Final Report

Improving strategies for dealing with increasing resource scarcity and variability in small scale fisheries

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By

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Abstract

In this paper we investigate to what extent resource dependency, which we here define as having few (or no) options to diversify one's livelihood, affects how fishers, sharing a common fishing ground, respond to increasing resource scarcity. To this end we run a framed dynamic CPR experiment in Thailand with small-scale fishers, where we observe and compare behavioural responses of fishers that are presented with different scenarios (treatments), reflecting different degrees of resource scarcity (none, moderate and severe). The fishers differ with respect to resource dependency. We find that fishers that are more resource dependent respond differently to resource scarcity compared to less resource dependent fishers, but that this depends on the severity of resource scarcity. In the no resource scarcity treatment, more resource dependent fishers exploit more cautiously compared to less resource dependent fishers. Under moderate resource scarcity more resource dependent fishers exploit more aggressively compared to less resource dependent fishers. Under severe resource scarcity there is no difference in behaviour between the two types of fishers, both types exploit quite cautiously. Our findings contrast earlier empirical findings that resource dependent fishers continue to exploit, or exploit more under resource scarcity. We find that severe resource scarcity can trigger less exploitation of resource dependent fishers. We argue that the common-pool nature of the situation brings an additional dimension to the situation that can affect behaviour and overall outcomes significantly, and that may explain the result. We suggest that future work focus on teasing out the importance of these different drivers.

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Chapter 1

Introduction

Small-scale fisheries (SSFs) abound mostly in developing countries throughout the tropics but are nevertheless important contributors to nutrition, food security, sustainable livelihoods and poverty alleviation. They account e.g., for more than 50% of total animal protein intake in many low income countries (Bené, 2007) and are also a major income source. Taking upstream and downstream activities into account and adding additional dependents (non-working household members) estimations suggest that more than 230 million people in low income countries are dependent on SSFs for their livelihoods (FAO, 2016).

Climate change is expected to lead to increasing resource scarcity and fish stock variability (e.g., due to changes in water temperature, frequency of hypoxia, and changes in species composition) (Pörtner and Peck, 2010). Moreover, because of climate change, tropical marine systems are more likely to undergo so-called regime shifts; abrupt, and potentially persistent changes in their structure and function (Litzow et al. 2014). Tropical coastlines are particularly vulnerable towards climate events as they may profoundly impact coastal marine ecosystems (Nicholls et al. 2007; World Bank 2012), cascading down through local SSFs thus potentially threatening livelihoods of millions of people (Hall et al. 2013; Golden et al. 2016).

In addition, many SSFs are already threatened by over-exploitation stemming from open access regimes and weak governance (Purcell and Pomeroy, 2015). SSFs are a classical example of common- pool resources (CPRs) often governed at the community-level (Ostrom 1990). The ability to deal with the increasingly challenging ecological conditions will thus crucially depend on whether fishers are able to adapt to them individually, and collectively. In light of this, it is a critically important task to map out and increase our understanding about behavioural strategies adopted by small-scale fishers for dealing with some of the climate challenges described above. More specifically we aim to answer the following research questions:

- How do fishers that crucially depend on availability of fish respond to and deal with (individually and collectively) an increasing resource variability (including e.g., regime shifts) and associated uncertainties?
- How do fishers that crucially depend on the availability of fish respond to and deal with (individually and collective) increasing resource scarcity?
- Can we see behavioural differences depending on the type of fishing community (e.g., w.r.t. various degrees of resource dependency and income distribution, w.r.t previous experience of ecological crises, or w.r.t. to share of women involved in various fishing activities)?

To answer these research questions, we will rely on a multi-method approach, combining observational social and ecological background data with behavioral laboratory (lab) and field experiments, which will be supplemented by interviews and surveys (see section 3.1 and 3.2). Based on the insights generated we will, at the end of the project, synthesize our results with the intent to aid local fishery communities and governments aiming to identify and nurture strategies that allow for these fishers to make a good livelihoods today (even in the face of an uncertain and challenging future), to continue to develop - socially, culturally and economically - without jeopardizing future resource stocks, i.e. to be resilient (Folke, 2016).

Decentralized resource management has increasingly being applied as a solution to deal with problems of overexploitation. Also in fisheries the implementation of property rights has gained more attention in recent years as a way to address the negative consequences of open access fishing (Afflerback et al., 2014). User communities are in these cases ceded the rights (or at least part of the rights) to the resource and have the responsibility to manage the resource. The long-term ownership rights may incentivize fishers to conserve the resource but this can of course only be realized if the fishers manage to cooperate and collectively agree on a sustainable exploitation levels; in which case they would be able to overcome a tragedy of the commons (Hardin, 1968). In reality sustainable self-organizing collective management in CPR settings is not always easy to obtain (see e.g., Bromley et al., 1992; Baland & Platteau, 1996; and Ostrom et al., 2002 for comprehensive overviews). Field researchers have identified a number of variables that seem to affect the likelihood of users' ability to self-organize and collectively manage the resource, including resource scarcity, variability and predictability of resource flows but evidence suggest that the directional effects of these features are ambiguous (see, e.g., Ostrom, 2009 and references therein).

Behavioral experiments have been proven valuable to study drivers of human behavior in CPR systems (see, e.g., Kopelman et al., 2002; Ostrom, 2006). Recently, studies have also demonstrated the advantage of using experiments for analyzing potential impacts of specific ecological features, such as spatial dynamics, different types temporal resource dynamics, path dependency, resource interdependencies, uncertainties, and regime shifts (see, e.g., Cardenas et al., 2013; Janssen, 2010; Lindahl et al., 2015; Lindahl et al., 2016; Schill et al., 2015; Janssen et al., 2015). Some experimental studies find e.g. that increasing resource scarcity can lead to resource depletion (Herr et al., 1997), whereas others find that the threat of resource collapse (a regime shift) can lead to more cautious behavior and more cooperative outcomes if users are allowed to communicate (Lindahl et al., 2016). Experimental studies focusing e.g., on stock size uncertainty show that subjects request significantly more from the CPR (in a one-shot game without communication) with increasing uncertainty about its size (Budescu et al., 1990; Gustafsson et al., 1999). This result is also confirmed with a dynamic design that incorporates temporal resource dynamics and path dependency (Hine and Gifford, 1996). However, it is important to note that these two latter studies do not allow for communication between resource users. Schill et al., (2015) allow for communication and find that when resource users face a higher risk of an abrupt drop in the renewal rate of the resource, they are more likely to form cooperative agreements, but that the magnitude of this effect depends on how resource users perceive the risk. Anderies et al., (2013) find that cooperative behavior becomes more variable when resource flows become more variable, but that a good understanding of system structure may enable communities to adapt to these challenges and cooperate. Baggio et al., (2015) use a similar design as Anderies and colleagues, but without communication, and find that environmental variability has little or no effect on exploitation and cooperation.

Most of these experimental studies, and generally the bulk of behavioral experimental evidence, is based on 'WEIRD' participants, i.e., students from Western, Educated, Industrialized, Rich, and Democratic countries (Henrich et al., 2010). Hence, if there is an interest in potential behavior of actual resource users, lab results need to be validated and evaluated in light of a relevant context (Anderies et al, 2010). For example, much research, including CPR research is centered on conditions for environmental sustainability. This may be an important question for researchers, but not necessarily for resource users (at least not in the short term). For them, their livelihoods and well-being comes first, which means that their measures of management success may be very different from the researchers' measures.

This becomes especially relevant in contexts where resource users critically depend on the resource for their livelihood. *Resource dependency* has been highlighted as one of those factors that will determine if users manage to self-organize and collectively manage the resource (see for example, Ostrom et al., 2002; Ostrom, 2009; Berkes and Folke, 1998) and some studies emphasize that resource dependency in combination with the open access nature of fisheries has led and will lead to resource degradation (Cinner et al., 2011). Some solutions that have been advocated are therefore centered on making these fisheries more economically efficient (while restricting access) and at the same time to incentivize fishermen to leave the sector. However such strategies fail to fully recognize the different potentials and limitations fishermen face such geographical immobility and restricted opportunities for livelihood diversification.

The strategies that fishermen are likely to adopt will of course depend on the available options they have such as opportunities for income substitution/diversification and to what extent they can relatively easy move from one fishing area to another. We also hypothesize that the strategies fishers are likely to adopt also crucially depend on their *past experiences (memories)* of previous fish stock changes and fluctuations and potentially also on their past experiences of cooperation efforts. Prediger et al., (2010), for example, explore experimentally the differences in cooperative behavior between communal farmers in Namibia and South Africa, who share the same ethnic origin but have different historical and ecological constraints. They present evidence that the relevant ecosystems (grasslands) in Namibia are more sensitive to over-grazing and more likely to become irreversibly degraded. At the same time the authors also note that Namibian resource users have a longer experience of cooperative resource management and intact traditional norms. This is also reflected in their experimental results: Namibian resource users behave more cooperatively in a CPR game than resource users from South Africa.

