Food and Agriculture Organization of the United Nations

FIRO/C1073 (En)

FAO
Fisheries and
Aquaculture Circular

ISSN 2070-6065

INTERNATIONAL COMMERCIAL FISHING MANAGEMENT REGIME SAFETY STUDY: SYNTHESIS OF CASE REPORTS

INTERNATIONAL COMMERCIAL FISHING MANAGEMENT REGIME SAFETY STUDY: SYNTHESIS OF CASE REPORTS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2016

ISBN 978-92-5-109181-4

PREPARATION OF THIS DOCUMENT

Fishing is considered the world's most dangerous occupation. In 1999, the International Labour Organization estimated that fishing caused more than 24 000 deaths per year (about 80 fatalities per 100 000 fishers per year). The issue of safety in the fisheries sector has been raised at the FAO Committee on Fisheries (COFI) on several occasions. For example, at the Twenty-seventh Session of COFI (in 2007), a large number of Members expressed concern about the safety at sea of fishing vessels, especially small-scale fishing vessels.

In 2001, FAO published *Safety at sea as an integral part of fisheries management* (FAO Fisheries Circular No. 966), a paper that argued that safety at sea should be integrated into the general management of the fisheries in each country. In spring 2008, FAO sponsored 16 case studies from around the world to review the issue of the relationship between safety at sea and fisheries management practices for fisheries or for a specific fishery in each country. The author of the present paper has reviewed the case studies against four hypotheses as to how fisheries management affects safety. This is the first document of its kind to provide an empirical review, at the global level, of the effects of fisheries resource management measures on the safety of fishing operations.

A draft executive summary of the global study was presented at the FAO Expert Consultation on Best Practices for Safety at Sea in the Fisheries Sector, held in Rome, Italy, from 10 to 13 November 2008. The Expert Consultation reviewed the recommendations made in the document and noted that it contained some very valuable observations. The experts agreed with the report's main finding that fisheries management has indirect and direct effects on fishing safety. Consequently, the purpose of this paper is to document (globally) the relationship between safety at sea and fisheries management practices and to provide practical guidelines for fisheries managers on how they can help to make fishing safer.
The case studies referred to can be found on the CD–ROM included in this publication.

FAO. 2016.
International commercial fishing management regime safety study: synthesis of case reports, by Gunnar Knapp. FAO Fisheries and Aquaculture Circular No. 1073. Rome, Italy.

ABSTRACT

Commercial fishing is a dangerous occupation. The degree of danger is in part a function of the options of fishers' choices about the risks they take, such as the weather they fish in, the boats they use, the rest they obtain, and the safety gear they carry. How fisheries are managed may affect the options of fishers and trade-offs as they make these choices – thus affecting the safety of the fishery. FAO contracted researchers to prepare country-specific case studies on fisheries management and safety in 16 countries. Each case study was reviewed to identify evidence supporting, or refuting, one or more of four hypotheses regarding potential effects of fisheries management policies on fishing safety. Where evidence was found for a hypothesis, the strength of the evidence was then evaluated. This publication presents the results and analyses of the case studies as well as conclusions and recommendations.

Contents

ACKNOWLEDGEMENTS

The author gratefully acknowledges the important contributions of many experts whose work is related to safety at sea in the fisheries sector for providing information in support of the preparation of the 16 case studies and of this review. The author also acknowledges all participants of the FAO Expert Consultation on Best Practices for Safety at Sea in the Fisheries Sector, held in Rome, Italy, from 10 to 13 November 2008.

The author also gratefully acknowledges the excellent support provided by a number of FAO staff and consultants, including Jeremy Turner, Ari Gudmundsson, Robert Lee and John Fitzpatrick of the Fisheries and Aquaculture Department.

The author is particularly indebted to Jennifer Lincoln of the United States National Institute for Occupational Safety and Health (NIOSH) for her extensive encouragement and assistance with the research and analysis for this study.

The financial contribution to the 16 case studies from the Government of Norway is acknowledged with appreciation. The author is also grateful to the Alaska Pacific Office of the NIOSH and the University of Alaska Anchorage for the support provided.

ABBREVIATIONS AND ACRONYMS

AFA	American Fisheries Act (United States of America)
AFRA	Artisanal Fishing Reserved Area (Chile)
ARE	Artisanal Regime of Extraction(Chile)
BSAI	Bering Sea and Aleutian Island
CFIVSA	Commercial Fishing Industry Vessel Safety Act (United States of America)
CR	crab rationalization
DFO	Canada Department of Fisheries and Oceans
EEZ	Economic Exclusion Zone
EPIRB	emergency position-indicating radio beacon
FAO	Food and Agriculture Organization of the United Nations
FTE	Full Time Equivalent
GHL	Guideline Harvest Level
ICFMRSS	International Commercial Fishing Management Regime Safety Study
IEZ	Inshore Exclusion Zone
IFQ	individual fishing quota
IQ	individual quota
ITQ	individual transferable quota
MCSD	Ghana Ministry of Fisheries Monitoring Control and Surveillance Division
NIOSH	National Institute for Occupational Safety and Health (United States of America)
NOAA	United States National Marine Fisheries Service, National Oceanic and Atmospheric Administration
OSHA	United States Occupational Safety and Health Administration
QMS	Quota Management System
SAR	search and rescue
SCOQ	Surf Clams and Ocean Quahogs
SSCC	Dock Stability and Safety Compliance Check
TAC	Total Allowable Catch or Total Allowable Quota
UHA	Canada Underwater Harvesters Association
USCG	United States Coast Guard

EXECUTIVE SUMMARY

Effects of fisheries management policies on fishing safety

Commercial fishing has always been a dangerous occupation. Although it is inherently dangerous, many would argue that the degree of danger is a function of fishers' choices about the risks they take, such as the weather they fish in, the boats they use, the rest they obtain, and the safety gear they carry. Multiple studies suggest that although fisheries management policies are not meant to regulate safety at sea, they do sometimes contribute to safety problems. For example, following interviews with 22 experienced boat owners, captains and crew in the fishing community of New Bedford, the United States of America, about their attitudes on safety at sea and fisheries management, one study reported: "Approximately two-thirds rated fisheries management regulations as an important factor that affected safety at sea. In fact, for over half of the fishers, fisheries management was believed to be among the most important issues that impact safety at sea. Fishers reported several problems in which increased dangers at sea were attributed to management regulations designed to protect various fisheries."

Despite a variety of evidence that fisheries management affects safety, there has been relatively little systematic analysis of how management policies affect safety or the extent to which changes in management can affect safety.

In order to understand more fully the relationship between fisheries management policies and fishing safety, the United Nations Food and Agriculture Organization (FAO) and the United States National Institute for Occupational Safety and Health developed a study to document globally the relationship between safety at sea and fisheries management policies and to provide practical guidelines for fisheries managers and safety professionals on how they can work together to make commercial fishing safer.

Methods

FAO contracted researchers to prepare country-specific case studies on fisheries management and safety in 16 countries and regions. Each case study was reviewed to identify evidence supporting, or refuting, one or more of four hypotheses regarding potential effects of fisheries management policies on fishing safety. For each hypothesis, applicable published reports and scientific papers on each topic were also summarized and included in the document.

Hypothesis 1

Fisheries management policies have wide-ranging indirect effects on fishing safety. Although fisheries management policies are enacted primarily to achieve resource management and social and economic goals, they may affect fishing safety indirectly by affecting fishers' options (how, when, and where they may fish), fishers' preferences, or by affecting the number of fishers or vessels, thus creating or eliminating incentives for fishers to make risky choices.

Hypothesis 2

Quota-based fishery management systems are safer than competitive fishery management systems. This is a specific example of indirect effects on fishing safety as examined in Hypothesis 1. In competitive or open-access fishery management systems, fishers compete with one another for the available fish. In quota-based fishery management systems, managers limit how much individual fishers may catch. Under the latter, fishers may have less incentive to take risks such as fishing without adequate rest or fishing in bad weather. Quota-based fishery management may also result in the use of newer, safer vessels and gear,

and more professional and better-trained crew. On the other hand, these benefits will only exist if the system is effectively implemented and enforced, and other market-driven incentives for risk taking may still exist.

Hypothesis 3

Fisheries management policies that are unsuccessful in protecting resources or limiting the numbers of fishers competing for limited resources negatively affect safety. If the resources are not managed well, fishers face trade-offs between safety and the income they can earn from fishing. Fishers may venture farther offshore and take greater risks. Similarly, if total catches are limited, more fishers participating in a fishery will result in less opportunity for each fisher to earn income. If the number of fishers competing for resources is not limited, then fishers' average incomes may decline, causing them to take greater risks.

Hypothesis 4

Fisheries management can contribute to safer fisheries directly by integrating safety policies with fishery management policies. For example, by requiring safety equipment, safety training, and/or inspections as a condition for participating in a given fishery, fisheries in remote locations or identified as being particularly hazardous could have additional requirements placed on participants.

Evaluation of evidence

Where evidence was found for a hypothesis in the case studies, it was grouped into four types:

- **empirical** – based on an analysis of quantitative data;
- **anecdotal** – based on observations by fishers or managers;
- **hypothesized** – based on reasoning by the study authors about potential effects;
- **implicit** – deducted from information presented by study authors that suggests potential effects that were not specifically identified or discussed in the studies.

Results

Between May and August 2008, researchers prepared case studies for the following countries and regions: Argentina, Chile, European Union (Member Organization), France, Ghana, Iceland, Japan, Malawi, New Zealand, Pacific Islands, Peru, the Philippines, Spain, Sri Lanka, Sweden, and Thailand. Each of the 16 case studies offered some level of evidence for one or more of the four hypotheses.

Hypothesis 1

Ten case studies provided evidence supporting Hypothesis 1. Most of the evidence was related to fishery management affecting fishers' options. Three of the reports provided some level of empirical evidence: Iceland, New Zealand and Sri Lanka. One of the most compelling studies was a report discussing the hypothesized effects of fisheries management on safety in Iceland, including the special line of dispensation and days of effort. The special line of dispensation allows small vessels to fish with baited hooks and lines rather than nets to catch 16 percent more than their allocated individual transferable quota (ITQ) limit without incurring any penalty. However, the vessel is required to return to the same port from which it sailed within 24 hours. This restriction may result in the vessel not being able to go to the nearest port to avoid dangerous weather. Days of effort resulted in a potential safety problem because when a vessel sailed from port, one whole day was deducted from the total allotment. This resulted in an incentive to stay out at sea even if problems were encountered or weather was deteriorating.. However, in 2003–04, this rule was changed and the hazard was eliminated by measuring effort by hours started. Rates of search and rescue (SAR) events and fatalities examined during the time this rule was changed were

consistent with the hypothesis, but were deemed unreliable for drawing conclusions owing to the few total cases.

Reports from other regions also supported the hypothesis. The European Union (Member Organization report discussed the safety effects of restrictions on the gross tonnage of fleets. Member States are obligated to reduce fishing capacity as measured by gross tonnage and engine power. The authors argue that gross tonnage restrictions have important negative impacts on safety owing to the ageing fleet and restrictions on new vessel construction. The physical characteristics of older vessels may make it almost impossible to install technological advances that protect workers, and constraints placed on new vessel construction do not allow modern construction methods to be used. Similarly, the Spanish authors suggest that the European Union (Member Organization)-imposed vessel size limits result in vessels carrying equipment that makes them unstable in bad weather. The case report from New Zealand discussed risks that fishers took in preparation for the implementation of a quota-based fishery management system. Quota shares are sometimes based on fishers' catches during a specified period (the "catch history years"). The financial benefits of catching fish during this period are greatly multiplied by the right they may confer to catch more fish in the future, and the authors expressed concern that the policy may provide an incentive for greater risk taking.

Hypothesis 2

Four case studies provided insights about whether quota-based fishery management systems are safer than competitive fishery management systems, three of which provided some empirical evidence. The reports from France and Chile provided the strongest support of this hypothesis. The study from France compared accident rates for three scallop fisheries where the local fisheries committees have adopted different management regimes for controlling fishing effort. In the Bay of St Brieuc, management regulations result in a 45-minute race to fish. In contrast, in the Bay of Seine and off the Bay of Seine, a daily quota system without time limits is enforced. The results provide strong empirical evidence that daily catch quotas resulted in fewer occupational accidents than the competitive fishery because they provided fishers with the option to fish more safely.

The study from Chile contrasted different strategies for using fishing quotas in the same fishery over time. In the first period (2001–03), global quotas were established for both industrial and artisanal fleets, and industrial fishing was banned from the Artisanal Fishing Reserved Area. Increased resources in the artisanal sector in this period led to substantial growth and encouraged a race for fish. In the second period (2004–07), the "Artisanal Regime of Extraction" was implemented, and shares of the global artisanal quota were allocated to ad-hoc organizations of fishers based on groups' past participation and landings in the fishery. Compliance with the global quota improved, which contributed to a lessening of the race for fish and vessel overloading. The rates of fatalities, injuries and SAR incidents show that safety problems increased in the first period but decreased in the second period.

The Argentina report examined the adoption of a quota-based management system for the hake fishery and demonstrated that SAR numbers stabilized after the system began, although the data were not fishery specific. Although the case report from Iceland did not evaluate the ITQ programme specifically, the authors did note that the ITQ system in Iceland "opened an opportunity for consolidation and modernization of older, less efficient and safe vessels", and contributed to a significant decline in the numbers of vessels and fishers. Under the quota system, there has been a significant decline in total SAR and medical evacuation missions and fatalities.

Hypothesis 3

Four case studies (Ghana, Malawi, Pacific Islands, and Thailand) discussed situations in which fisheries management agencies lacked the capacity to limit effectively catches and/or the number of fishers participating. None of the reports had empirical evidence, but they did include examples supporting their assertions and direct quotes from regional fishers. In all of these reports, economic pressures on coastal populations, for whom fishing is an important traditional activity and employer of last resort, led to increasing catches, which led to depletion of near-shore resources. This problem was sometimes aggravated by uncontrolled catches by larger industrial vessels, both domestic and foreign, operating (often illegally) in the same waters. As near-shore resources were overfished and declined, fishers fished increasingly farther offshore, where they faced greater risks.

Hypothesis 4

Eight case studies included information on the potential for fisheries management policies to affect fishing safety directly and listed the potential benefits for safety if managers placed safety requirements on fishery participants. The Iceland report, which reviewed the accident and fatality data from fishers between 1991 and 2007, made the strongest argument. The authors discussed three features of the Icelandic management system. Most importantly, in Iceland, a fishing licence is only issued when minimum safety equipment and crew training are achieved. The authors concluded that mandatory requirements for safety training, equipment and awareness have increased safety. From 1991 to 2007, SAR missions decreased by 50 percent. The Icelandic authors state that: “the system contributed to the increased safety through placing requirements on equipment and training, resulting in a lower accident rate.”

Discussion

The case studies provide evidence of how fisheries management policies can affect safety. Many case studies provided persuasive arguments for change. They add to a body of existing literature that demonstrates that fisheries management policies have wide-ranging effects on fishing safety. The FAO Code of Conduct for Responsible Fisheries provides a necessary framework to ensure sustainable and safe fishing. In FAO Fisheries Circular No. 966, the authors argue that “safety at sea should be integrated into the general management of the fisheries in each country.” They further recommend that regulations ensure “the safety and well-being of the fishers, as well as sustainable utilization of the fish stocks.”

Although fisheries management policies may be enacted primarily to conserve resources and achieve economic and social goals, these policies can affect safety as well. Fisheries managers would be well advised to consider whether management policies that negatively affect safety are necessary, or whether conservation, economic and social goals can be achieved, instead, through regulations that allow and encourage fishers to fish more safely. Safety in the fishing industry cannot be ignored by fisheries management.

To improve fishing safety, fisheries management personnel and fishing safety professionals need to work together to identify solutions to meet all goals. If safety is to be maximized, policies that result in fishers being forced to choose between risk-avoidant situations and maximizing profits will need to be examined. Most case studies (63 percent) provided some evidence of how fisheries policies affect safety (Hypothesis 1). To protect fishers, management regulations that negatively affect safety need to be modified.

Four case studies reviewed how safety was affected by quota-based fisheries management systems (Hypothesis 2) with mixed results. One of the underlying goals of quota-based management systems is to improve safety. In theory, quota-based systems may reduce fishers' incentives to take risks, such as fishing without adequate rest or fishing in bad weather. Thus, replacing a competitive derby fishery with an individual fishing quota may remove some incentives to take risk.

However, this does not in itself guarantee that such risks will not be taken. It is overly simplistic to argue that quota-based fishery management systems are always or necessarily safer than competitive fishery management systems. Therefore, it is not quota-based management in itself that makes a fishery more or less safe. Rather, it is how quota-based management affects those who participate in the fishery, how they participate, and the conditions and incentives under which they participate. These effects may vary widely across quota-based programmes, depending on how the programmes are structured and on other factors affecting the fishery, ranging from the marine environment to the market.

It is clear that under certain conditions quota systems can reduce the risks in a given fishery. The Comparative Analysis of Regulatory Regimes states: "Some fisheries have experienced significant improvements in health and safety following the implementation of IQ [Individual Quota] programs, including the Nova Scotia offshore fishery (Binkley, 1995), the Alaskan halibut and sablefish fisheries (CDC, 1993; Lincoln and Conway, 1999; Woodley, 2000), and the British Columbia geoduck fishery (Heizer, 2000); others have maintained relatively high accident and fatality rates under the IQ system, such as the surf clam and ocean quahog fisheries of New England (U.S.C.G., 1999; NRC, 1999; Woodley, 2000), and the national fisheries of Iceland (NRC, 1999) and New Zealand (MSA, 2003)."

Case studies reviewing Hypothesis 3 found evidence that if fishery resources are depleted, or competition for limited resources becomes more intense, fishers will take greater risks, such as fishing farther offshore, to seek a living. The challenge facing managers in addressing safety problems extends to balancing resource protection, economic development and social goals such as access to economic opportunities to what is in many places an occupation of last resort. It is clear from these case studies that fishery managers in developing countries face very serious challenges, and that fishers in these countries may face much greater risks than those in most developed countries. These risks are less likely to derive from constraints imposed by fishery managers than from the inability of fishery managers to constrain harvests and access to fishing by coastal residents willing to take risks in pursuit of their livelihoods.

Half of the case studies provided examples and ideas about how fisheries management can contribute to safer fisheries directly by integrating safety policies with fishery management policies (Hypothesis 4). It is recommended that this approach be taken whenever practical. A Canadian study concluded that: "If properly facilitated, many aspects of safety can be enhanced through the fisheries management definition without compromising other management objectives. Connecting licenses with competency, safety certificates and vessel seaworthiness may provide a good system of checks and balances for a long-standing problem. Incorporating safety oriented measures into other management procedures such as permitting variations on partnering and quota allocations, could introduce valuable safety practices that makes fishing in small vessels more practical. Before proceeding with these kind of measures however, there would have to be a serious buy in by other players, including fishing industry representatives."

Managers face the challenge of balancing multiple objectives under significant uncertainty, with limited resources. It is suggested that they adopt the view that: “Safety at sea must be integrated into the general management of fisheries in all coastal states if safer working conditions for fishers are to become a reality.”

Conclusions and follow-up

All case studies provided some level of evidence for one or more of the four hypotheses. Although most case studies did not empirically measure safety effects, the anecdotal and persuasive arguments regarding the effects of policies on safety cannot be dismissed. It is necessary that fisheries managers, safety professionals, and fishers work together to develop and coordinate strategies to improve safety and integrate safety into management policies that protect not only the fish but also the fishers.

Fishing safety is a complex problem. The significance and persistence of safety problems in fisheries around the world suggests that there are no easy or obvious solutions. Fisheries management is not the only or most important factor affecting fishing safety. However, the case studies reviewed add to the wide range of evidence that fisheries management can affect fishing safety in a variety of ways. It is important to understand what these effects are, and to consider the ways in which fisheries management policies, while continuing to meet fishery management goals, may also be used to make fishing safer.

There is a need for research to continue to examine relationships between fisheries management policies and safety to identify policies that create incentives for fishers to take risks, to identify modifiable factors, and to develop policy alternatives. This type of research will help support changes in policy to incorporate safety assessments into fisheries management decisions. This synthesis provides evidence for the significant potential for policies to contribute to improved safety in many fisheries. There is evidence of potential policy changes in the United States of America. In 2011, the United States National Marine Fisheries Service, National Oceanic and Atmospheric Administration initiated an Advanced Notice of Proposed Rulemaking to request public comment on potential revisions to its National Standard 10 Guidelines, which state “to the extent practicable, safety of human life at sea shall be considered”. In any country and commercial fishery, continued monitoring of the change in risks is warranted. Better data collection and categorization are necessary to track adverse events by type of fishery for future evaluation.

