Fisher Behaviour and its Implications for the Governability of the Inshore Fisheries in Atlantic Canada

by

Evan Andrews

A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Doctor of Philosophy
in
Social and Ecological Sustainability

Waterloo, Ontario, Canada, 2020

EXAMINING COMMITTEE MEMBERSHIP

The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

External Examiner	Dr. Ingrid van Putten Senior Researcher
Supervisor	Dr. Derek Armitage Professor
Internal Member	Dr. Simon Courtenay Professor
Internal-external Member	Dr. Prateep Nayak Associate Professor
Other Members	Dr. Sarah Wolfe Associate Professor
	Dr. Jeremy Pittman Assistant Professor

AUTHOR'S DECLARATION

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

STATEMENT OF CONTRIBUTIONS

Evan Andrews was the sole author for Chapters One and Five which were written under the supervision of Derek Armitage and were not written for publication. Chapters Two to Four was based on manuscripts that were co-authored. Chapter Two was co-authored with Jeremy Pittman and Derek Armitage. Chapter Three was co-authored with Prateep Nayak, Sarah Wolfe, and Derek Armitage. Chapter Four was co-authored with Simon Courtenay and Derek Armitage. Andrews was the lead author for all three co-authored manuscripts. As lead author of these three chapters, Andrews was responsible for contributing to conceptualizing study design, carrying out data collection and analysis, and drafting and submitting manuscripts. Co-authors provided guidance during each step of the research, and provided feedback on draft manuscripts. Bibliographic citations for the co-authored chapters have been included below.

Chapter Two
Andrews, E., Pittman, J., and Armitage, D. Accepted. Fisher behaviour in coastal and marine fisheries: a systematic scoping review. *Fish and Fisheries.*

Chapter Three
Andrews, E., Wolfe, S., Nayak, P., and Armitage D. Manuscript. Coastal fishers' livelihood behaviours and their psychosocial explanations: Implications for fisheries policy. *Frontiers in Marine Science*

Chapter Four
Andrews, E., Courtney, S., and Armitage D. Manuscript. Strategies to strengthen inshore fisheries governability in Atlantic Canada. *Canadian Journal of Fisheries and Aquatic Sciences.*

ABSTRACT

The purpose of this dissertation is to advance a comprehensive understanding of fisher behaviour (i.e., current and former boat owners and crew who harvest multiple species) to strengthen the governability of the inshore fisheries in Atlantic Canada. Here, fisher behaviour is defined as individual fishers' and groups of fishers' actions that result from the mental processing and social negotiation of change and uncertainty in physical and social environments. Understanding how and why fishers behave in relation to changes in fish stocks and management decisions is key social scientific knowledge for strengthening governability. Yet, there has been limited progress on clarifying, defining, and explaining fisher behaviour in ways that reflect local contexts in the inshore fisheries in Atlantic Canada and coastal fisheries more broadly.

This dissertation's empirical research is guided by three overarching research objectives: (1) to critically examine fisher behaviour in peer-reviewed scientific literature for theoretical characterizations and empirical explanations; (2) to cultivate evidence-based insights about fisher behaviour and its motivations in relation to change and uncertainty in Newfoundland and Labrador; and (3) to identify strategies to strengthen the governability of Atlantic Canada's inshore fisheries, including consideration of barriers and opportunities to incorporate fisher behaviour in science, policy, and management to advance multiple governance objectives.

This dissertation used a mixed-method design that combined a systematic scoping review of fisher behaviour in coastal fisheries settings research with a case study research in Atlantic Canada. A systematic scoping review of peer-reviewed papers (n=104) was conducted to examine fisher behaviour's characterizations, explanations, and implications for governance in the scientific literature (Chapter Two). Case study research included two aspects. First, an

examination was conducted of inshore fisher behaviours in Newfoundland and Labrador by examining narrative interviews with inshore fishers (n=26) (Chapter Three). Second, an assessment of governance for the inshore fisheries was conducted to identify strategies for the Canadian federal government to draw on fisher behaviour comprehensively in the governance of the inshore fisheries (Chapter Four). Data were derived from semi-structured interviews (n=10) with Canadian federal governmental employees, narrative interviews with inshore fishers and fishing community members in Newfoundland and Labrador (n=41), and a review of documents (n=99) that described and exemplified the scientific, policy, and management approaches for the inshore fisheries.

This dissertation highlights that fisher behaviour is a multi-faceted source of social complexity crucial to advance governance objectives. Results reveal that fisher behaviour was a key focus of fisheries policy. Further, examining fisher behaviour provided a lens into important contextual goals and factors that motivated fisher behaviour which, in turn, shaped the effectiveness of management decisions used to implement policy. Therefore, calls for context-sensitivity in fisheries policy and management can be answered with evidence on fisher behaviour and its explanations. Further, this dissertation highlights that the operation of explanatory psychosocial variables—human values, emotions, and perceptions—are critical to anticipating fishers' behavioural change, as those variables shape how fishers interpret and respond to change in the local context. With examination of fisher behaviour and its motivations, this dissertation contributes novel theory and evidence for fisher behaviour, including its types, explanations, and diversity.

Strategies for strengthening governability are recommended. Findings highlight that there are opportunities and barriers in governance to develop and use a comprehensive understanding

of fisher behaviour. Methodological and organizational barriers, and interorganizational opportunities can be addressed to fully incorporate fisher behaviour to advance governance objectives. Strategies defined for the governance of inshore fisheries provide insight into attenuating those barriers in Atlantic Canada.

ACKNOWLEDGEMENTS

This dissertation begins and ends with gratitude for the people that supported my doctoral journey. To begin, I want to thank the people that participated in this research, including inshore fishers and their families on the Great Northern Peninsula (GNP) in Newfoundland and Labrador, and representatives from Fisheries and Oceans, Canada (DFO). Also, many people living on the GNP and working in DFO supported data collection and analysis. On the GNP, town and village mayors, and other community residents helped me through my field season. In particular, I wish to thank Andre Myers, Bridget and Gary Carroll, and Joan Simmonds. From DFO, Alida Bundy, Robert Stephenson, Doug Bliss, Kevin Anderson, and Jacqueline Perry provided insight into data collection and facilitated introductions to potential participants.

During my doctoral studies, I spent time at Memorial University in St. John's, Newfoundland and Labrador. Scholars and students there armed me with a better understanding of key issues in the inshore fisheries. Those people included Ratana Chuenpagdee, Paul Foley, Nicole Power, Barb Neis, and Charles Mather. In particular, I owe a big debt of thanks to Jack Daly who helped me navigate some tricky times in the field.

Back at the University of Waterloo, I was supported by leadership and administration at the School of Environment, Resources, and Sustainability. Making it through the doctoral journey would not have been possible without Jennifer Nicholson and Amanda Campbell, both administrators extraordinaire, and through coursework and extra advice provided by Bob Gibson and Rob de Löe.

I was lucky enough to have met many colleagues and friends during my studies. I entered the program with a cohort of 23 Ph.D. colleagues, many of whom, such as Barb Davy, Amanda Joynt, Stephanie Barr, Sondra Eger and Norman Kearney helped me significantly through all sorts of professional and personal challenges. I am further grateful for the personal and professional experiences I shared with colleagues from other cohorts, including Beth Timmers, Phoebe Stevens, Sara Wickham, Lauren Smith, and Kiri Staples. My scholarship was advanced, and my life was enriched by colleagues from the Environmental Change and Governance Group, including Mark Andrachuk, Graham Epstein, Jessica Blythe, Cheryl Chan, Irene Brueckner-Irwin, Mellissa Mark, Iroshani Galappaththi, and Maria Battaglia. Further, my friends and family were so supportive during my doctoral studies, especially Cyril Dorgigné, Lily Olson, Kelly Tremblay, Rhiannon Cabarello, and Mohammed Abdulkhaleq.

My thinking and overall cognitive strength was improved through interactions with members of the Society of Policy Scientists and their research. I am so grateful for their constant support, intellectual course corrections, and, at a very difficult time, encouragement to start writing.

I am so grateful for the advice and support from my supervisor, Derek Armitage, and incredible committee members, Simon Courtenay, Jeremy Pittman, Prateep Nayak, and Sarah Wolfe. I cannot understate the impact each of these advisors had on my professional life. The research presented in this dissertation was made possible by funding from the Social Science and Humanities Research Council, through a talent program scholarship, and through the OceanCanada Partnership, a cross-Canadian research network led by U. Rashid Sumaila.

DEDICATION

For Ann Hurry, Ashley Rankin, and my parents, Theresa and David Andrews

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

DFO – Fisheries and Oceans, Canada
FFAW – Fish, Food, and Allied Workers – Unifor
IF – Inshore fishers
PD – Policy documents
PIIFCAF – Policy for Preserving the Independence of the Inshore Fleet
FMP – Integrated fisheries management plan
SA – Stock assessments
ED – Evaluation documents

Chapter One

Introduction

1.0. Research challenge and problem rationale

Strategies to strengthen the governability of the inshore fisheries in Atlantic Canada require investigation. Governability here refers to the overall capacity and ability to govern (Kooiman 2003; Jentoft 2007), whereas governance refers to the processes, rules, and practices through which societies come together to make decisions address change, such as to prevent, mitigate, foster, or to adapt change (Biermann et al. 2010; Oakerson 1992). Researchers can identify opportunities to strengthen the capacity to govern by examining the knowledge used in processes and practices to develop and implement rules (Jentoft and Chuenpagdee 2015). To date, knowledge about how and why Canadian Atlantic inshore fisheries (hereafter inshore fisheries) contribute to processes of change is largely restricted to biophysical science about sustaining the fish stocks, habitats, and ecosystems important the inshore fisheries, and economic assessments about the viability of inshore fishing fleets (Soomai 2017a; Kahn and Chuenpagdee 2014). Knowledge to strengthen governability is therefore needed about fishers' diverse responses to change, and the capacities in governance that shape how scientists, policy-makers, and managers develop and use that knowledge (Soomai 2017b; Stephenson et al. 2019a).