Similarly, Gneezy et al., (2015), compare experimental outcomes in two different fishing societies. The authors observe that in one of the regions, the ecological constraints favor more cooperative activities (to avoid and coordinate over risky activities). They observe higher levels of cooperation in the experiments in that region. These studies show that ecological factors and past experiences of such *do* influence the behavior of resource users and should be included in the set of contextual factors to explore further. Our research proposal can be seen as one attempt to approach this research gap. *Women* play a critical role in every link of the value chain in small-scale fisheries (processing, marketing, preparing nets, boats, capturing bait and fry). Many of women's roles and contributions to the fisheries sector have been invisible and undervalued for too long, resulting in women remaining in a marginalized position and excluded from decision-making mechanisms (Lentisco and Lee 2015). In recent times, more literature has been directed to making women's roles more visible. Nonetheless, much more can be done to improve gender-related data in the sector, especially in small-scale fisheries, which is something we also plan to do in the proposed research project.

Analytical models (and policy prescriptions) often rest on specific behavioral assumptions, such as the resource users being rational in the sense of making use of all available information, including probabilities of future events, to maximize their expected utility. Empirical evidence suggests, however, that decision-makers might often be better characterized as boundedly rational (Simon, 1955), and that in complex and uncertain environments, people typically violate the principles of expected utility maximization and rely instead on shortcuts or heuristics (Kahneman et al., 1982, Gigerenzer and Gaissmaier, 2011). Further, people have difficulties with interpreting probabilities (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) and are averse to situations pervaded by ambiguity (Ellsberg, 1961). If we want to study behavioral strategies of fishers in complex socio- ecological environments we need to acknowledge such behavioral features/biases as they can have a profound impact on behavior and consequently outcomes (World Bank, 2015). Our multi-method approach will allow us to also gather empirical data of individual attributes (e.g., social preferences and preferences towards risk and ambiguity) as well as socio-economic characteristics (e.g., gender, age, household income, household size, savings behavior, potential to diversity income, fishing behavior etc.) that may influence their individual and collective behavior.

Chapter 2

Literature Reviews

In the SSF literature response to resource scarcity has gained quite some attention. There are for example several studies investigating readiness to exit fisheries due to resource scarcity. These have found considerable variation between villages and countries (Daw et al., 2012, Daw et al., 2011, Cinner et al., 2009) and it has been suggested that this difference in response to scarcity is strongly influenced by resource dependency, meaning the extent to which these fishers can rely on alternative livelihoods. Cinner et al. (2009) found that economically poorer regions with few attractive alternative livelihoods were associated with less exits and more over-fishing in response to fish stock decline. Daw et al. (2012) found that fishers in more economically developed sites were less inclined to exit fishery. But these were typically fishers that did not have access to other sources of livelihoods. When fishing is the only source of livelihood (even if they make a good livelihood), there is a need and/or a want to continue fishing regardless of stock decline (see also Cinner et al., 2011, Hill et al., 2011).

There are other studies in the SSF literature highlighting the different ways in which one can think of resource dependency and how that links to adaptation to negative shocks for small-scale fishers. Some fishers may for example be resource dependent because of strong cultural ties, attachment to place, and identities as fishers (Van Putten et al., 2018), which may make them less willing and likely to exit the fishery sector. Other ways to buffer against negative shocks and to mitigate resource scarcity can then instead be to use multiple gears and switch between fish species and/or seek new fishing grounds (Gonzales-Mon et al., 2021, Finkbeiner, 2015). But such adaptations often entail costs e.g. associated with the need to go out further to find fish, changing and investing in different gears (Monnier et al., 2020), and many small-scale fishers simply do not have that financial capacity. Another way (for some fishers the only way) to adapt to negative changes in stock abundance is then to diversify livelihood through additional employment as low skilled part time workers in other sectors, such as tourism, agriculture, or construction.

To complicate matters further, many of these SSFs are also threatened by over-exploitation stemming from open access regimes (Purcell and Pomeroy, 2015, Monnier et al., 2020). Long-term sustainable resource use then hinges upon whether or not fishers manage to self-organise and collectively agree on a sustainable management. Evidence from behavioural common pool resource (CPR) experiments suggests an ambiguous directional effect (of responses to resource scarcity) on cooperation and sustainable resource use. On the one hand, increasing resource scarcity can lead to less cooperation, more competition for a scarce resource, and an increase in exploitation (see e.g., Prediger et al., 2014 , Blanco et al., 2015 , Gatiso et al., 2015 , Pfaff et al., 2015). On the other hand, resource scarcity can also promote cooperative behavior because of an additional incentive to use resources sustainably in order to maximize the welfare of the entire group, leading to more cautious exploitation behaviour (Lindahl et al., 2016, Schill et al., 2015, Oses-Eraso & Viladrich-Grau, 2008, Oses-Eraso & Viladrich-Grau, 2007).

We want to contribute to these fields of research in several ways by answering the question: How does resource dependency, defined as having few (or no) options to diversify one's livelihood, affect how fishers, sharing a common fishing ground, respond to increasing resource scarcity? We answer this research question with the help of a framed dynamic CPR experiment with small-scale fishers. In this experiment we observe and compare behavioural responses over time of fishers that have been presented with different scenarios (treatments), reflecting different degrees of resource scarcity (none, moderate and severe). The participating fishers differ in resource dependency, meaning that whereas some can diversify their income, others cannot, and we can then link observed behavior to this variable. We thereby contribute to the literature on SSFs by adopting a CPR context in which it is possible for fishers to self-organise, recognizing that many of these SSFs are already under such management and additionally, that it has gained an increasing attention in fisheries as a way to address the negative consequences of open access fishing (Afflerback et al., 2014). We also contribute to this literature, where most studies on behavioural responses have been collected through survey instruments, by using a controlled behavioural experiment which means we can observe real behaviour responses rather than hypothetical (Lindahl et al. 2021). We contribute to the (experimental) CPR literature by investigating the role of resource dependency for behavioural responses when resource users face resource scarcity.

When investigating responses to resource scarcity, there are of course other contextual factors that could affect behaviour, such as access rules, infrastructure, or local ecological conditions (Gonzales et al., 2021). To tease out the role of resource dependency, in the form of being more or less able to diversify income, one needs to isolate this effect from other contextual factors. We aim to do so by systematically targeting fishing communities that differ in the degree to which they can diversify their livelihood but still share other context specific factors. While we recognize the various ways in which fishers can buffer against negative shocks (and be more or less resource dependent), we focus here on the role of livelihood diversification that involves seeking part time employment in other sectors.

Based on previous empirical findings, our overall hypothesis is that fishers that can diversify their livelihood are more likely to respond to resource scarcity by reducing their fishing effort compared to fishers that cannot diversify their livelihood. We test this hypothesis by running our experiment with small scale fishers in Thailand. We chose Thailand because SSF is a relatively large sector in Thailand and many of the fishers are also facing the main challenges we are interested in - increasing resource scarcity of unregulated fish stocks in the face of climate change. Given the number of SSF it was also relatively easy to find communities in Thailand where fishers differed in resource dependency but that were still similar with respect to other contextual variables. Exactly how we choose communities and fishers is detailed below in the methods section.

Chapter 3

Theory and Methods

The CPR research field engages many different researchers from various disciplines, employing different methods and each with different research focus. When we formulate hypotheses, interpret results, and synthesize results, we will thus draw on theories and insights from various disciplines and fields in relation to the CPR research field (e.g., environmental and behavioral economics, cognitive and social psychology, and sociology, resilience thinking (Folke, 2016) and social-ecological systems research (Berkes and Folke 1998)). To elicit data on user behavior we will follow the experimental tradition of the CPR research field and perform behavioral experiments, which we supplement by interviews/surveys and observational data (see also section 3.2 for more details).

An experiment is a ‘randomized evaluation’ that can measure the impact of specific variables on behavior by randomly assigning individuals to treatment groups. Experiments thus create exogenous variation in the variable of interest that allows establishing causality, rather than mere correlation. We will employ both lab and lab-in-field experiments (sometime referred to as framed field experiments). The use of different types of experiments is important because different participants may convey different problem knowledge, experience that may influence behavior. By slowly progressing towards the real situation, we can learn which factors are of ultimate importance. Moreover, running the experiment with actual resource users helps us assess the explanatory power of the lab outcomes by comparing both settings (Levitt & List, 2009). Our lab experiments will mainly serve as critical test beds before we take the design out in the field. Our lab experiments will be conducted on Stockholm University campus with students, but with a real problem- and resource description (framed lab experiments, see Harrison and List 2006 for a classification). The field experiments will be conducted with small-scale fishing communities in Colombia and Thailand (see section 3.2 for more details).