1. BACKGROUND

To better understand the relationship between fisheries management policies and fishing safety, the Food and Agriculture Organization of the United Nations (FAO) and the United States National Institute for Occupational Safety and Health (NIOSH) developed the International Commercial Fishing Management Regime Safety Study (ICFMRSS). The purpose of the ICFMRSS is to *document* (globally) the relationship between safety at sea and fisheries management policies and to *provide practical guidelines for fisheries managers and safety professionals* on how they can work together to make commercial fishing safer.

Studies from many countries have suggested that fisheries management policies may affect commercial fishing safety. The following are examples:

> "*The actions and behaviours of fish harvesters are largely influenced by fisheries management regulations that set out who can fish, where, when and how they can fish, and the amount of fish they are permitted to take. Given this simple truth, it is surprising that the majority of national and international fisheries policies have traditionally been developed without regard for their potential impacts on health and safety. Fisheries management systems have the potential to affect safety at sea by indirectly encouraging unsafe behaviour or by leading to the reduction of safety features of fishing vessels ... "* (Windle *et al*., 2006).
>
> "*... Even though fisheries management systems are not meant to regulate safety at sea, they inevitably have an effect in this respect.*" (Petursdottir, Hannibalsson and Turner, 2001).
>
> "*... The entire way in which the fishing industry is organized must be regarded as a contributory factor to the current situation "* [of fishing safety problems]. (Jensen, 1997, p. 141).
>
> "*... Factors that contribute to safety issues in the small vessel fishing fleet ... include ... fish management regimes that do not give adequate consideration to safety issues*." (Wiseman and Burge, 2000).
>
> "*... Ten years ago, a survey of US west coast fishermen*[1] *... found that fisheries management problems were believed to be among the most important contributors to problems associated with safety at sea. Safety at sea becomes even more precarious if the inherent dangers involved with working in ocean waters are increased by management regulations designed to protect fisheries*." (Kaplan and Kite-Powell, 2000).
>
> "[Of fishers surveyed in New England] *approximately two-thirds rated fisheries management regulations as an important factor that affected safety at sea. In fact, for over half of the fishermen, fisheries management was believed to be among the most important issues that impact safety at sea."* (Kaplan and Kite-Powell, 2000).

[1] FAO house style is to use the gender-netural term fisher. The words fisherman and fishermen have been reatained where these were used in the original quotations.

However, there has been relatively little systematic analysis of *how* fisheries management policies affect safety or the extent to which changes in management policies can make fishing more or less safe. A recent study concluded:

> "*To date, there has been no comprehensive and comparative analysis of the impacts of various fisheries management measures on safety outcomes. This represents a significant research gap with important policy implications."* (Windle *et al*., 2006, p. 17)

To start to address this issue, the ICFMRSS was developed to:

1. Demonstrate a framework of how fisheries management policies affect fishing safety.
2. Evaluate hypotheses for how fisheries management policies affect fishing safety.
3. Conduct a literature review documenting current knowledge about how fisheries management policies affect fishing safety.
4. Gather international examples about effects of fisheries management policies on fishing safety.
5. Identify areas requiring continued research.
6. Provide practical guidelines to fisheries managers and safety professionals on how to consider safety in fisheries management policy making.

The work for ICFMRSS is being completed in five phases:

1. **Literature Review** of selected earlier studies was completed in February 2008 (Knapp, 2008).
2. **International Case Studies** conducted between May and August 2008.
3. **Synthesis Report** summarizing the international case studies, and selected other studies.
4. **Expert Consultation** hosted by the FAO in Rome in November 2008. (FAO Fisheries and Aquaculture Report No. 888, available at ftp://ftp.fao.org/docrep/fao/011/i0609e/i0609e00.pdf)
5. **Electronic Forum** for sharing and coordinating future research on fisheries management policies and fishing safety.

This document is the "Synthesis of case reports" summarizing the international case studies and selected other studies exploring how fisheries management policies affect safety. This synthesis proposes terminology, a conceptual framework outlining the relationships between fisheries management and fishing safety, and four hypotheses describing how fisheries management policies may affect safety (Chapter 2). It discusses methodology and limitations to the analysis arising from the wide range of fisheries and safety issues addressed by the case studies including data limitations (Chapter 3). The document then reviews the evidence provided by the case studies supporting one or more of the four hypotheses (Chapters 4–7). Conclusions and recommendations for fishery managers and safety professionals are given and future research areas are outlined (Chapter 8).

This document does not attempt to fully discuss the findings of the different international case studies, which used varying approaches to describe a wide variety of fisheries, fisheries management regimes, and fishing safety issues. Rather, it focuses on the extent to which available evidence from the case studies supports the hypotheses by which fisheries management may affect safety.

1.1. Code of Conduct for Responsible Fisheries

On 31 October 1995, the Code of Conduct for Responsible Fisheries was unanimously adopted by FAO's governing Conference. This Code provides a framework for efforts to ensure sustainable exploitation of

marine resources including the safety and health of the fishers. The direct references are set out in Article 6 General Principles, Article 7 Fisheries Management and Article 8 Fishing Operations.

References in Article 6 are:

6.17 States should ensure that fishing facilities and equipment as well as all fisheries activities allow for safe, healthy and fair working and living conditions and meet internationally agreed standards adopted by relevant international organizations.

6.18 Recognizing the important contributions of artisanal and small-scale fisheries to employment, income and food security, States should appropriately protect the rights of fishers and fish workers, particularly those engaged in subsistence, small-scale and artisanal fisheries, to a secure and just livelihood, as well as preferential access, where appropriate, to traditional fishing grounds and resources in the waters under their national jurisdiction.

Article 7 places a responsibility on States to manage fisheries resources properly:

7.1.8 States should take measures to prevent or eliminate excess fishing capacity and should ensure that levels of fishing effort are commensurate with the sustainable use of fishery resources as a means of ensuring the effectiveness of conservation and management measures.

In Article 8, responsibilities of all States and those of flag States are expressed in the following manner:

8.1.5 States should ensure that health and safety standards are adopted for everyone employed in fishing operations. Such standards should be not less than the minimum requirements of relevant international agreements on conditions of work and service.

8.2.5 Flag States should ensure compliance with appropriate safety requirements for fishing vessels and fisheries in accordance with international conventions, internationally agreed codes of practice and voluntary guidelines. States should adopt appropriate safety requirements for all small vessels not covered by such international conventions, codes of practice and voluntary guidelines.

8.4.1 States should ensure that fishing is conducted with due regard to the safety of human life and the International Maritime Organization International Regulations for Preventing Collisions at Sea, as well as International Maritime Organization requirements relating to the organization of marine traffic, protection of the marine environment and the prevention of damage to or loss of fishing gear.

In the Articles quoted above, the links between fisheries resource management and the safety in fishing operations are repeated. Indeed, Article 6.1.8 expresses the link between management and the rights of those engaged in subsistence, small-scale and artisanal fisheries, to secure a just livelihood, as well as preferential access, where appropriate, to traditional fishing grounds and resources. This study shows that failure to achieve this objective contributes to accidents and loss of life.

2 CONCEPTUAL FRAMEWORK

This chapter presents a conceptual framework for exploring how fisheries management policies affect fishing safety. Technical terms are defined to develop a common terminology and the conceptual framework of how government policies may affect safety is illustrated. Based on this framework, four hypotheses are proposed, and these are examined in the subsequent chapters.

2.1. Definitions

Below are definitions for selected technical terms used in this report. The definitions are to help readers understand the discussion, and to propose a common terminology for future discussions.

Fishing safety

Fishing safety is defined in two ways:

(1) By **events**: fishing safety increases as total injuries, fatalities and vessel casualties (damages to or losses of fishing vessels) decrease.
(2) By **rates**: fishing safety increases as rates of injuries, fatalities and vessel casualties decrease.

Direct and indirect contributing factors to safety

The term *direct contributing factors* refers to factors that are present or occur immediately prior to, during or following a safety incident or event (fishing fatality, injury or vessel casualty) without which the incident would not have occurred or would have had lesser consequences (Haddon, 1968). For fishing incidents, direct factors may be associated with the captain and crew (*human factors*), the vessel and machinery (*equipment factors*), location and weather conditions (*environmental factors*) or other direct factors. Table 1provides examples of potential direct contributing factors for fishing safety events.

The term *indirect contributing factors* refers to factors that occur prior to safety incidents and that affect the probability that direct contributing factors will occur in combinations leading to safety incidents. For example, suppose a fishery has a high rate of fatalities associated with overloaded vessels sinking in stormy weather conditions. Vessel overloading and stormy weather are direct contributing factors to the high rate of fatalities. Indirect contributing factors may include lack of training about vessel stability, financial pressure to catch as much fish as possible during a short opening, financial pressure to fish despite bad weather when prices are high, or the scheduling of a fishery opening during stormy weather.

Most fishing safety research and fishing safety policies have focused on mitigating direct contributing factors of fishing safety problems. However, to address fishing safety more effectively, there is a need to understand and address indirect contributing factors as well – including the role of fisheries management policies.

Table 1

Direct contributing factors to fishing fatalities, injuries and vessel casualties

Phase	Human factors	Equipment factors	Environmental factors	Other direct factors
Pre-event	Captain & crew fatigue Captain & crew stress Alcohol & drug use Lack of training in safe vessel and equipment operation	Unstable vessels Complex machinery	High winds Large waves Currents Icing Darkness Proximity to land and shoals	Vessel crowding Inadequate weather forecasting
Event	Lack of training in use of emergency and lifesaving equipment and procedures Delayed vessel abandonment	Vessel sinking Vessel fires Open door/hatches	High winds Large waves Currents Icing Darkness Proximity to land and shoals	Proximity of other vessels
Post-event	Poor use of emergency and lifesaving equipment	Lack of emergency and lifesaving equipment Malfunctioning of emergency and lifesaving equipment	High winds Large waves Currents Icing Darkness Proximity to land and shoals	Coordination of rescue efforts Proximity of rescue services

Safety policies, fisheries management policies, and other policies

The terms *safety policies*, *fisheries management policies*, and *other policies* are used to differentiate between three types of government policies with different primary goals.

Safety *policies* are those having the primary goals of improving safety and chances of survival. Examples are safety gear requirements (e.g. fire extinguishers, immersion suits, personal flotation devices, life rafts, emergency locator beacons, radios), safety training requirements, vessel construction standards and licensing.

Fisheries *management policies* are those undertaken with the primary goals of resource conservation and fisheries development. This includes policies regulating how much fish can be caught and when, how and by whom it may be caught. Examples are fishing seasons, fishing gear restrictions, limited entry licensing, and individual fishing quota systems.

Other policies are all other government policies. Examples include policies regarding unemployment insurance and health care.

Safety agencies, fisheries management agencies, and other agencies

The terms *safety agencies*, *fisheries management agencies*, and *other agencies* are used to describe those with primary responsibility for safety policies, fishery management policies and other policies. These policies may not be the sole responsibility of these agencies. In some countries, safety agencies may be the same as fishery management agencies – although this is not generally the case.

2.2. Conceptual framework for the effects of fisheries management policies on fishing safety

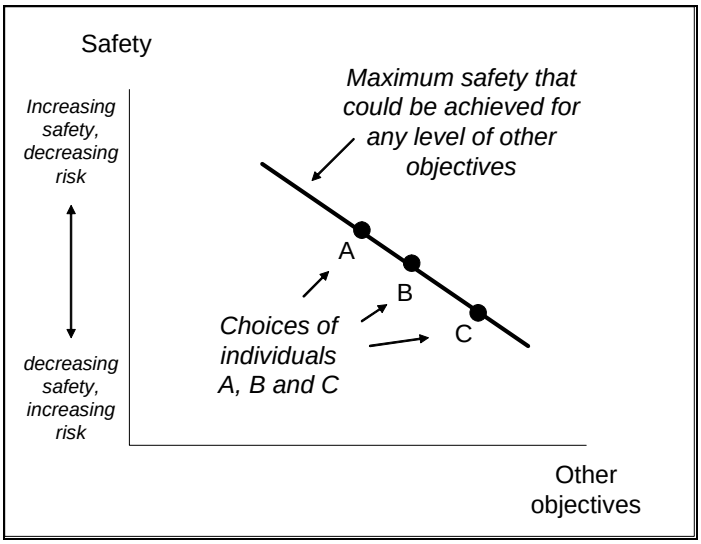
Fishing is inherently dangerous, but arguably the degree of danger is a function of the choices of fishers about the risks that they take, such as what kind of weather they fish in, what kind of boats they use, how much rest they take, and what safety gear they carry on board. These choices can be influenced by government policies, including fisheries management policies, which affect the options of fishers for how they fish. In order to think clearly about how fisheries management policies may affect fishing safety, it is important to begin with a clear conceptual framework or model for thinking about why fishers take risks and how government policies may influence the risks they take.

Models of risk taking – fishers

Fishers take risks because they have other objectives besides being safe, such as earning income. (A fisher who cared only about safety would never leave land.) To achieve these other objectives, they are willing to accept varying degrees of risks in fishing. Figure 1illustrates a simple model of risk-taking. The vertical axis represents increasing safety (decreasing risk) while the horizontal axis represents other objectives of the activity (such as earning income). For any specific type of fishing opportunity, fishers may face a trade-off between the level of safety they can achieve and the level of other objectives they can achieve. This trade-off is illustrated by the dark line in the figure and referred to as the "options curve". In this example, the options curve is shown as downward sloping, indicating that fishers can achieve more of their other objectives only by accepting more risk. The shape of the options curve may be affected by numerous factors, including human factors (fishers' experience), equipment factors (the kinds of boats they have), environmental factors (wind and sea conditions), and government policies (when fishing is allowed). For simplicity, this example depicts the options curve as a straight line. In reality, the shape of actual "options curves" may be much more complicated. They are not necessarily linear or downward sloping.

Figure 1

Simple risk-taking model



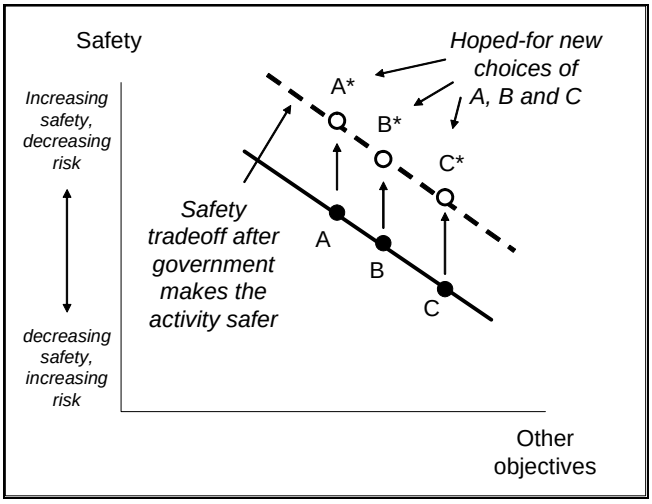
How safe individuals choose to be depends upon their *preferences*, or how important safety is to them relative to other objectives and their knowledge about their choices. For any given options curve, different individuals with different preferences may choose different combinations of safety and other objectives. For example, in Figure 1, individual C is willing to take more risk (such as fishing in worse weather) than individual B or individual A. Preferences may reflect many factors, including culture and other income opportunities. Someone who could earn the same living in a safe job on land

may not be as willing to take risks as someone who has no other opportunity to earn a living than by fishing.

Government policies affect not only fishers' *preferences*, they may also affect fishers' *options*. Figure 2 illustrates a situation in which the government policy has changed fishers' options in a positive manner. The policy has made it possible for fishers to achieve any level of other objectives (for example, income from fishing) more safely. An example might be providing better weather forecasting or better search and rescue (SAR) services.

Figure 2

Risk-taking model after policy change



A fundamental constraint to government policies that improve fishers' options to fish safely is that fishers will not necessarily choose to fish more safely. As illustrated in Figure 3, they may instead respond by choosing more of their other objectives, and less of an increase in safety (individual A), the same level of safety as before (individual B), or even less safety (individual C).

Figure 3

Alternative risk-taking model after policy change

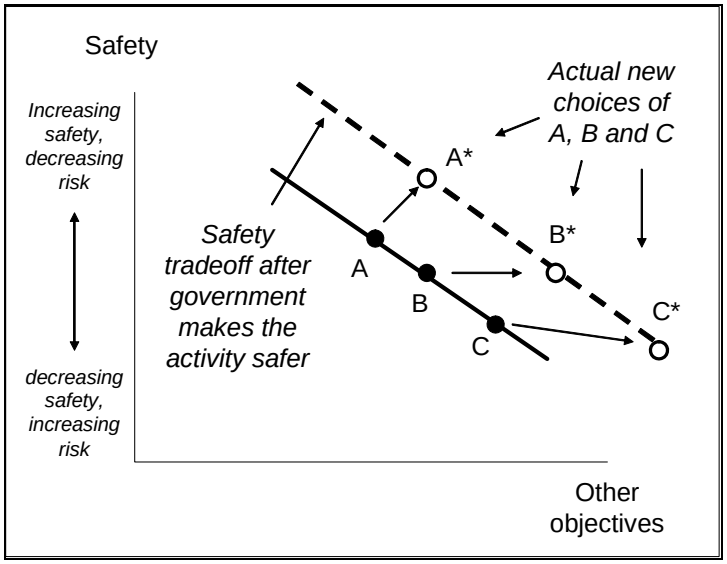
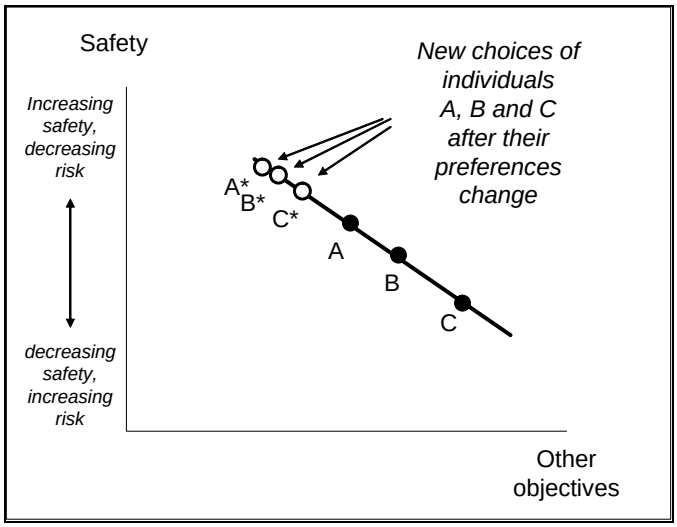


Figure 4 illustrates a situation in which policy has affected fishers' preferences so that they choose safer options. For example, an unemployment insurance programme that substantially increased

fishers' income during non-fishing seasons could have this effect, by reducing fishers' financial incentives to take risks fishing.

Figure 4

Another alternative risk-taking model after policy change



These models in these four figures illustrate why fishers take risks, that preferences can be different, and that policies may change options fishers have resulting in a change in the level of risk that exists.