The inshore fisheries (hereafter the inshore fisheries) are enduring social structures organized around fishing and processing fish species organized by three characteristics (McCracken and MacDonald 1976)[1]. First, fishing grounds are located within a range close to

[1] Due to the importance of harvesting fish species, these social structures are interdependent with change occurring in marine ecosystems (i.e., to fish, habitats, and ecosystems) and the management interventions used to control change (e.g., harvesting rules, area closures, fleet restrictions) (Ommer and Team 2007). Fisheries researchers often refer to these types of fisheries as social-ecological systems or complex adaptive systems (Adger 2000; Charles 2001).

the coastline (approximately an 80-kilometer range). Second, individual vessels have limited capacity demonstrated by vessel length (i.e., 64' or smaller) relative to large industrial trawlers (i.e., 190' to 290') that fish in offshore fishing grounds[2]. Third, fish is landed in local ports and processed in adjacent communities before export to Canadian and global markets (McCracken and MacDonald 1976; Neis and Ommer 2014; Sumaila et al. 2001).

Sustaining the inshore fisheries' three qualities is critical for maintaining the economic, socio-cultural, and psychosocial benefits from the inshore fisheries experienced by fishers, fishing families, and coastal communities in Atlantic Canada. Those benefits are situated in and contribute to a dynamic, historical, and socio-cultural context including diverse and long-standing values held in coastal communities about fish harvesting, and evolving place-based knowledges and perceptions of coastal and marine change in the Atlantic (Bodiguel 2002; Christiansen-Ruffman 2002; Norman and Power 2014; Knott and Neis 2017). Opportunities to advance sustainability for the inshore fisheries rest in strengthening governability for the inshore fisheries in ways that embrace their social complexity.

Like other smaller scale fisheries around the world, marine crises, and the drivers of change that precipitate them challenge current governance capacities to advance sustainability. Globally, the interaction of climate change effects with overfishing, habitat degradation, pollution, and coastal development are pushing systems across thresholds to produce often irreversible changes to human and natural communities (Bennett et al., 2015; Breitburg et al., 2018; Cheung et al. 2013; Worm et al., 2009; Sumaila et al., 2019). Under these conditions, fishers, their families, and other residents participating in local value chains can be particularly vulnerable to a range of ripple effects from stock collapse (Nayak and Berkes 2019; Jentoft

[2] It is common in Atlantic Canada to refer to vessel size in feet (as opposed to meters), and these measurements are regulatory requirements.

2019). In Atlantic Canada, many drivers of change – particularly climate change and harvesting pressure – have led to dramatic consequences to the inshore fisheries, and the livelihoods in coastal communities that depend on them. Insights from this research can therefore help address weak governability in other coastal fisheries.

The Northern Atlantic cod (*Gadus morhua*) collapse in Canada is the best example of the crises that faced the inshore fisheries. In 1992, Fisheries and Oceans, Canada (DFO)—the federal ministry responsible for fishing in federal waters—implemented a multi-year moratorium on harvesting Atlantic cod off the Grand Banks response to commercial collapse and near biological collapse of stocks. The moratorium effectively closed the local 500-year-old fishery leaving 40% of fishers and processors out of work and sending ripple effects along the Atlantic coast. This included plant closures, massive outmigration of harvesters and their families, and the closure of some entire communities (Bavington 2010; Davis 2014). Massive restructuring of science, policy, and management for the inshore fisheries followed the Atlantic cod collapse (Mather 2013). However, new challenges associated with rapid change have emerged. Northern shrimp (*Pandalus borealis*) and snow crab (*Chionoecetes opilio*) fisheries, both with strong fish stocks in the early 2000s, are now experiencing precipitous declines (DFO 2018; DFO 2019a). Examples such as the Atlantic cod caollapse and other coastal fisheries collapses around the world demonstrate a limited capacity to govern change (Kahn and Chuenpagdee 2014; Charles 2012; Pittman and Armitage 2016). In marine social science literature, this is referred to as 'weak governability' (Jentoft and Chuenpagdee 2005; Koimann 2008). Strengthening governability is therefore needed to address and anticipate social and environmental changes, and insights in this dissertation are particularly relevant for the onset of a shellfish collapse.

Research to strengthen the governability of the inshore fisheries is timely and salient. On August 28th, 2019, the Canadian federal government amended Canada's Fisheries Act (R.S.C., 1985, c. F-14) to include diverse conservation, socio-cultural, economic, and institutional objectives for the inshore fisheries. Diverse objectives broadens the scope of policies to consider human activity, and therefore makes new demands for interdisciplinary social sciences to implement those policies (see Howlett 2009; Sarewitz and Piekle Jr. 2007). Social science refers here to the theory, evidence, and methods that broadly examine the study of human societies and social relationships in coastal fisheries by drawing from cognate academic disciplines including sociology, social anthropology, social psychology, economics, and human geography (Barclay et al. 2017; Bennet 2019). Interdisciplinarity refers to science that weaves together different theories, evidence, and methods from diverse cognate academic disciplines and knowledge silos, such as science, policy, and practice spheres (Christie, 2011; Clark et al., 2011)[3].

Canadian researchers have argued that interdisciplinary social science is limited in the governance of the inshore fisheries (Bailey et al. 2016; Stephenson et al. 2019). Rather, social science insights used in DFO are restricted to economic assessments and monitoring basic human activity in fisheries such as catches, landings, and sales slips (Soomai 2017b; see Chapter 4). The Canadian government has invested in biophysical science and scientists and a peer-review process to generate stock assesssments (Soomai 2017a). Biophysical science is then reflected in management decisions (e.g., area closures or adjustments to catch quotas) to achieve the desired volume of biomass taken from fishing management areas (Soomai 2017a). Strengthening this process largely involves investment in natural science, in technological and

[3] Often in fisheries and marine sciences, interdisciplinarity involves working across and within social and natural sciences and in collaboration with communities, industries, and governments (Arbo et al. 2018; Cvitanovic et al. 2015).

human capital to monitor fishing activities and interactions in marine food webs, and in public referral systems to communicate policy changes to stakeholders (Ricketts and Harrison 2007; Soomai et al. 2013; Soomai 2017b; Webster 2009). However, to achieve desired social, environmental, and governance outcomes, broader social sciences are needed in governance required to effectively develop and implement policy through management decisions that sustain the inshore fisheries and their independence in the future (Foley et al. 2015; Stephenson and Lane 1995; Benson and Stephenson 2018).

A core assumption for strengthening governability is that strong governance includes capacities to address and anticipate human behaviour in coastal fisheries (Chuenpagdee and Jentoft 2009; Jentoft and Chuenpagee 2015b). A key form of human behaviour in coastal fisheries is fisher behaviour. Fisher behaviour here refers to actions by individual fishers and groups of fishers that result from the mental processing and social negotiation of change and uncertainty in marine environments, coastal communities, and governance (Fulton et al. 2011; see Lynn et al. 2015). Fisher behaviour is therefore an important focus for strengthening governability in coastal fisheries that are socially complex and rapidly changing.

Fisher behaviour provides insight into how and why fishers experience and respond to changes and uncertainty, including those brought on by policy implementation (Cove 1973; van Putten et al. 2012; Chuenpagdee and Jentoft 2009). However, while fisher behaviour reflects a promising avenue to strengthen governability, a systematic, rigorous, and comprehensive understanding of fisher behaviour is underdeveloped theoretically and empirically under conditions of change and uncertainty (Fulton et al. 2011; Lade et al. 2015; Bieg et al. 2017), including in specific local contexts (Barclay et al. 2017; Bennet 2019). Research that characterizes and explains fisher behaviour within and across problem contexts can contribute to

improved assessments, models, policies, and ecosystem-based management approaches for coastal fisheries (Guillotreau et al. 2018). Such efforts are needed to improve quantitative models' predictive capacity and by extension, the quality of harvest control rules and management strategies that emerge from those models and into fisheries decision making (Armitage et al. 2019; Nielsen et al. 2017). Evidence-based insights and practical guidance about fisher behaviour can enhance the navigation of trade-offs among governance objectives, and help policy-makers understand how to develop science and management that integrates governance objectives (Kittinger et al. 2014; Lubchenko et al. 2014).