In these experiments, we will zoom in on aspects which, to our knowledge, have not been analyzed systematically before. We build forth on our previous experimental work, allowing for cross comparisons and ensuring the implementation of experimental designs that have been carefully tested and evaluated before (see e.g., Lindahl et al., 2016 and Schill et al., 2015 as well as preliminary results). In a nutshell, the design captures a dynamic CPR game with path dependent resource dynamics (a logistic type of resource dynamics). Groups of four individuals share a renewable resource and are provided with complete information about the resource dynamics. To mimic the field, face-to-face communication is allowed (but not forced) but individual decisions are anonymous. Each decision has a monetary consequence and the experiment consists of a specific number of rounds (but the end of the experiment is not known), which means behavioral patterns over time can be observed. In each round the participants can communicate. If they take this opportunity they can share their knowledge about the resource dynamics and what they think is optimal to do. They can also form group agreements about what to do and how to share the resource. With this project we plan to 1) extend the design and allow also for other types of resource dynamics (variability, increasing scarcity) and 2) test and evaluate the design in different field contexts. Behavioral experiments can serve as an entry point for discussion about the natural resource dilemma participants are facing in reality. There is now also evidence that they can also contribute to an increased understanding and awareness of the collective action problem facing even lead to improved 'real' resource management, particularly in groups participating in debriefing session after the games they play (Meinzen-Dick et. al., 2014). For this reason, we also plan to hold post experimental meetings in each community.

3.1 Research procedure

To answer our research questions we will conduct our research in three phases. The first phase is about testing and evaluating different experimental designs using lab experiments. The second phase is about collecting relevant socio-economic and ecological data from potential field sites; to run the field experiments; perform individual interviews; and to hold group meetings with fishers. During the last phase, phase 3 the plan is to synthesize the findings obtained.

Phase 1: Lab experiments

The different treatments we propose to test are listed in Table 3.1 below. The procedure will be that all groups first play the baseline case (treatment LAB0 – control treatment). In a second stage of the experiment the groups then play one, and only one, of the other treatments (LAB1-1, LAB1-2, LAB2-1 or LAB2-2). All participants then play a risk game or an ambiguity game (LAB3-1, LAB3-2), where we will control for potential treatment effects by randomizing participants to one of the risk/ambiguity games. (Cardenas and Carpenter, 2013). We will run these risk/ambiguity games individually and in groups as we suspect (and want to test) whether 'risk behaviour' are also be affected by communication. Towards the end of the experiment they fill in a questionnaire to elicit individual attributes and characteristics (e.g., social preferences, age, gender and educational background).

Table 3.1 Lab experiments design. There are 4 participants per group. Each treatment we plan to run 10-15 times with 80-100 participants respectively. Some experimental parameters, e.g., the exact probabilities of a drop, and the range of the unknown drop in the resource growth rate and how to communicate these settings will be decided upon based on results from a pilot experiment.

Treatme	**Description**	**Variables collected**
LAB0	Deterministic dynamics: Logistic type of resource dynamics, see Fig. 1. (Control treatment)	Individual harvest behavior; group harvest behavior
LAB1-1	Moderate uncertainty (risk with known effects): Stochastic resource flow e.g., in each experimental round there is a certain probability that there will be a known drop in growth rate.	Individual harvest behavior; group harvest behavior
LAB1-2	High uncertainty (risk with unknown effects): Stochastic resource flow e.g., in each round there is a certain probability that there will be an unknown drop in growth rate.	Individual harvest behavior; group harvest behavior
LAB2-1	Predictable increasing resource scarcity: every X round there is a known drop in growth rate	Individual harvest behavior; group harvest behavior
LAB2-2	Unpredictable increasing resource scarcity: every X round there is an unknown drop in growth rate	Individual harvest behavior; group harvest behavior
LAB3-1	Risk game	Individual risk behavior, group risk behavior
LAB3-2	Ambiguity game	Individual behavior towards uncertainty, group behavior towards uncertainty
Q1	Questionnaire/survey	Socio-economic variables, understanding of resource dynamics and game setup, attitudes towards equality/inequality, cooperation etc.

Phase 2: Collecting observational data, experimental data and interview data in the field

We will conduct the field work in fishery communities in Thailand. We chose this country for two main reasons. First, these countries fulfil the criteria for ODA recipients. Although the countries do not belong to least developed countries, average income in the communities we plan to visit is within that range. Today, 75% of people living in poverty can be found in middle income countries (Skr. 2016/17:60), these are for example people, whose incomes are realized on a daily basis. We therefore argue that these communities are representative also for similar communities in the least developed countries of the ODA list. Second we can draw upon previous experience of field experiments (see preliminary results) in the respective countries as well as well-established contacts to research institutes and organizations that will substantially facilitate our field. In both countries, we have already - together with our on-site collaborators - identified potential field sites. In Thailand fishing communities along Andaman Sea would be our samples.

We visited two communities in Thailand that differ with respect to one contextual variable (e.g. resource dependency or past experience of ecological crises) but that in other respects (e.g., language, ethnicity and culture) are similar (these communities will be based on pre-visits and data collection of socio-economic and ecological data). For example, some communities have better access (e.g., due to geographical location) to other income sources like (e.g., tourism, agriculture etc.) and, hence, more opportunities for income substitution. In each of these community, within a country, we plan to run the same treatments. We plan for a minimum of two treatments and aim for 20 groups per treatment. One of the treatments will be the control treatment (LAB1-0). The choice of the other treatment(s) will be based on insights generated from phase 1 of the project. Thus although we run the same additional treatment(s) in each country; the additional treatment(s) may differ between countries. Lessons from the lab experiments will be factored in combination with information about predominant challenge the communities in the specific country are currently facing or are more likely to face. We also need to account for complexity of the treatments (we need to account for illiteracy and everything as to be communicated verbally and visually only). With the field experiments we will thus be able to explore the role of contextual variables outlined above that we are especially interesting in. In all communities, participants will also play the risk/ambiguity games.

We will also in the field complement the experiments with interviews for eliciting individual attributes (e.g., social preferences, attitudes toward collective action) and socio-economic characteristics (e.g., gender, age, household income, household size, savings behavior, potential to diversity income, fishing behavior, share of women involved in various activities etc.) that may influence their individual and collective behavior. We also plan for a follow-up meeting in each community where we together with the fishers aim to reflect upon the experiment in itself and on the potential insights they have gained from participating in the experiment, that may be relevant for their decisions (every-day and long-term) and for policy advice (see section 3.1).

Phase3: Synthesize findings

The synthesis of the project focuses on insights gained across the three phases with respect to individual and collective behavior and strategies employed to deal with increasing resource scarcity and unpredictability of resource flows. We want to synthesize for example how these strategies may differ depending on context such as degree of resource dependency or depending on past experiences of environmental crises and how these contextual factors may correlate (or not) with individual attributes. The aim of the synthesis is identifying strategies allowing for good livelihood opportunities without jeopardizing future resource stocks.

3.2 Scientific deliverables and time table

Our research activities will result in at least three peer-reviewed research articles and at least one synthesis paper. Project results will be presented at scientific conferences and other research meetings. The project work plan and time table is given in Table 3.2.

Table 3.2. Project work plan and time table for tasks and scientific deliverables.

	Lab experiments	Field experiments Colombia (FIELDC)	Field experiments Thailand (FIELDT)	Synthesize findings	Output
2019	Design, plan, run and analyze results	Design, plan			1-2 research articles reporting the results of the lab experiments
2020		Run, analyze results	Design, plan		1 research article reporting the results of the field experiment in Thailand
2021			Run, analyze results	Synthesis	1 research article reporting the results of the field experiment in Colombia; I synthesis article reporting the results of the whole project.

Small-scale coastal fisheries are central to local economies, poverty alleviation, and food security for millions around the world. Many of these fisheries are severely threatened by chronic overfishing and climate change impacts. These combined pressures call for better management but solutions can be hard to find, especially when they may depend on social, ecological and historical context. At the same time, more attention in the empirical literature on the commons is also directed towards understanding how different contextual factors influence emergence and dynamics of cooperation (see, e.g, Dietz and Henry, 2008) and overall resource use but, as far as we understand, relatively little attention has been directed towards understanding the specific influence of social-ecological contextual factors, at least not in a more systematic approach. The proposed research aims to help fill these research gaps by centering on individual and collective behavior, including their internal and external drivers in a systematic approach.

This is also in line with conclusions of the World Banks World Development report from 2015 'Mind, society and Behavior' that we need to account for and advance our understanding of the psychological, social, and cultural influences on decision making and human behavior as they have a significant impact on development outcomes.