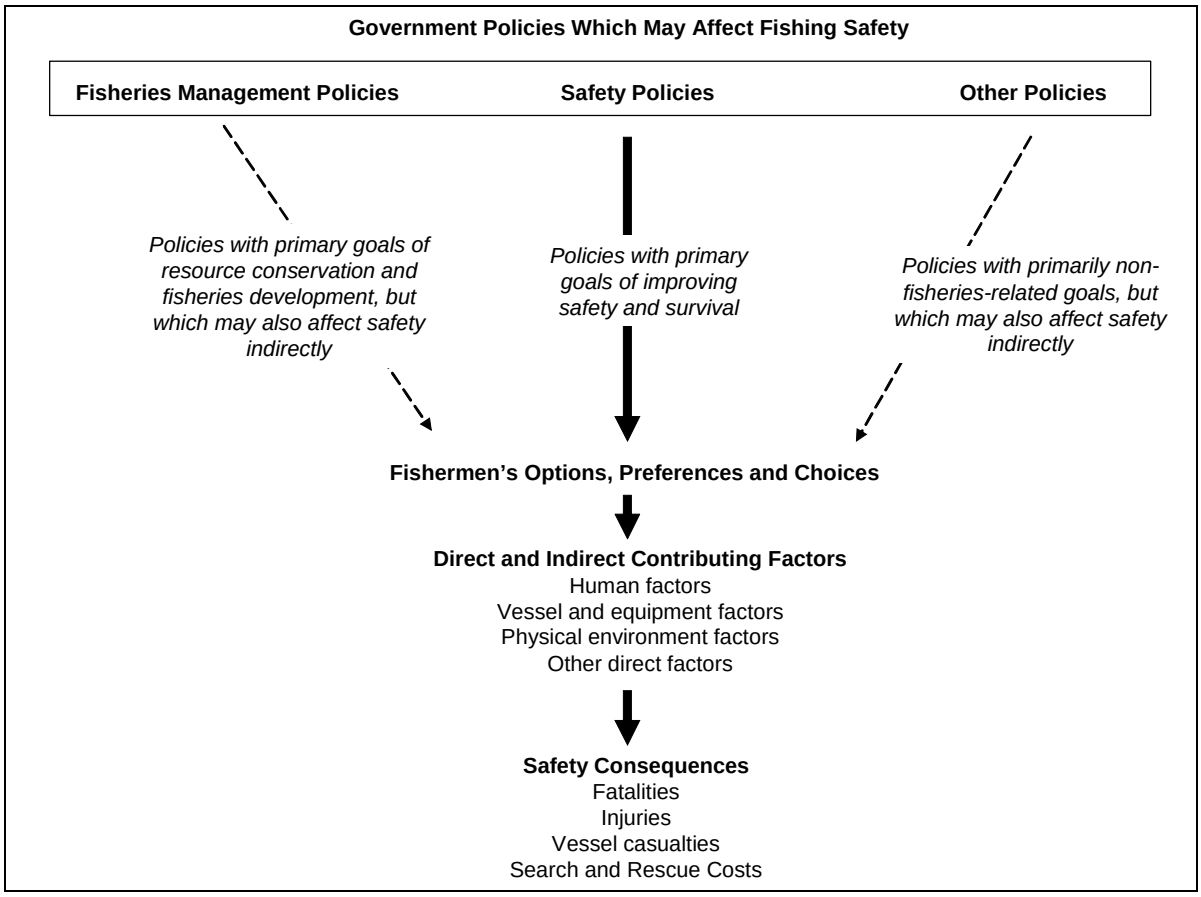
Models of risk taking – policies

Three groups of policies and their relationship to fishing safety are illustrated (Figure 5). The solid dark lines represent safety policies specifically intended to affect safety. The dashed lines represent fisheries management policies and other government policies that may have indirect effects on safety, either positive or negative.

Although fisheries management policies are enacted primarily to achieve fishery management goals, they may affect fishing safety indirectly. Other policies, undertaken for goals other than safety or fisheries management, may also affect fishing safety indirectly. Examples include marine liability laws, unemployment insurance laws, and economic development policies.

Figure 5

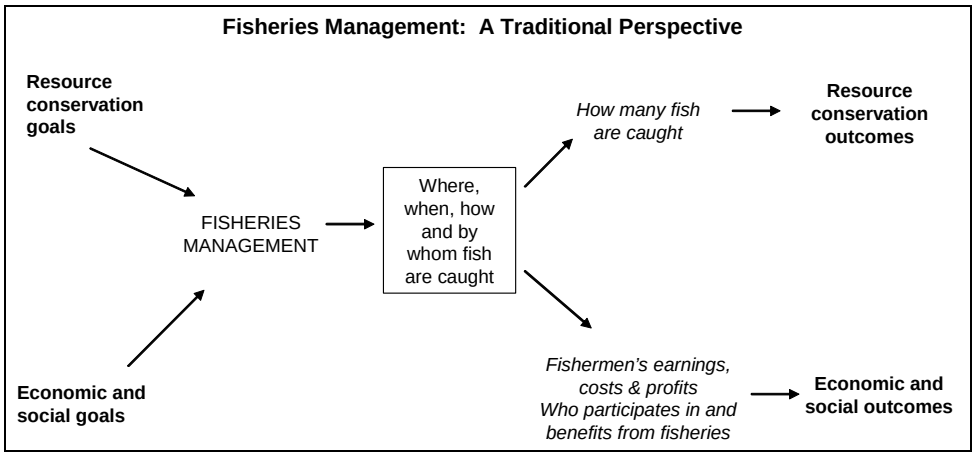
Pathways of how government policies affect fishing safety



The next two figures illustrate different perspectives of fisheries management policies. A traditional perspective of fisheries management, illustrated in Figure 6, shows that the goals of fisheries management are primarily resource conservation and economic and social goals (such as jobs and income for fishers and the welfare of fishing communities). To achieve these goals, managers adopt policies and regulations that affect where, when, how and by whom fish are caught. These policies in turn affect the economic environment within which fishers operate, how many fish are caught and the resource conservation outcomes of management. The policies and regulations also affect fishers' earnings, costs and profits, and who participates in and benefits from fisheries, and thus the economic and social outcomes of management.

Figure 6

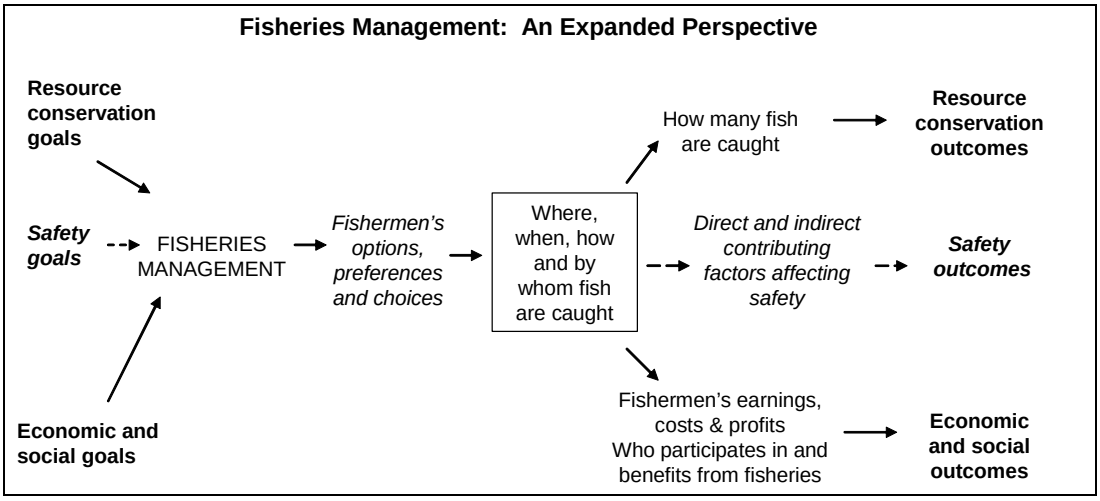
A traditional perspective of fisheries management



In contrast, Figure 7 illustrates an expanded perspective of fisheries management. The hypothesis is that fisheries management policies that affect fishers' options, preferences and choices may also affect the direct and indirect contributing factors affecting safety. Although their primary goals may be resource conservation and economic and social goals, fisheries managers will benefit from awareness of the indirect effects that policies have on safety outcomes. It is appropriate to consider safety among their other goals.

Figure 7

An expanded perspective of fisheries management



2.3. Four hypotheses for how fisheries management policies affect fishing safety

Four hypotheses are proposed about how fisheries management policies may affect fishing safety. In the remainder of this chapter, each hypothesis is explained in detail. The subsequent chapters review the extent to which the hypotheses are supported by the case studies.

Hypothesis 1. Fisheries management policies have wide-ranging indirect effects on fishing safety.

Hypothesis 2. Quota-based fishery management systems are safer than competitive fishery management systems.

Hypothesis 3. Fisheries management policies that are unsuccessful in protecting resources or limiting the numbers of fishers competing for limited resources negatively affect safety.

Hypothesis 4. Fisheries management can contribute to safer fisheries directly by integrating safety policies with fishery management policies.

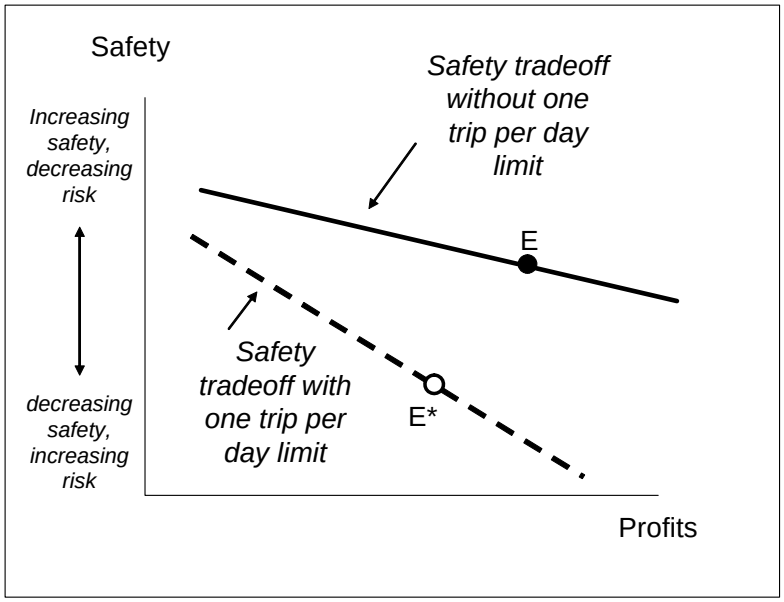
2.4. Hypothesis 1: Fisheries management policies have wide-ranging indirect effects on fishing safety

Although fisheries management policies are enacted primarily to achieve resource conservation goals and economic and social goals, they may affect fishing safety indirectly by affecting fishers' options and preferences for how, when and where they may fish – which in turn affect the trade-offs fishers face between safety and other objectives. Fisheries management policies may also affect the number of fishers and vessels participating in a fishery, and thus the number of fishers and vessels at risk.

Many fisheries management policies may affect fishers' options – the trade-offs that they face between safety and other objectives such as profits. For example, in some fisheries, managers limit the number of fishing trips a vessel may take. As illustrated in Figure 8, this may affect the trade-off fishers have between safety and how many fish they can catch. This trade-off results from the fact that the more fish the vessel carries per load, the greater the risk of vessel instability. With the option to make multiple trips, fishers can achieve any given catch and profit level with smaller loads per trip and less risk. With a limit on trips, fishers can catch any given volume only by carrying a larger load with more risk, as illustrated by the shift in the options curve from the solid to the dashed line. This shift in the options curve may result in fishers choosing a higher level of risk (shifting from E to E*) in an effort to compensate for the loss in profits they would face with a smaller vessel load but only one trip.

Figure 8

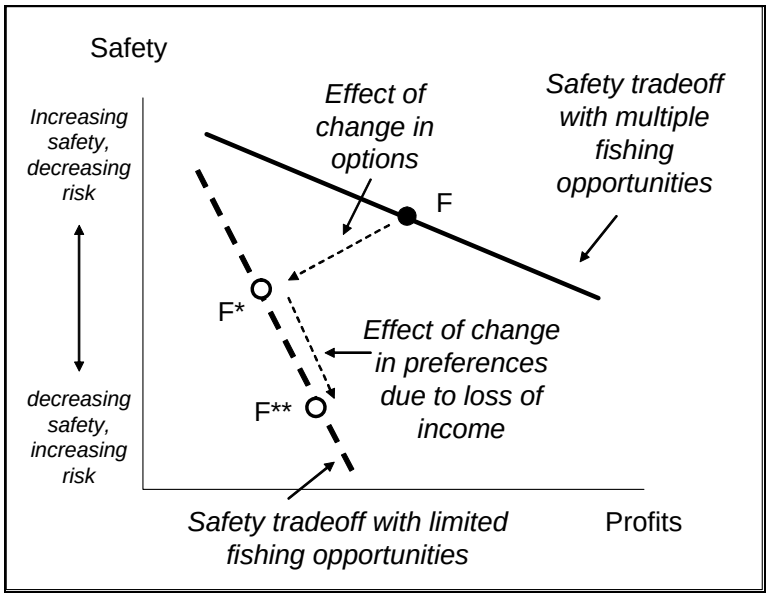
Mechanism 1 affecting fishers' options



Fisheries management may indirectly affect not only the options fishers face in choosing between safety and other objectives, but also their preferences in choosing between safety and other objectives. For example, suppose fisheries managers limit or close opportunities to participate in some fisheries. As illustrated in Figure 9, having fewer opportunities to fish shifts a fisher's options curve downwards, similar to the effect of a trip limit described above. If the fisher's preferences remained the same, he might shift from F to F*, with lower profits and lower safety. However, the fact that he has lost the income from other fisheries may aggravate the effect of the change in his options by also shifting his preferences. With a lower level of income, he may choose to accept a still greater level of risk (F**).

Figure 9

Mechanism 2 affecting fishers' preferences



Finally, fisheries management policies may affect not only how fishers fish, but also how many vessels and fishers participate in a fishery and/or how many days they fish. Even if they have no effect on safety risks, policies that affect the number of fishers or vessels at risk may also affect the number of fatalities, injuries and vessels that occur. For example, suppose that large boats can catch more fish per fisher-hour than small boats. Fisheries managers may limit the size of boats that may be used in order to increase employment in fishing. In so doing, they also increase the total number of hours that fishers are at risk. Mathematically, if fishing on small and large boats is equally safe, if small boats employ more fishers then fishing with small boats will result in more injuries and fatalities.

2.5. Hypothesis 2: Quota-based fishery management systems are safer than competitive fishery management systems

In competitive fishery management systems, fishers compete with one another for the available fish. In quota-based fishery management systems, managers limit how much individual fishers may catch. Under quota-based management systems, fishers may face less of a trade-off between safety and other objectives, giving them less incentive to take risks such as fishing without adequate rest or fishing in bad weather. Quota-based fishery management may also result in the use of newer and safer vessels and gear and more professional and better-trained crew.

For example, in highly competitive fisheries, fishing effort may be concentrated in short fishing seasons. This creates an incentive for fishers to fish even when weather conditions are bad, and to fish without adequate rest in order to catch as many fish as possible before the season ends. In contrast,

with quota-based management, fishers can choose to stay in port when the weather is bad, and to take time for adequate rest, without any loss in their total catch for the season.

This reasoning is illustrated by Figure 10. With quota-based management, fishers have the option to achieve any given level of profits more safely. Rather than choosing the full potential safety benefit, they also increase their level of profits – with the result that they enjoy both greater safety and higher profits.

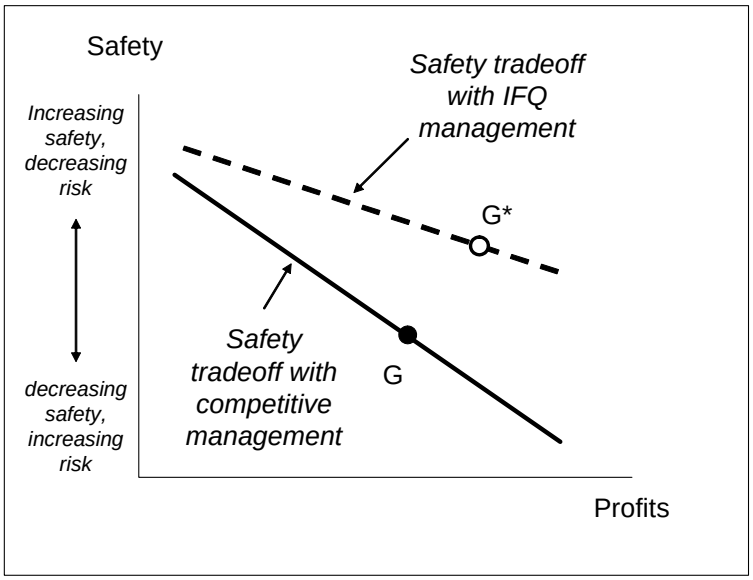
Quota-based fisheries tend to be more profitable, so that fishers who remain in the fishery may be better able to afford investments in vessel maintenance, safety equipment, and safety training. Quota systems may also lead to fleet consolidation and the exit of older, less efficient and less safe vessels, with the remaining vessels being crewed by relatively more experienced and professional crew.

These effects of quota-based management on fishing safety are examples of potential indirect effects of fisheries management on fishing safety as described by Hypothesis 1. However, these effects are stated here as a separate hypothesis because there is considerable interest in the safety effects of quota-based management.

Quota-based management has attracted significant interest and debate, and as there are several fisheries where quota-based management has replaced competitive management, its effects can be tested empirically by comparing safety measurements.

Figure 10

Safety trade-off due to change to quota-based fisheries management system



2.6. Hypothesis 3: Fisheries management policies that are unsuccessful in protecting resources or limiting the numbers of fishers competing for limited resources affect safety negatively

A primary objective of fisheries management is to protect fishery resources. In many fisheries, managers may not succeed in protecting fishery resources. This may happen for many reasons. Managers may not know what catch levels a fishery can sustain. Managers may face political pressure to allow fishing despite risks to the resource. Managers may have insufficient financial resources to be able to implement and enforce fisheries regulations effectively – particularly in developing countries.

Whatever the reason, if fishery resources are depleted, this changes the options available to fishers, and may change the trade-offs fishers face between safety and the income they can earn from fishing.

If resources are depleted in fisheries closer to shore, fishers may venture farther offshore and take greater risks to sustain their livelihood.

Similarly, even where managers succeed in protecting fishery resources by limiting total catches, the more fishers that participate in a fishery, the lower the opportunity for each fisher to earn income. If fishery managers do not limit the number of fishers competing for limited resources, then fishers' average incomes may decline, causing them to take greater risks.

2.7. Hypothesis 4: Fisheries management can contribute to safer fisheries directly by integrating safety policies with fishery management policies

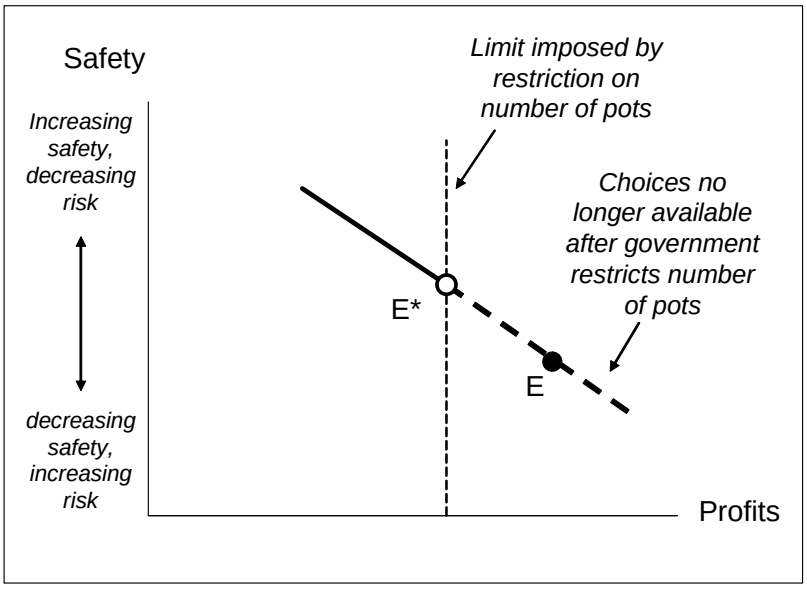
Earlier in this chapter, fisheries management policies were defined as policies undertaken with the primary goal of achieving fisheries management objectives, while safety policies were defined as policies undertaken with the specific goal of achieving safety objectives. In many countries, the agencies responsible for safety policies are different than those responsible for fisheries management policy.

This separation of fisheries management and safety responsibilities may result in less effective safety policies than might be possible with better coordination between safety agencies and management agencies and better integration of safety policies and management policies.

For example, fisheries management agencies could require safety gear, safety training, and/or safety inspections as a condition for participating in fisheries. They could also enact management regulations with the specific purpose of improving safety. For example, as illustrated in Figure 11, managers could impose a limit on the number of pots carried by a crab fishing vessel specifically for safety objectives (as opposed to conservation or economic objectives).

Figure 11

Fisheries management integrating direct safety policies



3. METHODS AND PRACTICAL CHALLENGES

3.1. Methods

In spring 2008, FAO contracted with researchers to prepare country-specific case reports on fisheries management and safety for particular management systems or fisheries in their respective countries and regions. Between May and August 2008, the researchers prepared 16 case studies, which are listed in Table 2.