1.1. Dissertation purpose, objective, and major contributions

Given the importance of strengthening the governability of the inshore fisheries in Atlantic Canada, and coastal fisheries more broadly, there is a need to critically examine opportunities to develop governability by studying fisher behaviour and the governance needed to assess, anticipate, and address fisher behaviour. Fisher behaviour is a crucial but underdeveloped subject in fisheries research with considerable promise to provide insights for achieving governance objectives to sustain the inshore fisheries. The purpose of my dissertation, then, is to advance a comprehensive understanding of fisher behaviour to strengthen the governability of the inshore fisheries of Atlantic Canada. This dissertation clarifies fisher behaviour and examines assumptions in explanations of fisher behaviour. Chief among the insights pursued are how fisher behaviour is a key focus of policy, how scientists, managers, and policy makers can better anticipate behavioural change in different contexts, and how those insights can be used to strengthen governability in ways that embrace social complexity for the inshore fisheries in Atlantic Canada and in coastal fisheries elsewhere. To glean those insights, the dissertation pursued three overarching research objectives:

1. To critically examine fisher behaviour in peer-reviewed scientific literature for theoretical characterizations and empirical explanations;
2. To cultivate evidence-based insights about fisher behaviour and its motivations in relation to change and uncertainty in Newfoundland and Labrador; and
3. To identify strategies to strengthen the governability of Atlantic Canada's inshore fisheries, including consideration of barriers and opportunities to incorporate fisher behaviour in science, policy, and management to advance multiple governance objectives.

This dissertation's results are presented in three inter-related manuscripts (Chapters Two to Four) written specifically for publication in peer-reviewed journals. Next, this introduction includes a review of literature and the presentation of a conceptual framework that guides and connects the results manuscripts. Then, this dissertations' empirical context and research design are discussed. This introduction concludes with an overview of the structure of the dissertation.

1.2. Literature review and conceptual framework

This dissertation contributes to three bodies of scientific literature: environmental governance and governability, fisheries policy and the role of context, and fisher behaviour as a lens to examine local context. To reveal areas for contribution, this research draws on the interdisciplinary foundations and criticisms about these bodies of literature from the marine social sciences, environmental change research, environmental sociology, political ecology, the policy sciences, and emotions research.

1.2.1. Environmental governance and governability for social complexity

This research draws from environmental governance theories to define problems and articulate solutions to advance sustainability for the inshore fisheries in Canada and coastal fisheries

around the world. Environmental governance is a 'broad church' with theoretical strands such as adaptive governance, multi-level governance, and interactive governance theories all developed to improve how societies address environmental complexity and uncertainty in environmental problems (see Glasbergen 1998; Young 2009). While each theory has a different ethos and lineage, all emphasize (a) linkages among resource users, civil society, the private sector, and government to define sustainability problems (i.e., social processes) and (b) linkages and interactions across jurisdictional levels and decision-making in governance to alternatives to those problems (i.e., decision processes) (Brunner et al. 2005; Lemos and Argawal 2006; Kooiman 2003). Such levels include the constitutive level (e.g., politicians, policy-makers, and lobbyists creating, influencing, and amending objectives for fisheries), intermediary level (e.g., governmental ministers, policy-makers, and senior managers, and non-governmental leaders that interpret constitutive-level objectives and shape the strategic direction for governance), and managerial level (e.g., scientists, policy-makers, and managers that implement higher level policies to control resource users' behaviour) (Ostrom 1990), although in this dissertation, policies at the managerial level are simply referred to as management decisions and in governance actors, such as managers and scientists may not work in concert, and scientists may not have influence over decision-making (Sarewitz and Piekle Jr. 2007).

Governance features the management of natural resources as a central decision process, but emphasizes that management is influenced by higher level activities, and vice versa (Dietz et al. 2003; Lebel et al. 2006). Therefore, governments have the opportunity to harness the knowledge and resources of these multi-level actors, including resource users, through partnerships to define problems and advance solutions that can influence better management (Armitage et al. 2012). The various arrangements of actors in networks in governance may leave

responsibility and authority for governing natural resources with governments (Koontz et al. 2005), in sharing agreements across actor groups such as co-management (Plummer et al. 2012), or outside of governments such as, for example, in the private sector (Rhodes 1997). Those different arrangements or modes have bearing on power and resources sharing (Armitage 2008), involve the public including resource users differently (Diduck et al. 2015), and privilege different types of knowledge in decision processes (Asher et al. 2010).

Governance arrangements and their implications for power, public participation, and knowledge can be studied as interactions all with bearing on governability. This emphasis is made in interactive governance theory (Kooiman and Bavinck 2005; Jenftoft and Chuenpagdee 2015a). This theory's ethos is the need to characterize social and decision processes as interactions among actors in the practice of governance (or in the governance system), the everyday activities of people being governed in coastal communities (or in the system-to-be-governed), and the relationships between governing actors and coastal people (or governance interactions) that facilitate implication of decisions (Mahon et al. 2005). According to this theory, actors' behaviour, values, and perceptions of change shape these interactions and hence contribute to the social complexity that enables and constrains policy implementation through management (Jentoft and Chuenpagdee 2009; Chuenpagdee and Jentoft 2009; Johnson et al. 2019).

Drawing from those theories, governance used in this research involves different scientists, policy-makers, managers, fishers and fishing industry representatives, coastal communities, and non-governmental organizations. These actors contribute perspectives, knowledge, policies, and demands on those policies for different scales of analyses. Scale here refers to the analytical standpoints from which a research problem is assessed, such as choices in

space, time, and jurisdiction (see Gibson et al. 2000). These actors' perspectives, knowledge, and values all have bearing on governability and set the conditions for understanding and addressing fisher behaviour

Governability reflects a total characterization of effects of all governance aspects, structural and procedural, on the entity or system being governed (Koimann 2003). Jentoft and Chuenpagdee (2015b: 21) describe that:

> Governability constitutes two complementary but necessary dimensions: (1) the capacity and ability to govern, which depends in part on the structure and function of the governing system, but also on the inherent and constructed characteristics of the system-to-be-governed that may either lend itself to governance or inhibit its functioning; and (2) the quality of governance processes and outcomes and the values that they express, whether or not they are in accord with a set of agreed-upon principles.

Governability theory and its applications to coastal fisheries research reveal a need for lessons about how to strengthen governability in ways that prioritize and embrace the social complexity, or social phenomena with interacting behaviours and their motivations, relationships, and social structures. Social complexity includes diverse needs, interests, and values of fishers, their families, and other residents in coastal communities (Jentoft and Chuenpagdee 2015b; Johnson et al. 2019). As Jentoft (2019: 310) describes, local context involves the complex ways that social interactions are shaped by 'tensions' often relating to power, access, rights, and norms, and the perceptions of actors, including "their own conceptualizations…how they make sense of the world and the change they experience" (Jentoft 2019: 310). Yet, the local context, as a window into social complexity that shapes governance outcomes has rarely been fully embraced in environmental governance, including that which is government-led (Brunner et al. 2010). In

other words, governability is about building capacity in decision processes to address complexity and contextuality in social processes in fisheries.

Decades of theoretical and empirical research from political ecology and the policy sciences indicate limitations in governance related to the design of decision processes to promote efficiency over social complexity, with the effect of ignoring or reducing social complexity in a local context (Sarewitz 2004; Young et al. 2018). Often these attempts involve state-making efforts to individuate societies (i.e., the idea that people must be recognized as individuals as opposed to part of collectives) so that they be counted and taxed, and somewhat paradoxically, to homogenize the interests and values of individuals (i.e., to be made to have similar interests maintaining economic systems) to more effectively control their behavioural (Polyani 1944). State-making (Polyani 1944) is coupled with natural resource-making through techniques of cutting and parsing natural environments into administrative units. Administrative units support efficient measuring and controlling, which then, in turn, reinforces individuation and homogenization (Argawal 2005). For example, Scott (1998) describes failed outcomes in the use technology and systems of measurements to reduce social and environmental complexity. These included the restructuring of forests in Germany to meet and improve maximum sustainable yields and the forced resettlements of people in Tanzania to improve agricultural production. In both cases, Scott argued, these efforts to reduce complexity completely disrupted local harvesting patterns, and eradicated the social, cultural and economic benefits associated with local value chains. Brunner et al. (2005) argued that similar attempts in North American reflect 'scientific management' as a core mechanism for advancing efficiency. Scientific management involves the privileging of economic and administrative science to govern social and environmental change. Scientific management involves the under-characterization of complexity

through policies that largely discount the resource users' interests and values through decision-making, where decision-making is centralized in the state to maximize its state economic returns from resources and reduce making decisions costs (i.e., increase efficiency) (see also Brunner and Lynch 2010).

In coastal fisheries, policies that neglect context or attempt to reduce the complexity in local contexts often do so in the name of efficiency. The goal of efficiency in North American gained attention from patterns in industrial manufacturing, reflecting a management theory known as Taylorism. Taylorism promoted technologically-oriented science to make decisions in cost-effective processes through a centralized decision-making authority (Brunner et al. 2005). In Canadian fisheries governance, efficiency was promoted in two ways: (1) through rationalization that involved parsing fishing grounds into manageable units and reducing the diversity of fishers, vessels and fishing strategies, as for example, through intricate systems of licensing (e.g., individual transferable quotas), controlling entry, and promoting exit of inefficient and overcapitalized fishers and vessels (Needler 1979; Pinkerton 2017; Pinkerton 2015), and (2) through the longstanding use of maximum sustainable yield (i.e., applying economic models to determine the rate of exploitation that 'guarantees' available fish in the following season) to determine access and allocations of fish stocks (Finley 2011). Rationalization policies have led to conflict among resources users because those policies assumed a singular vision of the local context: that fishers, their families and coastal communities' values, interests, and demands in fisheries related solely to maximizing profit (Chuenpagdee and Jentoft 2009). As such, the local context is important, but often not considered in the development and implementation of fisheries policies specifically (Young et al. 2018), and environmental policy more broadly (Ascher 2017).