The researchers involved in this project have conducted two field experiments in Thailand. The purpose of that project is to elicit behavioral responses to abrupt ecosystem changes (regime shifts) and to uncertainties associated with them. The results of the field experiments are currently in manuscript form (see below for a brief summary of results). In the very same project a number of lab experiments were also conducted that are published. (Lindahl et al., 2016 and Schill et al., 2015)

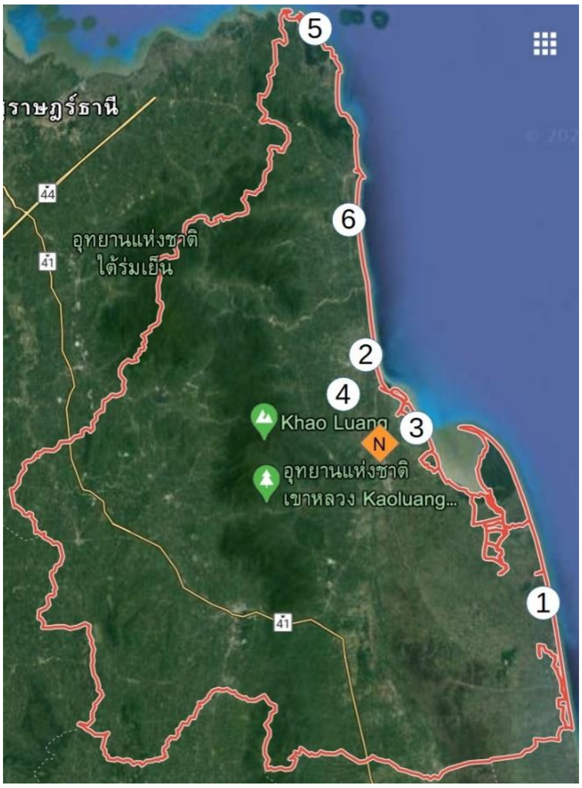
Field Experiment in Thailand We ran a dynamic CPR experiment with artisanal fishers (N=96) in a community in Thailand where participants faced either a smooth resource dynamics (the baseline treatment), or a resource dynamics that entailed an abrupt and potentially persistent drop in the resource growth rate (regime shift/threshold treatment). We found that groups confronted with a threshold were more likely to cooperate. However, cooperative groups did not manage the resource more efficiently than non-cooperative groups; they over-exploit less but also under- exploit more than non-cooperative groups. Our experimental results also indicated that other individual specific factors e.g., age and gender and if they had a side income seemed to influence behavior in the experiment, but only in the baseline treatment.

These studies have made it clear to us that if we want to advance our understanding of human behavior in CPR dilemmas in general and for SFFs in particular, which is more pressing than ever before, we need a more systematic explorations of how different ecological and socio-economic contextual factors influence behavioral outcomes. The work we propose here can be seen as one attempt in this direction.

3.3 Selection of communities

To be able to isolate the effect of resource dependency on extraction behaviour it is important that the communities included in our study are similar with respect to other contextual factors, such as cultural, institutional and ecological. For this reason we decided to conduct the field work in one geographical area. We needed this area to have a relatively large population of small-scale fishers to be able to draw a big enough sample. We looked into official statistics to get information on the number of small-scale fishers in different areas in Thailand and based on these statistics, and on already established contacts, we targeted the coastal area of the province Nakhon Si Thammarat (NST), more precisely the therein located Tha Sala district, Muang district, Hua Sai district, Kanom district, Sichon district, and Pak Phanang district. See Figure 3.1.

Figure 3.1 Study areas



NST is one of the southern provinces of Thailand located on the western shore of the Gulf of Thailand. In 2020, the service sector, industry sector and agricultural sector (including fishery) accounted for 45.5%, 27.6% and 26.9% respectively of total GDP (Comptroller General's Department, 2020). The number of households involved in fishery in NST province are close to 5800, which makes NST the province ranked second with respect to households involved in fishery, only outranked by the Songkla Province (around 6000 households) (Community Development Department, 2015).

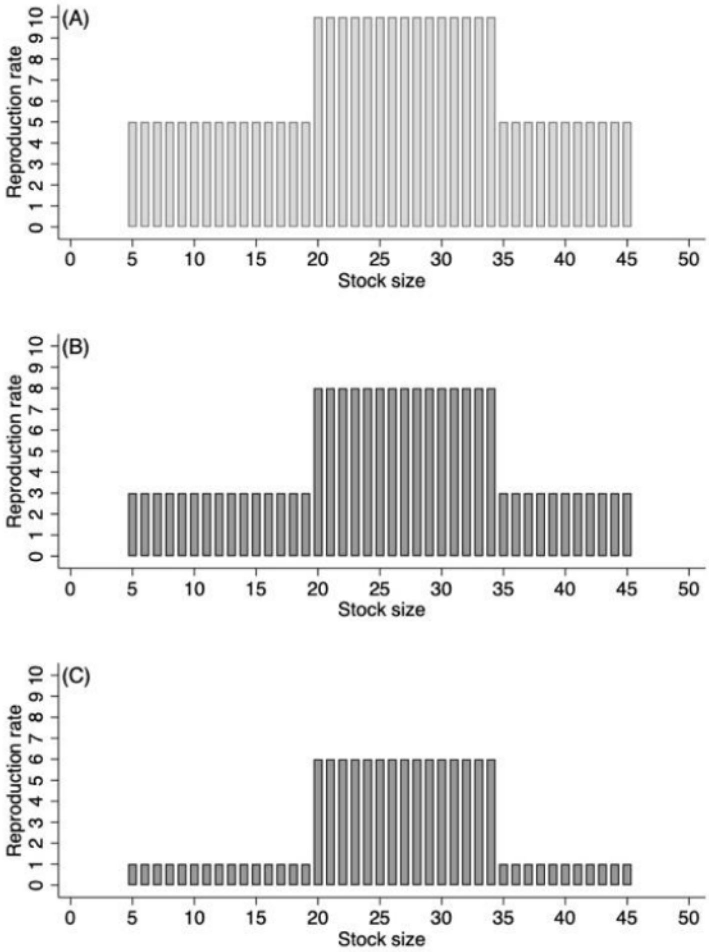
We interviewed our established local contact persons who work with fishing communities in the area to get more information on the different SSF communities in the districts and in particular to what extent they can be classified as resource dependent or not. Our definition for resource dependency at the community level hinges upon to what extent fishers in these communities diversify their source of livelihood. This means that we classify a community as resource dependent if the livelihood of most fishers in this community depends solely on what they catch from the sea. Fishers in a community that is less resource dependent can diversify their income, in our case e.g. by working in palm oil and rubber plantations, tourism, aquaculture, or in the fish processing industry. We wanted about half of our sample of fishers to come from resource dependent communities and about half to come from less resource dependent communities. We visited in total 10 communities along the coast, 5 of these communities we classified as resource dependent and 5 as less resource dependent.

3.4 Experimental design

A framed field experiment in the form of a dynamic common-pool resource (CPR) game was designed to capture the role of resource dependency measured in terms of alternative livelihood options for behavioral responses of small-scale fishers to potential resource scarcity. This experimental design directly builds on a series of laboratory experiments (with students as participants) introduced in Lindahl et al. (2016), which test the effect of a potential ecological regime shift on user behavior in a CPR context. Here, we are interested in the role of resource dependency for behavioral responses in the face of different degrees of resource scarcity. The particular design used here was further informed by a series of field experiments (with fishers as participants) conducted in Thailand (Lindahl and Jarungrattanapong 2018) and Colombia (Schill and Rocha 2020), which themselves also build on the previously mentioned laboratory experiments.

The experiment included a baseline group (no scarcity with certainty), and one treatment group with two different resource scarcity scenarios (moderate and severe). Figure 2 shows the underlying resource dynamics of both experimental groups. In both baseline and treatment groups, participants were confronted with a simple form of a discrete version of the logistic growth function where the minimum CPR stock size allowing for regeneration is set to five units and the maximum stock size is set to 50 units. What differs between the baseline and treatment groups is the regeneration rate between a stock size of 5-45 (compare panels A-C in Figure 2).

Figure 3.2 Graphical illustration of underlying resource dynamics



Note: (A) represents the resource dynamics of the control/baseline group; (B) represents the resource dynamics of the moderate scenario of the scarcity treatment; and (C) represents the resource dynamics of the severe scenario of the scarcity treatment.

At the beginning of the experiment the initial fish stock was 50 units, and each caught fish was worth 10 Baht (≈ EUR 0.28/USD 0.31). The experiment consisted of two stages. In the first stage of the experiment, all participants played the baseline scenario (Figure 2A) for a maximum of 6 rounds. In the second stage, participants were randomly allocated to either continue playing baseline or to the treatment. The resource was reset to 50 units for all experimental groups and the participants played additionally a maximum 10 rounds. In the uncertainty treatment participants were informed that the reproduction rate of the fish stock had changed severely or moderately. However, participants were not informed which scenario they were actually playing. The scenario was decided by the means of a lottery (see experimental procedure). Here it is important to note that once the participants have played the first round of the second stage they could, if they properly understood the resource dynamics, deduce which scenario they were playing, because they received information about the regeneration rate (see experimental procedure). So this means that in the very first round of the second stage there was uncertainty about how scarce the resource is. From round 2 and onwards we assume that there was certainty about the scarcity scenario they were playing (we actually asked this and almost everyone figured it out).

Participants (fishers), in groups of four, were asked to catch fish from a shared fishing ground, in order to resemble field context. Individual harvesting levels were treated anonymously; however, participants had no communication restrictions, i.e., participants were able to communicate face-to-face from the start and at any point during the experiment, and were allowed to discuss common fishing strategies and could disclose their individual exploitation levels. Participants were not informed about the exact number of rounds to be played to avoid the end-of-game effect. They only knew that the experiment had two stages and that it lasted a maximum of 3 hours. The experiment was dynamic in the sense that previous decisions of the user group determined the initial conditions for decision-making in the following round. The experiment was designed as a paper-and-pencil experiment (see Janssen et al. 2014). The experimental instructions are available upon request from the authors.

