined by the buyer according to the demand and sometimes, but the increase in costs of fishing supplies causes a financial burden that stimulates the fishermen to modify their diving behavior and work harder to compensate lost revenues,

If the fish had a good and stable price, with a lower catch you can cover your expenses, in the opposite situation there is not a benefit; sometimes you have to catch 140 pounds of fish to earn US$100, and after taking away US$30 of fuel, you only earn US$70 that day.

Cooperative fishermen attribute the lower price of fish to a middleman in the community who sells small fish at lower prices to the same buyers, besides as fishing cooperative group must follow government regulation releasing small fish or eggbeared in the case of lobsters. However, the value of specific marine resources (lobster, sea cucumber and red grouper) is an incentive for fishermen targeting the species with the highest value, switching when alternative species increase their price, as one participant said, "*If I see that the price of a fish is too low, why I should go to catch it and takes risk? It's not worthy*".

Local Efforts for Conservation of Marine Resources

Fishermen at the local cooperatives respect the closure of a fishing season ("*vedas*"), a four month period when diving for lobster is forbidden. In order to assure the implementation of such regulations, the fishermen remove the HDS from the fishing vessels. Fishermen reported that many years ago, when the lobster fishing season ended, the fishing cooperative allowed fishermen to keep their *hookah* system onboard to catch only fish. Unfortunately, some fishermen were still catching lobster and octopus, so as a common agreement between the neighboring coastal communities, they decided to prohibit any skin diving and diving with HDS during the "*veda*". They are proud of this agreement, but also feel disappointed that it is not upheld in all fishing ports when they think some are still diving for lobster and octopus to sell on the black market. One of the participants stated that promotion of conservation actions like those undertook by their cooperatives could help to avoid overfishing and improve the surveillance in the coastal area.

On the other hand, in the community of Rio Lagartos two fishing cooperatives with fishing licenses to catch lobster made an agreement to close the lobster season early if juvenile lobsters were found. This is an example of an active effort to avoid the catch of juvenile lobster even if the lobster season is still open by official regulation. Fishing cooperative can control access to lobster by eliminating free access of fishermen.

Other suggestions made by fishermen in order to protect resources include, the allocation of rights to resources by dividing the sea into parcels, similar to what occurs in a nearby fishing community (Punta Allen, Quintana Roo). In this way, each fisherman could take care of his own area and the products extracted would belong only to him. For a species like lobster, each cooperative had their concession fishing zone, those fishermen who do not belong to a cooperative cannot fish for lobster, but can fish for other resources in those areas, like sea cucumber. Those who have fishing license for sea cucumber can dive in the area and tend to catch other species, with the consequent impact on the resources. Regarding the fishing license for marine resources, fishermen stated that access to fish and octopus is free in the area, so there is no control on how many people go out to fish them.

Another issue associated with the overfishing in the region was referred to the semi-industrial fleet that, according to testimonies of fishermen who participated in the FGs, tend to move to catch red grouper, octopus, and lobster out of season or close to shore, having a negative impact on the catch of SSF.

Discussion

Diving as commercial activity is described as more risky than any other type of occupations (Liu, et al. 2013). Fishermen targeted in this study are aware about risks of using the HDS as fishing method and also recognized specifically the kind of diseases that are affecting their health. Eggert and Martinsson (2007) state that risk preferences could be explained by the proportion of household income and type of gear used, hence one can wonder what the attitudes of fisherman in Yucatan are.

Fishermen have to make daily decisions regarding their operations and catch revenue becomes one of the strongest incentives to lead diving behavior and trip duration. Availability of marine resources can also become an incentive for fishermen to dive deeper for longer periods of time and to undertake trips farther from the coast. Although this is dangerous, money plays an important role in their decisions because fishermen need to feed their families and pay debts, as it was expressed by participants in the FGs, debts are present before fishing season starts so getting good income is important. These kinds of attitudes have been described in other occupations

(Camerer, et al. 1997) as well as in diving fisheries (Naranjo, 2014).

All participants in this study had suffered at least one DCS event during their life as divers. Individual perception of risk generally is lower than real risk and if income is a strong incentive fisherman behavior could be compromised, leading to the tendency of trivialize risks as Davis (2012) stated about the fact of experience and survive accidents.