The international studies varied in approach and may be grouped into three broad types of analyses:

- Comparative Quantitative Evaluations: These studies assessed safety impacts of management by comparing a rate of some safety indicator such as deaths, injuries, and SAR missions before and after a management regime change was put in place. One study compared fisheries where the same species was targeted under different management regimes. These studies presented empirical evidence of changes in the safety indicator.
- Qualitative Evaluations: These studies reviewed fishery management and fishing practices and discussed how management affects safety and/or how changes in management could improve safety. Some studies included information from surveys of fishers. These studies tended to present anecdotal evidence based on statements from and surveys of fishers.
- Current Dangers Assessments: These studies generated hypotheses about how current management practices were affecting safety locally. They did not include any formal evaluation of a policy or any survey of fishers to quantify safety. These studies presented the hypothesized evidence as reasoned by the respective study authors.

This analysis reviewed each of the 16 international studies for 4 potential kinds of evidence of support for each of the 4 hypotheses discussed above:

- *empirical* evidence based on analysis of data;
- *anecdotal* evidence based on observations of fishers or managers;
- *hypothesized* evidence based on reasoning of the study authors about potential effects;
- *implicit* evidence based on information presented in the study that suggests potential effects not specifically addressed by the study authors.

In addition to the 16 international case studies that were prepared for FAO, additional published studies found in the literature were reviewed and summarized. These additional studies are listed at the back of this report.

Chapters 4–7 review the evidence in the case studies for each of the four hypotheses, respectively. Each of these chapters starts with a table listing the studies and the kinds of evidence for the hypothesis (if any) revealed in each study. Each of the chapters concludes with a short discussion and assessment of the evidence for the hypothesis found in the case studies and, where appropriate, the other published literature reviewed.

Note that quotations from the case study are italicized and referenced by the country and the case study page number.

Table 2

International case studies of fisheries management and fishing safety

Country/region	Fisheries studied	Report authors and title
Argentina	Hake	Godelman, E. *Argentine safety at sea and fisheries management.* August 2008.
Chile	Pilchard and anchovy	Carrasco, J.I. *The Artisanal Regime of Extraction and its impact on the safety at sea. The case of a Chilean coastal pelagic fishery as an artisanal fishery under transition.* 2008.
European Union (Member Organization)	All	Renault, C., Douliazel, F. & Pinon, H. *Incidence of gross tonnage limitations under the European Common Fisheries Policy.* June 2008.
France	Scallops	Le Berre, N., Le Roy, Y. & Pinon, H. *Safety incidence of the management of scallop fisheries in Brittany and Normandy (France).* June 2008.
Ghana	All	Bortey, A., Hutchful, G., Nunoo, F.K.E. & Bannerman, P.O. *Safety and management practices in marine fisheries industry of Ghana.* June 2008.
Iceland	All	Petursdottir, G. & Hjorvar, T. *Fisheries Management and Safety at Sea.* September 2008.
Japan	Several coastal fisheries	Matsuda, A. & Takahashi, H. *Present status of the study of safety and management of fishery in Japan.* November 2008.
Malawi	Southern Lake Malawi fisheries	Njaya, F. & Banda, M. *Fishing safety and health and fisheries management practices: Case of Southern Lake Malawi fisheries.* June 2008.
New Zealand	Albacore	Wells, R. & Mace, J. *Case study on the relationship between fisheries management and safety at sea. The New Zealand albacore fishery.* September 2008.
Pacific Islands	Tuna	Gillett, R. *Sea safety in the Pacific Islands: The relationship between tuna fishery management and sea safety*. June 2008.
Peru	All	Cardenas, C.A. *Project artisanal fisheries and survival at sea in Peru.* July 2008.
Philippines	Tuna	CBNRM Learning Center. *Sea safety and fisheries management: Tuna fishing industry in General Santos City, Philippines.* August 2008.
Spain	All	Seco, B.R. *Study of the relationship between safety at sea and fisheries management in the competence of autonomous regions and their influence on the safety of fishermen and fishing vessels and fisheries management in Spain.* July 2008.
Sri Lanka	Multiday fisheries	Hettiarachchi, A. *The multi-day fisheries of Sri Lanka: Management and safety at sea.* June 2008.
Sweden	Lobster	Roupe, U. *Fisheries management and lobster fishery: A case study on risk and safety from Sweden*. August 2008.
Thailand	Trawl & purse seine fisheries	Chokesanguan, B., Rajruchithong, S., Taladon, P. & Loogon, A. *Safety at sea of trawler and purse seiner in Thailand*. August 2008.

3.2. Practical challenges

The original goal was that the international case studies would include quantitative assessments of fishing safety and how fisheries management policy changes had affected fishing safety. However, in many countries, the case report authors stated that there is a lack of reliable data for deaths, injuries, vessel losses, and SAR missions. In other countries, if these types of data were available, they were not coded by fishery and were not useful in evaluating a particular fishery or fishery management policy. Table 3 illustrates the available data, how they were characterized and how they were used in the case report.

Below are comments from selected case study comments regarding safety data and data quality:

> "*The study revealed there is insufficient information about accidents at sea to arrive at conclusions which may allow avoidance* of *future injuries and fatalities. A more detailed historical series, as the one being built since 2005, will constitute an important tool not just for the authorities involved in safety, but also for the fishing authorities."* (Argentina, p. 7).
>
> *"The data is very scarce about work accidents on fishing boats and wrecks at sea in Japan. It can also be guessed from the* analyses *of Miwa et al. (2001) and Kawasaki (2002) were based on the same source of information. Especially almost no information is available about the cases that are not accompanied with serious obstacles such as long-term closure, death, etc. It is necessary to collect the actual conditions of various fishery spots in Japan."* (Japan, p. 10).
>
> *"Currently there is no organized database in Sri Lanka that has data on incidents of casualties of fishing vessels at sea.* Although *some data are available, such data are not sufficient to establish a quantitative relationship between the incidents of casualties at sea and the current fisheries management scheme of the country."* (Sri Lanka, p. 1).
>
> *"the* available *data are not coded by fishery…"* (Argentina, p. 4).

Lack of data on numbers of fishers and/or fishing vessels posed an additional challenge to quantitative analysis of fishing safety for the case studies. These kinds of "denominator" or "exposure" data are needed to calculate injury, fatality or SAR rates and how these rates may have changed over time in response to management changes.

"*The public availability of information about the number of fishermen and the average time at sea coded by fishery could also be of great help. This is not difficult to obtain: it is just a matter of organizing the available data and of coordination between different authorities, particularly from the Fisheries and Prefectura departments, freely and systematically offering that results to the public."* (Argentina, p. 7)

Given a lack of reliable data, many authors chose to present a qualitative assessment by conducting interviews with fishers to collect anecdotal evidence of safety impacts of fisheries management policies. These interviews were often revealing and helpful in understanding what fishers thought about these issues. Although quantitative data were scarce, authors were often able to provide anecdotal evidence to support or refute the study hypotheses.

Table 3

Available data for international case studies

Country/ region	Fisheries studied	Availability of data*			Characterization by study of available data**	Use of data for study analysis**
		Fatalities, injuries & vessel casualties	Population at risk	Incident rates		
Argentina	Hake	Annual SARs (not by fishery)	Standardized effort	SAR rates	SARs not available by fishery, but did not see that as a problem	Yes, extensive
Chile	Pilchard and anchovy	Fatalities Accidents SARs	Population at risk and population of boats at risk	Fatality rate Accident rate SARs rate	No mention of any problems	Used the three incident rates to compare safety in different periods
European Union (Member Organization)	All	None	None	None	Study described as a current danger assessment	
France	Scallops	Accidents	Calculated by multiplying numbers of vessels or fishers by hours fishery is open	Frequency rates	No concerns expressed – data are considered to be good	Compared frequency rates for quota and competitive fisheries
Ghana	All	None	Number of vessels	None	Data do not exist	
Iceland	All	SARs and fatalities	Vessels Man-years	Yes	Excellent	Compared rates across time to test hypothesized safety improvements
Japan	Several coastal fisheries	Accident and vessel casualty data collected			Data are “very scarce”	Used questionnaire data to characterize accidents and rates by age group
Malawi	Southern Lake Malawi fisheries	None	None	None	No data available	No data available

Country/ region	Fisheries studied	Availability of data*			Characterization by study of available data**	Use of data for study analysis**
		Fatalities, injuries & vessel casualties	Population at risk	Incident rates		
New Zealand	Albacore	Accidents: collisions, groundings and sinkings	Fishing effort and catch data	Accidents/ effort	Absence of categorization by fishery complicated analysis	Looked at changes in rates over time
Pacific Islands	Tuna	Multiple countries studied incidents and lives lost available sometimes	Vessels	Did not calculate	Sometimes not available or did not exist	Multiple countries reviewed. Primarily presented thought-provoking information but not data analysis
Peru	All	None	None	None		
Philippines	Tuna	None	No data on number of fishers	None	Official records were not substantial or reliable	No data available
Spain	All	Time loss Accidents	Population	Incident rates	No discussion	Compared rates across time periods and among severity of injuries
Sri Lanka	Multiday fisheries	Number of accidents by type	Number of vessels by type	Accidents as % of vessels in operation	Insufficient to establish a quantitative relationship between incidents and fisheries management"	Trends over time in numbers of accidents and accident rates
Sweden	Lobster		Data on number of licensed fishers			
Thailand	Trawl & purse seine fisheries		Department of Fisheries (DOF) vessel licence data for number of vessels	Accident rates calculated from survey responses	Discusses need for better data for fishing fatalities	Used DOF data to describe number and types of vessels

* “Data” refers to data collected on a regular basis by government agencies, and excludes survey data collected on a one-time basis. Blank cells indicate that the study did not discuss availability of data.

** Blank cells indicate that study did not characterize or use data.

3.3. Summary of case study evidence

Each of the case reports offered some level of evidence for one or more of the four hypotheses. Table 4 summarizes the evidence found in each study for the four hypotheses. Most of the case studies provided some level of evidence for Hypothesis 1. Many studies also provided evidence supporting Hypothesis 4 that fisheries management policies could have direct effects for fishing safety and this may be very important in reducing hazards in high-risk fisheries.

Hypotheses 2 and 3 had fewer case studies providing evidence; however, these hypotheses are specific to either a type of management system (i.e. quota based) or a particular situation (i.e. unsuccessful management).

Table 4

Types of evidence found in the international cases studies for the hypothesized effects of fisheries management policies on fishing safety

Country/ region	Fisheries studied	1: Indirect effects of fishery management on safety	2: Effects of quota-based management on safety	3: Effects of unsuccessful management on safety	4: Integration of safety policies with management
Argentina	Hake		Empirical Anecdotal		
Chile	Pilchard and anchovy		Empirical		
European Union (Member Organization)	All	Hypothesized			
France	Scallops		Empirical		
Ghana	All			Hypothesized Anecdotal	Hypothesized
Iceland	All	Hypothesized	Anecdotal		Hypothesized Empirical
Japan	Several coastal fisheries	Implicit			
Malawi	Southern Lake Malawi fisheries	Hypothesized Anecdotal		Hypothesized	Hypothesized
New Zealand	Albacore	Empirical Anecdotal			
Pacific Islands	Tuna			Hypothesized Anecdotal	Hypothesized Anecdotal
Peru	All				Hypothesized Anecdotal
Philippines	Tuna	Hypothesized Anecdotal			Hypothesized Anecdotal

Country/ region	Fisheries studied	1: Indirect effects of fishery management on safety	2: Effects of quota-based management on safety	3: Effects of unsuccessful management on safety	4: Integration of safety policies with management
Spain	All	Hypothesized Anecdotal			Hypothesized Anecdotal
Sri Lanka	Multiday fisheries	Empirical Hypothesized			Hypothesized
Sweden	Lobster	Implicit			
Thailand	Trawl & purse seine fisheries	Anecdotal		Anecdotal	

Notes: Shaded cell indicates that the hypothesized potential effect is not relevant for the fishery. Blank cells indicate that insufficient information was provided in the study to draw any inferences about potential effects.

4. RESULTS: EVIDENCE FOR HYPOTHESIS 1

This chapter examines evidence from the international case studies for Hypothesis 1: *Fisheries management* policies *have wide-ranging indirect effects on fishing safety*. As previously stated, although fisheries management policies are enacted primarily to achieve fishery management goals, they may affect fishing safety indirectly but significantly by affecting fishers' options, preferences, and the number of fishers and boats participating in fishing.

It is useful to differentiate between three fisheries management policies that may indirectly affect fishing safety. "Affecting fishers' options" refers to fisheries management policies that influence the potential choices that fishers have between different levels of safety and other objectives such as profits. The primary focus is on the effects of specific regulations that limit how, where and when fishers may fish. "Affecting fishers' preferences" refers to fisheries management policies that influence how fishers choose among fishing options available to them, primarily through effects on their income. "Affecting the number of fishers and boats participating in fishing" refers to the effects of fisheries management on the numbers of vessels or fishers, which in turn affect the number of fatalities and vessel losses that occur, even if they have no effects on the risks incurred by individual vessels or fishers.

Table 5 summarizes the evidence found in the case studies for Hypothesis 1. Most of the case studies included some kind of evidence suggesting the presence of indirect effects of fisheries management policies on safety. However, much of the evidence was anecdotal, hypothesized or implicit. Because of a lack of data, only some of the studies were able to examine empirical evidence.

Table 5

International case study evidence for Hypothesis 1: Fisheries management policies have wide-ranging indirect effects on fishing safety

Country/ region	Fisheries studied	Type of fishery management	Effects on fishers' options	Effects on fishers' preferences	Effects on number of fishers and/or vessels
European Union (Member Organization)	All	Varied; gross tonnage limitations on vessels	Hypothesized		
Iceland	All	Effort restrictions – return to same port and days of effort	Hypothesized		Empirical
Japan	Several coastal fisheries	Not described; regulations include vessel size restrictions	Implicit	Implicit	
Malawi	Southern Lake Malawi fisheries	Gear, area and timing restrictions; limited enforcement	Hypothesized Anecdotal		
New Zealand	Albacore	Open access during period of time studied	Empirical Anecdotal	Empirical Anecdotal	Empirical Anecdotal
Philippines	Tuna	Area-based policies / not species based	Hypothesized Anecdotal		

Country/ region	Fisheries studied	Type of fishery management	Effects on fishers' options	Effects on fishers' preferences	Effects on number of fishers and/or vessels
Spain	All	Varied; not described	Hypothesized Anecdotal		
Sri Lanka	Multiday fisheries	Not described	Empirical Hypothesized		Empirical Hypothesized
Sweden	Lobster	Input controls			Implicit
Thailand	Trawl & purse seine fisheries	Regulated open access	Hypothesized		

Note: Blank cells indicate that insufficient information was provided in the study to draw any inferences about presence of effects.

Terminology: *Empirical* evidence is based on analysis of data; *anecdotal* evidence is based on observations of fishers or managers; *hypothesized* evidence is based on reasoning of the study authors; *implicit evidence* is information presented in the study that suggests potential effects not specifically addressed by the study authors.

These results are generally consistent with the hypothesis. As noted in Chapter 3, it was not hypothesized that management would affect safety in all fisheries. In addition, not all of the international case studies approached the issue of fishing safety in a manner likely to address potential indirect effects of fisheries management on safety. For example, the authors of several studies appeared to assume that "effects of fisheries management on safety" referred only to management policies *intended* to affect safety:

> *"Nowadays in Spain there are no fisheries management regulations that actually include safety at sea developed into the regulation except in the case of Catalonia ..."* (Spain, p. 5).

> *"No specific relation has been found, since the fisheries management is geared towards protecting the* species*... No specific fisheries management is used for improving the risk and safety situation for the fisherman."* (Sweden, p. 28).

> *"In the general picture of safety at sea for trawlers and purse seiners in Thailand, the present fisheries management measures do not seem to have a clear evidence effect to the improvement of safety conditions. This may be because different authorities have a responsibility for boat registration and fishing licensing..."* (Thailand, p. 22).

If the authors of these studies were not considering potential indirect effects of management on safety as part of their analysis, they were less likely to find or present evidence of such indirect effects.

European Union (Member Organization)

The authors of the European Union (Member Organization) study focus specifically on the potential indirect safety effects of its restrictions on the gross tonnage of fishing fleets. Since the early 1980s, the evolution of the French fishing fleet and other European Union (Member Organization) fleets has been governed by the European Union Common Fisheries Policy. This policy has promoted a "fleet structural adjustment" intended to reduce the number of fishing vessels through "public grants for the withdrawal of

existing vessels" and "limitation of new constructions through a strict control of the overall fleet capacities in each member State." Member States are obligated to reduce fishing capacity as measured by gross tonnage and engine power.

The authors begin by noting that "this paper is not a quantitative evaluation", and that a quantitative analysis of the effects of gross tonnage restrictions on safety would be difficult because there is no valid comparison fishery without these restrictions.

> *"There is no statistical evidence of distortion in terms of safety between different fisheries institutional and management situations, for the good reason that the actual observed accident rates cannot be validly compared with those that would result from alternative provisions."* (p. 5).

The authors argue that gross tonnage restrictions have had important indirect negative impacts on safety, through two broad mechanisms:

> **Ageing of the fleet.** *"... The average age of the fishing fleet steadily increased from 15.4 years in 1991 to 24 years in 2008, which represents an average increase of six months each year. A similar trend was observed in* all *Europe, to a slightly lesser degree in some countries, but worrying anyway. This ageing phenomenon has a detrimental impact on safety, and on productivity as well. The desirable fleet renewal did not occur, despite the different decommissioning plans and the new constructions in too limited numbers.*
>
> *In the absence of new vessels in sufficient numbers, existing ones are transformed. Elderly ships are kept in operation, while in general they do not provide seafarers with the improvements in occupational safety and working conditions that should result from the technological evolution achieved since the time of their construction ...The mechanical impact of ageing on safety and fuel consumption is straightforward and demonstrated. Ships get heavier, as a result of the progressive accumulation of extra fishing gear, spare parts, paint layers, water absorption in insulating materials and other, usually leading to a 10 to 15% increase in displacement for a ship of a 15 years age, even in the absence of any significant transformation. This increased heaviness modifies the initial stability and load lines data ..."* (p. 5).
>
> **Restrictions on new vessel construction.** *"New constructions are scarce. Furthermore, as they are subject to numerous and complex constraints, they cannot take full advantage of the potential improvements that could be expected from recent and modern constructions. According to all statements from fishing vessel designers or builders, and from their customers ship-owners and fishermen, it has become extremely difficult to build a ship in accordance with all ship safety and occupational safety and health requirements, because the design and construction of adequate vessels are burdened with quite a set of constraints, and particularly with the gross tonnage limitation ...*
>
> *The constraints originated from the resource protection policies, and specifically the gross tonnage limitation, have a* particularly *detrimental impact on occupational health and safety, specifically through the resulting restricted space devoted to the crew for their work and daily life."* (p. 6).

> *"When designing a new ship, its promoter and the shipyard which receives his order are obsessed by one concern: they have the compelling obligation to contain their project within the limit of the tonnage amount* they *are authorized to use. However, it is quite obvious that pursuing a minimum tonnage objective is contrary to ship safety, having in mind that a minimized tonnage has, among others, the following consequences:*
>
> *• reduced freeboard,*
> *• reduced enclosed volumes in the upper parts,*
> *• reduced living and working space, detrimental to living and working conditions,*
> *• restricted potential for possible future adaptation to new resource conditions."* (p. 7).

The authors argue that the negative safety effects of the European Union (Member Organization) restrictions are particularly inappropriate because the restrictions are not effective in controlling fishing effort:

> *"The fishing effort control that the confinement of national fishing fleets within a limited overall envelope is supposed to achieve is illusive, and purely formalistic ... The gross tonnage constraints that hamper the quality and safety of the new ships appear to have no relevance with regard to their object."* (p. 8).

Iceland

This study hypothesized two potential indirect effects of fisheries management on safety as a result of policies that affect fishers' options:

> **Special line dispensation.** *"The special line dispensation is a rule under which small vessels fishing with baited hooks and lines rather than nets can catch 16% more than their allocated ITQ limit without incurring any penalty ... The potential for disaster lay in the requirement that the vessel return to the same port from which it sailed within 24 hours. In the event of a sudden change in weather, this would in theory place pressure on the captain of the vessel to attempt to make the original port rather than a closer, safer one. This concern was raised by fishermen early on, but was mitigated somewhat by unofficial assurances of government officials that "consideration of weather conditions" would be made in any ruling. No legal provisions were made for this however, and there are no known cases where an exception of this type was made or refused."* (p. 4).
>
> **Days of effort.** *"Before the introduction of the ITQ system and for several years there after, vessels of a certain class (especially the smaller vessels) could choose to adhere to a system of effort management rather than catch management. This entails limiting the number of days of effort, i.e. the total number of days the vessel could spend fishing. The potential for a problem lay in that initially vessels were required to measure their effort in started days. This meant that if a vessel sailed from port, one whole day was spent from the total allotment and the pressure was on the captain to make the most of it. This created an incentive to stay out at sea even if the weather was changing or some other problem such as signs of illness surfaced. In 2003-2004 this rule was changed to the effect that effort is now measured in started hours, thus eliminating this concern."* (p. 5)

The study examined empirical evidence for these potential effects by comparing rates of search and rescue events and fatalities after these regulations were introduced or ended. The empirical results were consistent with the hypotheses but "drawing reliable conclusions [was] not possible due to the relatively few cases in questions."

