Response of Fishermen to Fishing Control Policies in Southern Songkhla Lake, Thailand: A Field Experiment

Kunlayanee Pornpinatepong, Pathomwat Chantarasap,
Jumtip Seneerattanaprayul, Wittawat Hemtanon and Papitchaya Saelim

WorldFish

Published by WorldFish (ICLARM) - Economy and Environment Program for Southeast Asia (EEPSEA)
EEPSEA Philippines Office, WorldFish Philippines Country Office, SEARCA bldg., College, Los Baños, Laguna 4031 Philippines; Tel: +63 49 536 2290 loc. 196; Fax: +63 49 501 7493; Email: admin@eepsea.net

EEPSEA Research Reports are the outputs of research projects supported by the Economy and Environment Program for Southeast Asia. All have been peer reviewed and edited. In some cases, longer versions may be obtained from the author(s). The key findings of most *EEPSEA Research Reports* are condensed into *EEPSEA Policy Briefs*, which are available for download at www.eepsea.net. EEPSEA also publishes the *EEPSEA Practitioners Series*, case books, special papers that focus on research methodology, and issue papers.

ISBN: 978-971-9994-01-5

Photo Credit: Kunlayanee Pornpinatepong

Response of Fishermen to Fishing Control Policies in Southern Songkhla Lake, Thailand: A Field Experiment

Kunlayanee Pornpinatepong
Pathomwat Chantarasap
Jumtip Seneerattanaprayul
Wittawat Hemtanon and
Papitchaya Saelim

February, 2013

Comments should be sent to:
Ms Kunlayanee Pornpinatepong, Department of Economics, Prince of Songkla University,
Hat Yai, Songkhla, Thailand 90112.
Tel: (66) 74 282441
Fax: (66) 74 282460
Email: kunlayanee.p@psu.ac.th

The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support research and training in environmental and resource economics. Its objective is to enhance local capacity to undertake the economic analysis of environmental problems and policies. It uses a networking approach thatinvolves attendance in courses and meetings, technical support, access to literature, and opportunities for comparative research. Member countries are Thailand, Malaysia, Indonesia, the Philippines, Vietnam, Cambodia, Lao PDR, China, Myanmar, and Papua New Guinea.

EEPSEA is supported by the International Development Research Centre (IDRC) and theSwedish International Development Cooperation Agency (Sida). WorldFish of the CGIAR consortium has been administering EEPSEA since November 2012.

EEPSEA publications are also available online at http://www.eepsea.net.

ACKNOWLEDGMENTS

Dealing with fishing control in the Southern Lake is considered a sensitive issue. Hence, this study could not have been possible without the support of many people from its start to finish.

Personally, I thank Dr. Herminia Francisco, Director of EEPSEA, for the financial support as well as for the opportunity to meet resource persons who are experts in this type of experimental study.

My gratitude goes to Dr. Nancy Olewiler, my technical advisor from Simon Fraser University, for her comments and suggestions to the team throughout the conduct of this research that gave the study more focus.

Many thanks to Dr. Dale Whittington from the University of North Carolina for his suggestions on literature review during the development of the research proposal.

Thank you also to Dr. James Konow from Loyola Marymount University who gave valuable advice on the experimental designs plus additional related literatures.

The following colleagues from the Prince of Songkla University provided assistance and support to complete this study: Dr. Sakchai Kiripat, Dean of the Faculty of Economics; Mr. Sukampon Chongwilaikasaem, who inspired me to use experimental games; Ms.Chotima Pornsawang, who helped us at the beginning of the research proposal; and Ms.Wachinun Wongsriroge, my research assistant.

My appreciation goes to Ms. Catherine Ndiaye who took very good care of our administrative needs; and EEPSEA editor, Mr. Dave Patterson and Mr. Andrew Jonathan Tait, for their patient assistance in the language editing of this report.

My deep gratitude also goes to the villagers and fishermen who underwent long hours of experiments and interviews to provide very useful information for this analysis.

I firmly believe that results of this research can bring about more sustainable fishery in the Songkhla Lake.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

RESPONSE OF FISHERMEN TO FISHING CONTROL POLICIES IN SOUTHERN SONGKHLA LAKE, THAILAND: A FIELD EXPERIMENT

Kunlayanee Pornpinatepong, Pathomwat Chantarasap, Jumtip Seneerattanaprayul, Wittawat Hemtanon and Papitchaya Saelim

EXECUTIVE SUMMARY

Game theory was used to analyze the extraction behavior of fishermen around the Southern Sonkhla Lake in Southern Thailand. The field experiments were designed based on the concept of non-cooperative game theory for investigating fishermen's behavior in response to four management policy options: external regulations with individual transferable quotas (ITQs) and with individual quotas (IQ), and co-management with ITQs and with IQ.

The analysis examined fishermen's responses under high and low fish stocks that arose due to seasonal salinity in the Lake. Higher fish stocks encouraged fishermen to increase their extraction. A co-management policy led to better results than imposed external regulation in terms of reducing extraction and ensuring resource sustainability. There were no significant differences between 'with ITQ' and 'without ITQ' in terms of reduction of extraction and sustainability of resource use. However, there were significantly less violation behaviors when ITQs were used rather than with IQ. The ITQs provided more flexibility for fishermen who wanted to increase their extraction while still following conservation guidelines. Therefore, implementation of ITQ is recommended but with appropriate penalties.

1.0 INTRODUCTION

1.1 Background Information

The Southern Songkhla Lake, known locally as Thala Sap Songkhla or just Southern Lake, is the southernmost of the three lakes that make up the Songkhla Lake lagoon system. This system is located on the eastern coast of southern Thailand, and it covers an area of about 180 km^2 with brackish to salt water. It connects to the Gulf of Thailand at Songkhla Town.

Since the Southern Lake is connected directly to the ocean, species preferring saltwater can freely move into and out of this section of Songkhla Lake in summer, the dry season, when incoming seawater creates higher salinities. Freshwater species, on the other hand, dominate during the rainy season when the water has lower salinity. This special characteristic of the lake makes it abound with a wide variety of fishery species.

Although many species are fished in the lake, the shrimp fishery is the most profitable. Shrimps are available throughout the year. Historically, yearly shrimp income had been almost ten times more than the other catches combined. Therefore, many people around the lake are shrimp fishermen (Choonhapran et al. 1996).

Shrimp grows best in very clean water as they need a higher quality of water than most fishes for optimal growth (Kanchanawanich 1999). However, the decline in shrimp production in recent years has not only been caused by low water quality but also by the intensive fishery and catch. For example, in the Southern Lake, the use of standing traps increased from 900 units in 1983 (Sirimontaporn et al. 1983) to 5,250 units in 1995 (Sunhapran et al. 1996 in Mabuntham 2002). The figure further went up to 8,500 units in 1997 (Department of Fisheries 1997 as cited in ONEP 2005), to 29,604 in 2003 (Department of Fisheries 2003 as cited in ONEP 2005) and to 23,150 in 2010 (Department of Fisheries 2010 as cited in ONEP 2011) – an overall increase of approximately 120% per year.

In 2005, the Songkhla Lake Basin Master Plan strongly recommended reducing the number of standing traps by 30 % if the shrimp fishery was to survive. However, no reduction method was specified (ONEP 2005). In a related study, Kongprom (2008) showed that by using the Long-base Thomson and Bell Analysis to forecast the over-fishing status of Pink Shrimp (the number of standing traps was used as a reliable indicator of fishing effort), the amount of standing traps in the Southern Lake was over the optimal maximum sustainable yield level by 40 % in 2004. Because our earlier study dealt with pollution related to reduced fishery, controlling the fishing effort is the main focus of this study.

Two main types of fishery regulations to control aquatic resource exploitation in the Southern Lake have been implemented before 1986.

The first type of regulations prohibited the use of destructive fishing gears and methods, such as Fyke nets, trawlers and push-nets, underwater bombing, electric shocks, and suspension nets. The trawlers and push-nets have been banned from the Lake, but the other methods are still being used uncontrolled. Later, the Department of Fisheries offered the fishermen using these destructive equipment to exchange the latter for purse nets, which were allowed by the regulations in the Lake. But this strategy also failed because of ineffective enforcement and monitoring.

The second type of regulation involved restrictions in the how the allowed fishing traps could be used, such as the distance between traps, their location, etc. But again, these regulations were not strictly enforced (ONEP 2005). There were no regulations that limited the number of fishing traps per fisherman's household. Moreover, there were no regulations regarding "property rights" to fish, hence anybody could set traps in the lake where they could find space. Hence, fishermen could increase with no legal limit the number of traps they used throughout the Southern Lake. Enforcing even existing regulations was likewise very difficult. When a Fisheries Officer caught anyone using illegal fishing traps, he had to contend with a crowd of fishermen opposing any attempt of regulation. Because the regulatory mechanisms were not strictly implemented, the Southern Lake became over exploited during the last 30 years.

Surveys show that there is no longer any space left for fishing traps in the lower Songkhla Lake. By law, the space between rows of fishing traps should be at least 300 m. With this restriction, given the surface area of the Southern Lake (180 km^2) and the area needed for each trap (15,292 m^2), the approximate maximum number of traps should not exceed 12,000. However, as of 2003, a total of 29,604 traps have been recorded.

A focus group discussion with the fishermen and representatives from 12 related local government agencies revealed that all the traps were laid out closer than the required 300 m apart. Considering the current number of standing traps, the number of traps had reached a saturation point by 2003 and had most likely remained so since. Some fishermen have also chosen to sell their traps in some areas (Pornpinatepong et al. 2008).

Many people around the Lake are fishermen, comprising about 40.4 % of the total number of families around the Lake. Majority (73.3%) of these fishermen do not have other sources of income (ONEP 2005). Therefore, they are directly affected when fishing production is affected by over-fishing. To mitigate such a problem and to maintain the shrimp population in Songkhla Lake, the Department of Fisheries under the Sea Farming Project has been releasing post-larval shrimps into the lake every year since 1999. However, this project is only a short-term solution to alleviate poverty in the area; it does not resolve the problem of over-fishing.

Together with the Sea Farming Project, the Department of Fisheries has set up conservation areas in the Lake for fish nurseries. These nurseries are also used to prepare the post-larval shrimps for release into the Lake. No fishing traps of any kind are allowed in these conservation areas. Currently, 0.3 % of the total area of the Southern Lake is designated as conservation areas, with fishermen participating as volunteers.

A literature review and in-depth interviews with key persons working at the Department of Fisheries have confirmed that controlling fishing traps in the Southern Lake is a sensitive issue with no easy solution. Current strategies of the government focus more on poverty. However, these do not address the problem of over-fishing. Therefore, there is a need to investigate and identify appropriate ways to resolve the overfishing problem and to make fishing sustainable in the Lake. An important aspect of identifying the most feasible management policies is understanding fishermen's feelings about the issue and their behavior in solving problems through collective action. These were investigated through the field experiments in this study.

1.2 Research Objectives

Generally, the study aims to investigate fishermen's response to proposed management policies to control the fishing efforts leading to sustainable fishery in Songkhla Lake. Specifically, it aims:

1. To identify possible viable policy options to encourage sustainable fishery resource use in the Southern Lake;

2. To investigate fishermen's behavior in response to suggestions that they need to consider the public good when deciding on their personal behavior in terms of their fishing effort;

3. To investigate how sustainable fishery resource use would be encouraged under five scenarios: open access as the base case, external regulation with ITQs and with IQs, and co-management with ITQs and with IQs; and

4. To recommend potential policy options for managing the control on fishing efforts considering the probable response of the local fishermen to each option.

2.0 CONCEPTS AND RELATED LITERATURE ON FISHING EFFORT MANAGEMENT CONTROL

2.1 General Problems: Common-pooled Resource and Collective Action Problem

A common-pooled resource (CPR) is a particular class of goods or events with two important attributes: (1) non–excludability, and (2) 'subtract ability' or the benefit an individual receives from using a CPR reduces by a like amount the remaining benefit available to others. A resource system regime based on CPRs can be further defined to exclude potential appropriation rights of existing users. Under the identified attributes, non-excludability and subtract ability, the incentive for excessive resource exploitation throughout time and space has historically tended to produce tragic results (Ostorm, Gardner & Walker 1994). The same study pointed out, however, that if the individuals involved in such CPR situations police themselves adequately, they could devise a viable system to manage the resource.

Hardin (1968 as cited in Ostrom 2004) introduced the concept of the classic Tragedy of the Commons, in which there is no incentive for one person to reduce the use of the resource since if s/he will not do it, others will. With this thinking the resource tends to be used excessively. This explanation supports the 'logic of collective action', introduced by Olson (1965 as cited in Ostrom 2004). Both of these arguments are necessary to understand the basic issues faced in many CPR situations, such as the fishery resource use in the Southern Lake.

The case of the shrimp fishery in the Southern Lake presents two important characteristics. First, it is physically or legally impractical for one person to maintain exclusive use over the fishery. Second, the catch taken by one fisherman affects the present productivity of other fishermen as well as the future productivity of all the fishermen because of its negative effects on the shrimp stock. If a natural resource such as the Southern Lake is open to all, each user will exploit it as much as s/he can because any self-restraint on his/her part will merely make more resources available for others to exploit. This kind of problem is known as a collective action problem.

An effective collective action is normally achieved through external policymakers such as government regulation or private ownership. However, such systems need not always be imposed externally or involve government or private ownership. Indeed, efforts by national governments to impose uniform rules on large stretches of areas with diverse ecological and sociological systems have frequently led to worsening natural resource conditions rather than improvements (Ostrom 2004).

2.2 Experience with Traditional Methods to Solve the Problem

1) Regulations and economic instruments

Efforts to regulate fishing and prevent overfishing have ranged from quantitative controls, such as catch quotas, area controls, and restricted fishing instruments. Some countries have solved the problem of over fishing through customary territorial rights, which combine economic incentives and internally imposed quantitative controls sanctioned by the community's social organizations. However, the experience of one country does not readily transfer to another, as different countries vary in stages of development, in culture and traditions, and in political and administrative infrastructure. Nevertheless, lessons can be learned from their experiences in transcending these differences or at least in avoiding potential pitfalls in devising plans to regulate common resources and their use (Panayotou 1994).

As an attempt to reduce overfishing, the New Zealand government issued tradable catch quotas on all fish harvested based on the individual fisherman's historical catches. Fees were imposed on the recipients of these quotas, and the revenues generated were used to buy back quotas from fishermen who were willing to sell their quotas and leave the industry. The quotas were also tradable among fishermen. Through this trading mechanism, the quotas were steadily transferred to the most efficient fishermen, ensuring that the aggregate fishing quota was caught at minimum cost (Panayotou 1994).