Under this context, technology innovations in fisheries, like the HDS, could be described either as helpful or dangerous (Tuler, et al. 2008), helpful because they allow divers to have access to some marine resources previously unattainable, but dangerous because of the potential unlimited amount of time spent underwater (Huchim-Lara, et al. 2012). There is also a risk of COP due to the air contaminants exhausted by the engine into the HDS (Chin, et al. 2015). During the FG's sessions, fishermen stated that modifications on the HDS to prevent COP were impossible to implement; however, simple interventions could help to decrease the contaminants levels within the air breathed by divers (Gold, et al. 1999). Then, it is unclear why Yucatan fishermen are resistant to changes in their equipment, despite the implications in their health, but the role of sociocultural factors involved in risk-taking behaviors may play a part, as Tuler, et al. (2008) state. Use of HDS in Yucatan fisheries began in the 1980's, and over the years has become a part of the lifestyle of a fishermen's population, somewhat like a cultural identity. Fishermen look at their system as "just the way it is", and see no reason to change. It is necessary understand fishermen behavior and the cultural context to implement management strategies or intervention actions to reduce health problems and resources overexploitation.

Among the fishing strategies of Yucatan fishermen, the switching behavior involving change of target species according to value has been described by Salas, et al. (2004). When fishermen move from lobster to sea cucumber, initially only fishermen belonging to the fishing cooperatives can participate, but in the case of sea cucumber, both fishing cooperatives and other fishers can operate (fishermen with a permit and those hired by private companies). The short term fishing season of the sea cucumber (3 weeks) generates a "race for the fish", so all fishermen try to maximize their catches and revenues despite health risks. In fact, the cases of DCS at the HC were higher during the sea cucumber season, and more people died. When the high value fisheries close, then fishermen turn into the red grouper and octopus fishery (switching gears and methods) for revenue for the rest of the year.

Weather conditions were reported as a limiting factor for fishermen operations and for changes in resource abundance, with the FG's participants concentrating mainly on factors that holding back them from fishing. Even though the region recently had one of the worst lobster fishing seasons, due to red tide, this phenomena was not mentioned by anyone of the participants. Uncertainty of those factors that fishermen cannot control as the environmental factors, market conditions and biology of resources has been described in literature (Thorvaldsen, 2013).

Resource scarcity was associated to risky behavior, with some fishermen mentioning the conservation of marine resources as a way to decrease risk. In their operations, the cooperatives close the lobster fishery to avoid overfishing of juvenile lobsters, and during fishing season they respect legal size, but not all fishermen complain with these regulations. Despite the interest of some fishermen to obtain allocation rights for resources, including sea parcels in their fishing zone like in other regions (Seijo, 2008; Sosa, et al. 2008), it probably would not work because the characteristics of the sea bottom. The use of artificial habitats has been associated to the allocation rights in Punta Allen, Mexico. This system was introduced in the Yucatan coast in 2005 (Salas, et al. 2007), but many of them have been lost though time either because they were not placed as recommended, or the weather and tides buried them under the sand. The way fishers operate the artificial habitats in Yucatan is different to those in Quintana Roo. The lack of property rights does not give incentives to look after the artificial habitats or promote the introduction of more of these devices (Sosa-Cordero, et al. 2008).

Divergences in stewardship of marine resources between fishing communities along the Yucatan peninsula is devastating as stated by Blundell, et al. (2004). The lack of property rights or open-access conditions generates an attitude where some fishermen and buyers just look resources in the short-term despite the potential conditions of overexploitation of species, a common phenomenon among shared resources or common resources. To maintain fishing in the future, efforts of local fisherman must be taken in order to preserve marine resources.

Many authors have described fishermen in terms of risk (neutral, averse and seekers) (Seijo, et al. 1998; Herrero & Pascoe, 2003; Smith & Wilen, 2005; Eggert & Lokina, 2007); however, uncertainty is prevalent in fisheries, pressing fishermen to develop strategies and tactics to face such uncertainty, usually with increased risk (Thorvaldsen, 2013). Even though fishermen understand the risk, the pressure of economic needs on them and their families causes them to go through with these risky behaviors regardless. On the other hand, fishermen definitely are alerted

about the uncertainty and vulnerability of the resources they depend on and hence their future activities. They have promoted local efforts in order to decrease overfishing and protect some of the vulnerable members of the lobster populations under exploitation (juveniles, gravid females, etc.). However, they do not fully perceive the real benefit of their local efforts, as not all fishermen cooperate in such conservation actions; the willingness to cooperate is a fundamental component in the success of the implementation of fisheries management schemes (Salmi, 1998; Jentoft, et al. 2010).

Concluding Remarks

Fishermen perceive some risks based on their past experiences, but there is a lack of knowledge about other health problems that have the potential to decrease their overall health while concomitantly increasing the risk of DCS and other diving related activities. These risks remain without attention and have the potential to decrease quality of life and bring on disease. In addition, risk attitudes of fisherman during fishing journeys may be correlated mainly to external factors such as market demands and need of incomes to ensure their family's wellbeing. Multidisciplinary studies in fishing communities addressing risk attitudes, decreasing the health impact, increasing safety, and improving small-scale fisheries management are necessary.

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