The experiment was conducted in 10 rural small-scale fishing communities in the Nakhon Si Thammarat province, located on the coast of the Gulf of Thailand (see map in Figure 3.1), during the first half of 2020. Participants were recruited by researchers at the Sukhothai Thammathirat

Open University in Nonthaburi province in close collaboration with a local coordinator, who works for a local fishery organization and is well known by the local inhabitants in the area.
All participants were first gathered and welcomed, consent forms were read out and signed. Each participant was randomly assigned to a group of four people, and precaution was taken to avoid, if possible, assigning individuals from the same household or close friends to the same group. Participants were allowed to participate only once. All participants received 200 Baht for their participation together with individual earnings ranging between 330 and 1040 Baht (including show-up fee).

Once groups were formed, participants were explained that together with their group members, they had access to a common fishing ground. During each round, participants decided how much fish they wanted to catch. Their individual catch could be between 0 (which is to not fish at all) and the total amount of fish available in the current round, which depended on how much fish was collectively extracted in the previous round. After each round, the new resource stock was calculated by the experimenters. The new stock size, aggregate level of harvest, and corresponding regeneration rate were disclosed to the group, but not individual harvesting decisions to maintain anonymity. As long as there was fish left, participants were allowed to continue playing. To make sure participants understood the game, the experimental leader went through an example, clarified remaining questions and played two practice rounds with the group before the actual experiments started.

The experimental team for each group included at least: one experimental leader (reading out the instructions and making sure that everyone understood the experiment), a resource stock calculator, a resource stock calculator assistant, and two observers. Experimental leaders rotated across treatments to minimize experimenter biases. The experiment involved 82 groups (328 participants), of which 43 groups (172 fishers) came from resource dependent communities and 39 groups (156 fishers) from less resource dependent communities. Local research assistants fluent in the local dialect played an important role in providing participants with assistance throughout the experiment.

After the maximum of 6 rounds were played, the fish stock was reset to 50 and the second stage of the game was introduced. In the resource scarcity treatment, groups were informed that a reduction in the fish reproduction rate had occurred due to environmental changes (see Figures 2B and 2C). Participants knew that changes had led either to a moderate or severe resource reduction, and groups were presented with the moderate and severe depletion resource dynamics. 26 groups (104 participants) continued to play the baseline scenario, and the remaining 56 groups (224 participants) played one of the two scarcity treatments. A lottery determined which scenario (moderate or severe, Figure 2B vs. 2C) the participants played in the resource scarcity scenario. For this, an urn was filled with ten balls of green and red color.

Green balls represented the moderate-scarcity scenario, while red balls represented the severe-scarcity scenario. The ten balls in the urn were selected from a bowl containing 20 balls of which ten were red and ten were green. To ensure that the probability range for either scenario being played was between 0.2 and 0.8, the urn was firstly filled with two green and two red balls and, then, the remaining eight balls were randomly selected from the bowl containing the 18 mixed red and green balls. Neither the experimental leaders nor the participants knew the exact number of green and red balls that were in the end in the urn. Afterwards, the urn was covered, and one ball was randomly drawn to determine the scarcity scenario. Experimental leaders registered the groups' scarcity scenario without letting the participants know (although as we already mentioned they could figure the scenario out from round 2 of the new stage if they properly understood the resource dynamics). The lottery resulted in 24 groups (96 participants) playing the resource moderate-scarcity scenario, and 32 groups (128 participants) the severe-scarcity scenario. Table 1 illustrates the distribution of the number of groups (and fishers) in each treatment and across the two types of communities.

Table 3.3 Distribution of groups and participants across treatments. Number of participants in parentheses.

	Resource dependent communities	Less resource dependent communities
Baseline	14 (56)	12 (48)
Moderate	12 (48)	12 (48)
Severe	17 (68)	15 (60)

To better understand the responses of small-scale fishers to potential resource scarcity, the above described experiments were complemented with interviews with participants. All participants were interviewed collecting information on demographic and household questions.

Chapter 4

Hypotheses and Results

4.1 Formulating hypotheses

In this section we formulate hypotheses that can guide our empirical analysis. We formulate these hypotheses based on our research question and based on findings in previous literature (see Introduction).

Just to remind the reader, our research question is about how resource dependency at the community level (defined as being able to diversify one's income through another source of livelihood) affects how fishers respond to increasing resource scarcity. More specifically, we want to test if fishers from communities with less opportunities for livelihood options (more resource dependent) respond differently to resource scarcity compared to communities that are less resource dependent.

So what do we mean with response and how do we measure this in the analysis? In our experiment, fishers respond to the different situations by extracting more (or less) from the common pool individually and as a group. The group resource extraction is directly linked to the state of the resource, in our case the resource stock size, where more exploitative behaviour translates to a smaller stock size and potentially resource depletion. From a sustainability perspective it is interesting to make this connection and we will therefore focus on this as our measurement and compare stock sizes between treatments.

Based on previous research our overall hypothesis is that fishers in communities that can diversify their livelihood (from now on we refer to them as less resource dependent) are more likely to respond to resource scarcity by reducing their fishing effort compared to communities that are more resource dependent, hence they will sustain a higher stock size. We now need to operationalise this hypothesis. First we want to see how fishers respond under normal conditions. Thus our first testable hypothesis is:

H0a: In the first stage of the game, the average resource stock size of resource dependent fishers does not differ significantly from the average resource stock size of non-resource dependent fishers. In the second stage of the game, only considering groups who faced normal conditions the average resource stock size of resource dependent fishers does not differ significantly from the average resource stock size of non-resource dependent fishers.
We then move on to analyse responses to unknown and known resource scarcity. We begin with unknown resource scarcity.

H0b: In the first round of the second stage of the game, the average stock size of resource dependent fishers does not differ significantly from the average resource stock size of non-resource dependent fishers.

We can then proceed to analyze behavior under known resource scarcity (moderate and severe).
H0c: From the second round and onwards during the second stage of the game (when there is resource scarcity), the average stock size of resource dependent fishers does not differ significantly from the average resource stock size of non-resource dependent fishers. This is true for both the moderate and severe scenario.