This system of individual tradable catch quotas is particularly relevant and applicable to developing countries with heavily overexploited fisheries. They can be combined with fee-financed retraining and relocation programs to encourage fishermen to sell their quotas and to take up alternative occupations. However, problems arise when unemployment and underemployment are widespread for the rest of the economy. Understandably, few fishermen would be willing to sell their catch quotas and exit the fishery if good employment alternatives are not available. Under these circumstances, a fishing effort would be higher than the normal level. Thus, maximizing rents and distributing pre-assigned resource shares to existing fishermen are preferable to allowing overfishing to continue unchecked.

In eastern Brazil (Panayotou, 1994), canoe fishermen operating in a river estuary in Valencia succeeded through a system of zoning and timing based on the lunar-tide cycle. By limiting access, the fishermen were able to control internal population pressures and set limits on the intensity of fishing, hence making fishing a reliable long-term occupation. Although the resource moved with the tide, the fishermen were able to map out the resource's distribution in time and space and to establish the temporary territorial rights, which could be converted into longstanding territorial claims. Boat captains selected fishing spots based on their knowledge of tide movements and fishing grounds, hence reducing competition between the same types of gear. The captains who first reached the spot had a temporary territorial claim. In the absence of clear-cut prior claims, lots were drawn. This resulted to a situation where a few captains owned "chunks of the lunar-tide fishing space," deliberately controlled the "opportunity structure of fishing," and passed their skills to a limited number of apprentices. Through a system of temporary territorial claims, the fishermen on their own, were able to stabilize their production system, set limits on the intensity of fishing, and resolve inter-gear conflicts.

A third example involves Sri Lankan coastal fisheries who operate based on a history of traditional property rights in the form of rights of access and closed communities. Each seine owners control access to coastal waters and exercise associated fishing rights that, along with other property, were subject to bilateral inheritance (by descent or marriage). Sri Lankan coastal fishing villages are generally closed communities in the sense that persons from outside the village are not allowed access to the fishing grounds of the community. Outsiders are not allowed to anchor or beach fishing boats along the shoreline of the community, and labor is not recruited from outside the village. These restrictions on entry help to explain why Sri Lankan coastal fishermen earn incomes appreciably above their opportunity costs.

An example of how traditional fishing rights could be effective in managing a sustainable fishery is the case of Tagba lagoon fisheries in the Cote d'Ivoire (Panayotou, 1994). In this country, fishing is controlled by a limited number of fishing team leaders who are knowledgeable on the biological features of the resource. These team leaders also enforce traditional regulations on mesh size and on fishing in spawning areas. In the late 1960s, a severe conflict arose between fishermen from neighboring countries and local fishermen when the outsiders attempted to introduce purse-seine fishing to the lagoon. The local fishermen managed to capture the purse-seine nets and piled them up as a warning against similar attempts in the future. With strictly guarded territorial rights, the fishermen enjoy relatively high incomes and have no need for surplus labor.

2) Co-management

In Thailand, current fisheries management based on centralized government intervention could not adequately deal with the overexploitation of fishery resources. This is because of rigid regulation and inadequate monitoring devices. Pomeroy (1995) affirmed that the centralized approach had not solved the problem of resource degradation and over-exploitation. Hanna (1998) also found that centralized management had been fraught with problems, and in many cases, had proven ineffective in promoting long-term sustainability. Likewise, existing fishing communities are faced with the problem of enforcing an effective collaboration.

Recognizing the difficulties and failures of centralized management strategies, governments, development agencies, and researchers have increasingly accepted the co-management approach during the last decade as an appropriate management system for sustainable fisheries (Nielsen et al. 2004). The basic concept of co-management is decentralization of controls and active participation of rural residents in the process of resource regulation (FAO 1996). In other words, alternative management is an arrangement wherein responsibility is shared between the government and the fishing communities.

The government plays an important role in the allocation of property rights, while devolving some of its powers to local fishermen committees. For example, the government will establish fishing zones, set seasonal limits, and impose restrictions on fishing gears and techniques. Fishing committees, on the other hand, can act as fishermen regulators in setting community-specific rules and in facilitating conflict resolution and sanction mechanisms that are suited to local conditions. In Vietnam, the Ministry of Fisheries has approved fisheries co-management as a strategy for managing the resource. The Ministry delegated resource management functions to local institutions, including fishers' organizations (Hanna 1998).

Other examples of successful experiences are the Fisheries Co-operative Associations (FCAs) in Japan, the fishing control legislation in Norway, and the Fisheries Sector Program (FSP) in the Philippines (FAO 1996). The Japanese fishery management system is under the Fisheries Law of 1949, which grants fishing rights and fishing licenses and sets the arrangements for fishery coordination. The fishing rights and licenses granted to members in FCAs are not to be loaned, rented, transferred, or even mortgaged to others.

As in Japan, the Norwegian government enacted a special legislation for the Lofoten fishery where the Arctic cod has its spawning grounds because of the high number of fishermen entering the area. For example, special district committees of fishermen were set up to make the rules for the fishery, such as the allowable fishing times and types of fishing gear, zones of reserved space for certain gears, and election of fishermen inspectors.

In southern Philippines, the Philippine government established the Fisheries Sector Program (FSP) in 1989 in Panguil Bay area to address mangrove destruction and overfishing. The management program was based on site-specific planning and participation of local governments, NGOs, and fishing associations. For instance, some municipalities and communities developed territorial use rights in fisheries, set zones for specific fishing gears, and established areas for seaweed, mussel, and oyster cultivation.

2.3 Background: Experimental Economics

Game theorists have attempted to use game-theory to suggest possible practical solutions to the collective action problem. There are various games that economists use to help them understand the behavior of economic agents. For example, Cardenas (2000) used economic experiments with varying levels of heterogeneity in terms of wealth, occupation, and other variables to observe how economic actors behave in experimental situations. He found that face-to-face communication has a sustained impact on the level of cooperation.

Ostrom (2006) provided an overview of the effects of communication behavior in studies involving the common-pool resource dilemma. She performed a field experiment using a non-cooperation game to show how face-to-face communications affected the common-pool resources use. Her results confirmed Cardenas' (2000) finding that face-to-face communications could improve the outcome.

Cardenas, Ahn and Ostrom (2003) compared three scenarios: Open-access (baseline); One-shot communication (OSC), in which there was only one communication before beginning the second phase of the experiment; and Repeated-communication (RC), in which groups were allowed to communicate throughout the second phase as well as during the first phase. Their results, which was consistent with their prior conjecture or hypothesis that OSC would be less effective than RC, showed that communication could help reduce the resource extraction level. The authors concluded that in RC, the necessary condition to achieve the desired commitment is a common knowledge base among the groups, encouraged and enhanced by ongoing communication.

Cardenas and Ostrom (2004) analyzed the experimental research results gathered from actual ecosystem users. They found that prior experience of the participants, their perception of external regulation, and the composition of the group influenced decisions to cooperate or defect in the experiment. The study also indicated that the demographic and socio- economic data of each particular participant and his/her group would help explain variations in cooperation levels across groups based on the same experimental design.

A study by Fehr and Gochter (2000) provided interesting results on cooperation and punishment involving public goods. The authors showed experimentally that there was indeed a widespread willingness among cooperators to punish free riders. Their players were divided into two groups: a 'stranger' group in which the players had little communication and made no attempt to work together, and the 'partner-treatment' group, in which the players maintained communication and attempted to work together for the optimal outcome of all players. The researchers found that when punishment for non-cooperation was in effect, the players increased their level of cooperation, but if punishment for non-cooperation was not in effect, the level of free ridership increased.

Moreover, in the 'stranger-partner' treatment, the more an agent was heavily punished, the more his contribution fell below the average contribution of other group members. Contributions above the average were punished much less and did not elicit a systematic response. The presence of punishment opportunities eventually led to pecuniary efficiency gains, and the full credibility of the punishment threat was established by actual punishments.

3.0 RESEARCH METHODOLOGY

3.1 Research Questions

The research questions were:

1. What are the potential policy options for fishing effort control in the Southern Lake?
2. How would fishermen respond to management policies such as ITQs or IQs based on external regulation or co-management principles to sustain fishery resource use in the Southern Lake?
3. What would be the long-term impacts of open access on fishery resource use?

3.2 Methodology

When the study began, there had been attempts for more than 20 years to control aquatic resource exploitation in the Southern Lake through increased regulations. These regulations involved both prohibiting the use of destructive fishing equipment and imposing restrictions on how allowable fishing traps could be used. However, the regulations had not been effective, and severe overfishing continued to be a problem (Mabuntham 2002; Kongprom 2008). Failure to enforce these regulations had been recently identified as the main cause of overfishing in the Southern Lake (ONEP 2005).

In a CPR such as the fishery resource in the Southern Lake, experience and research both indicate that a system involving shared responsibility between government and the fishing communities would be a more effective management scheme. However, this would require effective collaboration among individuals in a situation of common resource use. Understand human behavior related to CPR may be difficult, but findings are essential in developing policy alternatives for controlling fishing efforts. Hence, this study investigated how fishermen would respond to various management options using field experiments in order to establish a sustainable fishery resource use in the Southern Lake.

3.2.1 Identification of potential policy options for fishing effort control in the Southern Lake

In a previous review, the links among the identified problems, causes of decreasing fishery value, government actions to resolve the problems, impacts of policy options, and obstacles to initiating such changes, were diagramed as shown in Figure 1. With this information, suggestions on the primary program options for fishing effort control in the Southern Lake are as follows:

1. The first priority is the need to seek and design appropriate mechanisms for fishing effort control, which fishermen can accept. In this study, various combinations of two policy options were examined in an experiment to investigate which combination would be more successful:
   - External regulation or co-management, in conjunction with ITQs and IQs
   - Individual transferable quotas (ITQs) or individual quotas (IQs) on the standing traps for shrimp
2. Specific property rights for the fishing traps
3. Restructured and effective monitoring system

This field experiment, using five cases, focused on number 1 above. The outcomes of the experiments for each case suggested how successful each strategy would be if implemented. These outcomes were used as central information inputs in the design of appropriate mechanisms for potential policy options to control the fishing effort in the Southern Lake. The five cases tested were:

Case 1: Open access extraction as a baseline case

Case 2: External regulation with ITQs and a penalty system

Case 3: External regulation with IQ and a penalty system

Case 4: Co-management with ITQs and a social sanction system

Case 5: Co-management with IQs and a social sanction system

The questions and hypotheses tested in this experiment were as follows:

1. With the management methods, a co-management situation was expected to exhibit better results than external regulation in terms of both the sustainability of the resource and the reduction in extraction.

2. With the different economic impacts of different quota methods, ITQs and IQs, the ITQ system was expected to exhibit better results. The latter offers an opportunity for fishermen to trade their own quotas, which gives them greater flexibility to increase or reduce their extraction.

3. Under conditions of higher and lower fish stocks due to seasonal salinity in the Lake, the time of higher fish stocks during high salinity was expected to encourage fishermen to increase their extraction attempts. The difference in fishermen behavior under two situations, low salinity or high salinity, was tested.

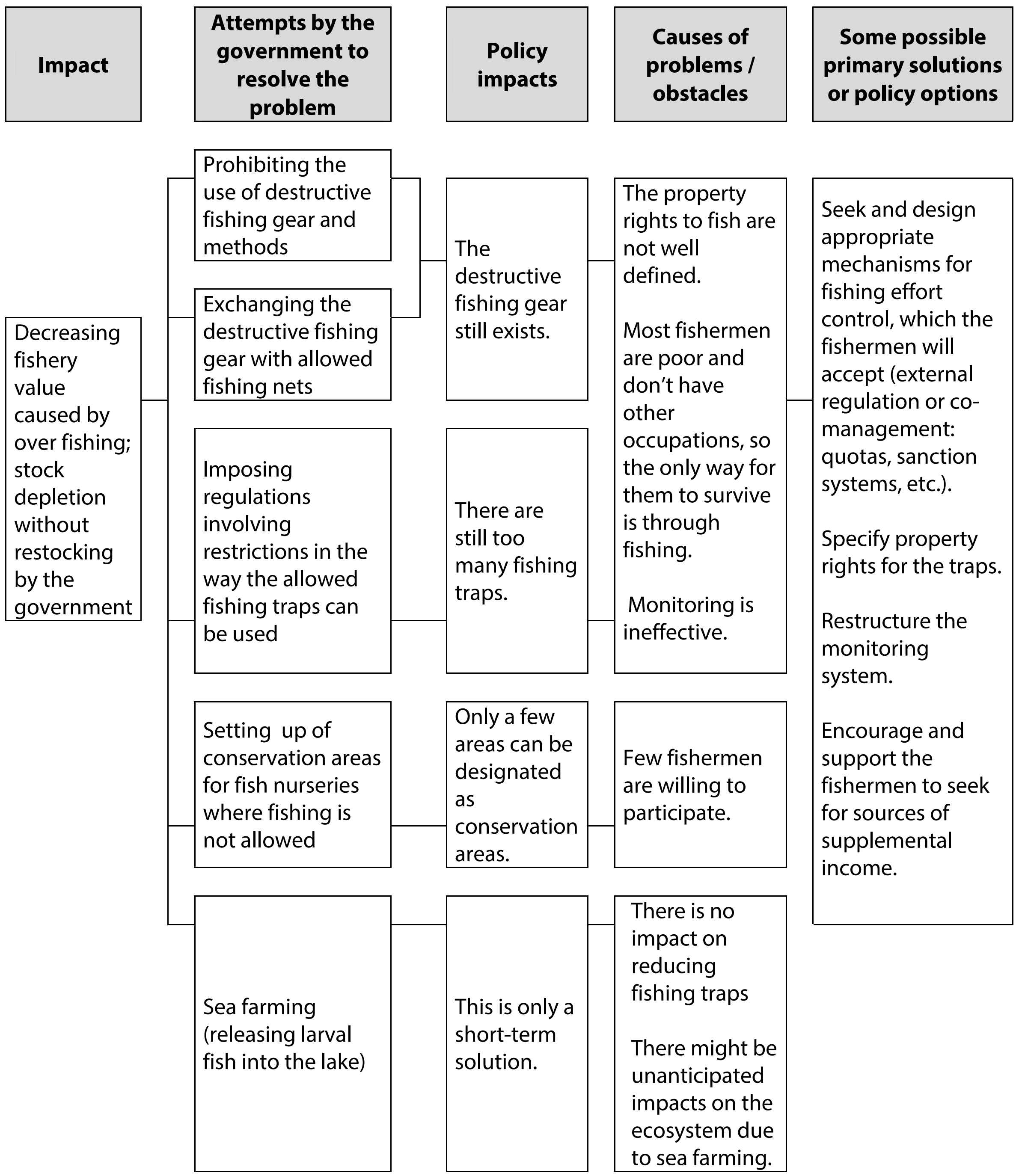


Figure 1. Links among problems and causes, government actions, policy impacts, obstacles, and primary proposed solutions

3.2.2 Theoretical framework

For this study, an analytical model of the situation of Southern Lake's resource extraction was based on two earlier studies: 1) "Norms from outside and from inside: An experimental analysis on the governance of local ecosystems" by Cardenas (2004), and 2) *"Can co-management strategies improve governance in a marine protected area? Lessons from experimental economic games in the Columbian Caribbean"* by Moreno-Sanchez and Maldonado (2008).