Data presented in the report are consistent with (but cannot fully test) the hypothesis that fisheries management may indirectly affect safety by affecting the number of fishers and vessels at risk.

Japan

Vessel and net size restrictions. In a brief case study of safety of the purse seiner fleet, the report suggests that new regulations of the Fisheries Agency of Japan allowing the use of larger vessels, with two vessels cooperating in catching and holding fish, have reduced risks of capsizing.

> *"Traditional Japanese purse seiners have no fish hold, and Japanese fisheries agency control purse seiners with their size. Some of Japanese purse seiners have met dangerous phenomena due to huge nets. Currently, huge purse seiners which have fish holds are constructed to have good stability."* (p. 5)

> *"The Fisheries Agency of Japan controls the allowance for catch by a size of purse seiner. Therefore, purse seiners are just smaller for a huge round haul net which they are using. So, when the purse seiner is drawing up the net, (another boat called the) searcher is pulling the purse seiner to avoid capsizing. However, new fleet of purse seiner comes into existence which is licensed by the Fisheries Agency of Japan. "New purse seiner has the same size of net hold area as old one, and it means that these two vessels have the same ability of catch. In addition, new purse seiner and fleet are laborsaving and low costs. The huge size of purse seiner realizes good stability and improves labor environment ..."* (p. 12)

The report also suggests that difficult economic conditions resulting from conditions of both fishery resources and fish prices – both potentially influenced by management – may have affected fishers' willingness to take risks:

> *"... Generally Japanese fishermen tend to have low concern about their daily safeties and work environments while they have high concern about the states of fisheries resources and their prices. Once the majority of fishery was what is called the high-risk and high-return management. However, it is difficult to get a high profit nowadays because of the aggravation of the states of fisheries resources and the inactivation of the fish prices. Therefore, it is necessary to aim the proper balance of profits and safety, and work environment in order to manage continuous fisheries. For this purpose, fishermen's own consciousnesses should be reformed as well as the regulations of fishery and fishing boat equipments."* (p. 13)

Malawi

This report focuses primarily on safety in small-scale fisheries of southern Lake Malawi. Despite a lack of data, it is clear that there are major safety problems in these fisheries, especially when small boats fish offshore.

The report suggests that fisheries management imposes few effective constraints on small-scale fisheries, due to a lack of effective enforcement:

> *"Although licenses are required for fishing operations, people have licenses in practice very few ...The government centre management system ... has not been effective in small-scale fisheries. Like in many countries, this basic regulatory framework has failed to prevent over-exploitation of the target inshore fisheries resources due to non-compliance to regulations. Non-compliance to management regulations is mainly attributed to weak enforcement and lack of understanding of the socio-economic characteristics of fishers."* (pp. 6–7)

The report suggests two primary mechanisms by which fisheries management may affect fishing safety indirectly:

> *"Fishing seasons when it is risky to fish due to mwera (south easterly) and mpoto (south westerly) winds.* (p. 25)
>
> *Resource decline due to lack of proper institutional arrangements (open access and common property) and weak enforcement capacity results in overfishing of stocks in shallower water and hence forces fishers to venture into risky offshore deep water fishing."* (p. 25)

These points are discussed in greater detail in Chapter 6 under the hypothesis involving the protection of fishing resources and safety.

New Zealand

This report examines safety effects of a "race for fish" resulting from competitive fishing for a fixed quota. Theoretically, a competitive race for fish may affect safety through at least three mechanisms: by affecting fishers options (the financial benefits associated with a given level of risk); by affecting fishers preferences (the choices they would make given a trade-off between fish catches and safety); and by affecting the number of fishers and vessels at risk. The race for fish, in this example, was the result of the planned imposition of a quota management system intended to end competitive fishing. It has been the practice in New Zealand and many other countries that have implemented quota-based management to allocate quota shares based on fishers' catches during a specified period of time (the "catch history years"). The financial benefits of catching fish during this period are greatly multiplied by the right they may give to catch more fish in the future. The phenomenon of "fishing for history" is widespread in fisheries where there is a perception that managers may impose quota management.

In general, the study findings, as summarized in the following excerpts, are consistent with these hypothesized mechanisms, although the empirical evidence is limited by the relatively small number of cases. Note that fishers expected that albacore catches would be included in catch history until the Minister of Fisheries announced in 2002 that the cutoff date had passed.

> *"During the years prior to the Minster's announcement, there was a growing expectation that introduction of tuna to the QMS [Quota Management System] was approaching ... The industry clearly understood the benefits of establishing a catch history in the tuna fisheries, and there was an escalation of effort in the longline fishery (for southern bluefin, yelloweye and bigeye tuna) and in the troll fishery for albacore.* (p. 10).

> *There were three motivations for increasing fishing activity in the albacore fishery: (1) existing fishermen wanted to maintain continuity of access to the fishery; (2) others saw an opportunity to secure a stake in a fishery that could form a long term seasonal fishing option; and (3) quota is a tradable asset of considerable value, so allocation of quota would provide a substantial capital gain.* (p. 10).
>
> *In the three seasons prior to the Minister's definitive statement on catch history years, effort in the albacore fishery showed a significant increase ... there is a belief in the industry that the trend in increasing effort was driven by the opportunity to generate catch history.* (p. 10).
>
> *There has been a clear upward trend in accidents in the West Coast albacore fishery over the past decade, with accident rates notably higher since 1997, and peaking in 2002 before the Minister's announcement of his intention to use historical catch history for allocation of ITQ ...* (p. 13).
>
> *Interviews were carried out with four albacore vessel operators, all with more than 15 years experience in the fishery. All considered fishermen took more risks in order to increase catch history ...* (p. 14).
>
> *While only limited data are available, records indicate that the frequency of vessel accidents in the albacore fishery increased substantially in the late 1990s and early 2000s, suggesting some change that increased the risk.* (p. 17).
>
> *How much the "race for fish" to generate catch histories contributed to this is uncertain. However, over this period, fishing effort increased, and anecdotal evidence suggests that at least some fishermen decisions were influenced by perceptions of potential capital gains from impending introduction to the Quota Management System.* (p. 17).
>
> *Fishing is a risky undertaking, and the risk can be inherently higher in the albacore fishery, for the reasons noted above. Risk taking is motivated by opportunities to earn returns. Where catches create catch history which is used to allocate quota, catches will be valued by fishermen not only for the sale value of the fish, but also the potential capital value of quota allocated. With quota being worth 5-10 times the annual the value of the catch, there can be a much greater incentive to take risks in a fishery in transition to the QMS if allocation mechanisms are conducive."* (p. 17).

Note that this New Zealand case study may seem at first to be an example of the introduction of quota-based management making fisheries less safe (rather than safer as is commonly hypothesized). However, this is not the case: the safety problems discussed by the case study occurred prior to the introduction of the quota management system in the fishery. The management factor that may have had a negative indirect effect on safety was not quota-based management, but rather the method of allocating future quota share under quota management based on catch history.

The Philippines

The authors of this report found no evidence of fishers racing to fish, or of management policies pushing tuna fishers to overload their vessels or leading to extended working hours. They did note that fishing grounds were changing with potential safety impacts.

> *The primary impact on the safety of the tuna fishers is the change in fishing grounds. With regard to linking safety and fishing grounds, distance, climate patterns, current conditions and wave patterns, and presence of pirates are just some factors that fisheries managers have to consider. Farther fishing ground leads to extended fishing days which may have an effect on the physical well-being of the fishers as a result of prolonged days at sea.* (p. 23).

Spain

This report focuses primarily on problems arising from multiple and overlapping jurisdiction over the management of Spanish fisheries, which "makes the system confused and irrational, with consequences for fishermen safety" (p. 3). The report argues that attempts to apply the same fisheries management regulation to widely varying fleets "is incongruous and has negative consequences on safety" (p. 22). For example, overlapping jurisdictions and resulting multiple inspections cause ship owners and crew to "reject the inspection activities" and "have no wish to improve safety conditions because they are tired of being pursued by all these excessive inspections" (p. 22).

The report focuses relatively little attention on specific management policies and how they might affect safety. However, it does suggest several ways in which regulations that limit fishers' options may negatively affect fishing safety.

Engine power limits. The report suggests that engine power limits might limit the opportunity to participate in some fisheries safely:

> *"... the State determines a maximum power for the engines of vessels, which is too low for shell-fishing out at sea, inshore fishing and the harvesting of goose barnacles in Galicia, as a higher power engine is necessary to escape from storms and maneuver better among rocks, etc."* (p. 16).

Vessel size limits. The report suggests that European Union (Member Organization)-imposed limits on vessel size result in vessels carrying equipment that makes them unstable in bad weather:

> *"Naval engineers are not free for building the ships because the European legislation forces to reduce the fishing effort. If you want to build a new fishing vessel you must take one from the scrap yard and the new one must have the same size that the oldest one. The consequence is that the ship owner builds a ship under these standards for passing the inspections and later adapts his ship to his activity introducing cranes or fuel tanks, for example. As a result, the ship loses stability and that is the reason why vessels recently inspected quickly sink under unfavorable weather conditions."* (p. 16).

Sri Lanka

This study focuses on Sri Lanka's multiday fisheries that use larger vessels fishing more than 50 miles offshore. The study suggests that government promotion of the development of an offshore fishing fleet indirectly affected fishing safety by: (i) changing fishers' options – new larger vessels allowed fishers to fish much farther offshore where they were exposed to greater risks; and (ii) affecting the number of fishers and vessels at risk.

> *"... In early 1990s the Government has implemented a project to provide financial assistance to 3.5-ton single-day boat owners to convert their 3.5-ton boats to multi-day fishing vessels ... Since then the multi-day fishing fleet has grown steadily."* (p. 5).
>
> *"Instances where single-day fishing vessels meet with accidents or distress at sea are rare in comparison to such instances faced by multi-day fishing vessels. Since a single-day fishing vessel operates only in near-shore waters and in close proximity to other such vessels, in an emergency situation a single-day fishing vessel can look forward to help from vessels fishing nearby. As the duration of a single-day fishing operation is less than 24 hours, the possibility of single-day fishers getting into fatigue or falling ill in the sea is less. On the other hand, multi-day fishing vessels are considered more vulnerable to accidents in sea since they spend a much longer duration and cover a long distance on a single fishing voyage."* (p. 4).
>
> *"Gulbrandsen and Pajot (1993) have attributed the high rate of incidents of losses of multi-day fishing vessels to a hurried development of the offshore fishery undertaken during that period (the 1980s) without upgrading the boat technology in respect of safety at sea."* (p. 13).

Sweden

The report does not explicitly consider potential indirect effects of fishery management on safety in the lobster fishery. It attributes the risks associated with the fishery primarily to five causes (pp. 22–23):

- weather conditions;
- the short duration of the busy fishing season;
- the location of the lobster, and the wave conditions;
- crowded locations with lots of lines in the water;
- anxiety to catch the lobster.

The discussion in the report does not imply that management contributes to any of these causes. Rather, they appear to derive from the location of the lobster resource and the timing when lobster are of optimal quality for harvest.

However, how the fishery is managed *may* indirectly contribute to one of these factors: crowded locations with lots of lines in the water:

> *"The lobster locations are well known to the lobster fishermen and thus the locations get crowded. This means that the waters are filled with lines, and it happens to lobster fishermen almost every season that the propeller gets caught in someone else's lines. Since the location of the fishing grounds is close to land with difficult wave conditions, there is a high risk of incidents with serious outcome if the propeller is caught on a line."* (p. 23).

The information in the report implies that managers do not limit the number of participants in the fishery, leading to participation by about 160 licensed fishers and 8 000 recreational fishers. It is unclear whether having "the waters filled with lines" is necessary to catch the lobster or whether it results from the fact that numerous fishers are competing for the lobster in the best locations. If the crowding is due to numerous fishers competing in the best locations, it could be argued that the fact that management does not limit participation contributes to crowding and the associated safety problems.

Thailand

The report does not focus specifically on potential indirect effect of fishery management on fishing safety in Thailand. However, it briefly discusses two kinds of management regulations, which based on the discussion *may* contribute indirectly to safety problems.

Area closures. The report suggests that closing certain areas to fishing causes vessels to fish in less safe areas, aggravating safety problems:

> *"The establishment of close areas may affect trawlers and purse seiners of smaller size because they go farther than they are used to"* (p. 9)

Race for fish. The report suggests that race for fish conditions are created by seasonal closures, aggravating risks:

> *"Due to these seasonal closures and the open access nature of the fisheries there is high competition to get to and from the fishing ground as fast as possible and return to port with the largest possible catch. Often important factors such as weather are not given due consideration. Some of the operators are increasing engine power and gear efficiency, fishing longer, and hiring more foreigners with lower labour cost. Under these conditions risks are higher for accidents."* (p. 9)

4.1. Indirect effects of fishery management on safety: evidence from other studies

The focus in this report is primarily on new evidence provide by the international case studies. However, a large existing literature also discusses indirect effects of fisheries management on fishing safety and presents examples from other countries. A small sample of this literature is quoted below.

The SafeCatch study (SafetyNet Centre for Occupational Health and Safety Research, 2006) described perceptions of risk of Newfoundland harvesters:

> *"Harvesters tend to see some injuries as part of the job. Harvesters also tend to normalize the risks to safety posed by bad weather. However, they also see weather risks as mediated by forecasting, by experience with the vessel and with different types of conditions, as well as by regulations. Regulations can both mitigate and enhance risk. The regulations our participants think matter most to risk include those that limit vessel length, set season lengths, that include strict rules about when gear can be in the water, and that require mandatory safety equipment and training."* (p. 4).

Wiseman and Burge (2000) conducted a fishing vessel safety review for Newfoundland and Labrador, Canada. As part of this review, they prepared a literature review of a number of earlier studies of fishing safety. Several of these studies described indirect effects of fisheries management on fishing safety (quotes are from Wiseman and Burge 2000):

> *"[A 1987 study by the Canadian Coast Guard]. identified a broad range of variables causing the high rate of casualties. While it noted that human error was a principle cause of most accidents, it was clear in its view that circumstances, often beyond the control of fishermen, set the stage for accidents to happen. It pointed to a high-risk activity where external influences, such as environmental conditions and fishery management practices were major factors leading to accidents. It argued that "arbitrary rulings in the pursuit of Department of Fisheries & Oceans (DFO) goals often had an adverse effect on safety".*

The application of vessel size restrictions and time line quota allocations were cited as major issues of DFO policy affecting safety. Overall, there was a serious expression of concern about a disconnect between DFO management policy and issues of safety."

"[According to a 1990 Canadian Coast Guard study] in 1988 DFO changed to cubic capacity of the entire fishing vessels, instead of just the fish hold capacity. In the Study's assessment "this had the effect of forcing fishermen to use smaller vessels and operate older vessels longer.""

"On the issue of safety, [a Memorial University of Newfoundland thesis by Carl Parsons] paper argues that the vessel classification system, which was essentially arbitrary in its design, may hamper the required transformation of the fishery in several respects. It is noted that preliminary results of the study suggests it may slow technological change, reduce economic efficiency and "compromise safety at sea" ... According to Parsons, [since] the vessel replacement regulations in the Newfoundland fishery will remain status quo for some time into the future, it means the problem may even worsen. Not only will new replacement vessels be fundamentally too small, but those in existence will continue to enter a further state of decline with age."

British Columbia (Canada) fisheries economist Frank Millerd (personal communication, 2008) argued that fishing vessel design limitations adversely affect safety in British Columbia fisheries:

"Often, in the case of a fishing accident, the actions of the fishermen are blamed when there are underlying contributing factors which put the fishermen at risk... Any constraint on fishing efficiency increases the risk to fishermen. Restrictions on vessel size, fishing gear, fishing time, and fishing area all increase the time spent fishing thus increasing the probability of an accident.

Fishing vessel design limitations imposed by regulation may be particularly significant.... The limited license program in the British Columbia salmon fishery is based on vessel tonnage, resulting in vessels built to maximize carrying capacity but likely less seaworthy than if tonnage restrictions did not exist. Similarly 'Alaska limit' seiners which... were limited in length likely resulted in vessels less seaworthy than if no such restrictions existed.

One problem in British Columbia has been the conversion of table seiners to drum seiners, significantly altering vessel stability. Net drums and associated equipment have been added to vessels originally designed and built as table seiners, increasing weight high in the vessel. This has been a factor in several capsizings. Permitting drum seining has contributed to this safety problem."

"One major issue is coordination between the Department of Transport (sometimes called Transport Canada) and the Department of Fisheries and Oceans. Transport certifies vessels and their crews; Fisheries and Oceans sets fishing management plans and issues licenses. But acquiring a fishing license does not always require that a vessel and crew meet safety requirements and the vessel meet stability requirements. Fishing management plans are not always drawn up with the safety of fishermen in mind:

-Vessels may be certified seaworthy for one fishery but then used in another, often with additional gear added. The extent to which multiple purpose vessels are encouraged and new types of gear allowed will influence how vessels are modified and operated.

-Once a vessel is certified authorities are not notified when changes are made to the vessel. Vessels and crews need to be frequently checked to ensure requirements are continuing to be met.

-Limits on vessel dimensions can compromise safety as vessels are modified to accommodate additional gear while remaining within the prescribed dimensions.

-Relaxing gear limitations without relaxing vessel restrictions could lead to vessel safety problems.

-There can be unforeseen consequences of fishing regulations. An example is limiting the volume of a prawn trap which led fishermen to make the traps more rigid and thus heavier. This added to the weight carried by vessels, often high in the vessel thus decreasing stability.

-Quality requirements with increased use of refrigerated and chilled sea water systems can decrease vessel stability if not properly operated."

In a review of co-management of the British Columbia (Canada) geoduck clam fishery, Khan (2006) found that input control management measures had contributed to "unsafe fishing practices":

"The geoduck clam fishery ... is British Columbia's most valuable invertebrate fishery. This fishery has been co-managed by the Department of Fisheries and Oceans (DFO) and the Underwater Harvesters Association (UHA) since 1989. Earlier input control measures such as effort regulation, seasonal closures, and licenses failed to work effectively for more than ten years, resulting in excess fishing capacity, over harvesting, poor economic returns, and unsafe fishing practices."

Kaplan and Kite-Powell (2000) conducted interviews with 22 experienced boat owners, captains and crew in the fishing community of New Bedford, Massachusetts, the United States of America, about their attitudes on safety at sea and fisheries management:

"Approximately two-thirds rated fisheries management regulations as an important factor that affected safety at sea. In fact, for over half of the fishermen, fisheries management was believed to be among the most important issues that impact safety at sea. Fishermen reported several problems in which increased dangers at sea were attributed to management regulations designed to protect various fisheries. Four problems were mentioned most often by the fishermen and are summarized as follows: (1) reduced crew size regulations created overworked and tired crew and prevented bringing new, inexperienced crewmen to learn the trade since `every man needs to pull his full weight'; (2) tightly limited or short-term fishing periods pressured fishermen to go out (or stay out) in bad weather or when there may be problems with their boats; (3) transiting around marine protected areas caused unnecessary dangers in various weather conditions. (Fishermen often seemed unsure about the conditions in which they might be allowed to transit closed areas.); (4) limiting areas for fishing often caused congestion among boats (especially within shipping lanes)."