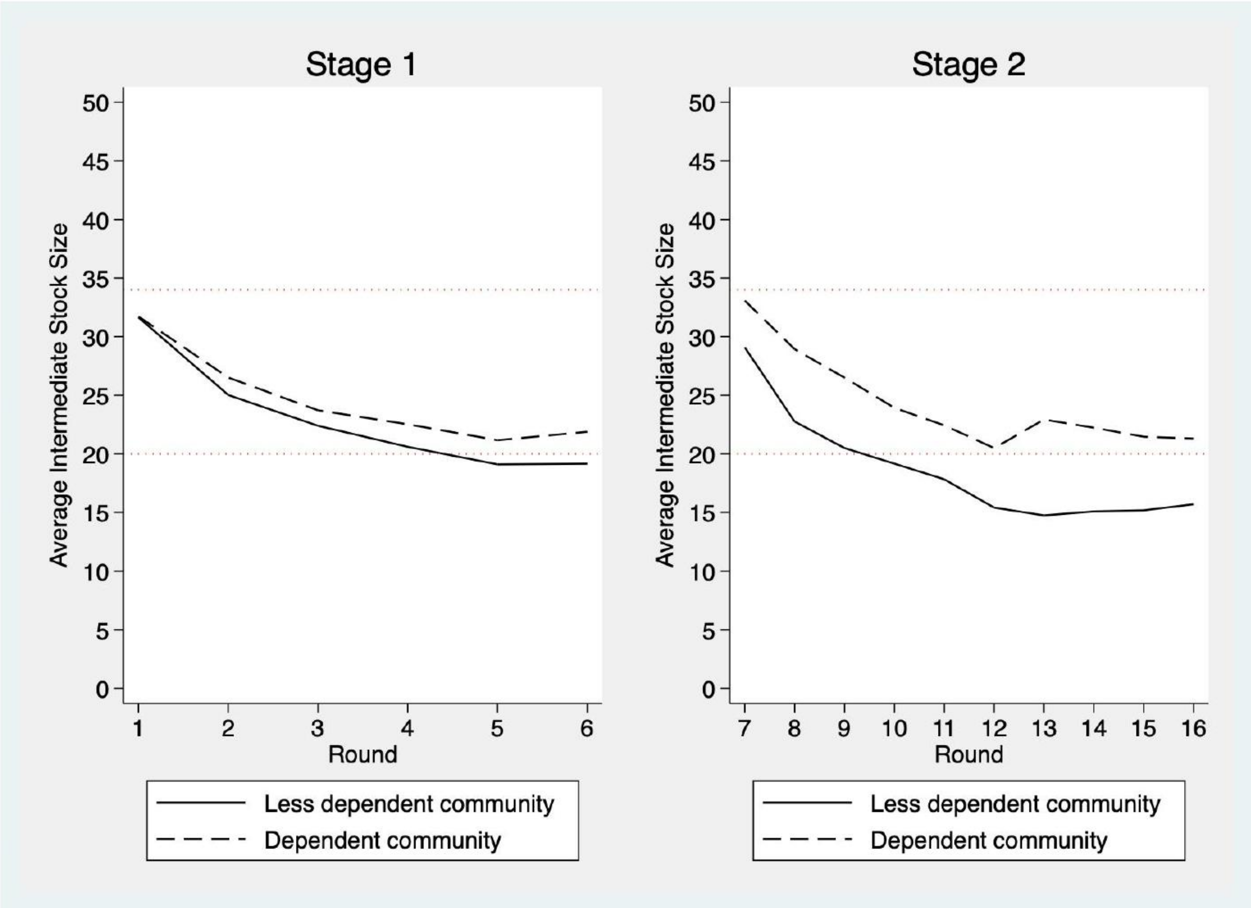
4.2 Statistical approach

We use STATA 16 for our statistical analysis. To test our hypotheses we compare group average values of stock size after extraction ('intermediate stock size'). We use nonparametric hypothesis tests when we can reject the normality assumption at the 5% significance level (Shapiro-Wilk test; Shapiro and Wilk 1965). In particular, we then use a Wilcoxon rank-sum test (MWW; also known as Mann–Whitney two-sample statistic; Wilcoxon 1945; Mann and Withney 1947) after we made sure that the assumption of equality of variances is not violated (using Levene's test; Levene 1960). If we cannot reject the normality assumption, we use standard two-sample t-tests (ref). We use multiple linear regression models to estimate average treatment effects, including interaction effects. We test the regression models regarding the assumptions of normally distributed residuals and heteroscedasticity. To account for heteroscedasticity, we use robust standard errors (robust sandwich type estimators; Elfron 1982, Long and Ervin 2000). We report exact p-values.

The role of resource dependency under 'normal' conditions

In order to test the effect of resource dependency under 'normal' conditions (i.e. no increased resource scarcity), we first focus on Stage 1 only. We find that the average stock size after exploitation for groups from resource dependent (24.25; SD=1.31) is slightly higher than the average stock size after exploitation for groups from less resource dependent communities (22.64; SD=1.34). Statistical analysis indicates that the distributions of average stock size after extraction between resource dependent and less resource dependent communities are not statistically different (MWW, P=0.241). We furthermore find that the probability that the average stock size after extraction of a random group of less resource dependent communities is larger than that of a random group of more resource dependent communities is 0.424. These results are in line with the left panel of Figure 3, which compares average stock size over time of groups from resource dependent with groups from less resource dependent communities. Groups from resource dependent communities sustain in each round of Stage 1 on average higher stock sizes (see Figure 4.1, left), however, this difference is not large.

Figure 4.1 Time series of average stock size after exploitation (intermediate stock size) for groups of resource dependent and less resource dependent communities. The left panel shows the time series for Stage 1 (round 1-6) and the right panel shows time series for Stage 2 (round 7-16). The red dotted lines indicate the stock size area with the highest regeneration rate.



We then focus on Stage 2 (see right panel of Figure 3). Since we are only interested in "normal conditions", we use only data from the control treatment (Baseline) (N=26). Using a two-sample t-test, we find that stock size averages are statistically different from each (P=0.0533); groups from resource dependent communities (26.7; SD=1.98) sustain on average higher stock size than groups from less dependent communities (20.13; SD=2.61). Hence, we can partly reject our first hypothesis (H0a).

Result 1: In the first stage of the game, the average resource stock size of resource dependent fishers does not differ significantly from the average resource stock size of non-resource dependent fishers. In the second stage of the game, however, (when only considering groups who faced normal conditions, i.e. played baseline) the average resource stock size of resource dependent fishers differs significantly from the average resource stock size of non-resource dependent fishers.

The role of resource dependency when facing increased but uncertain scarcity

To determine effects of increased but uncertain scarcity, given differences in resource dependency, we fitted a multiple linear regression with resource stock size after exploitation as dependent variable, while controlling for uncertain scarcity, resource dependency as well as interaction effects between the independent variables. We focus on the first round of Stage 2 only. We find that uncertain scarcity (i.e. uncertainty about whether scarcity is moderate or severe) has a significantly positive effect on average resource stock size after exploitation in the first round of Stage 2. This result is independent of resource dependency. Hence, although fishers respond to the uncertain scarcity we cannot reject our second hypothesis because there is no difference in average stock size after exploitation between resource dependent and less dependent communities.

Result 2: In the first round of the second stage of the game, the average stock size of resource dependent fishers does not differ significantly from the average resource stock size of non-resource dependent fishers. However, whether or not there is scarcity has a significantly positive effect on average stock size after exploitation.

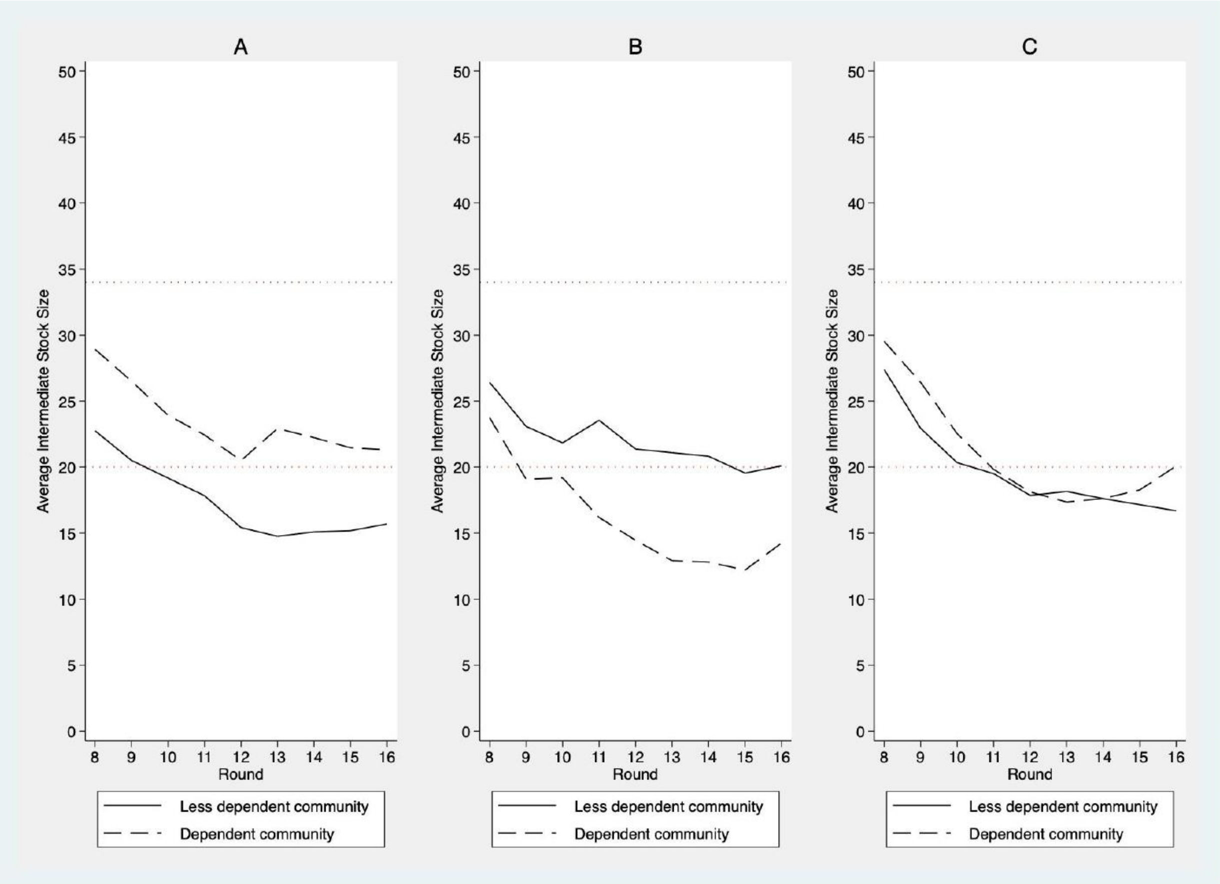
Table 4.1 Regression analysis. Estimated treatment effect given differences in resource dependency, including interaction effects. Stock size after exploitation of round 1 in Stage 2 as response variable.

Independent variable	**Stock size after exploitation (round 1 of Stage 2)**	
	Estimated treatment effect (robust std. err.)	**p-value**
Scarcity	5.806 (2.507)	0.023
Resource dependency	3.988 (2.767)	0.154
Interaction term		
Scarcity # dependent community	-4.394 (3.125)	0.164
Constant	29.083 (2.230)	0.000
R^2	0.1038	
Observations	82	

The role of resource dependency when facing increased and known scarcity

Figure 4 shows average stock size after exploitation over time for Stage 2 according to resource dependency (dependent vs. less dependent communities). We see that both resource dependency and the level of scarcity play a role. There is a difference in the patterns of average stock size after exploitation between the panels (A, B, C), indicating treatment effects. Moreover, there is also a difference within the panels comparing average stock size after exploitation of resource dependent with less resource dependent communities, indicating potential interaction effects. In the next step, we use regression analysis to analyse these effects.