These studies examined the concept of using non-cooperative game theory in attempting to solve resource-overuse problems. Particularly, a common-pool resource problem is one of the classical examples of non-cooperative game theory because the theory is that everyone seeks to maximize his or her extraction from a common pool resource. This theory attempts to explain the behavior of people by examining how individuals think in a given circumstance, and also how they respond to different conditions. The Nash equilibrium of non-cooperative games is not compatible with Pareto optimality in this situation as each player has the incentive to deviate from an agreement, (Dixit and Skeath 1999).

Several factors concerning the Southern Lake have a major impact on the shrimp catch. These are primarily fishing effort, water quality, salinity, and shrimp larva. These variables are divided into two categories: controlled and uncontrolled or random variables. The controlled variable is the level of extraction or fishing effort by the fishermen. The random or uncontrolled remaining variables are the shrimp larva, water quality, and salinity. The random variables, however, are to a certain extent predictable – that is, the fishermen do not know the exact value of these variables when they put their fishing effort into the lake, but they do know that the variables exist. Some may have an idea of the value of each of these variables and that they directly affect the shrimp stock, thus the payoff for the fishermen.

To choose the level of extraction, each individual fisherman forms an expectation of his catch based on his experience, and considering the value of the random variables at that particular time. As soon as each of the fishermen had chosen what s/he proposed to catch, the overall level of extraction would be revealed to everyone. As the common pool resource dilemma shows, there is an effect from others on any individual player, so the payoff to each individual fisherman depended not only on his/her catch and on the stock of shrimp but also on the overall extraction.

In order to encourage each fisherman to decide on the level of his/her shrimp catch to be as close as possible to the real situation in the Southern Lake, the experimental process started by providing them with information on the shrimp stock based on the given salinity condition. The logic of this model is illustrated in Figure 2.

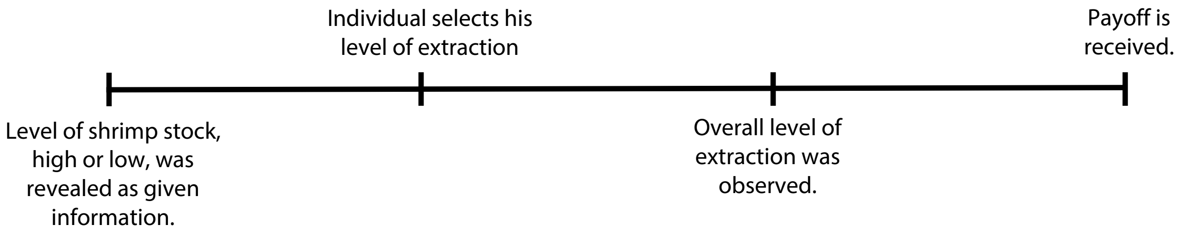


Figure 2. Chronology of the experimental model

Model specifications

According to the harvest function in Hardwick and Olewiler (1998) and the research of Cardenas (2004) and Moreno-Sanchez and Maldonado (2008), the payoff function of individual fishermen depends on two components: private and public. The private (net) benefit function is f (x_i, S), where x_i is the level of extraction and S is stock of shrimp. This private benefit depends on the level of extraction of fishermen and their costs in achieving that extraction. In this study, the level of extraction (x_i) of each fisherman is assumed to be from 1 to 8 units of extraction.

In studying CPR as the type of fishery resource use in the Southern Lake, there is non-exclusion but rivalry. Therefore, the decisions of each fisherman using the resource will affect the availability of the resource for other fishers. Therefore, a function g (Σ x_i), i=1-n is used to describe the public benefit function, and this reflects the effect of overall fishing on individual payoff. The payoff function of an individual fisherman is shown in Expression 1:

$$\pi_i = f(x,S) + g(\sum_i^n x_i) \qquad \text{(Equation 1)}$$

For optimization conditions, we assume $f_x > 0$, $f_{xx} < 0$, $f_s > 0$, $f_{ss} < 0$ and $g_x < 0$, $g_{xx} > 0$ In the private function, there are private benefits and cost functions. The private benefit, αx_i, is the revenue that the fisherman receives from his/her output. It depends on α, the revenue parameter such as the price in a competitive market and level of extraction. On the other hand, the cost function, $\beta x_i^2/2S$, depends on his/her level of extraction, x_i, and the available shrimp stock, S. This cost is negatively related to the shrimp stock because the smaller the existing shrimp stock, the greater the per-unit cost of extraction to the fisherman, such as search cost. But the cost is positively related to the level of extraction. In addition, it also depends on the cost parameter, β.

As the common pool resource, the public function, $\gamma\Sigma$ (e-x_i), i=1-n, implies that the fisherman's payoff will increase if social fishing declines and vice-versa. The term Σ (e-x_i) represents a benefit transferred from resource abundance to the individual, in which the coefficient γ measures the proportion of transferred benefit, and e is the capacity of level of extraction, so it equals 8.

We analyze the behavior of fishermen by specifying the payoff function as in expression 2[1].

$$\pi_i = \alpha x_i - \frac{\beta x_i^2}{2S} + \gamma ne - \gamma \sum_i x_i \qquad \text{(Equation 2)}$$

For setting the experiment described in the following section, we use the individual payoff as a benchmark to analyze the outcome in three scenarios, namely: a standard non-cooperation game; a positive social outcome (extraction at an optimal level); and an external regulation (extraction under regulation by government or agreement of the community).

Scenario I: Standard non-cooperative game

Each fisherman is free to choose the level of extraction at which s/he considers his/her personal payoff to be maximized. The objective function is

$$\max_{x_i} \left[\alpha x_i - \frac{\beta x_i^2}{2S} + \gamma ne - \gamma \sum_i x_i \right]$$

The necessary conditions for maximizing the payoff are as follows:

$$x_i = \frac{(\alpha - \gamma)}{\beta} S \qquad \text{(Equation 3)}$$

Because this scenario is not dependent on the level of extraction of the other fishermen, it is the dominant strategy. And as all fishermen follow this rule, it is also the Nash equilibrium for the game.

The optimal level of extraction is a function of the expected shrimp stock and is negatively related to the cost parameter, β. It is also negatively related to the transferred benefit coefficient, γ, because the greater benefit each fisherman obtains from an abundant stock, the more incentive s/he has to reduce his/her personal extraction. If this coefficient is high, fishermen can maintain the same revenue with a smaller investment and level of extraction.

Scenario II: Socially optimal outcome

In order to achieve the socially optimal outcome, the social welfare function for this scenario is established by adding the individual payoff function.

$$\max_{x_i} \sum_i \left[\alpha x_i - \frac{\beta x_i^2}{2S} + \gamma ne - \gamma \sum_i x_i \right]$$

[1] The public function, $\gamma\Sigma$ (e-x_i) , can be rearranged as γne - $\gamma \Sigma x_i$

The necessary condition is

$$x^{soc} = \frac{(\alpha - \gamma n)}{\beta} S$$

(Equation 4)

As with a general non-cooperative game, the socially optimal outcome is less than the individual's maximum outcome because the social level of extraction has to consider the transferred benefit for everyone, γn.

Scenario III: Non-cooperative game with external regulations

In order to enforce external regulations, the fisherman will be fined if s/he extracts more of his/her share of the resource than the defined socially optimal level. Excess extraction is measured by ($x_i - x^{soc}$). However, even if the government chooses to institute such regulations, it faces a very high cost in monitoring compliance with the regulations. It is also common for the government to try to control through fines those who transgress against regulations. However, as government oversight can never be 100 % foolproof, fishermen who break such regulations can get away with it and even benefit from these dubious activities. All of these factors need to be considered. Thus, two other coefficients are included in the payoff function, namely: a "value of penalty", *m*, and a "probability of fine", ρ. The objective function of the fishermen then becomes:

$$\max_{x_i} \sum_i \left[\alpha x_i - \frac{\beta x_i^2}{2S} + \gamma ne - \gamma \sum_i x_i - \rho m(x_i - x^{soc}) \right]$$

The first order condition of external regulations, considering imperfect modeling, is:

$$x_i^r = \frac{(\alpha - \gamma - \rho m)}{\beta} S$$

(Equation 5)

This still tends towards a socially optimum outcome, as the fishermen have to take the probability of a fine, ρm, into account, which should act to reduce the overall level of extraction. And in our experiment, the level of the fine is a value that can be changed to test the response behavior of the fishermen.

Based on this theoretical framework, the researchers used the following experiment in the field.

Parameterization and payoff table

To compute the payoff table, the parameters of the model must be defined. The level of the stock value was specified as 60 for high abundance and 30 for low abundance. The other parameters are as shown in Table 1.

The value of the revenue, cost and transfer benefit parameters, α, β and γ, were selected to be consistent with the study of Mahbuntham (2002), while the values of ρ followed the study of Moreno-Sanchez and Moldonado (2008). The 'fine value' *m* was specified as 200 or 500 based on the result of the experiment as a pre-test at the beginning of the experiment. Mahbuntham (2002) recommends that the socially optimal level should be around 50-60 % of the existing level of extraction.

With these parameter assumptions, the model predicts the socially optimum extraction in the case of high stock as 4 units of extraction for each individual (or 20 units for overall extraction), and with low stock as 2 units of extraction for each individual (or 10 units overall). Meanwhile, the non-cooperative outcome is 8 units of extraction for each individual in the case of high stock and 6 units for low stock.

Table 1. Parameters used in the model

Symbol	Definition	Value
x	individual level of extraction	1-8 (traps)
n	number of participants of each group	5 (persons)
e	maximum level of extraction	8 (traps)
α	revenue parameter	150 (units of payoff)
γ	proportion of transfer benefit	20 (units of payoff)
β	cost parameter	700 (units of payoff)
ρ	probability to be fined	0.1
m	fine value per unit	500 (units of payoff)

Given these parameters, equation (2), the payoff function, was used to calculate the payoff table results, as shown in Appendix A. The payoff table represents the major characteristic of CPR, that if others do not harvest much, the more the individual payoff increases. In each row, the individual payoff increases from left to right (increasing the extractions). In addition, the payoff of overall catch (bottom right corner) is lower than that of low catch (top, left corner).

The payoff, which is the difference between revenue and cost, is also affected by the stock level. In a low stock situation, the share of the catch for each individual is lower but costs are still high, hence the revenue may not cover the cost. However, in the high stock case, the high costs are less than the high revenues.

These parameters and the payoff table were then used to prepare the field experiment.

3.2.3 Scope of the study

The Southern Lake was chosen as the focal study area because it has the most intensive fishing equipment, high biodiversity, and the highest population density in the Songkhla Lake basin. Using field experiments, the investigations focused on fishermen's behavior in response to possible policy options for fishing effort control. Fishermen who own standing traps for shrimp fishing were selected as target respondents. Standing traps are the most prevalent fishing instruments in the Lake.

3.2.4 Samples

The economic experimental games were carried out with 205 individuals who were shrimp fishers using standing traps in the Southern Songkla Lake. The pretesting was conducted with 35 individuals: 10 undergraduate students; 15 fishermen randomly sampled from the villages around the Middle Sonkhla Lake (not the study area); and 10 fishermen in the study area.

To have an appropriate sample, seven fishing villages from the four districts around the Southern Lake were selected as representative communities. These included: Pak-ro, Pa-khat, Sathing-mo, KoYo, Ku-tao, Bang-riang, and Khuan-so. Then the experimental sample was randomly selected from the households of fishermen who owned more than ten fishing traps and had experience with fishing traps for more than two years.

3.3 Experimental Design and Procedures

3.3.1 Specifications and assumptions

To make the game understandable to the fishermen and practical for field work application, this study followed earlier field experiments conducted by Cardinus (2004) and Moreno-Sanchez and Maldonado (2008). The game details are as follows:

- Five fishermen played in each group (different treatments were conducted by different groups).
- The level of extraction available for each fisherman was from 1 to 8 units.
- The pay-off table used was constructed following the theoretical framework described in the previous section.

Assumptions of the experiment were:

- To simplify the experimental game for the fishermen to understand, the experiments were conducted under a steady-state static fishery framework.
- The resource stock (S) was available at two levels - low and high abundance. The optimal catch in low and high were assumed to be 10 and 20 fishing traps, respectively.
- To reduce the effect of information related to the price of fishing traps on extraction behavior, this price was assumed to be constant over the experiment. Although the price per trap of fishing traps was fixed, it was still considered a variable input since the fishermen could increase the number of fishing traps when they wanted a higher catch. For instance, the fishermen could increase their time spent, or fuel cost for their boat when they decide to harvest more. Hence, the fishing trap was defined as a variable input even though the unit price was constant.

3.2.2 Value of stock and individual payoff

Because the varying salinity in the Southern Lake, which significantly impacts the shrimp stock, is an uncontrollable factor (Pornpinatepong et al. 2008), this was included in the experiment. It was assumed that the stock of shrimps, S, would vary following the salinity of the Lake.

From a focus group, we learned that the fishermen knew that the shrimp stock directly depends on the salinity of water. To simulate the impact of changing salinities on the stock, the game divided salinity into two variables: high and low salinity. Salinity was then specified as "S" in each round and announced to the fishermen before the game began and they had to decide on their level of catch.

When the experiment was conducted using the variables, a player chose his/her level of extraction (x_i) and then his/her payoff (π_i) was calculated. The payoff depended not only on his/her personal level of extraction but also on the total level of extraction of the group (Σx_i, i = 1-5) and on the size of the shrimp stock.

To highlight the dilemma of common pool resources and the tradeoff between individual and social benefits in Southern Lake - that individual profits depended not only on individual decisions but also on the group decisions - the share of shrimp received by each fisherman was divided into two clusters. If the sum of the level of extraction of the group was more than 10 in low salinity condition and 20 in high salinity conditions, the shrimp share was deemed to be low due to overfishing. The shrimp share was high if the sum of the levels of extraction of the group as a whole was less than 10 in low salinity condition and 20 in high salinity condition.

3.3.3 Procedure

An overview of the experiment is shown in Figure 3. First, the salinity was specified and announced to the fishermen. Then each fisherman chose his/her level of extraction. The state of high or low catch was then calculated by summing up the individual extraction levels of the five players in the group. With high or low abundance, the exact value of S was specified depending on the salinity sitution, which was used to calculate each fisherman's payoff.