Thomas *et al*. (1993) described how the management system for the Gulf of Mexico Red Snapper fishery (the United States of America) affected safety both by influencing the amount of money fishers could earn for boat maintenance and also by the weather conditions in which they fished:

> *"Derby conditions have existed for both the 1992 and 1993 fishing seasons. One effect has been a dramatic reduction of the price for red snapper … One hidden factor of reduced income is that 77 percent of fishermen state that regulations have affected the amount of money available to them for boat maintenance. As one fisherman told us, 'it's difficult to work out there when you're not sure if it'll all hold up. Fishermen are concerned not only over the safety issues associated with a poorly maintained boat, but have serious concerns over the conditions in which they believe regulations have forced them to work … Fishermen know that when the commercial quota of red snapper is reached the season is over. What this means is that fishermen feel they are being forced to fish in weather they would normally avoid. As one fisherman stated during a focus group, 'Back in 89, it (the season) was open year round. You could pick your weather. Now, you can't pick your weather.'"* (pp. 12–13)

Townsend (personal communication, 2008) presented anecdotal evidence of the effects of management regulations on safety in one season of the Northwestern Hawaiian Islands lobster fishery (additional discussion is provided in Townsend, Pooley and Clarke [2003]):

> *"Of 15 permits, 2 boats were lost due in part to response to dumb regulations. One boat went fishing in December, during an "opening" that resulted from inability to meet notification requirements, and was lost with one or two deaths. A second boat went fishing with a freezer container lashed to its deck, because the owner needed to "use it or lose it." The boat rolled; fortunately no one died."*

In an analysis of potential individual transferable quota management of the Baltic Sea herring fishery, Kulmalaa *et al*. (2007) argued that current management regulations decrease fishing safety:

> *"Finnish herring fishery regulations based on TAC [Total Allowable Catch] and time restrictions have decreased fishing safety and increased fishing costs. For instance the "race for herring" and the limited number of allowed fishing days oblige fishermen to fish in all weather. Fisheries managers in Finland have largely ignored the economic and social consequences of current management practices."*

4.2. Conclusions

Both the new international case studies and a large existing literature demonstrate that fisheries management policies have wide-ranging indirect effects on fishing safety. Although these policies may be enacted primarily to achieve resource conservation goals or economic and social goals, they may have real effects on fishing safety. If fishing is to become safer, the indirect effects of fisheries management on fishing safety cannot be ignored. Managers will need to be aware of how management affects safety, and consider whether management regulations that negatively affect safety are necessary, or whether resource conservation and economic and social goals can be achieved through regulations that allow and encourage fishers to fish more safely.

5. RESULTS: EVIDENCE FOR HYPOTHESIS 2

This chapter examines evidence from the international case studies for Hypothesis 2: *Quota-based fishery management systems are safer than competitive fishery management systems.*

This hypothesis has generated significant interest and debate among safety researchers, fisheries managers and fishers.

5.1. Competitive vs quota-based fisheries management

Traditionally, most fisheries management systems have been competitive. In competitive or open fisheries, there are no management-imposed limits on how much fish individual fishers may catch, only on the total catch for the fishery. Managers may impose regulations on when, where and how fishers may fish, and (in limited-entry fisheries) on who may fish. Within the constraints imposed by these regulations, fishers compete with one another to catch the fish that are available. In general, the intensity of competition increases as the number of fishers and the catching power of their vessels and gear increases, as fish prices increase, or as the available fishery resources decrease.

Quota-based fisheries management refers to management systems in which fishers have specific quotas for how much they are allowed to catch. The most common form of quota-based fisheries management is individual quotas, in various forms and with varying terminology such as individual fishing quotas (IFQs), individual transferable quotas (ITQs), or simply individual quotas (IQs). However, a wide variety of other forms of quota-based fisheries management also exist, such as fishing cooperatives and community quotas. In all of these, the essential characteristic is that fishers' catches are limited by their quotas, rather than by their ability to compete successfully against other fishers.

Quota-based fisheries management has generated intense controversy. Much of the controversy has been driven by the distributional effects of "privatizing" fishery resources – which has the potential to significantly benefit some stakeholders and to harm others. Implementation of quota-based management has the potential to change fisheries dramatically, including altering the risks to the fishers involved.

5.2. Hypothesized effects of quota-based management on fishing safety

One of the many questions that have arisen with respect to quota-based management is the effects of these kinds of policies on fishing safety. Fishery managers, fishers, economists, and safety researchers have hypothesized that quota-based management will make fisheries safer through several mechanisms:

- **Reduced incentive for risk-taking.** In highly competitive fisheries, fishing effort is concentrated in short fishing seasons. This creates an incentive for fishers to fish even when weather conditions are bad. Fishers also have an incentive to fish without adequate rest – increasing the risks associated with fatigue – in order to catch as much fish as possible during the limited fishing opportunity before the short season ends. In contrast, with quota-based management, the total catch is not controlled through the season length, and thus fishers can choose when to harvest their quotas over much longer seasons. They can stay in port when the weather is bad without risk, and can take adequate rest, without loss of income.
- **More professional crew.** With a longer season and more predictable earnings, fishers have an opportunity to hire, train and retain more experienced and professional crew.

- **More financial stability and predictability.** With more stable and predictable income resulting from knowing how much they will be able to catch, fishers will be better able to plan and make investments in vessel maintenance, safety equipment, and safety training.
- **Newer fishing vessels.** Quota-based management typically leads to fleet consolidation, as some quota-holders buy or lease quotas from others in order to achieve larger-scale more efficient operations. Those vessels that remain in the fleet are likely to be the newer and safer vessels.

However, several hypotheses have also been advanced as to why the safety benefits of quota-based management might be less than the hypotheses listed above suggest:

- **Ineffective quota-based management.** Quota-based fishery management will not have these hypothesized safety benefits unless it is effectively implemented and enforced. Unless fishers' catches are really limited to their quotas, and they feel secure that other fishers will not catch their allotted shares before they can, fishers will still face the same incentives to fish competitively, and take risks related to weather and fatigue, that they did before the imposition of quota-based management.
- **Market-driven incentives for risk-taking.** Even if they have quotas, fishers may still choose to take risks such as fishing in bad weather or fishing without rest for other reasons, including market-driven demands. Under a quota-based management system, if a period of bad weather causes some boats to stay in port, the resulting shortage of fish may result in higher price offers, creating an incentive for some boats to fish in bad weather to take advantage of the higher price opportunity. A more direct market-driven incentive may be requirements of fish processors for fishers to make steady deliveries to meet processing schedules and market requirements, which may also create incentives to fish in bad weather or without rest.
- **Uncertain effects on crew.** Quota-based management will not necessarily result in more professional or experienced crew. Without the need to catch fish fast, some fishers may find it more profitable to hire less-experienced crew willing to work for lower pay.
- **Uncertain effects on profits.** While quota-based management may result in higher profits for the industry as a whole, this will not necessarily be the case for all fishers. Those fishers who buy or lease quota from other fishers will only earn profits if they earn enough money to cover not only their fishing costs but also their quota costs.
- **Absence of hypothesized safety problems in competitive fishery.** The hypothesized safety benefits of quota-based management are premised on the fact that it will address the causes of safety problems in the preceding competitive fishery, such as incentives to fish in bad weather or to fish without rest. However, these incentives are not necessarily present or a cause of safety problems in all competitive fisheries. As a simple example, if the weather is generally good in a fishery, then implementing quota-based management will not result in fishers fishing in better weather.

In summary, while there are strong theoretical arguments as to why quota-based management might be expected to improve fishing safety, there are also theoretical arguments as to why implementation of such a system might not improve safety in all fisheries. Rather, theory suggests that quota-based management may improve safety in some fisheries, under certain conditions.

5.3. Evidence from case reports for Hypothesis 2

Table 6 summarizes evidence from the four international case studies that discussed quota-based fishery management systems. Following the table is a summary of each of these studies.

Table 6

International case study evidence for Hypothesis 2: Quota-based management systems are safer than competitive fishery management systems

Country/ region	Fisheries studied	Type of management	Type of evidence	Type of support
Argentina	Hake	Quota management system	Empirical	Mixed support for improvement
Chile	Pilchard and anchovy	Collective quotas allocated among artisanal groups	Empirical	No support for improvement
France	Scallops	Daily/weekly quota vs 45 minutes fish/day	Empirical	Much support for improvement
Iceland	All	Individual transferable quotas	Anecdotal	Some support for improvement

Argentina

This case study discusses the adoption of a quota-based management system for the hake fishery. Available data suggest a stabilization of SAR occurred after implementation of the quota management system. However, aggregate data included other fisheries not under the new system and may not reflect actual trends in the hake fishery.

> *"The objective of this study is to initiate a systematic assessment of the relationship between different fisheries management conditions and its effect on the safety of the hake fleet in Argentina, and in particular its relationship to the implementation of the provisional IFQ system in 2001 and more generally since restrictions were implemented in 2000."* (p. 3)
>
> *"The stabilization of restrictions after 2000, and particularly after the enforcement of the provisional IFQ system, seems to have had an effect of relative stabilization of the number of SARs."* (p. 6)
>
> *"From 48 telephonic interviews with hake skippers, we could know also that a portion of fishermen have a subjective feeling of some improvements in regards to safety since 2000, also we could know that, despite the statistics, there is not a memory of worsening between 1993 and 1998."* (p. 6)
>
> *"In this study we could see that restrictions imposed to the hake fishery from 1999, and particularly the provisional IFQ system enforced since 2001 meant some improvement in the safety at sea for that fishery. We can associate this improvement with some limits to the effort and to the race for fish."* (p. 7)

Although the author concludes that safety improvements were made, the data do not provide strong support due to the lack of fishery-specific safety data.

Chile

This study examined effects on fishing safety of changes in the regulatory regime of the artisanal fishery for pilchard and anchovy in a southern region of Chile. The report contrasts two periods, 2001–03 and 2004–07. In the first period, global quotas were established for both the industrial and artisanal fleets, and industrial fishing was banned from the Artisanal Fishing Reserved Area (AFRA), including an area extending five nautical miles offshore. The increase in resources available to the artisanal sector led to substantial growth in the artisanal fleet during these years, which encouraged a race for fish. In the second period, the Artisanal Regime of Extraction (ARE) was implemented, under which shares of the global artisanal quota were allocated to ad-hoc organizations of fishers based on groups' past participation and landings in the fishery. In addition, compliance with the global quota improved, which also contributed to a lessening of the race for fish and vessel overloading.

Empirical data on rates of fatalities, injuries and SAR incidents suggested that safety problems increased in the first period but decreased in the second (ARE) period. The study analysis suggested that the increase in safety problems in the first period was caused by the lack of an adequate system for enforcing the global artisanal quota, which made the quota ineffective, contributing to overloading of fishing vessels and a race for fish. The decrease in safety problems in the second period resulted from a better system for auditing landings, which made the quota effective.

In summary, the ARE policy was designed to create opportunities for the artisanal fishery by reserving fishing areas and quota for the non-industrial artisanal fleet. However, the new opportunities created by these policies led to a rapid growth in the fleet – putting more fishers and vessels at risk – and a race for fish that may have contributed to continuing safety problems. The ARE fishery may be a transitional phase in the evolution of the fishery from open access to individual quota management. The competitive conditions during this transitional phase, including growth in the fleet and less than fully effective enforcement, do not resolve, and may to some extent, aggravate safety problems.

Below is selected text from the study illustrating these conclusions.

> *"This is a case of transitional fishery. It starts as a challenge for a sustainable management for this large and growing artisanal fishery."* (p. 1)
>
> *"The main objective of the ARE is to generate a commitment on the part of the fishermen in the compliance with the quotas allocated by the fisheries authority. Although not originally created for safety matters is foreseen a better safety performance in the fishery when following a decrease of the race–for–the–resource trend and a consequent more responsible behavior at the loading of the boats. Nevertheless, upon comparing the period before and after its implementation, it can be shown increased fatality and accident rates appears. Only since 2005 this scenario begins to improve."* (p. 3)
>
> *"The (empirical) results show an increase in the fatality, accidentability and SAR rates, during the ARE implementation phase, which can be explained by the weak institutional development at that phase, as corresponding mechanisms were not applied at the beginning of its implementation: an adequate landings audit system; days–at–sea and storage capacity restrictions; reduction of the technological fighting between the segments of the artisanal fleets through the separation of the fishery season between them; and stable criteria for the quota allocation."* (p. 1)

"Improvements in the compliance of the collective quotas became apparent since 2007, decreasing also the race–for–the–resource trend and the overloading of fishing boats." (p. 5)

"At the implementation phase, the ARE was not provided with normative devices focused on its consequences on the safety at sea. As a matter of fact, the race–for– the–resource and the Derby style behavior, besides boat overloading remained present throughout this phase.... The increased number of boats implies new requirements of surveillance on safety conditions by the maritime authority. But actual capacities were deficient at that time... Furthermore, although ARE seeks for the control of the number of boats effectively operating, the increasing trend remains ..." (p. 13)

"An effective landing audit system was not in force until 2006 ... Without an adequate landings audit system an incentive for non-compliance occurs. It compels the fisher folks to overload the boats, and pass over the safety rules." (p. 14)

"The increasing of the SARs rate in the smallest boats expounds a technological competition among the different types of boats ... Usually, the best fishing grounds are reached most easily by the technologically advanced boats. Therefore, smaller boats are displaced toward worse or riskier grounds, so avoiding that technological competition." (p. 14)

"Three rules were put in force since 2006: limitation of days at sea to Monday to Friday (2005); limitation of daily fishing trips: one at day (2006); and storage limitation: ≤ 80 M3 per boat ranging from 15 to 18 meters length (2007)... These elements could explain the positive trend in the safety since 2005 ..." (pp. 14)

"Any change of a fishery regime that hits on the expectations of fisherfolks involves challenges in the safety at sea matters. It occurred in a pilchard and anchovy fishery exploited by an artisanal fleet in Southern Chile. From the beginning of the artisanal expansion of this fishery the safety was impacted. Nevertheless, a lack of accurate normative devices was apparent." (p. 15)

"The artisanal pilchard and anchovy fishery becomes a fishery under transition. The quota regimes impel its challenges and pathways, and here a series of question remains unanswered about its future. Probably new entrants will be obstructed, and new and more stringent rules focused on the Derby style behavior will be in force. Perhaps, a kind of individual quotas will be designed and imposed. But, in any case the managers must bear in mind the way how their decisions always changes the structure of the distribution of risk in a given fishery." (pp. 15)

France

This study compared three scallop fisheries where the local fisheries committees have adopted different management regimes for controlling fishing effort. In the Bay of St Brieuc, management regulations result in a 45 minute race to fish. In contrast, in the Bay of Seine and Off the Bay of Seine a daily quota system without time limits is in force. Safety in scallop fisheries is of particular concern because, while scallop fisheries account for less than 6 percent of full-time equivalent fishers in France, they account for more than 15 percent of fishing fatalities.

The study reviewed the respective scallop fishing fleets including the types of vessels, the gear used and the fisheries management regulations. They also estimated the population at risk, reviewed accident data, and calculated accident rates.

The results show strong empirical evidence that daily catch quotas resulted in fewer occupational accidents than the competitive fishery because they provided fishers the option to fish more safely.

> *"The occupational accident rate is by far higher in Brittany, where a limitation of 45 minutes fishing time per day is implemented, than in Normandy where a daily quota of catches, without time limitations, is in force*." (p. 2)

> *"... Overall accident rates, and in particular the rate of fatal accidents resulting from fall overboard, are much higher in the Bay of St Brieuc than in and off the Bay of Seine. Different factors can be considered as contributing, but it is quite clear that the major one is by far the management mode, which results in hasty behaviors, without time enough for cautious handling of fishing gear... The competent public authorities and private organizations are aware that this rush to scallops during a very short time is obviously dangerous."* (p. 13)

Much higher accident rates were found in the competitive scallop fishery than in the two quota-based management fishery (Table 7). The study concluded that the major contributing factor to these differences was the management regime.

Table 7

Comparison of accident rates in three French scallop fisheries

Fishery	Type of management	Total accidents 2000–05	Yearly average accidents	Yearly exposure time[1)]	Frequency rates[2)]
Bay of St Brieuc	Competitive	80	13.3	108 900	**122**
Bay of Seine	Quota-based	227	37.8	638 600	**59**
Off Bay of Seine	Quota-based	313	52.2	2 860 000	**18**

[1)] hours

[2)] Yearly number of accidents per 1 000 000 working hours

This study offers clear support for the hypothesis that quota-based management contributes to improved safety by reducing incentives to take risks by fishing aggressively.

Iceland

Although the case report from Iceland did not evaluate the ITQ programme specifically, the authors did note that the ITQ system in Iceland "opened an opportunity for consolidation and modernization of older, less efficient and safe vessels" and contributed to a significant decline in the numbers of vessels and fishers. Since the full implementation of the quota system in 1990, there has been a steady decline in the total number of SAR and medical evacuation missions and fatalities, although these changes cannot be directly linked to the ITQ programme.

5.4. Quota-based management effects on safety: evidence from other studies

There is a body of literature examining changes in fisheries after the adoption of quota-based fisheries management plans. This section discusses several relevant studies, but is in no way an exhaustive review

of the literature. Previously the National Research Council published a review of international fishing quota systems and their impact on the resource and the fishers involved (NRC, 1999). Only studies published since that review and not included in the regional case studies are discussed here.

Windle *et al.* (2006), and later in Windle *et al.* (2008), examined the effects of fishing management regimes on occupational health and safety. The report and paper were the result of a comprehensive, multinational project to compare the regulatory regimes of several countries and review the existing literature. A primary finding was that only a limited number of empirical studies have examined the effects of changes in management regimes on safety. While IQ systems have been promoted as a way to improve safety, the authors found that the evidence for this contention is limited and mixed. They note that fisheries without defined aggregation limits have had continued problems with major vessel accidents and fishing fatalities, such as the United States surf clam and ocean quahog fishery. The authors also recommend that comparative analyses take into account the degree of enforcement and compliance with any fisheries regulations when examining their effects on safety.

Since 1995, Alaska, the United States of America, has implemented quota-based management systems replacing open access management systems in the Alaska halibut and sablefish fishery, the Bering Sea and Aleutian Island (BSAI) pollock fishery and the BSAI crab fishery. Several recent reports have examined the effect of these changes including their effects on safety.

Hughes and Woodley (2007) examined changes to fishing fleets, operations, crew employment, economics and safety records for all three fisheries and provide a good overview of the history of each fishery. Prior to 1995, the Alaska halibut and sablefish fishery was managed as an open-access fishery with annual harvest quotas. Owing to declining resources, in the early 1990s the openings were two 24-hour “derby” fisheries. Between 1989 and 1994, 33 vessels were lost and 14 fatalities occurred. This safety record was attributed to the result of the “derby” style prosecution of the fisheries, which combined factors of small vessels, poor weather, and fatigued crews operating in intense fisheries.

Prior to 1998, the BSAI pollock fishery was slightly to moderately overcapitalized. In the 1990s the season durations were growing shorter and the operations becoming intensely competitive and turning into more of a “derby style” fishery. To stop this trend, quota-based management programmes were implemented in the pollock fishery in 1999. The 1999 American Fisheries Act (AFA) provided for total allowable catch to be allocated to the three sectors of the pollock fleet (mother ships, factory trawlers, catcher vessels) in which cooperatives issue quota shares to vessel owners.

The BSAI crab fishery consists of the Bristol Bay red king crab fishery and the opilio Tanner crab fishery. During the last season of open-access management of these fisheries (2004–05), the Bristol Bay red king crab fishery was conducted by 243 catcher boats and 8 catcher processors with a season of only 4 days. The opilio Tanner crab fishery was conducted by 168 catcher vessels and 6 catcher processors with a season of only 5 days. These fisheries had become classic “derby” fisheries with each vessel operating at maximum capacity for the short season to harvest as much crab as possible.

The authors concluded that under quota-based management there was substantial fleet consolidations and that the longer season length has lessened risk taking and incentives to maximize fishing power. While the authors examined vessel loss and fatalities, there were no analyses of changes in safety due to the changes in management.

Lincoln, Mode and Woodley (2007) evaluated the impact of the implementation of quota-based management on measures of safety in two of these Alaskan fisheries: Alaska halibut and sablefish and the Alaskan pollock fishery. The objective of this study was to assess systematically whether safety improvements had occurred after quota-based management systems were implemented.

The authors found evidence of a significant improvement in safety for the Alaskan halibut and sablefish fishery after implementation of the IFQ programme, as measured by a significant decline in the rate of both fatalities and SAR missions after IFQs. The fatality rate decreased by 81 percent (Table 8) and the SAR mission rate decreased by 46 percent (Table 9).