Figure 4.2 Time series of average stock size after exploitation (intermediate stock size) across treatments in Stage 2. Panel A shows the time series for Baseline groups; Panel B shows the time series for moderate severity; and Panel C shows the time series for severe scarcity. Time series start at round 8, the round from which the severity of the resource scarcity was known to the participants. Panel A is the same as the Stage 2 panel in Fig. 4.1 but starting at round 8 (rather than round 7). The red dotted lines indicate the stock size area with the highest regeneration rate.



To determine average effects of moderate versus severe scarcity, given differences in resource dependency, we fitted a multiple linear regression with average resource stock size after exploitation in Stage 2 as dependent variable, while controlling for moderate and severe scarcity, resource dependency as well as interaction effects between the independent variables. We find that scarcity does not have a significant effect on average resource stock size after exploitation. However, resource dependency significantly influences average stock sizes (p=0.070). Resource dependent communities sustain on average higher stock sizes compared to less resource dependent communities. However, in comparison to groups from less resource dependent communities facing no scarcity, groups from resource dependent communities faced with moderate scarcity sustain on average lower stock sizes (p=0.16). This effect is stronger than the positive effect of resource dependency. Hence, we can only partly reject our third hypothesis (H0c): there is a significant difference in average stock size after exploitation comparing dependent with less dependent communities for the moderate scenario of resource scarcity.

Result 3: From the second round and onwards during the second stage of the game (when there is resource scarcity), the average stock size of resource dependent fishers differs significantly from the average resource stock size of non-resource dependent fishers. However, we only find a significant negative effect of moderate scarcity in combination with resource dependency.

Table 4.2 Regression analysis. Estimated average treatment effects given differences in resource dependency, including interaction effects. Average stock size after exploitation as response variable.

Independent variable	Average stock size after exploitation (Stage 2)	
	Estimated average treatment effect (robust std. err.)	**p-value**
Moderate scarcity	4.133 (3.712)	0.269
Severe scarcity	2.08 (3.105)	0.505
Dependent community	5.667 (3.087)	0.070
Interaction terms		
Moderate scarcity # dependent community	-11.608 (4.713)	0.016
Severe scarcity # dependent community	-3.946 (4.246)	0.356
Constant	18.033 (2.419)	0.000
R^2	0.088	
Observations	82	

Chapter 5

Discussion and Conclusions

In this report we wanted to investigate how resource dependency, defined as having the option or not to diversify one's livelihood, affect how fishers, sharing a common fishing ground, respond to increasing resource scarcity. Based on previous empirical findings, our overall hypothesis was that fishers that can diversify their livelihood are more likely to respond to resource scarcity by reducing their fishing effort compared to fishers that cannot diversify their livelihood. To test our hypothesis we ran a framed dynamic CPR experiment with small-scale fishers, where we could observe and compare behavioural responses over time of small-scale fishers that were presented with different scenarios (treatments), reflecting different degrees of resource scarcity (none, moderate and severe). The participating fishers differ in resource dependency, meaning that whereas some could diversify their income, others could not, and we could then link observed behavior to this variable.

We can first conclude that before we introduce the treatments, in the first stage of the game there is no significant difference in behaviour between resource dependent and less resource dependent fishers. Also before the exact scarcity scenario has been revealed (there is uncertainty about the severity of scarcity) there is also no significant difference in behavior. But when we introduce the treatments in the second stage of the game we find that resource dependent fishers respond differently to resource scarcity compared to less resource dependent fishers, but that this depends on the severity of resource scarcity. In the no resource scarcity treatment, resource dependent fishers exploit more cautiously compared to less resource dependent fishers. Under moderate resource scarcity there is also a significant effect but here resource dependent fishers exploit more aggressively compared to less resource dependent. Under severe resource scarcity there is no difference in behaviour between the two types of fishers, both types of fishers exploit quite cautiously.

These results could reflect that there are two contrasting forces at work. On the one hand responding with more aggressive exploitation behavior (which is in line with our overall hypothesis) can reflect that resource dependent fishers need to continue fishing to secure their livelihood. This is what we would expect based on empirical findings from the SSF literature. On the other hand responding with less aggressive exploitation behavior can reflect that more is at stake for resource dependent communities, triggering more cooperative behaviour (and less over-exploitation) to secure future livelihoods, which is in line with previous experimental results on commons management.

For future work we need to tease out these potential explanations and drivers more in detail so we account for them in policy design. Solutions that center on making small scale fishing more profitable, for example by incentivizing some fishers to leave the sector may not only fail to recognize that some fishers cannot leave the sector, but also that the common-pool nature of many of these fisheries bring an additional strategic/social dimension to the situation that can affect behaviour and overall outcomes significantly. Based on our results we suggest turning to one of Ostrom's design principles for successful commons management, the importance of facilitating arenas for conflict resolution. Such an arena could be especially important for strengthening community ties, for building social relationships, and for knowledge sharing (about ecological conditions), which we think can be essential in these vulnerable communities.

To strengthen our conclusions, however, additional studies, e.g., in different field settings, would need to confirm our findings. For one, it would be interesting to take the design to other locations, both within Thailand (keeping ethnicity and culture constant), but also to locations that differ with respect to socio-economic conditions. It would also be interesting to investigate whether (other) individual characteristics can be linked to behavioural responses.

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Appendix

Questionnaire

Info for interviewers: *information in italics is not to read out loud but provides instructions for how to ask a certain question or how to guide the respondent while answering*

First, please introduce yourself to the respondent, and ask him/her about his/her name. That makes the interview much more personal. But do not write down the respondents name because they should feel that their answers will be anonymous.

What is your name?

Please state the gender of the respondent without asking ☐ *Female (0)* ☐ *Male (1)*

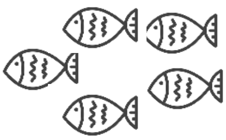
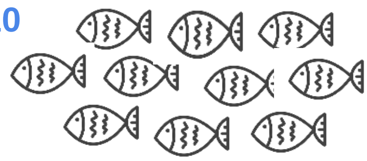
We now move on to the interview. We will ask you some questions about the game you just played, about your background, about your fishing activities, and about your views and perspectives on fishing etc. This information is important to us so we don't want to rush – please take your time for answering the questions. Also remember that the answers you provide will be treated anonymously. We will not tie your answers to you as a person.

POST-EXPERIMENTAL INTERVIEW

Section 0: Questions about the game

INTRO: We are going to start with some questions that are similar to the questions we asked you before during the game.

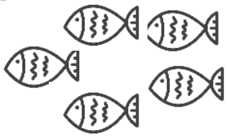
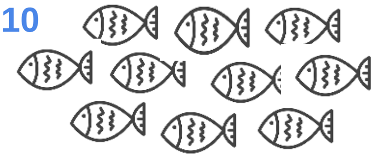
1. Imagine there are 22 fish left after each of you in your group has caught fish. How many fish will be regenerated in the next round? Please circle/cross away.

0	5 	10 	?

2. How certain are you that your answer is correct? Please mark " X " on this range below: *(explain the range: far left: not at all (was guessing); far right: to absolutely certain)*

Not at all (I was guessing) ________|________|________|________|________ Absolutely certain

3. Imagine there are 16 fish left after each of you in your group has caught fish. How many fish will be regenerated in the next round? Please circle/cross away.

0	5 	10 	?

4. How certain are you that your answer is correct? Please mark " X " on this range below: *(explain the range: far left: not at all (was guessing); far right: to absolutely certain)*

Not at all (I was guessing) ________|________|________|________|________ Absolutely certain

Assume that you start again with 50 fish in the fishing ground. This time, you are the **only** fisher (i.e. you have the fishing ground to yourself) and you want to get as much fish as you can in this game.

5. How many fish would you catch in the *first* round? ____

6. How certain are you about this amount? Please mark " X " on this range below:

Not at all (I was guessing) ________|________|________|________|________ Absolutely certain

7. How many fish would you catch in the *2nd* round?__________

8. How certain are you about this amount? Please mark " X " on this range below:

Not at all (I was guessing) ________|________|________|________|________ Absolutely certain

9. Remember the beginning of the last round, before you were going to make your last decision and right after hearing the new number of fish , which was <X>. (please insert here the respective stock size)
Were you surprised about this number of fish?

a. ☐ No, this was more or less what I expected. [continue with Q.10a]
b. ☐ Yes, I was surprised, I expected <u>more</u> fish. [Go to Q.10b]
c. ☐ Yes, I was surprised, I expected <u>less</u> fish. [Go to Q.10b]

*If **(a = not surprised)** in Question 9:*
10a. Can you explain why you were not surprised by this number of fish? *(you may tick multiple boxes)*

a. ☐ We had an agreement and I expected everyone to stick to it.
b. ☐ I was not surprised because I did not have any expectations.
c. ☐ Other, please specify:____

*If **(b or c = surprised)** in Question 9:*

10b. Why do you think the number of fish was not what you expected?

a. ☐ I don't seem to understand how the fish grows.
b. ☐ It seems that someone took more fish than agreed.
c. ☐ It seems that someone took less fish than agreed.
d. ☐ Something weird is going on that is out of our hands.
e. ☐ Other, please specify:________________________________

11. Were you at some other point during the game (game 1 or 2) surprised about the number of fish at the beginning of the round?

a. ☐ No *(go to Question 13)*
b. ☐ Yes *(continue with Question 12a)*

*If **Yes (= b = surprised during the game)** in Question 11:*

12a. In which game was this surprise?

a. ☐ Game 1
b. ☐ Game 2
c. ☐ Both games

*If **Yes (= b = surprised during the game)** in Question 11:*

12b. If you think of that moment, in how far were you surprised?

a. ☐ I expected there to be <u>more</u> fish.
b. ☐ I expected there to be <u>less</u> fish.