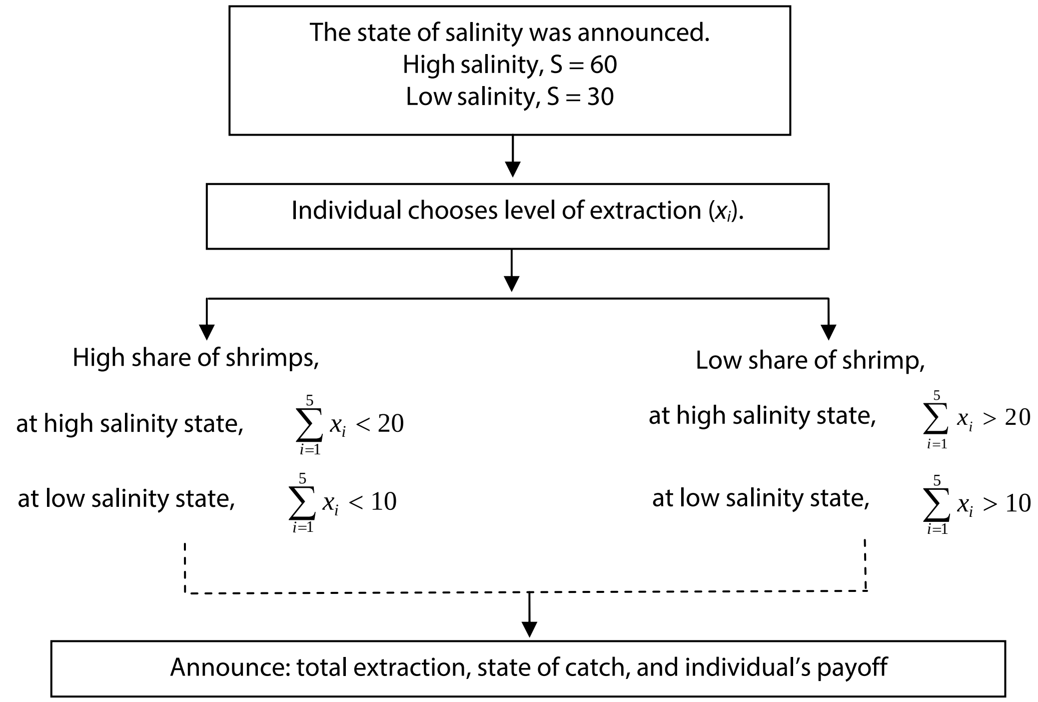


Figure 3. Process of calculating the payoffs

3.3.4 Experiments

The experiments were conducted with groups of five players, in a non-finite repeated game of 20 rounds performed in two phases. During the first phase, the players faced no rules. During the second phases, the players operated within a framework of external regulations with ITQs (and with IQs), and co-management with ITQs (and with IQs).

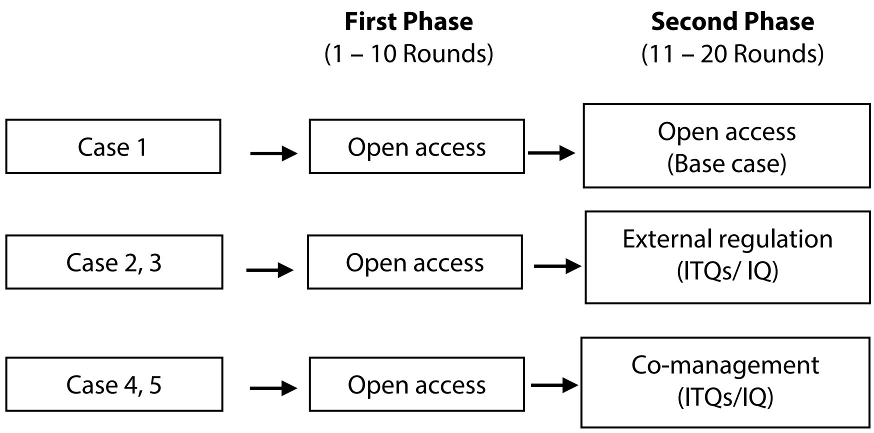


Figure 4. Dynamic component of the experiments

In every round of the first phase, each player had to decide on a level of extraction ranging from 1 to 8 units, and these decisions generated points, convertible to monetary units that each player received. In general, the individual payoff was generated by the individual extraction, with higher individual extraction resulting to higher profit. This profit, however, depended not only on individual decisions but also on the decisions made by each of the five members in the group. Profit also depended on uncontrollable factors at the study site such as salinity and rainfall, which are related to the shrimp stock.

Following the first 10 rounds, the groups played a second phase, with 10 additional rounds subject to different rules. There were three rules assigned to each group as discussed below.

3.3.5 Rules of the game

To provide the fishermen with realistic scenarios related to different policy options, the rules of the game were drafted based on initial information received from the FGDs and pretests. The rules were finalized as follows:

Phase I. Period of open access with no policy

The first phase of the experiment in every session was Open Access, which examined the dynamics of fishery extraction with no rules. This period was performed for the first 10 rounds, under the following assumptions:

Steps in Phase 1

The experiment started with the moderator introducing the players to the general concepts of common pool resource use and to the theories of corrective action to solve the problems in the fishery resource use in Southern Lake. The moderator also provided an overview and details of the experiment as well as the steps on how the experiment would be conducted. The instructions for the moderator are detailed below:

1. Explain the assumptions of the game (see Appendix 2 for script talks)
2. Provide information on the level of salinity, high or low, which affect the stock size of shrimp in the Lake (low salinity for rounds 1-5 and 11-15; high salinity for rounds 6 -10 and 16-20)
3. Let players decide the level of their extraction privately, ranging from 1 to 8 units, which they will record on a form provided and given later to the moderator.
4. Announce the total extraction and fishing situation in the Lake, whether over the optimal level of extraction or not.
5. Announce the payoff for each player using the special monetary units designed for the game, which are to be converted to rice grain at the end of the game.
6. Give each player his/her payoff.
7. Start the next round (revert to steps 2-6).

Note: After rounds 5, 10, and 15, the moderator would remind the players the general information on common pool resource and optimal level of extraction, which is:

"The determination of quantity of shrimp catch depending on three factors: the number of fishing instruments used by each fisherman, the total number of fishing instruments in the Lake, and the shrimp stock. The optimal level of extraction is the level of catch that every unit of the trap set at that time that received the highest share of shrimps. In low stock situation, the optimal level of extraction is 10 unit traps per group and 20 unit traps for high stock situation."

Phase II. Experimentally testing reactions to different management policies

After the first round, when every group finished the 'open access' trial, the fishermen then separated into five different groups. Each group was given different policy option to see their responses. This second phase involved rounds 11 – 20. The assumptions and rules for these sessions were as follows:

Case 1: Open access in the long-term (baseline case)

The players continued playing under the same assumptions and rules as in the first phase for 10 additional rounds. This enabled the researchers to assess baseline values wherein no attempt was done to regulate the long-term fishery resource use in the Lake.

Before round 11, the moderator informed the players about the current situation of shrimp fishing in the Lake and the optimal level of shrimp fishing. Then, the 10 rounds were conducted following the same steps as in Phase 1. To be consistant with the instructions given to the players, scripted talks were provided for those overseeing the game (see Appendix 2).

Case 2-5: The application of management options

Proposed policies and assumptions

In general, if quota (permit) is transferable, economic efficiency will be achieved. Therefore, ITQs were used for this phase's round of experiments, which was divided into two sub-situations: external regulation and co-management. The total quotas for extractions were limited to 20 units under high salinity conditions and 10 units under low salinity conditions.

An IQ system was also examined for two situations - external regulation and co-management - to assess the outcomes from a simple IQ system compared to that of an ITQ system.

Rule 1: Under external regulations with ITQs (and IQ) (Cases 2 and 3)

Each fisherman was allotted an extraction quota of two units under the low salinity situation and four units under high salinity conditions. A fisherman was allowed to sell his quota (if ITQ) to another fisherman or to the government by auction (but not an IQ). Nobody was allowed to fish more than his/her own quota or to fish without a quota. If a fisherman extracted a higher catch than the allowable quota or any catch without a quota, s/he had to forfeit the excess in his/her quota. To simulate real-life situations of imperfect enforcement of government rules, the monitoring process was randomised in the game. Every player had a 1/10[2] probability of being monitored during each round, based on the method suggested by Moreno-Sanchez and Maldonado (2008).

Operatively, imperfect monitoring was simulated using 10 balls: 9 white and 1 red, representing the 10 players. Each player blindly picked a ball from the box, and the player who picked the red ball was inspected. If the individual inspected was found to have violated the rules, s/he would have to pay a fine equivalent to the value of the assigned penalty, *m*. This penalty was subtracted from the individual payoff secretly before the payoffs were announced. This draw was made every round in this second phase, so any player could be monitored more than once, and some not at all. All the other rules remained as in the first phase of open access. Decisions as well as fines were private and confidential througout the course of the game. Also, communication among the players was confined to discussion of buying and selling extraction quotas.

Under these rules, before starting the second phase, the moderator played a role as a representative of the government. S/he entered briefly into the game to discuss the current (hypothetical game) situation of shrimp fishing in the Lake and the optimal use of fishing traps. The concept of ITQs (IQ) was introduced at this time, as detailed in scripted talk 3 (see Appendix 2).

[2] In the developing world, the probability of being monitored was 1/10 of total monitoring (Moreno-sanchez and Maldonado 2008).

Rule 2: Under co-management with ITQs (and IQ) (Cases 4 and 5)

Under these rules, the group received extraction quotas of 10 units per group under the low salinity situation and 20 units per group under high salinity situation. Before starting the second phase, the moderator provided information on the ITQ or IQ system based on a script. The group discussion among the players themselves lasted around 10 minutes. The discussion covered first, how the initial quotas would be distributed; second, the penalty system for individuals who violate the rules of extraction for their group; and third, how the quotas received could be transferred if the fishermen wished to do so. (In case of IQ, the third topic was omitted.) The group was also asked to select a leader before the group discussion.

After the group discussion, the group leader informed the fishermen of their agreement about the rules, and the next round began. The group members made their private decisions about their level of extraction for the 11th round, and made their secret submissions to the game moderator. The total extraction was then announced and everyone was told of their payoffs. The moderator had another minute to talk to the group to confirm their rules of extraction. Then the group had an additional minute to discuss for any adjustment in their rules of extraction as needed before the next round would begin until all rounds had been played and the game was finished.

Note: The roles of the moderators in the second phase were:

- To provide information on the optimal level of extraction (as given).

- To persuade every member of the group to extract only the socially optimal level of the resource.

- To introduce the quota system being used, either ITQ or IQ; describe how the initial quotas would be distributed (by giving them away for free or by auction); and describe how quotas could be transferred in the case of ITQs, which would be decided by the group, along with the rules of extraction. Any revenue from the fishing control process was to be returned to the community in the game.

- To assist the group in selecting a leader.

3.4 Preparation for Field Experiment

To facilitate the final study and to yield reliable results, a preliminary study was done to pretest the planned experiments for the main study.

Information used during the game

Five pre-prepared sets of information were used during the pre-test:

a) baseline information for the first phase of every session,

b) set scripts for particular cases during the second phase of the experiment, which were the open access situation, external regulation with ITQs (and with IQ), and co-management with ITQs (and with IQ),

c) rules for particular cases,

d) a payoff table, and

e) a post-game interview questionnaire

To prepare realistic information, FGDs were conducted to obtain initial information needed for a, b, and c. These information included, for example, the perceptions of fishermen about common pooled resources, especially in fishery resource use in the Lake, what strategies the fishermen used for shrimp fishing, what kinds of information the fishermen used when/if they decided to increase or decrease their fishing, and how the salinity in the fishing area of the lake affected the fishermen's decisions on fishing, etc. This information was then used in devising the experimental game design and the rules of the game (Section 3.3).

Payoff method

The payoff table was designed as shown in No. 3.2.2. To encourage the players to behave naturally, a special monetary unit was designed, and paid to the players round by round to stimulate some enthusiasm in the experiment. The participants received a payoff based on their own game results, and this special monetary unit was then exchanged for some real rice grains at the end of the experiment. Rice was selected as the payoff in this experiment rather than actual cash. Rice was a better option to avoid any effects on the social customs in the community and to provide some real incentive that was good for everyone.

Questionnaire design

After the game, the participants took part in a discussion to give more information about their perceptions on the policy options proposed. They were asked about their perceptions on the procedure of the games they played. Some socio-economic information were also solicited. The questionnaire included three sections:

Section 1: Socio-economic background of the fishermen
Section 2: Appropriateness or difficulty to understand the experiment they were asked to play
Section 3: Opinions about the policy options proposed in the experiment.

3.5 Pretest

The objectives of the pretest of the experiment were three-fold. First, was to test how understandable the procedures and rules of the game were for the players in the actual study. Second, was to test how reliably the games would help in the analysis of how fishermen in a 'real' situation would behave in response to policy options. And third, was to help gauge the probable effects of various policy options on the sustainability of the resource.

Two pretests were performed. The first was with a group of 10 undergraduate students, to allow correction to any obvious problems before the second pretest with a group of 15 fishermen. Both pretests were done with the more complicated scenarios: the 'external regulation' of Case 2 and the ITQ situation of Case 4. The fishermen from the Middle Songkhla Lake were selected for this pretest because the place was close to but was not the actual study site, hence not prejudicing the results.

The performance of the students and fishermen during the experiments and the discussions after each game were recorded to determine how well the players understood the game they had played. Personal interviews were also conducted to elicit more information for a full understanding of the fishermen's perceptions about the games they played. The latter information were then used as input for correcting the procedures of the actual experimental games, the rules of the game, the working assumptions, and the scripted talk details as shown in Section 4.3. The questionnaires and all doccuments needed in the experiment were also polished based on information gained from the pretests.

4.0 FINDINGS AND RESULTS

The final actual experimental games were conducted with 165 fishermen selected from the study area. Three fishermen were excluded because they did not understand the game. There were five sets of experiments: 6 based on the Open Access model; 7 based on external regulation with ITQs, 7 based on external regulation with IQ; 7 on co-management with ITQs; and 7 on co-management with IQ.

Findings of the study are divided into five sections, namely: (1) the socio-economic background of the players, (2) the quality of the fishermen's participation in the experiments, (3) the impacts of policy options on fishery resource use, (4) summary of the results, and (5) the fishermen's opinions about management options.

4.1 Socio-economic Background of the Participating Fishermen

The fishermen selected as players for these experiments came from seven fishing villages around Southern Lake. Most of them (87%) were male with an average age of 42.3 years. Majority (69%) had only primary school level of education. Most of them (90%) gave fishery as their main occupation. Further details of their socio-economic backgrounds are shown in Table 2.