1.2.2. Fisheries policies and the role of context

Fisheries policies, like other types of public policy, are key decisions made to solve problems in a given social system (Laswell 1971; Lasswell and McDougall 1992). Research in the early 2000s reveals considerable theoretical and evidentiary support for context-sensitive policy implementation. In a synthetic review assessing the promotion of property rights in fisheries governance in the United States, Steelman and Wallace (2001) compare and assess the effectiveness of command and control, individual transferrable quota, and common pool resource regimes. Steelman and Wallace (2001) describe the influence of context that includes the status and size of the fishery, the ecosystem conditions supporting fish stocks, and the history and culture of the communities involved in fishing. In their research reviewing challenges and opportunities for governing small-scale coastal fisheries, Berkes et al. (2001) discuss the importance of context-sensitive policies and indicate that context consists of the members in coastal communities and their interests, demands, and expectations with respect to rights, incentives and rules in fisheries policies. At that time, research had indicated that context had considerable influence over the fit and effectiveness of policies (Berkes 2001; Steelman and Wallace 2001). More recently, with attention paid to the importance of context, researchers are indicating the need for guidance to develop an understanding of this context through rigorous procedures (Young et al. 2018).

Whether policies are written down (e.g., regulations, formal policies, memos) or understood and expected (e.g., norms), they share five qualities. First, policies are prescriptions or outcomes of policy processes or systems of knowledge transfer and use to make, promote, evaluate and terminate decisions that involve leaders who are responsible for advancing the interests, values, and demands of the people they represent (Auer 2017). Second, policies are

tools to solve problems of distribution or access to resources and services with the desired effect to advance the people's interests, values, and demands in a policy's jurisdiction (Laswell 1936). Third, policies control people's behaviour in relation to this redistribution by shaping human values (Lasswell and Kaplan 1950). As a result, policy processes only work when policy-makers have legitimacy to make policies from the standpoint of people whose behaviour is being controlled (Lasswell and McDougall 1992). Fourth, policy processes require an understanding of the local context, that includes people's behaviour as it is shaped by their interests, values, and demands (among other social elements), and their perspectives of legitimacy (Clark 2012). Fifth, the knowledge used to make policies must integrate different knowledge sources to appropriately characterize this local context (Ascher et al. 2010). Policies, therefore, are principles and rules that are meant to control behaviour that exists in a local context (Stone 2002). Decisions about what knowledge types are generated, communicated, and used in policy processes make policies and policy-making about behaviour inherently political (see Ascher et al. 2010).

To develop and implement context-sensitive policies, a commonly recommended approach is to involve fishers or other desired actors in governance to make decisions, as for example, through various forms of collaboration (Jentoft and Chuenpagdee 2015b). Involving different actors in governance is supposed to increasing the legitimacy and accountability of policies and management decisions because those actors "literally have to live the consequences" (Brunner 2010: 322). The assumption here is that context-sensitive knowledge follows from collaborative policy and management decision-making. For example, in a synthetic review, Young et al. (2018) critique one-size-fits-all approaches (or panaceas) to governing fisheries, and highlight the importance of local context in shaping sustainable outcomes. Young et al. (2018) conclude that collaborative policy processes with local actors can reveal local context:

> For any given management challenge, the creation of a toolkit would start with transdisciplinary working groups that bring together academics, decision-makers, and stakeholders to develop a set of institutional diagnostic checklists that capitalize on the wealth of knowledge on environmental governance to make it easier to determine the fit of a set of policies to a specific context. These groups would also develop corresponding case narratives that go beyond just-so stories to highlight the importance of considering context. Hopefully, this process itself would ameliorate the conceptual narrative portion of the panacea mindset by breaking through groupthink, although this will depend on the willingness of participants to step out of their ideological boxes.

Yet, not all perspectives are represented in collaboration, and issues of power, access, standing and influence shape whose information is used (Armitage 2008; Diduck et al. 2010). Scientific protocol is rarely used in collaboration to glean contextual information, and therefore rigorous comprehensive knowledge may not follow, despite the importance of collaboration and the local and traditional knowledges derived from it for steering change (Brunner et al. 2005; Said et al. 2019). An underexamined alternative is how social science can contribute context-sensitivity in policy and management.

Social science, in particular research about fisher behaviour, can inform context (Bennett 2019). In empirical research about common pool resource problems in fisheries, for example, Castillo et al. (2011), determined that the importance of fisher decisions and expectations about access and allocations for fish harvesting were important contextual variables. Decisions and expectations of fishers and other residents of coastal communities are informed by their values, interests, and demands and their behaviour reflects those desires in the face of complex changes

to long-attachments to coastal communities and marine ecosystems (Bennett 2019; Castillo et al. 2011; Fulton et al. 2011).

1.2.3. Fisher behaviour as a focus of policies and lens to the local context

Through their behaviour, fishers respond to changes in the marine environment, coastal society, and in governance. Human behaviour results from cognitive processing of sensory information (Bechara 2004; Meyfroidt 2012) and the effects of this processing through social relationships and structures (Franks 2010; Giddens 1971). Human behaviour is an important lens to identify opportunities to strengthen governability by understanding the local context of harvesting rules including fishers' motivations to cooperate, share resources, follow rules, and respond to changes in environments, human communities, and policies (Lambin and Meyfroidt 2010; Larrosa et al. 2015). Hence, fishing as a form of human behaviour is critical for incorporation of context at various levels of fisheries policies (Fulton et al. 2011), and such context informs decision processes with insights about social complexity (Chuengagdee and Jentoft 2009).

Human behaviour is expressed either by individuals or groups (Kerr and Tindale 2004), Within the individual mind, cognitive processing that leads to behaviour engages several different neurological and chemical systems in the brain (Panskeep 2008). Those systems that produce and coordinate perceptions, memory, and affect are the foundation of the experience of emotions and learning more broadly (Feldman Barret 2017). Affect here refers to neurological and chemical appraisals of new information around us represented in a physiological response (Feldman Barrett 2017a; Panskepp 2008). Perceptions, memory, and affect are central to decision-making that precedes behaviour, and are completely blended in the psychological experience of mature adults (Panskepp 2008). Cognition that leads to behaviour almost always involves the experience of emotions (Bechara 2004; Cohen 2005; Franks 2010; Panksepp 2008),

where emotions are the social manifestations of affect (LeDoux 2013; Feldman Barret 2017). This complicated process can lead to unconscious and conscious behaviours, ranging from changes in heart rate to actions that can affect the physical and social world (Franks 2010).

Group behaviour manifests from social relationships that involve the negotiation or subconsciously acceptance of the beliefs and values of others (Kerr and Tindale 2004). Both individual and group behaviour are important for describing social dynamics (e.g., Hentati-Sundberg et al. 2015), the ingenuity and novelty of people to adapt to, or resist change (e.g. Gunderson et al. 2002), and the efficacy of institutions (e.g. Ostrom and Cox 2010). However, the utility of behaviour can be undermined when policy processes incorporate theoretical missteps about individual and group cognition (Wolfe 2017). Those often including assumptions about the goals and explanations for behaviour, and the relationships between individual behaviour and social dynamics that are not supported in evidence (van Kleef 2016; Thargard 2006).

Three potentially problematic limitations about fisher behaviour are prevalent in fisheries research, specifically, and environmental change literature, more broadly. First, fisher behaviour can include many different types of behaviour, that is multi-leveled and shapes change at different scales. There are some types related to fish harvesting such as effort (Branch et al., 2006), discarding (Catchpole et al., 2011) and compliance (Gezellius and Hauck 2011). Additionally, there are behaviours related to livelihood strategies, including entering a fishery (Lansford and Howorth 1994), investing in different gear, vessels or licenses (Lane 1988), diversifying outside of the fishery (Allison and Ellis 2001), exiting the fishery (Maullil et al. 2011), and migrating out of coastal communities (Pomeroy et al. 2006). All behaviours have bearing on responses to change, well-being, and capacity and capitalization within a fishery. Yet,

it is unclear how these behaviours relate to one another when incorporating different levels and scales for behaviour (Beitl 2014). Counter examples that simulate behaviour in modelling highlight the importance of level and scale in relation to collapse. Bieg et al. (2017) used a dynamic social-ecological systems model to illustrate that effort can create stabilizing or disrupting effects for coastal fisheries, including fisheries collapse (see also Anderies 2015). In their social-ecological systems model of a coastal fishery, Lade et al. (2015) identified that both individual and group behaviours can influence the stability of a coastal fishery, and demonstrated that psychological, economic and regulatory factors shape how individuals and groups experience change that leads to fisher behaviour. Relationships between individual and group behaviour at different scales are discussed in Chapter Three.

Second, fisheries researchers typically assume that fishers pursue profit as the only goal or value that drives their behaviour, and assume that the pursuit of this value can be fully explained by economic rationality (Chuenpagdee and Jentoft 2009; van Putten et al. 2012). Economic rationality reflects a blending of micro-economics and rational choice theories (discussed and critiqued in Chapter Three). Applications of economic rationality have driven theoretical insights and practical recommendations for the development of interventions and incentives recommended for governance (Fulton et al. 2011; Essington et al. 2017). For example, in a conceptual paper on fisheries management and fisher behaviour, Hilborn (2007: 288) illustrates the universality of rational economic thought to explain fleets dynamics:

> Quite simply, fishing fleets can be thought of as a rational economic entity, that will, in aggregate, make decisions to maximize their well-being within the constraints of the legal and institutional incentives that are imposed on them. This provides a powerful framework for predicting the consequences of incentives.