Table 8

Estimated annual fatality rates in Alaska halibut and sablefish fisheries

Year	No. fatalities	Full-time equivalent	Rate per 100 000 full-time equivalents
Pre-IFQ period (1991–1994)	15	10 444	144
Post-IFQ period (1995–2000)	2	7 033	28

Table 9

Estimated search and rescue (SAR) case rate in Alaska halibut and sablefish fisheries

Year	No. SARs	Vessels	Rate per 100 000 vessels
Pre-IFQ period (1992–1994)	82	13 621	602
Post-IFQ period (1995–2000)*	45	13 827	325

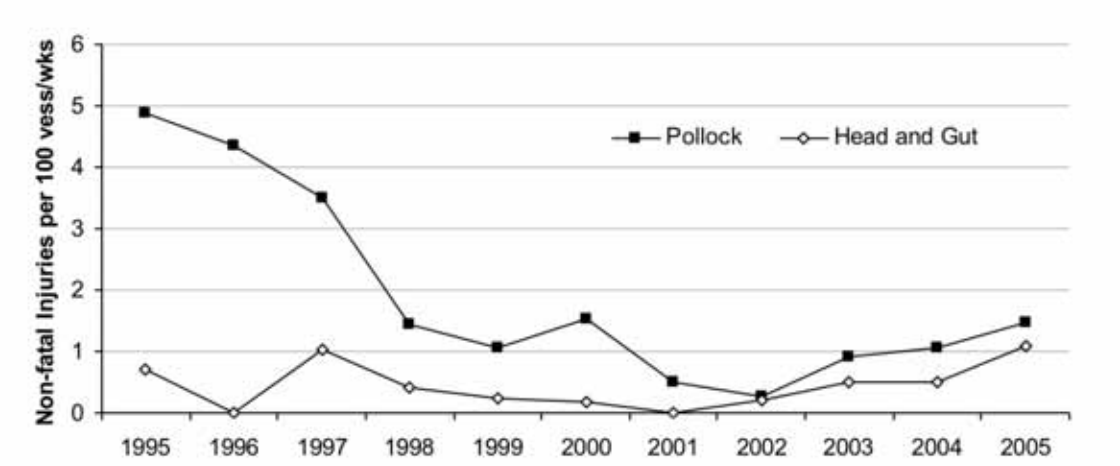
* Values for 1997–98 were imputed using the average value from adjacent years.

The authors concluded that the IFQ management programme resulted in significant safety improvements for the halibut and sablefish fishery and that the IFQ programme had an effective impact on the safety problems that had existed in these fisheries previously.

Lincoln, Mode and Woodley (2007) also evaluated the impact of the implementation of quota-based management on the BSAI pollock fishery. They found a measurable improvement in safety for the pollock fleet over the time period studied (Figure 12). However, unlike the halibut and sablefish fishery, the annual data suggested that other influences besides the AFA may have been associated with the observed improvement. The decline in non-fatal injuries pre-1999 could have been the result of vessels dropping out of the fishery prior to implementation of the AFA or because the fishing companies who owned these vessels started making corporate safety improvements prior to the AFA. The authors concluded that the data did not allow determination of the causes of the decline – they were unable to determine if the declines observed prior to 1999 were due to the AFA or other more general industry changes.

Figure 12

Non-fatal Serious injuries per 100 vessel-weeks for pollock and head and gut vessels in Alaska before and after the American Fisheries Act in 1999



Woodley, Lincoln and Mendicott (2009) examined the economic and safety impacts of quota-based management on the BSAI crab fishery. In the BSAI crab fleet, the catching power or capability of a vessel is directly related to the number of pots a vessel is able to carry. Adding pots beyond the vessel's stability requirements raises the centre of gravity, decreases the freeboard of the vessel, and lessens the vessel's righting arm. The authors note that this dangerous scenario resulted in many fatalities in this fleet. From October 1990 to March 1999, 73 people died in the BSAI crab fisheries as a result of capsizing, sinking, falls overboard, and industrial accidents, such as being struck or crushed by crab pots.

The study examined two major interventions to the crab fishery, with the change to quota-based management happening after a change affecting vessel stability. In 1999, an interagency safety programme was developed for the BSAI crab fleet, known as the "At the Dock Stability and Safety Compliance Check (SSCC)". Vessel loading and stability issues were reviewed with the master of vessels participating in the BSAI fisheries. Vessels found to be without stability reports, overloaded, or having missing, outdated, or inoperable primary life saving equipment (i.e. immersion suits, life rafts, emergency position-indicating radio beacon [EPIRBs]) would be issued captain of the port orders and not allowed to depart until the safety discrepancy was corrected. As previously noted (CDC, 2008), this programme resulted in a 60 percent reduction in the fatality rate in the BSAI crab fleet. Only eight lives were lost, or slightly more than one life annually, in 2007. The authors note the improvement over the period 1990–99 where the fleet lost an average of eight fishers annually.

In 2005, the BSAI crab fishery management regime underwent comprehensive and dramatic change with the implementation of the BSAI crab rationalization (CR) programme. This quota-based system provides allocations of crab resources to vessels, processing companies, and vessel masters. The authors found that with implementation there was an immediate consolidation of the fleet, the number of pots carried decreased, and the number of pot lifts per vessel per day decreased. This last measure is taken as an indication of the pace of the fishery and the effect of the CR programme. The SSCC programme continued through this management regime change and safety continued to benefit from the programme. Since beginning of the CR programme in August 2005, the authors report that there have been no vessel

losses, and only one fatality on vessels participating in the rationalized crab fisheries. Measures taken prior to the implementation of this quota-based management system in the Alaska crab fisheries had already reduced risk taking in the fishery, leaving less potential for further gains from IFQs.

5.5. Conclusions

Quota systems can improve safety, but other factors such as market prices can continue to create incentives for risk taking. Windle et *al*. (2006) concluded:

> *"Some fisheries have experienced significant improvements in health and safety following the implementation of IQ programs, including the Nova Scotia offshore fishery (Binkley, 1995), the Alaskan halibut and sablefish fisheries (CDC, 1993; Lincoln and Conway, 1999; Woodley, 2000), and the British Columbia geoduck fishery (Heizer, 2000); others have maintained relatively high accident and fatality rates under the IQ system, such as the surf clam and ocean quahog fisheries of New England (U.S.C.G., 1999; NRC, 1999; Woodley, 2000), and the national fisheries of Iceland (NRC, 1999) and New Zealand (MSA, 2003)."*

In the BSAI crab fisheries, Woodley, Lincoln and Mendicott (2009) found that:

> *"With implementation of the CR (crab rationalization) program, other influences have developed that could negatively impact safety. Interviews with individual masters have indicated that since the CR program dictates a percentage of the catch be delivered to pre-designated processors, there are times when vessels are forced to deliver to ports where waterway conditions are poor due to winter icing. In addition, vessel masters have also expressed concern about rigid delivery dates established by processors and the implications of having to "race" to meet pre-established delivery schedules."*

The authors of the CARR Report offered hypotheses as to why quota systems do not necessarily result in safety improvements:

> "*The maximum amount of quota that individuals or organizations are permitted to aggregate within an industry may be an important factor influencing safety, as fisheries in the U.S. that restrict quota aggregation (e.g., sablefish and halibut fisheries of Alaska) have documented significant declines in fatality rates and vessel incidents following the implementation of IFQs (Lincoln and Conway, 1999), while fisheries with no defined aggregation limit (e.g., surf clam and ocean quahog fisheries) have had continued problems with major vessel accidents and fishing fatalities (U.S.C.G., 1999). Small operators are often limited to leasing quota from large corporations or non-fishers, or working under contract for vertically integrated businesses. In such examples, the expected safety benefits of IQs (e.g., reduced incentives to rush for fish or operate in poor conditions) may be removed if pressures from quota holders supersede the independent decision-making abilities of vessel owners. This may have safety implications for the fisheries of Atlantic Canada, where owner/operator and fleet separation policies are being undermined by so-called "trust agreements" whereby processors essentially pay for licenses and vessels on behalf of small-scale vessel owners and subsequently exercise some control over their fishing activities.* (CCPFH, 2005)

In general, the argument that has been advanced (and demonstrated for some fisheries) is that IFQs may reduce or eliminate the incentive to take risks associated with the short and highly competitive derby fisheries that they may replace – risks such as fishing continuously without adequate rest, or fishing in unsafe weather conditions. In a derby fishery, the incentive to take such risks is created by the limited time window in which fish may be caught.

Replacing a competitive derby fishery with an individual fishing quota may remove this particular incentive to take risk. However, this does not in itself guarantee that such risks will go away. In the situation described above, fishers working under contract for vertically integrated businesses (which demand delivery of product according to a given schedule) may still be pressured into taking risks, even if they have a guaranteed quota.

Thus, it is overly simplistic to argue that quota-based management, or any other single aspect of fisheries management, can ensure safety. A preferable hypothesis – testable by research – is that under certain conditions IFQs *may* make a fishery safer.

6. RESULTS: EVIDENCE FOR HYPOTHESIS 3

This chapter examines evidence for Hypothesis 3: *Fisheries management policies that are unsuccessful in protecting resources or limiting the numbers of fishers competing for limited resources negatively affect safety*. If *fisheries* resources are not managed well, options available to fishers may change, altering the trade-offs fishers face between safety and the income they can earn from fishing. If resources are depleted in safer fisheries closer to shore, fishers may venture farther offshore and take greater risks to sustain their livelihood. Similarly, even if managers succeed in protecting fishery resources by limiting total catches, the more fishers that participate in a fishery, the lower the opportunity for each fisher to earn income. If fishery managers do not limit the number of fishers competing for limited resources, then fishers's average incomes may decline, causing them to take greater risks.

6.1. Evidence from case studies

Five of the case studies (those for Chile, Ghana, Malawi, Pacific Islands, and Thailand) discussed situations in which fisheries management agencies had lacked the capacity to effectively limit catches and/or the number of fishers (Table 10). Economic pressures on coastal populations, for whom fishing is an important traditional activity and employer of last resort, led to increasing catches, which in turn led to resource depletion of near-shore resources. This problem was sometimes aggravated by uncontrolled catches by larger industrial vessels, both domestic and foreign, operating (often illegally) in the same waters. As near-shore resources were overfished and declined, fishers fished increasingly farther offshore where they faced greater risks.

This pattern is disturbing and challenging from multiple perspectives, including resource management, economic development, and fishing safety. The only long-term solution to the resource depletion problem is more effective controls on catches and fishery participation. However, such controls are extremely difficult to implement given the dependence of coastal populations on access to the fishery.

Table 10

International case study evidence for Hypothesis 3: Fisheries management policies that are unsuccessful in protecting resources or limiting the numbers of fishers negatively affect safety

Country/ region	Fisheries studied	Type of evidence
Ghana	All	Hypothesized anecdotes
Malawi	Southern Lake Malawi fisheries	Hypothesized anecdotes
Pacific Islands	Tuna	Hypothesized anecdotes
Thailand	Trawl & purse seine fisheries	Hypothesized

Ghana

This report clearly describes a pattern of Ghanaian fishers venturing farther offshore and taking greater risks as fishing opportunities closer to shore decline, as described by three fishers quoted in the report:

> *"I have been fishing with drift gill net for the past twenty-two years. Our fishing grounds have dramatically changed due to the operations of other fishers. We are now fishing in higher seas ... Now we spend between four and five days at sea for each trip."* (p. 10)

> *"I am the captain of an inshore boat and started fishing since 1983. Due to declining fish catch, we have moved from our fishing grounds in Ada Foah in the Greater Accra Region, Keta in the Volta Region, Elmina in the Central Region and Sekondi in the Western Region, to deeper waters."* (p. 11)

> *"I am a 40 years old fisherman based at Kpone on sea. I have been fishing hook and line (lagas) for the past twenty years. We normally spend around seven days on the sea. And we bunker the canoe with food, water and fuel sufficient to sustain us for the period ... Formerly we fish between 30 and 70 m depth off the coast of Tema for demersal fish and pelagics mainly mackerel during the period November-March. This situation has gradually changed over the past ten years. Fish landings has declined compelling us to move from our traditional fishing grounds to the Central and Western fish in certain periods of the year."* (p. 12)

The discussions and conclusions of the report describe how ineffective resource management, inability to limit access to the resource, and competition from industrial vessels aggravate fishing safety problems:

> *"An open access system in the dominant artisanal fishery in Ghana results in various conflicts even within the same artisanal fishers and among the various sub-sectors of the industry hunting for the same resources (Sardinellas and Anchovy)... Incidences of using light attractors in fishing and paired trawling has increased dangers at sea and with the weak enforcement capacities of the Monitoring Control and Surveillance Division (MCSD) of the Ministry of Fisheries, this negative trend (disrupted biological cycle of fish habitat) has further affected their livelihoods making them move into deeper waters on search for fish. Originally their crafts were not designed to fish in deep waters but with this trend they are forced to risk their lives."* (p. 20)

> *"Due to scarcity of fish resources of late, the search for fish has become evident as seen in cases where fishermen say they run out of food, fuel and water leading to unsafe fishing. In the race for fish, they have to search longer hours and due to tiredness they sometimes fall asleep endangering their lives to storms and collisions which have occurred. Despite all these no fishermen had changed their mode of operation even in major crisis such as accidents leading to loss of lives."* (p. 21)

> *A major drawback reported by some fishers, especially APW and DGN, was the extensive destruction of their nets by industrial trawlers. These trawlers not only destroy their nets but compete with them in the inshore exclusion zone reserved for artisanal fishing."* (p. 21)

> *The lack of comprehensive fisheries regulatory and management in Ghana has had a negative effect on safety of fishers at sea. The fisheries administration and maritime authorities have not collaborated enough to effectively regulate the industry. As a result there is a perceived increase in risks, dangers and fatalities at sea instead of expected safety from the establishment of a more appropriate fisheries management system.*

> *Artisanal fishing has been important to the Ghanaian fisheries sector with inherent risks associated with the profession.... Considering the reality of operations within the artisanal fisheries, their livelihoods and safety are clearly in conflict with each other in*

> *their quest for survival. They will go fishing as far as their passion allows and as such ignore simple basic safety measures and risk that seems petty but could be disastrous. The fishermen are now taking high risks by going further offshore due to the scarcity of fishery resources in the Inshore Exclusion Zone (IEZ). Their crew has little or no training in maritime safety and the lack of enforcement of fisheries rules and regulations are hindering effective management of the resources. Fisheries authorities indicate financial, logistics and human capacity constraints as posing a limitation on the deployment of search and rescue operations. Thus leaving the fishermen even more vulnerable to the dictates of the weather and large industrial fishing and merchant vessels."* (p. 29)
>
> *"Comprehensive and adequately enforced fisheries regulation and management regime- will contribute to a greater extent to reducing risk, dangers and fatalities during fishing operations."* (p. 29)

The report also notes that subsidies intended to promote fisheries development may have aggravated pressure on fisheries resources:

> *"Subsidies on pre-mix fuel and waivers on taxes on fishing gears in recent times has led to more effort in the fishery to offset poor catches ..."* (p. 20)

Malawi

This report suggests that ineffective management may indirectly contribute to fishing safety problems in Lake Malawi fisheries, through lack of effective resource protection and access restriction:

> *"Race for fish is inevitable on Lake Malawi considering open access and management measure that limits fishing seasons for certain fishing gears such as seines. There are also conflicts between the small-scale and commercial sectors as the small-scale fishers believe the trawl fishing unit has been responsible for overfishing that has occurred on the southern Lake Malawi while the commercial fishers blame the small-scale fishers for using seines including nkacha which is proven to be destructive on Lake Malombe. The weak capacity of DoF's enforcement unit is largely blamed by both large (commercial) and small-scale fishers."* (p. 20)
>
> *"Resource decline due to lack of proper institutional arrangements (open access and common property) and weak enforcement capacity results in overfishing of stocks in shallower water and hence forces fishers to venture into risky offshore deep water fishing."* (p. 25)

Thus, the report argues that if fisheries management fails to achieve its primary goal of resource protection, this can cause further problems because without the option to fish inshore fishers will take risks by fishing farther offshore.

Pacific Islands

This reports examines the relationship between fisheries management and safety in five Pacific Island nations, focusing on artisanal (small-scale commercial) fisheries. Lack of data made empirical analysis impossible:

> *"Although Pacific Island countries have some of the highest sea safety accident rates in the world, most government fisheries agencies have limited involvement with safety issues (FAO 2004). There is a large range in the types of sea accidents in the various tuna fisheries of the region. Data are insufficient to statistically demonstrate which activities are particularly risky, but there is a general perception that offshore tuna trolling in small outboard powered skiffs is responsible for many, if not most, of sea safety incidents."* (p. 8)

Thus, the report is based primarily on anecdotal evidence and the author's extensive knowledge of the regional fishery.

Fisheries management, resource conditions, and participation varied between the five countries. In general, the study does not suggest that management constrains artisanal fishers' options in ways that significantly affect safety. However, it cites several examples of the general hypothesis examined in this chapter, for example, that the inability of managers to control catches or limit access can lead to more fishers fishing farther offshore and taking greater risks.

> *"In Tuvalu's other fisheries the lack of management action could be having an effect on sea safety related to tuna fishing. The population of some of Tuvalu's islands is increasing, resulting in very heavy fishing pressure on inshore resources. The absence of effective fisheries management measures focused on preventing over-exploitation of inshore fisheries has led to resource decline and indirectly promoted more offshore tuna trolling, the fishery that causes most sea safety problems."* (p. 19)

> *"There is the possibility that departure from the regime specified in the tuna management plan has adversely affected sea safety. The audit of the tuna management plan in 2005 ... indicated that limits on the number of vessels were not followed by the Fisheries Department, resulting in too many vessels chasing too few fish. The industry responded by moving outside the EEZ to catch sufficient fish to sustain the level of the fleet. Fishing far from land and the safety of a port is more risky, and it is likely that this negatively affected vessel safety."* (p. 23)

> *"Other types of links between fisheries management and safety are likely to exist in the region. Although good data does not exist, anecdotal information in the above country sections suggests that poor management (e.g. lack of adhering to a vessels limit in Fiji), or a deterioration in management (reduced enforcement in Samoa) has had a negative effect on safety. In all five country studies examples were given where safety in tuna fisheries has apparently suffered from management of other fisheries."* (p. 27)

Thailand

This report suggests that overfishing of inshore resources may have contributed to greater fishing effort offshore, exposing inexperienced fishers to new and less safe conditions.

> *"With the high concentration of fishing effort close to shore, the inshore resources are generally over fished and this has led to the promotion of offshore fisheries. Large commercial scale fisheries from Thailand most of whom are trawlers have been fishing outside Thailand's waters. Many of them had joint venture fisheries in Bangladesh and India, as well as fishing in Myanmar waters. Besides Thai fishermen also had joint*

> *ventures in other countries including Indonesia, Malaysia, Myanmar, Somalia, and Madagascar. For these joint ventures, there had been an agreement on share of local crew on board as well as share of landing in coastal states. There has been an exchange in access to fisheries resources and enhancing fishing crew capacity. However, in many cases fishermen are unfamiliar with the offshore fisheries and cannot draw upon the experience of the past generations who themselves have only fished in inshore waters. Fishing trips may last for several days, regardless of the fact that the vessels are designed to fish near shore and be more suitable for a day trip only. There is a limited area for carrying safety equipment, spare parts for engine repairs, or even the heavy fishing gear commonly used. It poses a considerable risk of death or injury to the crew. It could also be seen that in some case the fishermen bought second hand fishing boats from neighbouring countries. Even if there are some extra areas in the boats, those boats are quite old and safety equipment are out of date. From the safety point of view, there is a real problem, in Thailand as it is quite commonly seen that small fishing boats or old boats are forced to fish farther out to sea beyond their designed capacity and construction."* (p. 10)

6.2. Conclusions

It is clear from these five case studies that fishery managers in developing countries face serious challenges, and that fishers in these countries may face much greater risks than in most developed countries. These risks are less likely to derive from constraints imposed by fishery managers than from the inability of fishery managers to constrain harvests and access to fishing by coastal residents willing to take risks in pursuit of their livelihoods. The challenge faced by managers in addressing safety problem extends to the far broader challenge of achieving effective management that balances resource protection, economic development, and social goals such as access to economic opportunities. Effective fisheries management is important not only for protecting fishery resources and the economic potential that they represent for coastal residents. It is also important for addressing significant and worsening safety problems in fisheries where increasing numbers of fishers face increasing risks to earn a living from the sea.

7. RESULTS: EVIDENCE FOR HYPOTHESIS 4

This chapter examines evidence for Hypothesis 4: *Fisheries management can contribute to safer fisheries directly by integrating safety policies with fishery management policies*. Fishery managers may be able to promote fishing safety directly, with measurable results. For example, managers may make safety training or safety gear a mandatory condition for participation in a high-risk fishery.

7.1. Evidence from case reports

Nine case studies discussed the potential benefits for safety if managers placed safety requirements on fishery participants. Table 11 lists these studies and notes that only two of the countries (Iceland and Sri Lanka) have integrated fisheries management and safety policies in place.