Table 2. Socio-economic information of the players

Categories	Total (N = 202)
Gender (%)	
Male	86.6
Female	13.4
Age (average: years)	**42.3**
Education (%)	
Primary school	69.3
Secondary school	23.8
Other	6.9
Religion (%)	
Buddhist	59.4
Muslim	40.6
Family (average: persons)	
Family size	5.3
Working members	1.8
Family members attending a school	2.5
Fishery Labor (average: persons per household)	
Self-employed in family members	1.8
Employ from local labor	0.1
Fishing experience/working in fishery (average: years)	**14.7**
Land ownership (average: rai (1 ha = ~10 rai))	**2.8**
Income (average: baht/month ($1US=~30 baht))	
Main occupation	11,943.6
Secondary occupation	3,673.6
Main occupations of the players (%)	
Fishery	94.1
Agriculture	2.0
Laborer	1.5
Commercial	1.5
Other	0.5
Secondary occupations of the players (%)	
Agriculture	23.8
Aquaculture	15.8
Laborer	11.4
Commercial	9.4
Livestock	8.9
Other	7.9
Private employee	0.5

Table 2 continued

Categories	Total (N = 202)
Fishery trap ownership (average : units)	
Standing traps	19.5
Trawler	13.4
Gill seine	4.9
Shrimp ring net	2.0
Fish trap	1.0
Crab ring net	0.9
Shrimp trap	0.7
Fish net	0.1
Other	2.8

4.2 Quality of the Fishermen's Participation in the Experiments

In the post game interviews, the opinions of players on the factors that determined the quantity of shrimp caught in the experments and the factors that they considered when deciding how many standing traps to put into the Lake in real life were the same. These factors included the availability of shrimp stock and season, and the number of fishing traps they owned. The fishermen who participated in the experiments did not pay much attention to the total number of fishing traps set in the Lake. However, there was evidence that more than 85 % of the players took the game seriously, and their decision in the game about the number of traps to use was similar to the decision they would make in real life. Almost all (95%) confirmed that they used their 'real-life' fishing experiences when they made decisions in the experiment (Table 3).

Because this experiment was designed as a non-finite game situation, the expectations of the players concerning the time the game was to end was also checked. 'Hurrying' things up to make such games end quicker could influence the process. However, more than 80 % of the players said that they no longer thought about the time left before the game would end . A few of them occasionally did think about the time because "it had already taken a long time" or "it was getting close to either lunch or the end of the day".

During the game, a few players put out fewer traps than their quotas allowed. When asked about this, they said that the game conditions indicated a low-stock season, and they wanted to maintain an optimal level of extraction as well as to save cost as the catch would be lower in a low-stock season. Most players did the reverse and put out more traps than their quotas allowed, reasoning out that in a high-stock season, putting out more traps would give them more income.

To better assess the understanding of the players about the experiments, the enumerators designed an observation sheet to evaluate how the players behaved during the experiments. Based on these enumerator observations, more that 95 percent of the players understood the game and the quota system, thus they participated in a realistic manner in the experiments (Table 4). It could be said that most of the fishermen participated in the experiments in a realistic fashion, resulting to high-quality information from the experiments.

Table 3. The participations and their opinions of the experiment

Categories	Value (% from total)
In the experiment, what factors determined the quantity of shrimp caught?	
1. The number of fishing traps that you set personally	42.1
2. The total number of fishing traps in the Lake	14.9
3. The availability of shrimp stock	40.1
All three factors above	35.6
Other	12.9
In real life, what factors do you consider when setting your traps?	
The availability of shrimp stock	63.4
Season	53.0
The number of fishing traps I own	37.1
household expense requirements	31.7
Other	20.8
The intention to play the game seriously	
With intention	87.6
No intention	12.4
Was your decision about how many traps to put into the Lake similar to your real life assessment?	
Yes	88.1
No	11.9
Did you have any pre-conceived expectations about when the games will be over?	
Yes	17.8
No	82.2
Did you use knowledge from your fishing experience in this game?	
Yes	95
No	5
How many traps did you set?	
Over the allowed quota (permits) received	42.6
Under the allowed quota (permits) received	50

Table 4. Understanding of the players in the experiments (from observations by the researchers)

Categories	Value (% from total)
Does the player understand the game s/he is playing?	
Good	33.5
Okay	63.0
Poor	3.5
Does the player understand the quota system used in the game?	
Yes	95.7
No	4.3.
Quality of the player's participation in the game.	
Good	35.9
Okay	59.4
Poor	4.7

4.3 Impact of Policy Options on Fishery Resource Use

The research aimed to explain how various management strategies proposed would alter fishermen's behavior and improve the sustainability of fishery resource use in the Southern Lake. Hence, the following issues were discussed: (1) effects of management policies on extraction decisions, (2) effects of management policies on the sustainability of the resource, (3) factors determining the extraction behavior of fishermen, and (4) effects of tradable and non-tradable systems on violation behavior. The findings of these experiments were analyzed using non-parametric and parametric tests.

4.3.1 Effects of management policies on extraction decisions

The significant results on the different extraction decisions under various options are presented in Table 5.

Two independent variables - management options and the level of stock - were associated with a statistically significant impact on extraction decisions. The other tested independent variables were statistically insignificant. These results are further discussed below.

Table 5. Statistical testing of the effect of management options on extraction decisions

Dependent variable	Independent variable	Mann-Whitney U Test (P-value)	T- test (P-value)
Average extraction	• Policy (open access, and regulation)	79602.50 (0.000)**	6.441 (0.000)**
	• Policy (open access, and co-management)	50665.00 (0.000)**	17.843 (0.000)**
	• Policy (regulation, and co-management)	162538.50 (0.000)**	12.443 (0.000)**
	• Level of salinity (low and high)	23917.00 (0.00)**	-11.15 (0.00)**
	• ITQ and IQ	187888.50 (0.368)	-0.24 (0.810)
	• Gender	10910.00 (0.781)	0.20 (0.840)
	• Role of leadership (under co-management with ITQ)	12343.50 (0.136)	-1.36 (0.170)
	• Role of leadership (under co-management with IQ)	11464.50 (0.766)	-0.19 (0.170)

**significant at 99% confidence level

The difference in extraction decisions under external regalation versus co-management

When players were exposed to the game under no policy management (the first 10 rounds) with a range of possible extracted units of 1-8, the average extractions were 5.5-6.1 units. The figure was lower when (a) information on the optimal level of extraction was given, and (b) after the regulation or co-management policy was applied, at which times the average extractions were 4.0 and 2.7 units, respectively (Figure 5). Figure 6 shows that co-management was the most effective policy for reducing extraction because the average number of traps was minimized under such condition.

The Mann-Whitney Test was then applied to test the median of extraction associated with the three policies of open access, regulation, and co-management. The Independent samples *t*-test was also applied to test average extraction associated with these policies. Results showed that the extraction decisions of the players of the three groups (i.e., open access, external regulation, and co-management) were different at a 99 % level of confidence (Table 5).

Upon examining the percentages of extraction reduction from open access extraction (of the tested policy options), it was found that the co-management option had the most impact on the players' extraction decisions. In co-management, extraction was reduced from open access by 44.5%, which is more than in the regulation option as show in Figures 5 and 6. Co-management was shown to be a good management strategy because it is flexible, it concides with the fishermen's need, and it involves the fishermen in the decision-making process. Fishermen are more likely to follow any decisions they participate in making.

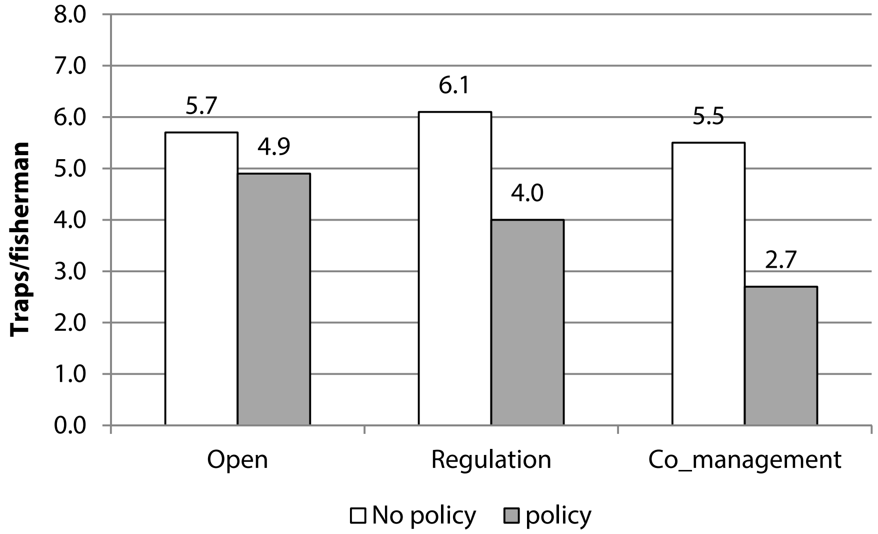


Figure 5. Average extractions for each management option compared with open access

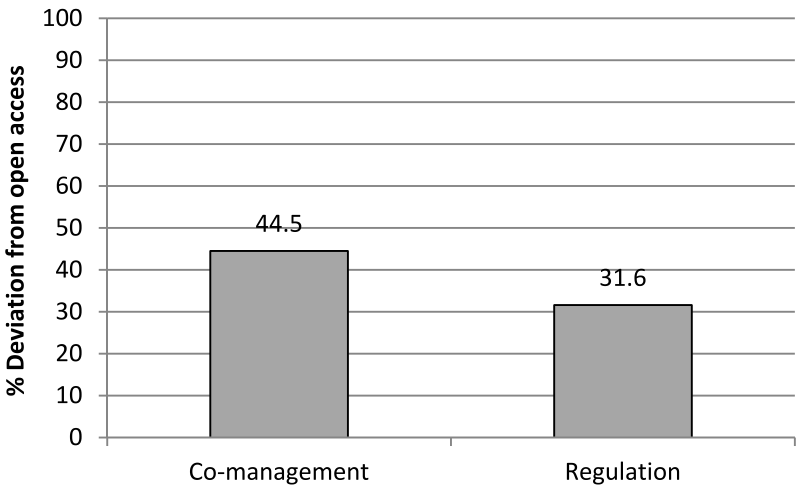


Figure 6. Percentage of extraction reduction from open access according to management options

What different decisions are made by the fishermen under low versus high shrimp stock situations?

Previous empirical studies have indicated that salinity changes in the Southern Lake have had significant impacts on shrimp production. The FGD interviews indicated that most fishermen had experience in using the salinity of the Lake to forecast the shrimp catch. Therefore, how the fishermen would differ in their extraction decision under seasonal high and low salinities was investigated. The Mann-Whitney Test and the independent samples *t*-test were applied as a tool for testing whether the extraction decisions under conditions of low and high shrimp stock were different or not. Results showed that the average extractions were significantly different at a 99 % confidence level (Table 5).

Figure 7 shows that under game situations, assuming either a fishing policy or no policy, the players chose to increase their catch under conditions of higher salinity. In the game situations, after management policies and information about the optimal level were applied (the last 10 rounds), the average extraction was reduced in all cases. But only under the co-management policy were the extraction levels not over the optimal levels, which were 1.8 and 3.6 units in low and high salinity conditions, respectively.

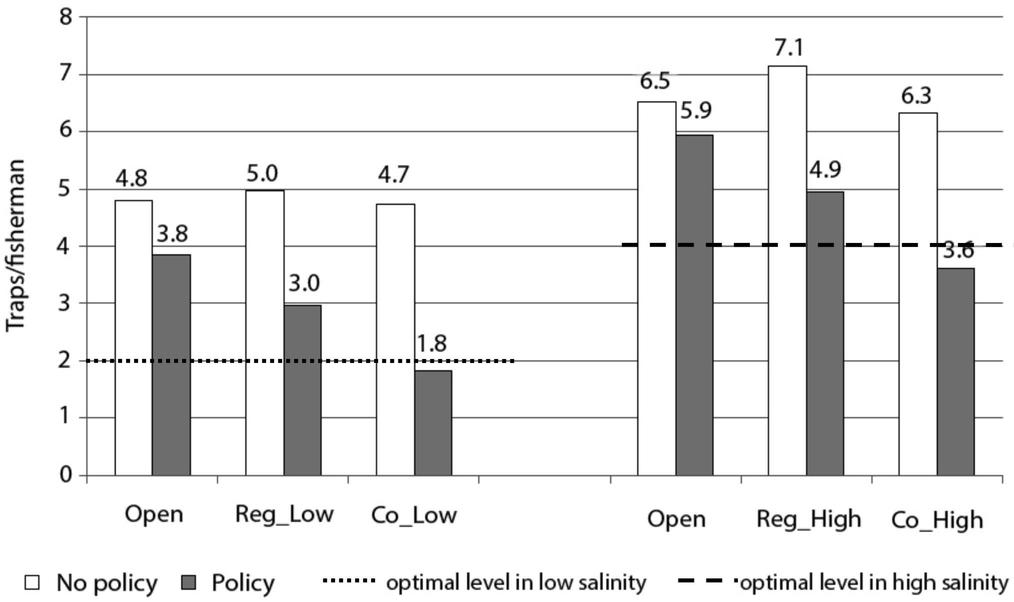


Figure 7. Average extraction under each management option compared to open access in low saliniy and high salinity situation

Considering the round of games, when players were exposed to the game under no policy (first 10 rounds), the average extraction was 4.1-5.8 units in a low salinity situation (or low stock), and higher, ranging from 6.9 - 7.3, in the high salinity situation (Figure 8). In game situations of no policy and with a regulation policy (the last 10 rounds), after the players received information about the optimal level, the average extraction was reduced, but the extraction level was still above the optimal level in both low and high stock situations.

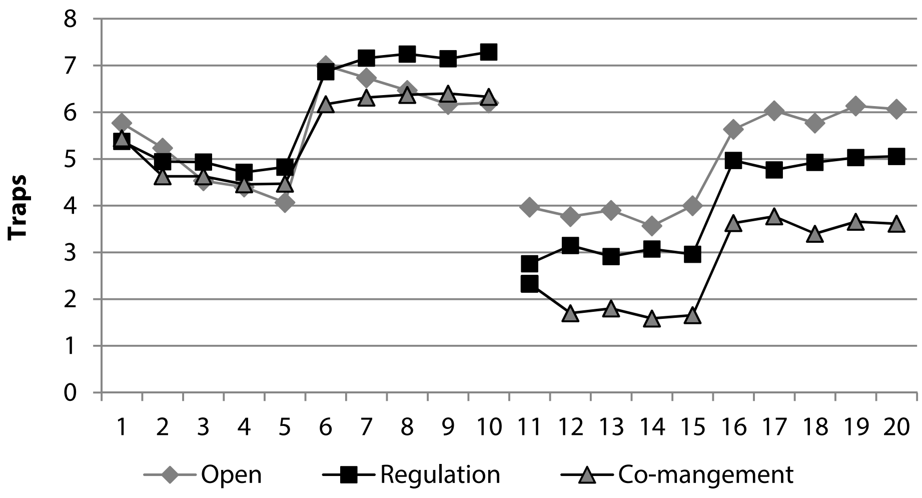


Figure 8. Average distribution of extraction decisions of players round by round

Results show that the fishermen's extraction decision was influenced by information about the optimal level, but this was not enough to reduce the catch to the optimal level. Hence, this indicates that the most effective policy would involve the government giving information about the optimal level and applying a management policy, especially co-management, at the same time.