Many academic disciplines include concerns and critiques about using neoclassical economic and rational choice theory to explain human behaviour, pointing to more nuanced understandings of rationality (discussed in Chapter Three). Recent qualitative fisheries research has described limits to economic rationality by drawing from social science insights about fisher behaviour (Barclay et al. 2017). By drawing on sociological research, for example, studies have illustrated situations in which economic rationality did not explain fisher responses to interventions (e.g., Lade et al. 2015; Symes and Hoefnagel 2010). Other social science research has adopted participatory approaches to modelling coastal fisheries in which fishers describe their goals for action that sometimes do not reflect the sole pursuit of profit (Teh et al. 2012; Wise et al. 2012). Examples such as these highlight the multiple values used to guide fisher behaviour in which wealth is an important value among others (Vaughan et al. 2017), including individual goals such as psychological well-being and status, or community goals, such as the desire to sustain harvesting in coastal communities (Britton and Coulthard 2013).

Third, a common approach to understanding fisher behaviour is to aggregate through various forms of models the activities of fishing fleets, and to use aggregated assumptions to anticipate their reactions to different social and environmental changes or policy interventions (Fulton et al. 2011). By aggregating the fishing fleet activities, fisheries scientists have improved decision support for policies using empirical experiments, statistical models, and simulations (Essington et al. 2017). Yet, models underrepresent the diversity of fishers' responses to change (Fulton et al. 2011), and this can undermine recommendations for governance and limited context-sensitivity (Armitage et al. 2019). However, there are practical constraints in governance for developing more robust and integrative models, such as data availability, access, knowledge of behaviours including how and why their change, and the expertise of actors in governance to

evaluate new information from models that incorporate behaviour (Shepperson et al. 2016). These implications are discussed further in Chapter Two.

The literature reviewed above contributes to a conceptual framework. A conceptual framework is an iterative schema with three connected conceptual areas each with opportunities for theoretical contributions[4]. First, this research uses governance that embraces social complexity as the yardstick for identifying strategies to strengthen governability of Canada's inshore fisheries (Objective 3). In doing so, this research provides alternatives to societal tendencies of ignoring or reducing social complexity in coastal communities through governance. Second, this research contributes to calls for fisheries policies to be context-sensitive. In doing so, research examines barriers and opportunities for social science as a means to glean contextual knowledge (Objectives 1 to 3). Third, this research examines fisher behaviour as a focus of policies and a social science lens through which to understanding local context (Objectives 1 and 2). In doing so, this research develops systematic evidence of fisher behaviour characterizations and explanations discussed in synthetic reviews and empirical cases (Objective 1). Furthermore, this research contributes theoretical, evidentiary, and practical lessons from a case study that examines inshore fisher behaviours (e.g., investing in the fishery, diversifying incomes, and exiting the fishery) from the fishers' perspectives, and explores diverse motivations (e.g., emotions, values, and human relationships) to examine inshore fisher behavioural change (Objective 2). Taken together, these three components and areas of contribution inform a conceptual framework that examines fisher behaviour as an important

[4] A conceptual framework is a set of related constructs—symbolic representations of ideas or aspects of the social or natural world—joined together to examine a set of relationships in research problems seemingly too complicated for the use of a single theory (Imenda 2014).

intervention to strengthen governability in ways that embrace social complexity (Research Purpose).

1.3. Empirical context

The empirical context for this research is Canada's Atlantic coast. The Atlantic coast is the eastern-most region in Canada, comprised of four provinces: New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador (Figure 1). This empirical context is ideal for developing theoretical, practical and methodological lessons about strengthening coastal fishery system governability with fisher behaviour due to: (1) the importance of inshore fisheries to Atlantic coastal communities and broader Canadian society; (2) the historical cultural attachments to fishing held by fishers, their families, and coastal communities in the Atlantic; (3) the intensity, magnitude, and scope of marine crises in the region, and (4) the shared policies and processes that are developed and recommended by scientists, policy-makers, and managers in the governance of inshore fisheries in the region.

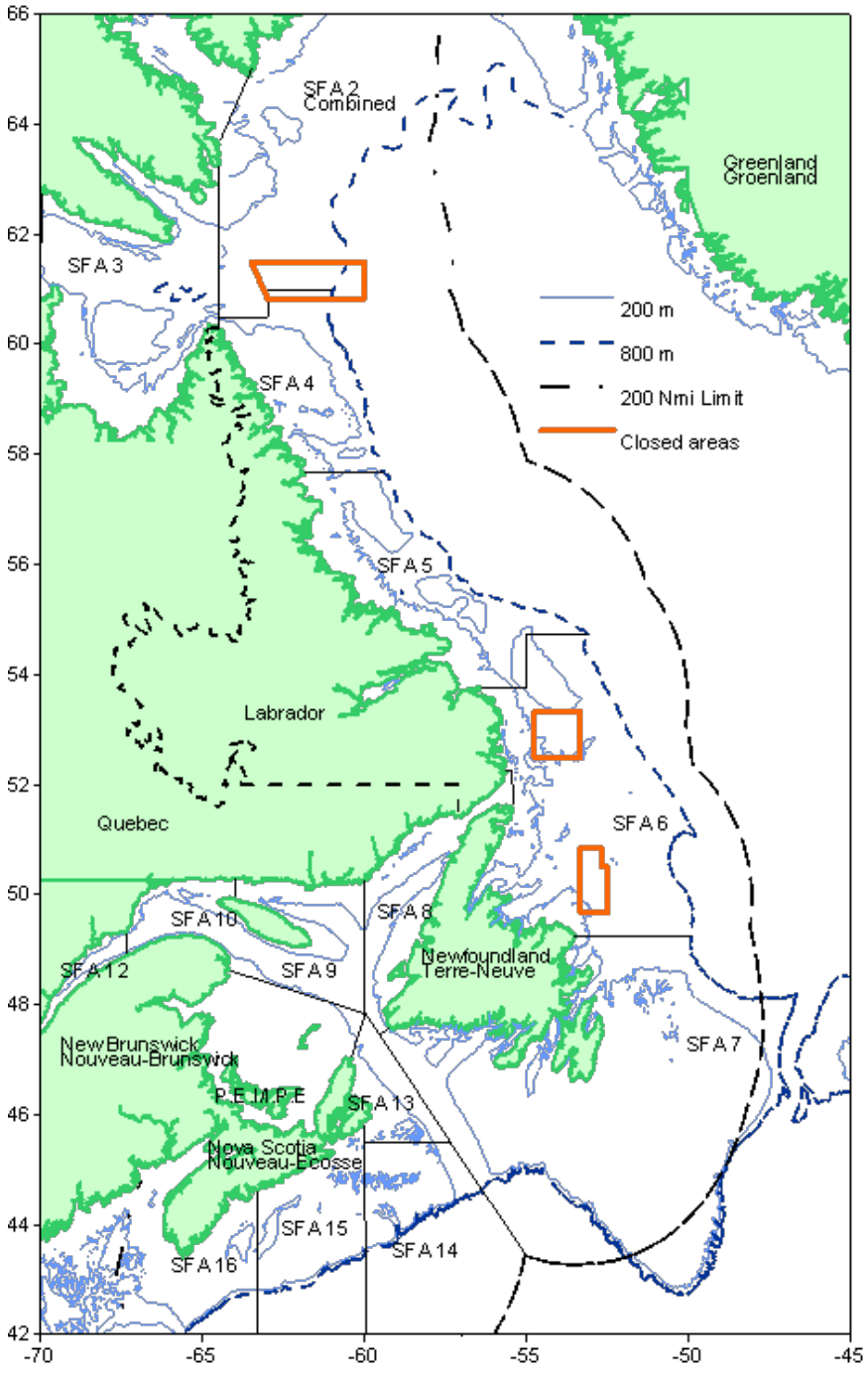


Figure 1.1. Canadian Atlantic coast with closed areas and examples of fishing management areas for northern shrimp identified (Epstein et al. 2018)

The inshore fisheries in Atlantic Canada are critical for employment, revenues, rural livelihoods, and provincial and national gross domestic product measures making practical recommendations to strengthen the governability of those fisheries broadly important (Table

1.1). For example, in Newfoundland and Labrador in 2016, almost half of the population lived in rural towns (i.e., settlements under 1000) (Bollman 2016). In 2018, over 15,000 people were employed in capture fishing and processing in rural areas (Government of Newfoundland and Labrador 2019). In the same year, those people contributed to just under 780 million dollars in total value for fish landings (DFO 2019b), and over 600 million dollars of total landed values were attributed to shellfish (Newfoundland and Labrador 2019). In 2013, Statistics Canada reported that fish harvesting, producing, and exporting resulted in over 28.8% of Newfoundland and Labrador's gross domestic product (Statistic Canada 2013). The fishing industry's contribution to other Atlantic provinces' gross domestic product was considerable but less so than in Newfoundland and Labrador: Nova Scotia (15.2%), New Brunswick (7.8%), and Prince Edward Island (10.4%) (Statistics Canada 2013).

Table 1.1: 2018 Demographic, employment in fish harvesting and processing employment, and value of landings from commercial fishing per Atlantic province (Statistics Canada 2019; Newfoundland and Labrador 2019).