12c. Why do you think the number of fish was not what you expected?

a. ☐ I don't seem to understand how the fish grows.
b. ☐ It seems someone took more fish than agreed
c. ☐ It seems someone took less fish than agreed
d. ☐ Something weird is going on that is out of our hands
e. ☐ Other, please specify:________________________________

13. Did you feel that you were a group, i.e. working together and taking decisions together?

a. ☐ Yes
b. ☐ No

14. Did you trust your group members?

a. ☐ Yes
b. ☐ No

15. Imagine you could win some extra money through a lottery, which one would you choose?

a. ☐ A lottery in which you know for sure that you win 115 Baht
b. ☐ A lottery in which there you have a chance of winning either 335 Baht or nothing.

TRANSITION: Now this is about you…

Section 1: Demographics and household info

18. Age: *(specify)* _______ years old

19. Education:

☐ No formal education (1) ☐ Primary school (2)
☐ Secondary school (3) ☐ Vocational school (4)
☐ Bachelor degree (5) ☐ Higher than bachelor degree(6)

20 Were you born in this village?

☐ Yes (1)

Have you always lived here? Yes __ *(1)* No __ *(0)*

[IF 'No'] How many years have you lived in*this* village? Which years? *(specify)* ___________

☐ No (0), I was born in *(specify village/province)* __________________

When did you move here? *(specify the year)* _____

21 Size of Household *(unit of household means they share their income)*: ______persons (including yourself)

22. During the -year 2019, were there any months when you did not fish?

Yes ___ *(1)* No ___ *(2)*

[IF 'yes'] In which months did you not fish?

*Months **NOT** fishing mark with an X*											
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**

[IF 'Yes'] What do you do in the months you are not fishing? ________________

23.Household income, including remittances in Baht/month: *(If anyone has more than one source of income, please specify by source of income separately).*

Household member	Source of income	Monthly income (Baht)
Yourself	Fishery	
Yourself	Other	
Spouse		
Your son		
…		
	Remittances	
Total household income		

24.Household expenditure :__________________________ Baht/month

25.Do you want to have income from additional sources?

☐ Yes (1), because ____

Specify what kind of job you want _____________________________

☐ No (0), because ____

26. Imagine one of your family members becomes seriously ill and needs expensive treatment, how would you get the necessary money? *(you may tick multiple boxes)*

☐ Selling something (1) ☐ take a loan at the bank (2)

☐ take a loan shark from the informal moneylender (3)

☐ Borrow money from a friend or relative (4) ☐ Spend my savings (5)

☐ Other (6)

Section 2: Identity as a fisher and place attachment

27.. Do you think you will remain a fisher, say, in the next 10 years?

☐ Definitely not (0) Why?......................................

☐ No (1) Why?......................................

☐ Yes (2)

☐ Definitely yes (3)

☐ Don't know (4) Why?......................................

28. Do you see your children engaged in fishing in the future?

☐ Definitely not (0) ☐ No (1)
☐ Yes (2) ☐ Definitely yes (3)
☐ Don't know (4)

To what extent do you agree with the following statements? *Mark with an X on the scale 1-5 (where 1 = completely disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = completely agree). Please make sure that the respondent answers according to how (s)he feels right now, not some time ago.*

Q	Statement	1	2	3	4	5
29	I miss this villagewhen I am far.					
30	I feel like a outsider in this village.					
31	I feel safe while in this village .					
32	I am proud of this village.					
33	I would like to move away from this village					
34	I am rooted in *this village*					
35	I would like my family and friends to live in this villagein the future:					

Section 3: Description of fishing activities

Let's talk about your fishing activities.

36. How long have you been working in fishery? ________________ years.

37. Does your fishing activities only entail processing?
No, it also involves fishing (0)__________
Yes, I only work with processing (1) (go to Q45).
No ,it also involves coastal fishing

38.Do you at times fish with other people?
No ___ *(0)*
Yes ___ *(1)* How often do you fish with other people?
Rarely (1) ____ Half of the times (2) ____ Most of the times (3) ____
Always (4) ____

39.Do you use a boat/vessel? Yes (1) ___ Sometimes (2) _____ No (3) ___ *[IF 'no', move to Question 40]*
40. Are you the captain of the boat? Yes ___ *(1)* No ___ *(0)*
41. Do you own the boat? Yes ___ *(1)* No ___ *(0)*
42. How many people are you usually on the boat? _____ (persons)

43.. How many hours per day (approx.) or how many days per week do you spend on fishing activities including going to the sea and fishing processing?

___________ hours/day or ______________ day/week

44. a. If you think of a normal day in terms of catches, with how much fish (in kg) do you go home with on average, and how much do you earn on average on such a day?
Normal day: _____ kg   _____ Bath

b. If you think of a typical bad day (much worse than normal) in terms of catches, with how much fish (in kg) do you go home with, and how much do you earn on such a day?

Bad day: _____ kg   _____ Bath

c. If you think of a typical good day (much better than normal) in terms of catches, with how much fish (in kg) do you go home with on average, and how much do you earn on average on such a day?

Good day: _____ kg   _____ Bath

45. In case a bad day means no catch/earnings at all, how often does that happen?

(1) once a year; (2) once a month; (3) once a week; (4) several times per week

46. How much of your share of the daily catch…

1. …do you consume yourself (your household, includes what you eat right away and what you keep for storing)? *(indicate with an X)*

   None ___ Some ___ Half ___ More than half ___ All ___

2. …do you sell?

   None ___ Some ___ Half ___ More than half ___ All ___

3. …give away? *(e.g., to neighbors, friends, …)*

   None ___ Some ___ Half ___ More than half ___ All ___

47. What is the most common species you land and with what gear? If you work only in processing, what species do you work with and what gears have been used to catch these species? If your target/work with multiple species indicate also the other (at most three species in total)

	1. What species do you land the most?	**3. What gear do you use to capture said species?**

Section 4: Knowledge and attitudes about the fish abundance in the area

48. Have you been landing the same types of species since you started fishing here *<name of place>*? Yes (1)___ No (0)____

49. Is there a certain type of species that the villagers in this village cannot get enough of today in comparison to the past? Yes (1)___ No (0)___
[IF 'Yes'] Which one(s)? ____

50. Is there a certain type of species that the villagers in this village catch in abundance today in comparison to the past? Yes (1)___ No (0)___
[IF 'Yes'] Which ones? ____

51. Have you been changing gear since you started fishing here *<name of place>*?
[IF 'Yes'] From what to what? ______________________________
And why?________________________________

To what extent do you agree with the following statements? *Mark with an X on the scale 1-5 (where 1 = completely disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = completely agree).*

Q	Statement	1	2	3	4	5
52	I expect changes in fish abundance in the future					
53	I believe that our current fishing (by our community and other fisher communities) will have a significant negative affect on the abundance of fish in the future					
54	I believe that fishing done by other actors (commercial fishery) will have a significant negative effect on the abundance of fish in the future					
55	I believe that pollution will have a significant negative effect on the abundance of fish in the future.					
56	I believe that global warming will have a significant negative effect on the abundance of fish in the future.					

Section 5: Strategies for coping with 'harder times'

57. If you have a problem with, for example, your boat engine or fish traders, who do you ask for help? ________________________________

58. Do you (fishers) in this village lend gears to each other ? Yes (1)___ No (0)___

59. To what extent do you agree with the following statements "In the community we (fishers) help each other out during harder times (e.g. when it is difficult to make a livelihood from fishing)":

1	2	3	4	5
Completely disagree	Disagree	Neither agree nor disagree	Agree	Completely agree

60. Imagine that fish would decrease so much so you get about half of what you normally get today (for a forseeable future) – what would you do?

Let respondents answer this questions first without providing the options. If this does not work, provide the answer options. Once one option is chosen, ask the accompanying follow-up question.

☐ continue fishing (0) ______Why?: ____

☐ increase effort (1) ________How?: ____

☐ reduce effort (2) _________What would you do instead?: _____________________

☐ change fishing area (3) __ Where would you go?: ___________________________

☐ change gear (4) _________To which one: ___________________________________

☐ stop fishing (5) __________What would you do instead? _____________________

☐ other (6) ________________Describe: _______________________________________

61. Other comments (e.g. about fishing, about the game):

____

____