Under both external regulation and co-management policies, fishermen reduced their extraction in high salinity situations much less than in low salinity conditions (Figure 9). This is because the share of shrimps, which fishermen would gain in a high salinity situation, motivates them to extract more shrimps. Therefore, controlling and monitoring efforts should be more strictly enforced during the high salinity season. Again, these efforts should be in conjunction with a co-management policy for the most effective extraction reduction.

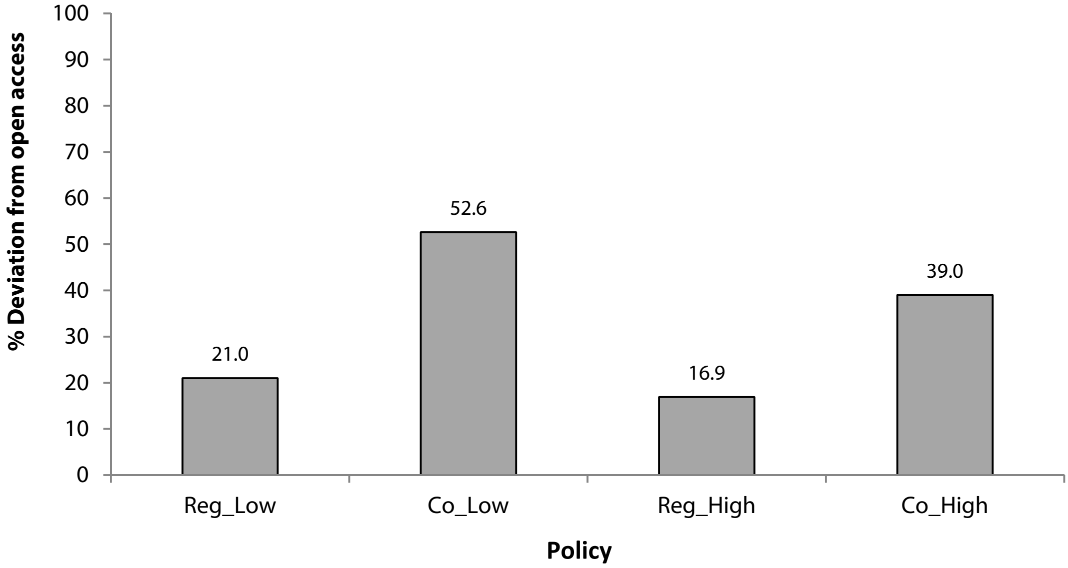


Figure 9. Percentage of extraction reduction from open access according to management options

As mentioned above, co-management policies would give better results than an external regulation policy in the Southern Songkhla Lake. In the experiment simulation, these options reduced the average extraction to the minimum level. Moreover, the deviation of extraction reduction from open access under co-management was maximized.

4.3.2 Effects of management policies on the sustainability of resource use

In this section, findings on the sustainability of resource use under various options are presented. The hypotheses used during the experiment were:

H_0 : Average sustainable round of groups are not different.
H_1 : Average sustainable round of groups are different.

Results of testings are shown in Table 6.

From Table 6, only the independent variable, "management options", showed a statistically significant impact on sustainability. These results are further discussed in the next sections.

Table 6. Statistical testing of the effect of the 'management option' on sustainability in the game situation

Dependent variable	Independent variable	Mann-Whitney U Test (P-value)	T- test (P-value)
Average number of rounds with a sustainable level of catch	Policy (open access and regulation)	645.50 (0.003)*	-3.044 (0.003)*
	Policy (open access and co-management)	135.00 (0.000)**	-13.149 (0.000)**
	Policy (regulation and co-management)	1225.00 (0.000)**	12.443 (0.000)**
	Level of salinity (Low and High)	354.00 (0.196)	1.13 (0.27)
	ITQ and IQ	2307.00 (0.857)	-0.37 (0.72)
	Gender	23.000 (0.717)	0.59 (0.56)
	Role of leadership (under co-management with ITQ)	100.500 (0.135)	0.32 (0.75)
	Role of leadership (under co-management with IQ)	109.00 (0.719)	0.47 (0.64)

** significant at 99% confidence level * significant at 95% confidence level

In the experiment simulation, how did sustainability of the resource use differ under the "external regulation" versus "co-management" options?

Because the simulated extraction was still higher in some cases than the optimal level, the sustainability of shrimp stock in the long run was considered.

Moreno-Sanchez and Maldonado (2008), writing about simulation experiment similar to this study, explained that "sustainability of the resource can be measured as the proportion of rounds that a group reached optimal level (or high abundance) during a phase of the game; it ranges from 0 to 100 %. The closer the number to 100, the more the number of the times the resource was high in abundance and therefore, the more the sustainability in the use of the resource." In this study, therefore, the percentage of rounds that reached optimal extraction value was observed for sustainability.

Results show that the second phases in the open access cases, which included information about optimal extraction levels, generated a higher percentage of sustainable rounds (16-33%) than games played without this information. Games played assuming either management policy - under regulation and co-management policies - also generated higher percentages of sustainable rounds at 14-59 % and 16-93 %, respectively (Figure 9). Co-management gave the highest number of sustainable rounds.

The average number of sustainable rounds resulting from the three policies (i.e., open access, external regulation, and co-management) was then tested for differences using the Mann-Whitney Test and the independent samples *t*-test. Results showed that the average sustainable rounds resulting from the three policies were different at the 99 % confidence level (Table 6). The co-management policy was the best strategy to maintain a sustainable shrimp stock (Figure 10). Since the fishermen could participate in designing the rules for management control in a co-management option, these rules would be more in line with their needs, thus resulting to more acceptable outcomes.

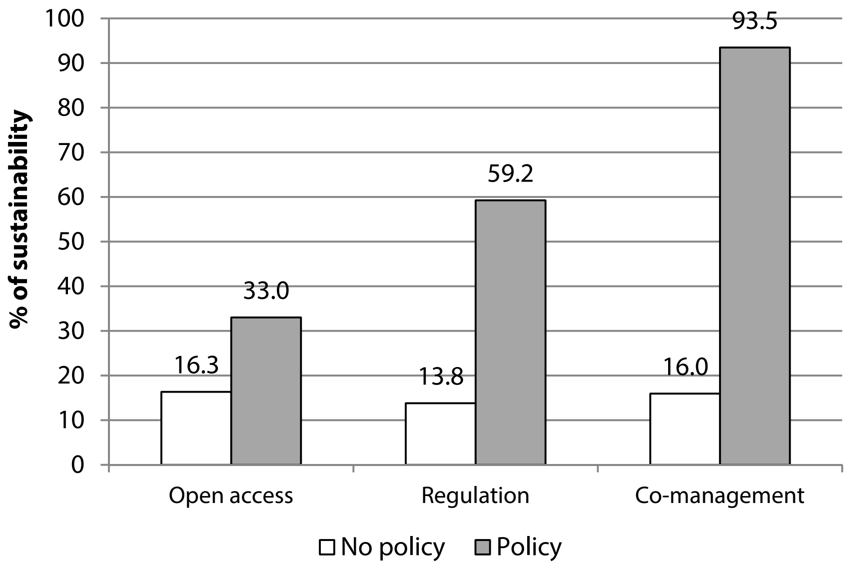


Figure 10. Percentage of rounds that stock reached optimal level according to management options

Different sustainabilities of resource use under high or low shrimp stock situations

Under open access or no policy situations, 12-19 % of the rounds reached optimal sustainability levels (Figure 11). Adding the condition of external regulations induced the participants to keep the stock in high abundance state in 59 % of the rounds in both high and low salinity situations. The co-management situations induced the groups to reach higher availability in 98 % of the rounds in high salinity situations or high stock of shrimp, and 89 % in low salinity situations with low stock of shrimp. Thus, co-management proved to be the most effective management strategy in terms of sustainability of the resource being extracted.

In order to specify the relationship between the abundance of shrimp stock under low and high stock situations, the average sustainable round of shrimp harvesting between low and high stock was tested using the Mann-Whitney Test and the independent samples *t*-test. Results showed no statistical difference between low and high shrimp stock situation (Table 6.). It is possible that the percentage increase of optimal level from low to high shrimp stock in the experiment had the same rate of increase in the extraction decisions.

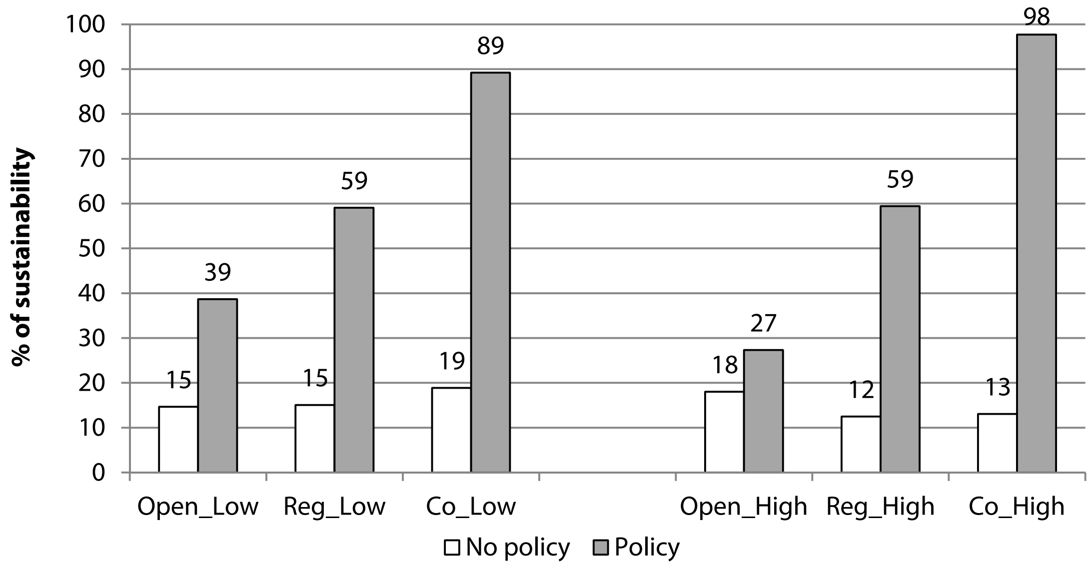


Figure 11. Percentage of rounds where fishing reached optimal level according to management options

4.3.3 Factor determination for the extraction behavior of fishermen

The factor determination for the extraction behavior of fishermen was investigated using linear regression analysis. The dependent variable was level of extraction and the independent variables were socio-economic information, management options, policy implementation (ITQs and IQ), the number of traps, and the shrimp stock level. The dummy variables, namely: the management options (regulation and co-management), level of education, religion, and shrimp stock were used and related to the level of extraction. The hypothesis was that with regulation and co-management options, the fishermen should reduce their extraction as compared to open access.

The fisherman's education was categorized into three levels: primary, secondary, and high school and above. The hypothesis was that the higher the education, the lower the fish extraction level, since it was assumed that higher educated fishermen would have more understanding about the environmental and pooling of resources. The two religions of the fishermen, Buddhist and Muslim, were conjectured to be a significant factor affecting extraction. Location was also considered to be a potentially significant factor, as small fishing communities in this region were independent and tended to be somewhat isolated in outlook. Any outstanding debt of a fisherman and the specified level of stock, were also expected to be significant factors affecting extraction.

In addition, two quantitative variables - wealth and the number of traps – were used to test the hypothesis. The coefficient of the number of traps was expected to be positive, since the more traps there were, the more opportunity for the fishermen to extract. A similar effect was expected for the wealth variable. Wealth was usually gauged based on income, although the income of some occupations was intermittent (e.g., agriculture or fishing varied almost daily depending on factors such as rain, stream flow, etc.). As 'wealth' based on income was quite difficult to record, land possession, which was easier to collect and more precise, was also considered. To prevent the multi-colinearity problem, two models with different wealth variables were estimated in order to capture the effect of wealth. As a result of regression, the model with land possession was selected for use in the explanations since it provided higher R-squared and F-statistic values.

The model shows that the variation of the level of extraction was around 18 %. Despite the lower the R-squared value in the models (Table 7), those variables explain the extraction results at a level of some significance, which is one of the great values of the F-statistic (Table 7). Most variables tested, such as were management options (external regulation and co-management), high school education, religion, and stock of shrimp, had the correct sign and significant effect on the dependent variable. The other variables tested did not have a significant effect on the dependent variable.

The coefficients of management option variables showed that the co-management option had a greater effect on the level of extraction than the external regulation option. This finding supports the earlier analysis.

The dummy variable of high school education – which postulated that the higher the educational attainment, the lower the fishing extraction – was negative, as expected. In Songkhla Lake, most fishermen only reached secondary school or lower (Table 2), meaning that a higher extraction was predictable.

The dummy variable of religion, which postulated that Buddhists and Muslims would have diferent levels of extraction – was also negative.

The greatest effect on the level of extraction was the stock of shrimp, which in turn, depended on the salinity of the Lake. With higher salinity inducing a higher stock, extraction was also higher. From observations during the field experiments, periods of high stock were also periods of high rate of extraction, with some fishermen infringing on the rules. This also occurred even in the case of co-management.

Table 7. Regression results

Variable	Coefficient (Land Model)
Constant	4.555472**
External regulation (dummy; Reg = 1, Others = 0)	-0.375601**
Co-management (dummy; Co-m = 1, Others = 0)	-1.065757**
Secondary education (dummy; EDs = 1, Others = 0)	-0.131429
High school education (dummy; EDh = 1, Others = 0)	-0.379422**
Religion (dummy; Buddhist = 1, Muslim = 0)	-0.216478**
Debt (dummy; Yes = 1, No = 0)	0.004825
Stock (dummy; High = 1, Low = 0)	1.827033**
IQ	0.130532
ITQ	-0.020022
Wealth (numeric variable)	-0.018755
Number of traps (numeric variable)	-0.005739
Method: Panel Least Squares	
Total observations	3980
Individual observations	199
R-squared	0.183509
Adjusted R-squared	0.181199
F-statistic	79.43996**

Note: **significant at 99% confidence level

4.3.4 Effect of tradable and non-tradable system on violation behavior

In order to investigate how extraction decisions would differ under ITQs versus IQs, the average extractions between the two management options were studied (Figure 12). After either external regulation or the co-management option were applied, an obvious reduction from open access was seen. However, the average extractions were almost the same between regulation with ITQs or IQs, and co-management with ITQs or IQs. The outcomes of sustainability, the average number of sustainable rounds for the option of shrimp extraction, between these management option with either ITQs or IQs were very similar. Both Mann-Whitney Test and the independent samples *t*-test results showed that the different extraction decisions and the different sustainability levels between the tradable and non-tradable options were not statistically significant (Tables 5 and 6), meaning that the extraction behavior of fishermen under both tradable and non-tradable options were the same.