Province	Population total	Population rural	% of Population in rural areas	Fish Harvesting employment	Processing employ-ment	Value of landings ($1000)
Nova Scotia	923,598	315,024	34.1	12,649	4,664	1,226,263
New Brunswick	747,101	279,058	37.4	6,008	6,895	410,748
Prince Edward Island	142,907	56,995	39.9	4,199	1,716	212,778
Newfound-land and Labrador	519,716	243,356	46.8	9,417	8,457	789,522

The Atlantic coast includes communities with cultural attachments to fishing that have persisted for centuries altered over time by technological, economic, social, and ecological changes (Christiansen-Ruffman 2002; Norman and Power 2014; Knott and Neis 2017; Ommer

1994). Salted cod and other groundfish (e.g., Atlantic halibut [*Hippoglossus hippoglossus*] and haddock [*Melanogrammus aeglefinus*]) were important early exports to European countries (Kurlansky 1999). Nowhere in the colonial history of North American was this more pronounced than off Newfoundland and Labrador's coasts. Historian D.W. Prowse (1895) estimated that fish harvesting with harpoon-like hook and line began in 1498, only one year after English 'discovery' of the Newfoundland and Labrador by John Cabot[5] (Prowse 1895). Then, the Portuguese (1501) and the French (1504) laid claims to Newfoundland and Labrador and the abundant cod stocks off its coasts (Prowse 1985). By these accounts, fish harvesting in the Atlantic is a 500-year-long endeavour with historical techniques (e.g., splitting, salting, and drying groundfish) used today mostly for a recreational and food groundfish fishery (Lear 1998).

Throughout this history, fishing, processing, and export have driven claims to foreign ownership Atlantic regions until the provinces joined Canadian confederation starting with New Brunswick and Nova Scotia in 1867 and followed by Prince Edward Island in 1873 (Pope 2009). Newfoundland and Labrador remained a British territory until 1909 when it became a self-governing dominion until confederation in 1949 (Pope 2009). After confederation, historical cultural attachments to fishing in the Atlantic provinces have shaped the settlement and migration patterns, increased specialization of ancillary services and sectors to fishing, and the uptake and extent of modernization in the fishery specifically and provinces more broadly (Pope 2009).

[5] Indigenous settlements predate English discovery. There were two points of contact between Indigenous peoples (e.g., the Mi'kmaq, Maliseet, and Innu or Montagnais-Naskapi people) and European settlers. Before contact with the English, there was a brief settlement by the Icelandic Norse in early 1000s who attempted to settle in the northern most tip of the region (Vinland according to the Vikings) now called the Great Northern Peninsula, Newfoundland. The specific site of the settlement, L'Anse aux Meadows, was designated a National Historic Site of Canada in 1968 and UNESCO World Heritage in 1978 (Reid 2016).

Beginning in the early 1960s, there have been significant technological and social advancements that modernized the inshore fisheries (Gough 2007). Modernization included the slow development of property rights and rents, the use of technology and gear (e.g., gillnets, large traps, grates, otter trawls), and the influence of globalization and local economic development local value chains and global seafood export and trade patterns (Gough 2007). Furthermore, the emergence and fluctuations of informal economies have been shaped over hundreds of years of interacting and adapting to marine crises in Atlantic marine ecosystems, coastal communities, and Canadian fisheries governance (Ommer and Turner 2004; Smith et al. 2014). Examining how to govern fisher behaviour in this context is valuable as many modern coastal fisheries are influenced by a historical and cultural setting (see Bavinck et al. 2015).

Residents in Atlantic coastal communities have experienced a considerable number of marine crises. Ommer (1994, 2018) estimated over 100 years of fisheries crises have occurred in the Atlantic. For example, in the early 1980's, the Atlantic groundfish industry experienced a major economic downturn due to increases in large-scale, vertically-integrated fishing fleets operating off Nova Scotia and Newfoundland's coasts. Vertical integration was a key driver of overfishing that resulted in major policy and financial restructuring (Apostle and Mikalsen 1995). In addition to moratorium on Northern Atlantic cod fishing in 1992, weakened Atlantic salmon stocks (*Salmo salar*) led to the commercial closure in the same year that intensified the impacts associated with the cod moratorium. DFO used extensive license 'buyouts', a program for purchasing back existing licenses for commercial salmon fishing (Chase et al. 2003). In 1995, Spanish factory trawlers within the Canada's 200-mile exclusive economic zone depleted Greenland halibut (or turbot) (*Reinhardtius hippoglossoides*) stocks, culminating in an international conflict known as the 'Turbot War' (Weiner 2016). These were only a few of the

examples that indicated major fluctuations of fish stocks and emergence of policy problems on the Atlantic coast, particularly in Newfoundland and Labrador. Case study research can therefore provide an opportunity to study fisher behaviour in relation to patterns of crises and the policies used to address them.

To govern fisheries and prevent crises, DFO has developed and implemented shared policies frameworks and similar decision-making processes for the inshore fisheries in Canada's Atlantic management regions: Maritimes-Scotia-Fundy, Gulf, and Newfoundland and Labrador. For example, in the three regions, inshore fisheries are sustained through a policy on *Preserving the Independence of the Inshore Fleet in Canada's Atlantic Fisheries* (PIIFCAF) (DFO 2010a) now included in Canada's Fisheries Act and through national-level policies including the *Sustainable Fisheries Framework* (DFO 2019c) that enshrines the precautionary principle as a guiding approach for harvest-level policies. Furthermore, the regions share similar processes for including how science and other knowledge types are produced, communicated and used to control inshore fisher behaviour (Soomai 2017a).

To implement policies, integrative fisheries management processes exist that shape three to five-year long goals for specific fish stocks that are then incorporated into annual work plans for DFO managers (DFO 2019d). DFO conducts stock assessments annually or biennially that incorporate peer-reviewed biophysical science about fish stocks from surveys and on-board observers that incorporate information about landings from fisher logbooks (e.g., DFO 2018 & 2019e). The information from stock assessments along with the parameters established in policies like PIIFCAF are considered in advisory meetings that include representatives from the fish harvesting sector, such as fishers (Soomai 2017a). Specific fisheries are managed through various mechanisms including input controls (e.g., vessel size and gear restrictions), output

controls (e.g., Total Allowable Catches and individual quotas), temporal restrictions (e.g., competitive fishing times with no trip limits are established) and spatial restrictions (e.g., area closures). Regional actors shape how decision processes are adapted to local contexts. For example, in Newfoundland and Labrador the local union—FFAW-Unifor—has a considerable role in formally representing both fishers and processors, participating in referral processes about policy outcomes, and lobbying for new management strategies (Pinkerton et al. 2018). Despite the specifics like this, the similarities of governance responses to change across the Atlantic regions provide opportunities for lessons learned in one region to be salient for others.

1.4. Research design, methodology, and methods

The dissertation's research design combines a systematic and qualitative, case study methodology grounded in an epistemological framing known as critical realism. Critical realism refers to the idea that "reality has an objective existence but that our knowledge of it is conceptually mediated: facts are theory-dependent but they are not theory-determined. This in turn means that "all knowledge in fact is fallible and open to adjustment. But – not all knowledge by far is equally fallible" (Danermark et al. 2002: 15). Critical realism is a midway path between positivist and constructivist traditions. Positivism indicates all reality that is knowable and quantifiable whereas constructivism indicates that reality exists only from the varying perspective of different perceivers (Brown 2013). Critical realism rejects both positions in their most extreme forms and argues that science needs to address the people's perceptions in a natural and social reality, acknowledging the need for various knowledge types to assess claims about truth about reality, including the values and interests that underpin those claims (Danermark et al. 2002; e.g., Sarewitz 2004). Critical realism therefore provides opportunities investigate material changes along with fishers' interpretations of those change, that may or may not be consistent

across different fishers, where both are critical for advancing capacity and ability in governance to address change (Jentoft and Chuepagdee 2015).

The research design included three components to meet the dissertation's purpose and objectives (see Figure 1.2). The first component was a conceptual and systematic synthesis of fisher behaviour (Chapter Two). The purpose of the synthesis was to identify characterizations of fisher behaviour, explanations for behaviour, and implications for governance (Dissertation Objective 1). To achieve this, a systematic scoping review was conducted of 104 peer-reviewed papers from 2012 to 2017 (see Chapter Two). Key recommendations from the systematic scoping review included the need for case-study research that empirically assessed the typology and novel explanations to develop lessons about fisher behaviour in a local context and context-sensitivity in governance. Hence, the systematic scoping review served as a foundation for two case study research manuscripts.