Table 11

International case study evidence for Hypothesis 4: Fisheries management policies can affect fishing safety directly

Country/region	Fisheries studied	Type of evidence	Current level of safety integration in policy
Ghana	All	Hypothesized	No integration present
Iceland	All	Empirical	Strong integration
Malawi	Southern Lake Malawi fisheries	Hypothesized	No integration present
Pacific Islands	Tuna	Hypothesized	No integration present
Peru	All	Hypothesized	No integration present
Philippines	Tuna	Hypothesized	No integration present
Spain	All	Hypothesized	No integration present
Sri Lanka	Multiday fisheries	Hypothesized	Limited integration present

Ghana

The case study from Ghana "*sought to identify, illustrate and analyze current fisheries management practices and their safety effects nationwide.*" The study focused on the issue of fishers being forced to go farther from shore in order to fish as discussed in the previous chapter. In light of the issue of being forced to fish farther offshore, they say "*it is therefore prudent for a fisheries manager to have as his objective to achieve world class regulatory and safety standards in the fishing industry by designing and implementing more comprehensive regulatory and management systems to deter fishermen from taking undue risks during fishing operations.*"

In a survey of canoe owners and fishers, the authors found that the majority did not use any safety equipment and that no training or very little training in basic safety, survival or fire fishing had occurred.

The authors suggest that it is not surprising that resource managers avoid incorporating fishing safety as another objective of fisheries management as it is already so difficult to achieve the conservation, economic and social goals. They do believe, however, that "*comprehensive and adequately enforced*

fisheries regulations and management regimes will contribute to reducing risk, dangers and fatalities during fishing operations at sea."

Iceland

This case report reviews accident and fatality data from Iceland fishers for the period 1991–2007. The authors discuss three feature of the Icelandic management system that may affect safety. One relevant feature is that in Iceland a fishing licence is only issued after minimum safety equipment and crew training is achieved. The authors conclude that mandatory requirements for safety training, equipment and awareness have increased safety. The number of SAR and medical evacuation missions decreased from about 20–25 per year in 1991–93 to about 10 per year in 2000–07. This 50 percent decline in annual missions was much greater than the decline in the number of vessels during the same period. The Icelandic authors state: "*The system can also contribute to increased safety through placing requirements on equipment and training, resulting in a lower accident rate*." (p. 3)

Malawi

Key informant interviews and a literature review were used to examine the relationship between fisheries management policies and safety in Malawi. The authors note that "*Since 2005, fisheries managers in Malawi have started to consider safety issues. This is evidenced by the implementation of the SOFTDP that has focused on training small-scale fishers on fishing safety. The main areas include distress signals, loading, first aid, rescue measures and preparing for fishing.*" (p. 21) The Malawi case study shows a relationship between fishing safety and fisheries management both directly and indirectly. "*This mainly relates to several reasons such as management measures that focus on measures, operational procedures and institutional arrangement and collaboration.*" (p. 21)

Pacific Islands

This case study examines safety in the tuna fishery in selected islands in the Pacific Islands.

In Tonga, vessels must hold a valid safety certificate. They must pass an inspection and be "*fit for fishing and meet any prescribed safety and hygiene standards*." (p. 11)

In Samoa, fishing licences depend on the tuna vessels holding "*a valid certificate of seaworthiness and safety*." Samoa has also established a commercial Fisheries Marine Advisory Committee to address several functions including sea safety. The plan also includes an extension service promoting safety at sea. "*It is conceivable that fisheries management interventions in other fisheries in Samoa are having some effect on sea safety in the tuna fisheries*." (p. 16)

In Fiji, the government requires a valid safety certificate for each tuna vessel prior to issuing the annual licence. The certificate covers the hull, engine, and safety equipment.

In summary, "*in developing countries where the state of management is rudimentary, rather than improving safety by changing the type of management measure, it may be more relevant to alter the process so as to include safety as specific fisheries management objective."* (p. 27) "*Making safety an integral part of fisheries management. If safety is not an objective of management, its not "integral"*." (p. 28)

Peru

This report describes the need for coordination with the vice ministry of fisheries. The authors recommend that training programmes for survival and safety at sea be guided and implemented by the regional commissions. At this point, this does not occur, but the authors present it as an idea to improve safety and connect the authorities to one another.

The Philippines

This case study agrees with the potential benefits of directly linking fisheries management policies to safety. An important note from the Philippines case study is that "*For fisheries management policies to insist on physical and practice changes that will improve safety at sea, it would also have to highlight the increase in revenue or decrease in cost to become effective.*" (p. 27)

Spain

Currently, there are no fisheries management regulations that have direct safety requirements in Spain. The case report "*emphasizes collaboration in the area of fishing activity and the safety of fishing vessels.*" (p. 18)

Sri Lanka

This report assesses the "*qualitative relationship between management of the multi-day fisheries of Sri Lanka and safety at sea*". The government has tried to improve safety by linking resource management to safety. "*With a view to establishing a management scheme for ensuring safety of fishing vessels at sea, explicit provisions among others have been incorporated in the Fisheries and Aquatic Resources Act, enabling the Minister to make necessary regulations concerning safety of fishing vessels at sea.*" (p. 7–8)

7.2. Evidence from other studies

A Canadian study stated that: "*If properly facilitated, many aspects of safety can be enhanced through the fisheries management definition without compromising other management objectives. Connecting licenses with competency, safety certificates and vessel seaworthiness may provide a good system of checks and balances for a long-standing problem. Incorporating safety oriented measures into other management procedures such as permitting variations on partnering and quota allocations, could introduce valuable safety practices that makes fishing in small vessels more practical. Before proceeding with these kind of measures however, there would have to be a serious buy in by other players, including fishing industry representatives.*" (Wiseman and Burge, 2000, p. B5)

Linking safety requirements to fishing permits is a direct way to improve safety. In FAO Fisheries Circular No. 966, *Safety at Sea as an Integral Part of Fisheries Management*, the authors argue that "*safety at sea should be integrated into the general management of the fisheries in each country*." They recommend that regulations ensure "*the safety and well-being of the fishermen, as well as sustainable utilization of the fish stocks*."

The NIOSH examined the impact of the Commercial Fishing Industry Vessel Safety Act (CFIVSA) of 1988 on the safety of fishers in Alaska (NIOSH, 1997). This act is an example of fishing regulation that directly addressed safety. In the period 1990–95, the requirements of the CFIVSA came into effect that stated that fishing vessels had to carry specific safety, survival, and fire-fighting equipment, and that crew members had to obtain first- aid and emergency drill training. The report analysed United States Coast Guard (USCG) vessel casualty statistics from 1991 to 1996 and found that the number of vessel casualties

(vessels lost) remained relatively constant (mean 34.5, median 37), as did the number of people on board (number at risk) (mean 106.7, median 110). However, the case-fatality rate (number killed / number at risk) associated with these vessel casualties dropped significantly from 27 percent in 1991 to 11 percent in 1996.

The authors conclude that the CFIVSA is directly related to this increase in survival. The report stated that the progress made in the early 1990s in reducing mortality occurred primarily by keeping fishers who evacuated capsized or sinking vessels afloat and warm (using immersion suits and life rafts), and being able to locate them readily via EPIRBs. The CFIVSA classified all waters in Alaska as “cold” waters (< 60 °F,< 15.6 °C), in which hypothermia can lead to death by drowning within minutes of immersion. Thus, immersion suits are required for all crew members on board vessels operating in Alaskan waters. The CFIVSA also permitted the USCG to establish the Voluntary Dockside Exam Program in 1992. This is a voluntary programme in which fishers permit USCG examiners to board their vessels and review their safety equipment, including EPIRBs, immersion suits, and life rafts, and to discuss the new regulations. The report states that the programme has been a useful tool in educating fishers about safety and encouraging compliance with the regulations.

7.3. Conclusions

The international case studies provide some examples of how fisheries management policies can directly affect safety. Tailored policies can be developed from the resource management side to remove existing hazards and make fishing safer.

8. CONCLUSIONS AND RECOMMENDATIONS

This synthesis report has compiled quantitative and qualitative evidence on how safety is affected by fisheries management systems. All of the international case studies reviewed for this report provided some level of evidence for one or more of the four hypotheses. Although most of the case studies did not empirically measure these safety effects, the anecdotal evidence and thoughtful arguments regarding the effects of policies on safety cannot be dismissed. Many case studies provided persuasive arguments for change. Fisheries managers, safety professionals and fishers should work together to develop and coordinate strategies to improve safety and integrate safety into management policies that protect not only fish but also fishers.

8.1. Summary of support for hypotheses

Hypothesis 1. Fisheries management policies have wide-ranging indirect effects on fishing safety.

Most of the case studies (63 percent) provided some level of evidence supporting Hypothesis 1. The indirect effects of fisheries management on fishing safety cannot be ignored. Safety professionals need to engage fisheries managers, and managers need to be aware of how management affects safety. Management regulations that negatively affect safety need to be modified to protect fishers.

Hypothesis 2. Quota-based fishery management systems are safer than competitive fishery management systems.

Four of the case studies and several other published studies have reviewed this topic empirically with mixed results. One of the underlying goals for all of the quota-based management systems included in this report was to improve safety. In quota-based systems, fishers face less of a trade-off between safety and other objectives, giving them less incentive to take risks such as fishing without adequate rest or fishing in bad weather. Replacing a competitive derby fishery with an individual fishing quota may remove some incentives to take risk. However, this does not in itself guarantee that such risks will go away. It is overly simplistic to argue that quota-based fishery management systems are inherently safer than competitive fishery management systems. However, under certain conditions quota systems can make a fishery safer.

Hypothesis 3. Fisheries management policies that are unsuccessful in protecting resources or limiting the numbers of fishers competing for limited resources negatively affect safety.

Another four case studies provided insight and evidence to support Hypothesis 3. If fishery resources are depleted or competition for limited resources becomes more intense, fishers will take greater risks, such as fishing farther offshore, to seek a living. The challenge faced by managers in addressing safety problem extends to the far broader challenge of achieving effective management that balances resource protection, economic development, and social goals such as access to economic opportunities in what is in many places an occupation of last resort.

Hypothesis 4. Fisheries management can contribute to safer fisheries directly by integrating safety policies with fishery management policies.

Half of the case reports provided examples and ideas to support Hypothesis 4. To some degree, it appears that safety can be improved if it is approached directly as a fisheries management objective.

8.2. Recommendations for fisheries managers and safety professionals

Fishery management is a complex challenge. Managers balance multiple objectives, under significant uncertainty, with limited resources. It is recommended that they acknowledge the relationships outlined in this document, identify the risks present in their local fishery and then take steps to mitigate or eliminate those risks – this will help save lives and reduce injuries to fishers. "*Safety at sea*

must be integrated into the general management of fisheries in all coastal states if safer working conditions for fishermen are to become a reality." (Petursdottir, Hannibalsson and Turner, 2001).

The following list of recommendations is provided based on the review of the case studies and published literature.

Fisheries managers need to be aware that the way fisheries are managed affects safety.

Decisions taken by managers can directly or indirectly affect how many fishers are injured or killed. Safety might be affected by: (i) the scheduling of fishing opportunities; (ii) restrictions on boats and gear; and (iii) potential incentives the regulations might create to fish in unsafe ways, such as in bad weather or without adequate rest.

Fisheries managers need to consider safety an explicit goal of fisheries management.

Fisheries managers could consider regulations focused specifically on improving safety by including requirements for training and vessel inspections as a condition for participation in the fishery. This is particularly important for fisheries with significant safety problems.

Fisheries managers will need to build up mechanisms for close collaboration and cooperation between the administrations responsible for safety and themselves.

This also applies to maritime administrations. Discussions will be needed, aimed at a clear understanding of each other's responsibilities and limitations, followed by cooperative efforts to obtain mutual objectives.

Fisheries managers will need to engage safety professionals to become knowledgeable of the safety record for the fisheries they manage.

Safety professionals can be asked to regularly provide data on fatalities, injuries and vessel losses. The collection and analysis of resource quality data is a prime function of fisheries management. This appropriately includes not only catches and effort, but also safety data. This collection of data would correspond to an explicit management objective of increased safety and can be used to identify appropriate interventions. Effective regulations can only be formulated when the problem is understood. Safety information needs to be regularly included in management reports and published on websites, including positive information such as "days fished safely". Safety audits of current management regulations are part of this effort. Safety professionals need to systematically review management regulations and consider if and how they might affect safety. Managers can also include fishers in the safety audit. This entails asking fishers how management affects safety, and what could be done to make fishing safer.

8.3. Future research

Several broad recommendations for future research on the relationship between fisheries management and fishing safety are proposed.

Research should continue in identifying the relationship between fisheries management policies and safety.

While this synthesis report provides evidence of the significant potential that polices can contribute to improved safety in many fisheries, it is not a definitive analysis of this topic. As new policies are developed, they will need to be examined for their effectiveness and potential indirect effects on fishing safety.

Research should also identify policies that result in fishers having to choose against safety with the goal to identify modifiable factors and policy alternatives.

The case studies identified several cases where there were indirect and negative effects on safety from policies aimed at fisheries management. It is unclear how pervasive this problem is. Future research is needed to specifically address this potential conflict between fisheries management and safety with the goal of removing the conflict.

Better data collection and categorization is necessary to keep track of adverse events by type of fishery so that future evaluations can be done.

In any commercial fishery, continued monitoring of the change in risks is warranted. Changes in risk, as well as effectiveness of current policies cannot be assessed without specific, reliable data collection.

8.4. Conclusions

While the risks associated with commercial fishing cannot be completely eliminated with a change in policy, there is no need for a conflict between existing policies and the choice to be safe. "*Safety regulations cannot provide a completely danger-free environment, but other management regulations should not add to the risks associated with fishing*." (Kaplan and Kite-Powell, 2000). In the best situation, fishing policy will encourage and reward safe practices.

Safety in the fishing industry cannot be separated from fisheries management. The FAO Code of Conduct for Responsible Fisheries recognizes this fact, as outlined in Chapter 1. As a unanimously adopted code, it provides a necessary framework for efforts to ensure sustainable and safe fishing.

Fishing safety is a complex problem. The significance and persistence of safety problems in fisheries around the world suggest that there are no easy or obvious solutions to these problems. Fisheries management is not the only or most important factor affecting fishing safety. However, this report argues that in some circumstances fisheries management affects fishing safety in a variety of ways, both directly and indirectly. It is important to understand what these effects are, and to consider ways in which fisheries management policies, while continuing to meet fishery management goals, may also be able to make fishing safer.

REFERENCES

Binkley, M. 1995. *Risks, dangers and rewards in the Nova Scotia offshore fishery*. Montreal, Canada, McGill-Queen's Press.

Canadian Council of Professional Fish Harvesters (CCPFH). 2005. *Setting a new course*. Ottawa.

Centers for Disease Control and Prevention (CDC). 1993. Commercial fatalities - Alaska, 1991-1992. *Morbidity and Mortality Weekly Report*, (42)18: 350–359.

Centers for Disease Control and Prevention (CDC). 2008. Commercial fishing fatalities - California, Oregon, and Washington, 2000-2006. *Morbidity and Mortality Weekly Report*, 57(16): 426–429.

FAO. 2009. *Report of the expert consultation on best practices for safety at sea in the fisheries sector, Rome, 10–13 November 2008*. Rome. 40 pp. (also available at www.fao.org/docrep/014/i0609e/i0609e00.htm).

Haddon, W. 1968. The changing approach to the epidemiology, prevention, and amelioration of trauma: the transition to approaches etiologically rather than descriptively based. *American Journal of Public Health*, 58(8): 1431–1438.

Heizer, S. 2000. The commercial geoduck (*Panopea abrupta*) fishery in British Columbia, Canada - an operational perspective of a limited entry fishery with individual quotas in use of property rights in fisheries management. *In* R. Shotton, ed. *Use of property rights in fisheries management*, pp. 226–233. FAO Fisheries Technical Paper No. 404/2. Rome, FAO. 468 pp. (also available at www.fao.org/docrep/003/x8985e/x8985e00.htm).

Hughes, S.E. & Woodley, C. 2007. Transition from open access to quota based fishery management regimes in Alaska increased the safety of operations. *International Maritime Health*, 58(1–4): 33–45.

Jensen, O. 1997. Health hazards while fishing in heavy weather. *Occupational and Environmental Medicine*, 54(2): 141.

Kaplan, I.M. & Kite-Powell, H.L. 2000. Safety at sea and fisheries management: fishermen's attitudes and the need for co-management. *Marine Policy*, 24(6): 493–497.

Khan, A. 2006. Sustainability challenges in the geoduck clam fishery of British Columbia: policy perspectives. *Coastal Management*, 34(4): 443–453.

Knapp, G. 2008. *Commercial Fisheries Management and Safety: A review of Selected Literature,* prepared for National Institutes for Occupational Safety and Health, Alaska Pacific Regional Office.

Kulmalaa, S., Peltomäkib, H., Lindroosa, M., Söderkultalahtic, P. & Kuikkab, S. 2007. Individual transferable quotas in the Baltic Sea herring fishery: a socio-economic analysis. *Fisheries Research*, 84(3): 368–377.

Lincoln, J.M. & Conway, G.A. 1999. Preventing commercial fishing deaths in Alaska. *Occupational and Environmental Medicine,* 56(10): 691–695.

Lincoln, J., Mode, N. & Woodley, C. 2007. *An evaluation of quota based management systems in Alaska*. North Pacific Research Board Project 533. Anchorage, USA, NPRB.

Maritime Safety Authority (MSA). 2003. *Fishing industry safety and health advisory group final report*. Auckland, New Zealand, Ministry of Transport.

National Institute for Occupational Safety and Health (NIOSH). 1997. *Current Intelligence Bulletin 58. Commercial fishing fatalities in Alaska: risk factors and prevention strategies*. Cincinnati, USA.

National Institute for Occupational Safety and Health (NIOSH). 2008. *Commercial Fisheries Management and Fishing Safety: A Review of Selected Literature*.

National Oceanic and Atmospheric Administration (NOAA). 2011. *National Standard 10 Guidelines: a proposed rule by the National Oceanic and Atmospheric Administration on 04/21/2011* [online]. [Cited 28 November 2013]. www.federalregister.gov/articles/2011/04/21/2011-9718/national-standard-10-guidelines

National Research Council (NRC). 1999. *Sharing the fish; towards a national policy on individual fishing quotas*. Washington, DC, National Academy Press.

Petursdottir, G., Hannibalsson, O. & Turner, J.M.M. 2001. *Safety at sea as an integral part of fisheries management*. FAO Fisheries Circular No. 966. Rome, FAO. 39 pp. (also available at www.fao.org/docrep/003/x9656e/x9656e00.htm).

SafetyNet Centre for Occupational Health and Safety Research. 2006. *SafeCatch: final report*. St John's, Canada, SafetyNet Centre for Occupational Health and Safety Research.

Thomas, J.S., Johnson, G.D., Formichella, C.M. & Riordan, C. 1993. *Perceived social and economic effects of current management policies on red snapper fishermen operation in the Gulf of Mexico: a report to the Gulf of Mexico Fishery Management Council*. Rolla, USA, University of Missouri-Rolla.

Townsend, R.E., Pooley, S.G. & Clarke, R. 2003. Evidence on producer bargaining in the Northwestern Hawaiian Islands lobster fishery. *Marine Resource Economics*, 18(2): 195–203.

United States Coast Guard (USCG). 1999. *Living to fish, dying to fish*. Fishing vessel casualty task force report. Washington, DC.

Windle, M.J.S., Neis, B., Bornstein, S. & Navarro, P. 2006. *Fishing occupational health and safety: a comparative analysis of regulatory regimes*. St John's, Canada, SafetyNet Centre for Occupational Health and Safety Research.

Windle, M.J.S., Neis, B., Bornstein, S. & Navarro, P. 2008. *Fishing occupational health and safety: A comparison of regulatory regimes and safety outcomes in six countries*. Marine Policy 32: 701-710.

Wiseman, M. & Burge, H. 2000. *Fishing vessel safety review (less than 65 feet)*. St John's, Canada, Canadian Coast Guard, Maritime Search and Rescue Newfoundland Region.

Woodley, C.J. 2000. Developing regional strategies in fishing vessel safety: integrating fishing vessel safety and fishery resource management. University of Washington. (unpublished thesis)

Woodley, C.J., Lincoln, J.M. & Medlicott, C.J. 2009. Improving commercial fishing vessel safety through collaboration. *Proceedings of the Marine Safety and Security Council*, 66(1): 38–46.

ISBN 978-92-5-109181-4 ISSN 2070-6065

I5552E/1/04.16