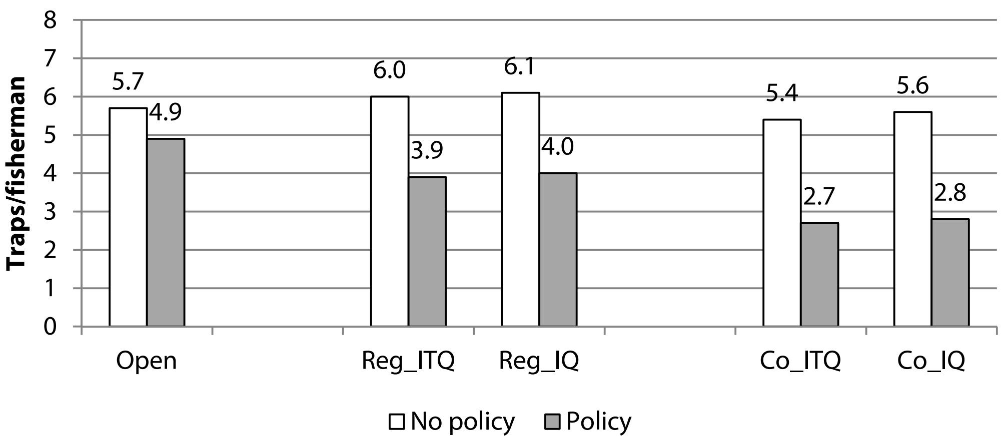
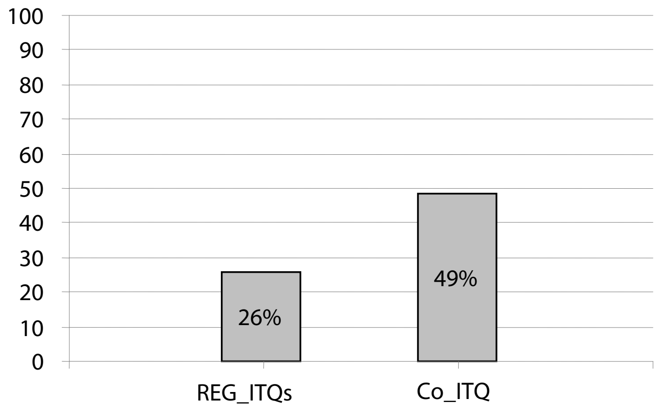


Figure 12. Average extraction under each policy, external regulation with ITQs and IQs, and co-management with ITQs and with IQs, compared to open access

Based on observations during the games, there was evidence that there was a demand for permits, but few players wished to sell his/her permit. Figure 13 shows that this behavior led to the prices of the permits getting higher and higher until they exceeded the level of the fine. Once the price of a permit was higher than the cost of the penalty and monitoring was inefficient, the players tended to violate the rules and extract more than their quota allowed instead of buying more quota. This result was found in all cases (Figure 14).



Average permit price per round	872	1,274

Figure 13. The percentage of round trading quotas and the average permit price per round

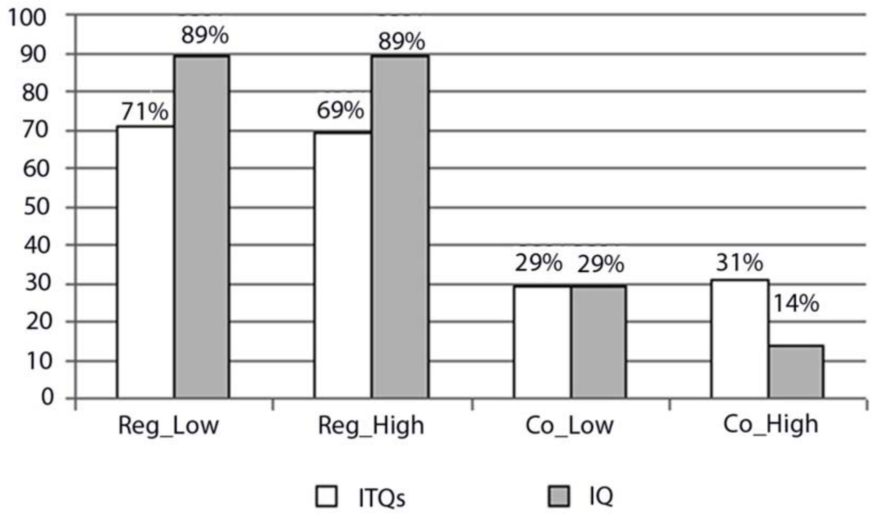


Figure 14: The percentage of violations (by round per total), extraction without an allowable quota

There were more violations in the external regulation case than in the co-management case because the penalties in the latter were designed by the group. Social sanctions were much stronger in the co-management situation, hence discouraging cheating. From Figure 13 it can be seen that there was more trading during the co-management games (49% of total rounds) than under external regulation (26% of total rounds).

At this point, another interesting issue became apparent - was there any relationship between tradable and non-tradable systems on violation behavior? As shown in Figure 14, the violations are more prevalent under IQs than ITQ when there is regulation. However, the difference in violations becomes negligible under low salinity and co-management, but violations under ITQs are more prevalent with co-management.

On cases with external regulations with ITQs and with IQ, the violations were obviously different. However, a test for the impact of tradable and non-tradable systems on violation behavior was needed. Hence, the Mann-Whitney Test and the independent samples *t*-test was applied to test whether violation behavior between these two cases was different or not.

Results in Table 8 show that the number of violations between the ITQ and IQ options in the external regulation case were significantly different at the 95 % confidence level. This result implies that a tradable system can reduce violations. This result also confirms literature advising that ITQs should be more efficient because they provide more flexibility. It could be recommended that ITQs would be more efficient if applied together with appropriate fines, and the fines should not be too low.

Moreover, results of the statistics tests show that the number of violations between the management options is significantly different at 99 % confidence level. Results confirm that there were more violations in the external regulation option than in the co-management option.

Table 8. Statistical testing of the different violations occuring between ITQ and IQ options

Dependent variable	Independent variable	Mann-Whitney U Test (P-value)	T-test (P-value)
Violations	External regulation (ITQs and IQ)	3.090E5 (0.002)*	-2.997 (0.03)*
	Co-management (ITQs and IQ)	1.593E5 (0.726)	0.476 (0.634)
	External regulation, and Co-management	1.150E6 (0.000)**	13.00 (0.000)**

**significant at 99% confidence level *significant at 95% confidence level

4.4 Summary of Results

When considering the potential policy options for managing fishing efforts, the response of the local fishermen to the proposed and tested options should be considered. Findings showed that factors impacting fishermen's decisions on resource extraction were management options, high school education, religion, and stock of shrimp.

The different violation behaviors of the players between tradable and non-tradable options were also investigated. The findings are summarized as follows:

Management methods

Considering the management methods of external regulation and co-management, co-management exhibited better results than external regulation in terms of both the sustainability of the resource and the reduction in extraction. Advantages and disadvantages between these two methods are compared in Table 9.

Effect of stock level

Under high and low fish stocks due to seasonal salinity in the Lake, higher fish stocks or a high salinity situation encouraged fishermen to increase their extraction, as expected. In a high salinity situation, the percentages of extraction reduction from open access were significantly lower than in a low salinity situation. Although the extraction decisions under these two situations were statistically and significantly different, there was no apparent effect on sustainability (the percentage of rounds that a group reached the optimal sustainability level).

Moreover, the percentage of rounds the stock was fished at an optimal level was greater in the co-management situation than in the external regulation option on both stock levels.

Table 9. Advantages and disadvantages between management methods

<table>
<tr><th>Advantages / positive outcomes</th><th>Disadvantages / concerns</th></tr>
<tr><td>Co-management</td><td></td></tr>
<tr><td>• Lowest extraction compared to the others; the average number of fishing traps is minimized.
• Higher percentage change of extraction reduction from open access
• Extractions achieve optimal levels in both high and low stock situations
• Highest average of rounds with high abundance (highest sustainability) compared to the others.
• Less violations because
- the rules are designed by the group
- social sanctions tend to have a stronger effect on fishermen's behavior</td><td>• The process is more complicated and needs more cooperation.
• Most fishermen are concerned that this option is impossible.
• These could be burdens to community leaders.</td></tr>
<tr><td>External regulation</td><td></td></tr>
<tr><td>• Lower extraction compared to open access
• Higher average of rounds with high abundance (higher sustainability) compared to open access</td><td>• Extraction is over optimal levels in both high and low stock situations.
• It is difficult to identify optimal cost of penalty.
• This needs efficient monitoring.</td></tr>
</table>

Fishery regulation, ITQs versus IQs

Between the tradable and non-tradable options, the ITQ management results were not different from management with IQs on both sustainability and fishermen extraction decisions. These results show that the fishermen did not behave differently with either the ITQ or IQ systems. Considering the violations or extractions without allowable quotas, there was a higher percentage of violations in the IQs had than in the ITQs because ITQs provide an option to buy and sell permits. However, when the price of permits grew higher than the cost of the penalty and when monitoring was inefficient, the players tended to violate the rules instead of buying permits. In the co-management options, there were fewer violations than with the regulation option, because the penalties were designed by the group, and enforced partially through social sanction.

The violations occurring between the ITQ and IQ options provided important information, since the fishermen behaved significantly different in these two cases. Analysis showed that there were more players extracting over the allowable quotas in the IQ option than in the ITQ option, with other things being equal. This result confirms that the ITQ option can be expected to exhibit better results, as it offers an opportunity for fishermen to trade their own quotas, thus providing them more flexibility if they wished to increase or reduce their extraction.

Effect of information on the optimal level of extraction

It's worth mentioning that information on the optimal level of extraction played an interesting role, apparently influencing the decision of many players to reduce their extraction. However, the effect was not enough by itself to reach the optimal level, and appropriate management options were needed as well.

4.5 Fishermen's Opinions about the Management Options

The fishermen's opinions about the management options that they would prefer, and how they might be applied to Songkhla Lake, were also investigated. The post-game survey indicated that 78% of the players agreed that the main problem of the current fishing situation in the southern Songkhla Lake was overfishing.

For fishing control policies, a quota system was preferred to a tax on equipment. Most fishermen (f=53) who supported a quota system said that such a system could be manageable as long as the quotas were fairly distributed. A smaller number (f=15) said that there were too many traps in the Southern Lake, so the Lake needs tools for sustainable management. For the tax system, most fishermen (f=19) who supported a tax system said that it would be fair since the total amount of tax to be paid would depend on their catch. Some of them (f=5) thought that it would be easier to control fishing efforts. Some 31 people said that whatever the system was, quota or taxes, what was needed were clear procedures and rules.

As for applying a quota system to control the fishing effort in Songkhla Lake, the fishermen were equally divided, with 50 % of them agreeing that it is possible and the other 50 % saying it is not. Most of them (f=78) believed that some fishermen would cooperate with the quota system. Some did not express their opinions on this question. But a lot of them (f=92) thought that it would be hard to control the fishing efforts since some fishermen may not cooperate.

For co-management as a management strategy, 64 % of the fishermen said it would be impossible to apply it for fishing control in the Songkhla Lake, while only 36 % of them thought it would be possible. The most troubling issues among them were the right to fish, how to cooperate among themselves, how to manage someone who was too dominant, and who would be the leader in a group.

5.0 POLICY RECOMMENDATIONS

The major objective of this study was to investigate fishermen's behaviours in response to policies concerning the management or control of fishing efforts for a sustainable fishery in Southern Songkhla Lake. The two main management options, namely: external regulation and co-management, together with the two fishery regulations, tradable and non-tradable options, were selected for experimental comparison under high and low shrimp stock conditions. Two criteria were selected to compare the different options, namely: the extraction decision and sustainability. The violation behaviours were checked and post game surveys were conducted.

The advantages, disadvantages, and implications of each option for the Lake are discussed below.

For co-management

The analysis showed that co-management has many positive benefits over external regulation. When co-management was a game option, it gave the lowest extractions compared to the other options, with the extractions often achieving optimal levels in either high or low stock conditions. Co-management also allowed for community participation in designing the fishing rules, which created stronger social sanctions against those who violated the rules. Therefore, co-management is recommended as the best option for fishing effort control in the Southern Songkhla Lake.

However, the co-management process is more complex to manage. It requires greater cooperation among the fishermen. It also places some burdens on the community such as the opportunity cost of time used for community management. While most fishermen also think that it is the best system, they felt that it would be very difficult to implement it because of the potential resistance from those who wish to fish freely. Therefore, in order to apply the co-management option to a real situation such as in the lower Songkla Lake, there must be solid support from government agencies, particularly during the initial stages of implementation.

The external regulation option

This option was found to be the second best option, as it could at least reduce the overall extraction and improve sustainability compared to open access. In order to be an effective control measure, external regulation would require strict monitoring, particularly during the high salinity-high stock season. In addition, an appropriate fine system must be specified, at a level high enough for effective fishing control.

When comparing **tradable and non-tradable quotas,** ITQs are recommended for either the external regulation or co-management options, as the analysis confirmed that there were significantly less violations under the ITQ scenarios. ITQs provide more flexibility for the fishermen who desire to increase their extraction. However, fine values need to be carefully specified, and these should not be lower than the value of the quotas traded in the market. Such would discourage those who would violate the rules instead of buying quotas. In order to apply a quota system for Songkhla Lake, further studies are required, examining various factors, especially the distribution of quotas at the initial stage of implementation. The system needs to be fair to everyone in community.

Our analysis indicates that providing only information on optimal levels could affect fishermen's behavior and reduce extraction, but not to optimal levels. Additional management options are strongly needed for sustainable fishery resource use.

6.0 LESSONS LEARNED FROM THE EXPERIMENT

Several valuable points learned during these experiments are as follows:

- In order to conduct an experiment in common pool resource, the players need to be real persons in the study area. In this case, local fishermen were selected as players. Based on observation during the pretest, students and the fishermen had obviously different behaviors. The post-game discussions revealed that the fishermen's extraction decisions were based on their own fishing experience, while the students based their decisions on other factors. For example, the students might try to get higher payoffs simply as competition among themselves, while the fishermen had to think more of their actual lives and link their fishing experience into the experiment.

- The field experiment needs careful attention as to the selection of experimental subjects. A 'show-up' fee might be useful to ensure that the players who agreed to participate actually come to the sessions. In order to reduce costs, the size of the experimental groups could be increased from five to eight players.

- In order to be consistent, a prepared script is needed for every trial. The use of an observation sheet during the experiments is recommended. This will be used to record any unexpected things that might occur or to note things of interest. Follow- up surveys are highly recommended as these can elicit more information needed for a full analysis. It is important to conduct these surveys directly after the end of the experiment to ensure a high rate of participation. Also, better information will be obtained when the game is still fresh in the players' minds.

There are two issues which could further be investigated.