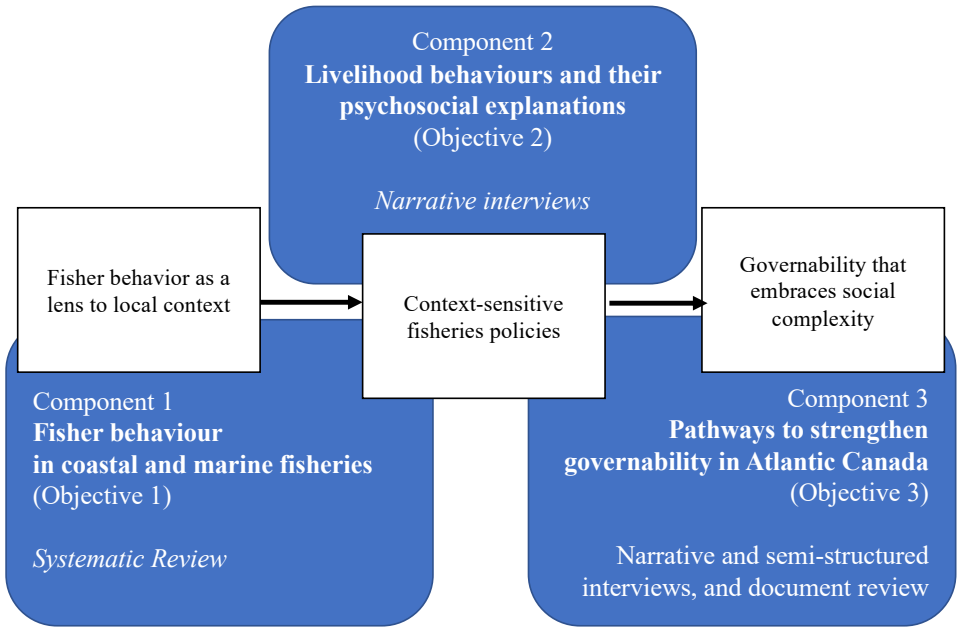


Figure 1.2: Research design

Drawing on the systematic scoping review's conceptual outcomes, the second component examined the behavioural foundations of inshore fishers involved in fishing multiple species off the coasts of the Great Northern Peninsula (Chapter Three). The purpose was to build evidence-based insights about fisher behaviour and its explanations in relation to uncertainty and change (Dissertation Objective 2). To address this objective, long-form narrative interviews were conducted with 26 fishers (see Chapter Three). The third component focused developing strategies to strengthen the governability of inshore fisheries in Atlantic Canada (Chapter Four). Component Three's overall aims were to assess social science knowledge about fisher behaviour in the science and management decisions taken to implement governance objectives, and to examine potential barriers and opportunities for the incorporation of fisher behaviour to integrate governance objectives (Dissertation Objective 3). Data for the third component were derived from 10 semi-structured interviews with senior DFO employees working in Atlantic regions, 41 narrative interviews with inshore fishers and community members living in Great Northern Peninsula, Newfoundland and Labrador, and a review of 99 documents related to the governance of inshore fisheries (see Chapter Four). Interviews from Component Two supplemented and guided interpretations of interviews with DFO representatives in Component Three.

Data were collected from January 2018 to January 2020. Data for the systematic scoping review were collected from two databases—Web of Science and Scopus—starting January 2018 with all data collected and screened by June 2018. The final sample of papers used for the systematic scoping review can be found in Supplementary Material A. Moreover, analytical codes, procedures, and appended results for the review can be found in Supplementary Materials B to D. Narrative interview data were collected from an in-person field season in the Great Northern Peninsula from April 2018 to September 2018. Data collection began in June 2018

after extensive preparation in meetings with academic researchers and local mayors in the region. Semi structured interviews with DFO employees were conducted over the phone from November 2019 to January 2020. During this time period, documents were collected and reviewed. An interview guide used for the semi-structured interviews can be found in Supplementary Material E. A list of documents reviewed can be found in Supplementary Material F. Hence, data collection followed a straightforward sequence to ensure that data collected effectively linked research design components.

1.4.1. Case study approach

Case studies in Chapters Three and Four used two different scales. In Chapter Three, the case study scale was geographical, and bounded to area known as the Great Northern Peninsula, Newfoundland and Labrador (Figure 1.3). The Great Northern Peninsula, or Viking Peninsula, is the largest peninsula in Newfoundland and Labrador. It extends north from the Town of Rocky Harbour along the coast of the Strait of Belle Isle in the Gulf of St. Lawrence. On the northern tip of the peninsula rests the large Town of St. Anthony, with several fishing communities located past St. Anthony on the east side of the peninsula. This region—the St. Anthony-Port-au-Choix region—is a key planning region for the rural secretariat of Newfoundland and Labrador (Greenwood and Vodden 2011). Narrative interviews were collected from inshore fishers living in towns and villages across the western coast, northern tip, and east coast in the St. Anthony-Port-au-Choix region (Table 1.2). In Chapter Four, the case study scale was jurisdictional, and bounded to three administrative regions for DFO in the Atlantic, including the Maritimes, Gulf, and Newfoundland and Labrador regions. As such, insights about fisher behaviour are drawn the inshore behaviour in Great Northern Peninsula, and used to guide the development of strategies for stronger governability across DFO's Atlantic regions.

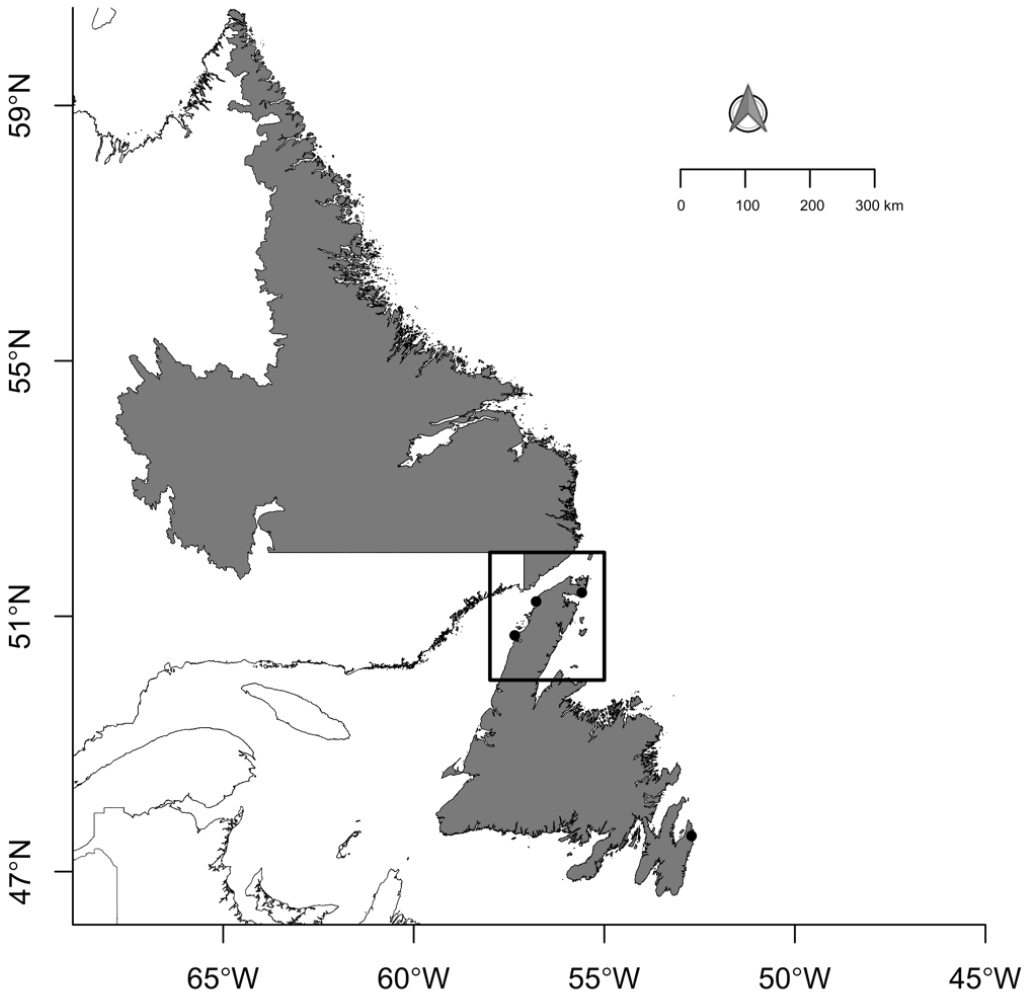


Figure 1.3. Map of Newfoundland and Labrador, Canada, with Great Northern Peninsula highlighted in black box

Table 1.2: Coastal communities, species harvested, and vessel sizes in St. Anthony-Port-au-Choix region

Subregion	Example communities	Fish stocks likely harvested	Common vessel size
Western coast	Bird Cove, Anchor Point, Green Island Brook	Scallop, capelin, northern shrimp, snow crab, halibut	15’ to 64’
Northern tip	St. Anthony, Raleigh, Goose Cove	capelin, northern shrimp, snow crab, halibut	15’ to 64’
Eastern coast	Conche, Englee	Lobster, snow crab, bearded seal, squid	15’ to 64’

1.4.2. Data analyses and integration

Content analyses were conducted for each dataset in this research. Content analysis refers to the systematization of text by empirically coding relevant items, and then examining relationships among those items (Krippendorff 2013). This synthetic process occurred in four iterative phases including data segmentation, the development of data matrices and coding, reflecting by memoing, and reflecting by diagramming (see Table 1.3). Analysis varied by initial segmentation phase of the analysis for each method. For the systematic scoping review, analysis included assessing the main text of the literature as raw data, and then proceeded systematically to make evidence-based inferences about organizing codes following Table 1.3 (Finfgeld-Connett 2014). Initial segmentation was done by study type—synthesis or case study— then further segmentation was done according to behavioural type and their explanations.