First, the effects of penalties versus monitoring systems on management outcomes could be further studied. There are different costs between these two systems: therefore, the question of what would be the most efficacious combination of the two options in creating an efficient, common pool resource management system would be useful for management control.

Second, similar field studies can be replicated to study in-depth the effects of different payoff methods, either payment in kind or in cash, on the outcome of similar experiments, and which would give more reliable results.

REFERENCES

Cárdenas, J.C. “Real wealth and experimental cooperation: Experiments in the field lab.” *Journal of Development Economics* 70 (2003): 263-289.

Cárdenas, J.C., T.K Ahn, and E. Ostrom. Communication and cooperation in a Common-Pooled Resource dilemma: a field experiment. *in*: S. Huck (ed.): “Advances in Understanding Strategic Behavior: Game Theory, Experiments, and Bounded Rationality”. New York: Palgrave, 2003.

Cárdenas, J.C. and E. Ostrom. What do People Bring into the Game? Experiments in the field About Cooperation in the Commons. USA: Elsevier Ltd., 2004.

Cárdenas, J.C. “Norms from outside and from inside: An experimental analysis on the governance of local ecosystems.” Forests Policy and Economics 6 (2004): 229-241.

Cárdenas, J.C.; Strandlund, J; and Willis, C. “Local environmental control and institutional crowding-out.” *World Development,* 28 (10, 2000): 1719-1733.

Choonhapran, A., C. Ratanachai, and A. Meechookunt, A. *Assessment of Fisheries Resources in Songkhla Lake During 1994-1995.* Technical Paper No. 4/1996. National Institute of Coastal Aquaculture, Department of Fisheries. Ministry of Agriculture and Cooperatives, Songkhla, Thailand, 1996.

Dixit, A and S. Skeath. *Games of Strategy*. New York: WW Norton & Co., 1999.

Fehr, E. and S. Gochter. “Cooperation and punishment in public goods experiments.” *The American Economics Review* 20 (4, 2000): 980-994.

Hanna, S. *Co-management in small-scale fisheries: creating effective links among stakeholders*. Plenary presentation, International CBNRM workshop, 10-14 May, Washington D.C., 1998.

Hartwick, J. and N. Olewiler. *The Economics of Natural Resource Use*. Second edition. USA: Addison-Wesley, 1998.

Kanchanawanich, A. “Aquatic index for water quality from Thai wisdom.” *Green World* 8 (5, 1999).

Kongprom, A. *The Status of Moyebi Shrimp (Pink Shrimp) in the Outer Songkhla Lake*. Thailand: Department of Fisheries, 2008.

Mabuntham, J. “Species Diversity and Quantity of Aquatic Animals Caught with Standing Traps in the Outer Songkhla Lake.” Master of Science Thesis, Prince of Songkhla University, Songkhla, Thailand, 2002.

Moreno-Sanchez, R. and J. Maldonado. *Can Co-management Strategies Improve Governance in a Marine Protected Area? Lessons from Experimental Economic Games in the Columbian Caribbean*. Paper presented during the 16th Annual Conference of the European Association of Environmental and Resource Economists, 25-28 June 2008, Gothenburg, Sweden, 2008.

Nielson, J.R., P. Degnbol, K.K. Viswanathan, M. Ahmed, M. Hara, and R.N.M. Abdullah, “Fisheries co-management - an institutional innovation? Lessons from South East Asia and Southern Africa.” *Marine Policy* 28 (2004):151-160.

ONEP (Office of Natural Resources and Environmental Policy and Planning). *Master Plan for Songkhla Lake Basin Development Project (Final Report).* Bangkok: ONEP, 2005.

ONEP (Office of Natural Resources and Environmental Policy and Planning). *Songkhla Lake Basin Development Project: the Reviewing of Master Plan for Songkhla Lake Basin 2013-2016 (Executive Summery)*. Bangkok: ONEP, 2011.

Ostrom, E. "Collective action and the evolution of social norms." *Journal of Economic Perspectives* 14 (3, 2003):137–158.

Ostrom, E. *Collective Action and Property Rights for Sustainable Development: Understanding Collective Action*. 2020 Vision for Food Agriculture. USA: International Food Policy Research Institute, 2004.

Ostrom, E. "The value-added of laboratory experiments for the study of institutions and common-pool resources." *Journal of Economic Behavior & Organization*. 61 (2006):149-163.

Ostrom, E., R. Gardner, and J. Walker. *Rules, Games, and Common-Pool Resources*. USA:The University of Michigan, 1994.

Panayotou, T. *Economic Instruments for Environmental Management and Sustainable Development*. USA: International Environment Program, Harvard Institute for International Development, Harvard University, 1994.

Pomeroy, R. S. "Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia." *Ocean & Coastal Management*. 27 (3, 1995):143-162.

Pornpinatepong, K., S. Kiripat, S. Treewanchai, S. Chongwilaikasaem, C. Pornsawang, P. Chantarasap, C. Chandee and P. Jantrakul. 2008. Pollution Control and Sustainable Fisheries Management in Southern Songkhla Lake. EEPSEA Research Report. Thailand: EEPSEA.

Sirimnataporn, P., K. Chaiyakam and K. Sae-Chu. *The Study of Aquatic Catch by Standing Traps in Outer Songkhla Lake. Research Report*. No 16/1983. National Institute of Coastal Aquaculture (NICA). Thailand: Department of Fisheries, 1983.

Appendix 1. Pay-off Tables

Pay-off Table (S=30)
Non – Cooperative Game

The payoff table represents the major characteristic of CPR: the lower the total catch, the more the individual payoff increases. In each row, the individual payoff increases from left to right (increasing the extractions). In addition, the payoff of overall catch (bottom right corner) is lower than low catch (top left corner).

		Individual payoff							
		1	2	3	4	5	6	7	8
The rest payoff	4	838	933	1005	1053	1078	1080	1058	1013
	5	818	913	985	1033	1058	1060	1038	993
	6	798	893	965	1013	1038	1040	1018	973
	7	778	873	945	993	1018	1020	998	953
	8	758	853	925	973	998	1000	978	933
	9	738	833	905	953	978	980	958	913
	10	718	813	885	933	958	960	938	893
	11	698	793	865	913	938	940	918	873
	12	678	773	845	893	918	920	898	853
	13	658	753	825	873	898	900	878	833
	14	638	733	805	853	878	880	858	813
	15	618	713	785	833	858	860	838	793
	16	598	693	765	813	838	840	818	773
	17	578	673	745	793	818	820	798	753
	18	558	653	725	773	798	800	778	733
	19	538	633	705	753	778	780	758	713
	20	518	613	685	733	758	760	738	693
	21	498	593	665	713	738	740	718	673
	22	478	573	645	693	718	720	698	653
	23	458	553	625	673	698	700	678	633
	24	438	533	605	653	678	680	658	613
	25	418	513	585	633	658	660	638	593
	26	398	493	565	613	638	640	618	573
	27	378	473	545	593	618	620	598	553
	28	358	453	525	573	598	600	578	533
	29	338	433	505	553	578	580	558	513
	30	318	413	485	533	558	560	538	493
	31	298	393	465	513	538	540	518	473
	32	278	373	445	493	518	520	498	453

Pay-off Table (S=60)
Non – Cooperative Game

		Individual payoff							
		1	2	3	4	5	6	7	8
The rest payoff	4	844	957	1058	1147	1224	1290	1344	1387
	5	824	937	1038	1127	1204	1270	1324	1367
	6	804	917	1018	1107	1184	1250	1304	1347
	7	784	897	998	1087	1164	1230	1284	1327
	8	764	877	978	1067	1144	1210	1264	1307
	9	744	857	958	1047	1124	1190	1244	1287
	10	724	837	938	1027	1104	1170	1224	1267
	11	704	817	918	1007	1084	1150	1204	1247
	12	684	797	898	987	1064	1130	1184	1227
	13	664	777	878	967	1044	1110	1164	1207
	14	644	757	858	947	1024	1090	1144	1187
	15	624	737	838	927	1004	1070	1124	1167
	16	604	717	818	907	984	1050	1104	1147
	17	584	697	798	887	964	1030	1084	1127
	18	564	677	778	867	944	1010	1064	1107
	19	544	657	758	847	924	990	1044	1087
	20	524	637	738	827	904	970	1024	1067
	21	504	617	718	807	884	950	1004	1047
	22	484	597	698	787	864	930	984	1027
	23	464	577	678	767	844	910	964	1007
	24	444	557	658	747	824	890	944	987
	25	424	537	638	727	804	870	924	967
	26	404	517	618	707	784	850	904	947
	27	384	497	598	687	764	830	884	927
	28	364	477	578	667	744	810	864	907
	29	344	457	558	647	724	790	844	887
	30	324	437	538	627	704	770	824	867
	31	304	417	518	607	684	750	804	847
	32	284	397	498	587	664	730	784	827

Appendix 2. Scripted talks

In order to be consistent, scripted talks were made at the beginning of each game round as follows:

Phase I. Experiment on open access with no policy (first 10 rounds)

Scripted talk 1: Assumptions of the game

The following shrimp catch activity is supposed to occur in one specific Lake under the following assumptions:

a) At one specific Lake in which the water quality is standard, there are five (5) fishermen using standing traps for shrimp fishing. Each fisherman owns eight (8) traps.
b) The standing trap is the only fishing method use in this Lake, and fishing is allowed for 10 months of the year.
c) Price of the traps and price of shrimp is constant over the experimental period.

Phase II. The experiment in which different management options were included (last 10 rounds)

Case 1: Open access in the long term (baseline case)

Scripted talk 2: Optimal level of extraction

Determining the quantity of shrimp caught depends on three factors: the number of fishing traps set by each fisherman, the total number of fishing traps in the Lake, and the shrimp stock..

The evidence indicates that the optimal level of extraction in this Lake is 10 units for low water salinity and 20 units for high salinity. Therefore, most extractions in the previous round were over the optimal level.

Case 2-3: Under external regulation policy (Case 2 and 3)

Scripted talk 3: Under external regulations with ITQs (and IQ)

The quantity of shrimp caught depends on three factors, namely: the number of fishing traps of each fisherman, the total fishing traps in the Lake, and the available shrimp stock.

Evidence indicates that the optimal level of shrimp extraction from this Lake is 10 units for the whole lake, or two units per fisherman (for this game situation) for low salinity and 20/4 units for high salinity. Based on such figures, most extractions in the previous rounds were over the optimal level.

To control fishing extraction at an optimal level, a system of ITQs (IQ) has been selected for the simulation on this Lake. The procedure for fishing using ITQs (IQ) will be as follows:

a) Each fisherman will receive an extraction quota of 2 units under low salinity situation and 4 units under high salinity.
b) The fisherman can sell his quota to others or to the government by auction.
c) The fishermen can't extract over his/her quota or without quota.
d) Monitoring will be conducted for every round, as previously done, by having each player pick a ball from a box. The player who picks the red ball is inspected, and if s/he is found to be violating the quota rules, s/he will have to pay a fine of 200 payoff units. (There will be one red and nine white balls in the box.)
e) Communication among the players will be confined to discussion concerning buying and selling extraction quota.

Note: In case of IQ, step b) was omitted.

Case 2-3: Under co-management policy (Case 4 and 5)

Script talk 4: Under co-management with ITQs (and IQ)

Determining the quantity of shrimp catch depends on three factors, namely: the number of fishing traps of each fisherman, the total number of fishing traps in the Lake, and the available shrimp stock.

Evidence indicates that the optimal level of shrimp extraction from this Lake is 10 units for the whole lake for low salinity and 20 units for high salinity. Based on such figures, most extractions in the previous rounds were over the optimal level.

To control fishing extraction at an optimal level, a system of ITQs (IQ) has been selected for this Lake. The ITQ (IQ) procedure is as follows:

a) Catch quotas of 10 units under low salinity and 20 units under high salinity have been given to fishing communities around the Lake.
b) Each fishing community has authority to determine the methods to use. First, the quotas are initially distributed. These can be given away for free, auctioned, or disposed by some other method. Second, are the rules of extraction. Third are the rules of quotas transfer.
c) Any revenue from the fishing control process will be returned to the community.

Note: In case of IQ, the rules of quota transfer were omitted.

Strengthening local capacity in the economic analysis of environmental issues

Recent EEPSEA Research Reports

Exploring the Forestry Carbon Finance Potential for an Indigenous Cultural Community in the Philippines
Margaret M. Calderon, Nathaniel C. Bantayan, Florencia B. Pulhin, and Lourdes J. Cruz
2013-RR1

Response of Fishermen to Fishing Control Policies in Southern Songkhla Lake, Thailand: A Field Experiment
Kunlayanee Pornpinatepong, Pathomwat Chantarasap, Jumtip Seneerattanaprayul, Wittawat Hemtanon and Papitchaya Saelim
2013-RR2

Economic Analysis of Multi-pollutant Control in Coal-fired Electricity Plants in China
Wu Dan and Xie Xuxuan
2013-RR3

Impact of Piped Water on Household Welfare in Vietnam
Nguyen Viet Cuong, Vu Thieu, Pham Minh Thu, and Nguyen Xuan Truong
2013-RR4

Evaluating the Pilot Implementation of Payment for Forest Environmental Services in Lam Dong, Vietnam
Nguyen Thi Y Ly
2013-RR5

To Burn or not to Burn: Making the Burning of Chocolate Hills of Bohol, Philippines Carbon Neutral
Nathaniel C. Bantayan, Margaret M. Calderon, Florencia B. Pulhin, Canesio D. Predo, and Rose Ann C. Barruga
2013-RR6

An Economic Analysis of the Use of Water Hyacinth for Phytoremediation and Biogas Production in Dianchi Lake, China
Zanxin Wang and Jin Wan
2013-RR7

Economic Analysis of Rice Straw Management Alternatives and Understanding Farmers' Choices
Cheryll C. Launio, Constancio A. Asis, Jr., Rowena G. Manalili, and Evelyn F. Javier
2013-RR8

Impact of Eco-Labelling on Indonesia's Smallholder Coffee Farmers
Nuva, Yusif, Nia Kurniawati H., and Hanna
2013-RR9

Linking Climate Change, Rice Yield and Migration: The Philippine Experience
Flordeliza H. Bordey, Cheryll C. Launio, Eduardo Jimmy P. Quilang, Charis Mae A. Tolentiono and Nimfa B. Ogena
2013-RR10

Determinants of Flashflood Evacuation Choices and the Assessment of Preferences for Flashflood Warning Channels: The Case of Thailand
Kannika Thampanishvong
2013-RR11

Insurance Approach for Financing Extreme Climate Event Losses in China: A Status Analysis
Haitao Yin
2013-RR12

The Way to CO_2 Emission Reduction and the Co-benefits of Local Air Pollution Control in China's Transportation Sector: A Policy and Economic Analysis
Mao Xianqiang, Yang Shuqian, and Liu Qin
2013-RR13

Sida

IDRC CRDI