Table 1.3: A content analysis process (adapted from Finfgeld-Connett 2014)

Content Analysis Phases	Description
Data segmentation	• Initial sorting of data into broad descriptive categories • Secondary sorting of each category into segments
Data coding	• Organizing segments in a matrix to manage codes and separate quotations • Iterative and inductive identification of phrases that are separated into similar or dissimilar themes and subthemes. • Describing and interpreting the body of literature based coded data
Reflecting by memoing	• Note-taking for a clear "audit trail" as data analysis progresses • Note-taking on immediate reflections of phrases and codes within studies and then on themes across studies.
Reflecting by diagramming	• Constant revising of visual representations of relationships between codes

For the narrative interviews, analysis followed four iterative steps. First, data were segmented into life stories for fishers and fishing households (see Murray et al. 2008). Second, coding was conducted to assess behavioural events and their explanations in each life story. Third, life-stories were compared as units of analyses (see Lal et al. 2012). Fourth, codes were applied to the entire dataset and assessed for fishers' behavioural explanations in the dataset (see Chapter Three for further details how these steps and triangulation were conducted). Codes from the second step also contributed to Chapter Four.

For the semi-structured interviews and document review, data were segmented first according to region or type. For example, interview data were organized by Atlantic region (i.e., Gulf, Maritimes, or Newfoundland and Labrador Region), and documents were organized by type (i.e., policies, plans, stock assessments, and departmental evaluations). Then, those segments were analyzed by deductive themes informed by conceptual outcomes from Chapter Two and literature reviewed in Chapter Four. Themes were then compared within datasets (i.e.,

across interviewee regions or document type) and across dataset (i.e., narrative interviews). Last, a comparison of datasets revealed emergent themes that were then reapplied to the both datasets.

Data integration emphasized triangulation within and across these distinct sources of evidence (i.e., from peer reviewed literature, narrative interviews, semi-structured interviews, and documents review). Triangulation is a goal in mixed-method research that attempts to examine phenomena from multiple perspectives within the same method (i.e., within-method triangulation) and across different methods (i.e., between-method triangulation) to determine their convergence (Curry et al. 2009). Triangulation can support stronger reliability when themes converge, and can reveal nuanced information when themes are related but do not converge (Farmer et al. 2006). Convergence involved pulling out major themes that appeared to be shared from different perspectives held by interviewees, described in scientific literature or documents from the same research sample (e.g., within-method triangulation in semi-structured interviewing), from different perspectives across two distinct datasets (e.g., Chapter Four) or across the entire dissertation for overall synthetic discussion and conclusions (e.g., Chapter Five) (Bryman 2001). The goal of highlighting divergence was to demonstrate points of disagreement and highlight nuance within major themes.

This research was transparent about convergence and divergence by indicating the types of perspective behind the themes (e.g., "both fishers agreed that…"). In addition, results indicated the number of peer-reviewed papers in the systematic scoping review (e.g., 60% of studies shared…), people in the interviews that shared the perspectives (e.g., "10 fishers indicated that…), or documents (e.g., 10 stock assessments revealed). Indicating the convergence in the systematic scoping review was intended to indicate statistical representation. Convergence for interviews or documents did not indicate statistical representation. Rather, convergence of

interview or document themes was intended to indicate depth in perspective in interview themes or extent of themes in documents, known as analytical generalization.

Analyses used three different analytical softwares. To analyze interview, document, and peer-review literature data, research used *QSR International's NVivo 12* qualitative analytical software to code and compare themes (Chapters Two to Four), and create some figures (i.e., for Chapter Three). Codes, reflections, other diagrams (i.e., Chapters One and Four), and metadata were created and housed in *Microsoft Excel (2012)*. Social networks used in Chapter Two were created in R CRAN'network' (2017). This research was approved by The University of Waterloo Office of Research Ethics (ORE) (ORE# 22704) on January 31, 2018. Preliminary results were presented back to participants for verification. Pertinent ethics documents are included in Supplementary Material G to J.

1.5. Organization of dissertation

This dissertation is manuscript-based, and comprised of an introductory chapter, three empirical manuscripts, and a concluding synthesis chapter. The introductory chapter was used to 'set the stage' for the dissertation by describing the research challenge, problem rationale, literature review, conceptual framework, and the research design used apply the conceptual framework.

Chapter Two, the first empirical manuscript, characterizes the current scientific knowledge base about fisher behaviour in coastal and marine fisheries settings with a key focus on characterizations and explanations for behaviour and their implications for governance (Objective 1). This chapter contains a manuscript titled, "Fisher behaviour in coastal and marine fisheries". This manuscript has been accepted to *Fish and Fisheries*.

Chapter Three, builds on the findings of Chapter Two to empirically assess fisher behaviours in response change and uncertainty and psychosocial explanations for behavioural

change (Objective 2). It contains a manuscript titled, “Coastal fishers’ livelihood behaviours and their psychosocial explanations: implications for fisheries policy”. This manuscript will be submitted to *Frontiers in Marine Science* to influence and contextualize criticisms of conventional assumptions in science and policy about how and why fishers behave in response to change.

Chapter Four, the final empirical manuscript, followed recommendations made in Chapter Three. This chapter contains a manuscript titled, “Strategies to strengthen fisheries governability in Atlantic Canada”. The findings in Chapter Four shaped three evidence-based and novel strategies were described that can strengthen the governability with inshore fisher behaviour. This manuscript will be submitted to *Canadian Journal of Fisheries and Aquatic Sciences.*

Chapter Five summarizes the major findings, and outlines the contributions of this dissertation. Furthermore, the final chapter considers the limitations of the overall research design, and identifies areas for future research. The chapter concludes with reflections of the author’s doctoral journey.

Chapter Two

Fisher behavior in coastal and marine fisheries: a systematic scoping review

2.0. Chapter summary

This chapter scopes and reviews fisher behaviour in coastal and marine fisheries. Fisher behaviour refers to individual and group level action that reflects the psychological processing and social exchange of information in fisheries. Fisher behaviour is poorly conceptualized and explained in the fisheries research, and its implications for governance outcomes remain uncertain. To address this gap, this chapter includes a systematic scoping review of peer-reviewed literature (n=104 journal articles published from 2012 to 2017). Results highlight a typology of fisher behaviour, and reveal insights into the behavioural types and their explanations commonly used models. Findings show fisheries researchers have emphasized fishing effort, specifically, and fisher behaviour in coastal and marine ecosystems, more broadly, in conceptual and empirical models. Further, research that explains behaviour often emphasizes that fisher behaviour is motivated by profit maximization, and fishers' individual and group decision-making is characterised by ecological, economic, and governance factors. This research reveals three major implications for governance. First, researchers can strengthen recommendations for governance by examining fisher behaviours as multi-level and -scale phenomena occurring across ecosystems, communities, and governance. Second, scientists in governance can improve capacities to anticipate behavioural change with theoretical models that prioritize psychosocial variables, and interdisciplinary collaboration that uses empirical research on the context-sensitive factors shape the fishers' psychosocial responses to change. Third, policy-makers and researchers can strengthen incorporation of fisher behaviour in policy

processes with examination of the governance barriers and opportunities for using new models that incorporate fisher behaviour to develop, implement, and evaluate fisheries policies.

2.1. Introduction

How fishers shape and respond to change through their behaviour is an important knowledge gap in the governance of coastal and marine fisheries. Fisher behaviour refers here to the action of individuals and groups of fishers that result from cognitive processing and social exchange of information. Behaviour is understood as both a driver and response to change in biophysical and social environments in sustainability science (Lambin and Meyfoidt 2010; Fischer et al. 2012), and throughout substantive research in affective neuroscience, social psychology, and sociology (Barclay et al. 2017; Bechara 2004, Kerr and Tindall 2004; Pellow and Brehm 2013).

Governance refers to the processes, rules, and practices through which societies come together to make decisions to prevent, mitigate, foster, and adapt to change (Oakerson 1992; Biermann et al. 2010). To foster sustainability through governance, societies produce and implement policies or informal and formal political decisions taken to solve problems (Kooiman 2003). Fisher behaviour has implications for these governance contexts and policy processes. In coastal and marine fisheries, fisher behaviour manifests as short term tactics (e.g., adapting effort, discarding, and compliance) that enable or constrain the implementation of, as for example, marine protected areas or individual transferrable quotas which, in turn, shape the adaptive capacity of marine ecosystems (Abbott and Haynie, 2012; Emery et al. 2012). Additionally, fishers respond to changes in ecosystems (e.g., range shifts) and governance (e.g., new regulations) through their long-term strategies to pursue, protect, and enjoy their livelihoods (e.g., investing, diversifying, and exiting fisheries) (Daw et al. 2012; Pascoe et al. 2015). Understanding these tactical and strategic responses is essential to understand social-ecological

feedbacks in coastal and marine fisheries that influence capacity and capitalization, including the effectiveness of spatial closures, input and output controls, and collaboration and collective action (Anderies 2015; Bietl 2015; Saldaña et al. 2017).

Since the 1970s, the ubiquity and utility of fisher behaviour has garnered scientific attention to understand and anticipate change in governance (Cove 1973; Pitcher and Chuenpagdee 1993; Branch et al. 2006; Hilborn 2007). However, since the 2000s, social and policy sciences research that addresses fisher behaviour has highlighted the need for new insights to strengthen knowledge for governance and policy develop (Chuenpadee and Jentoft, 2009; Fulton et al. 2011; Teh et al. 2012). Imperatives for new research and practice on fisher behaviour are based on three criticisms. First, research on fisher behaviours at different scales is limited, including broader spatial scales that integrate tactical and strategic behaviours across ecosystems, coastal communities, and governance settings (Beitl et al. 2014; Coultard 2012). Second, mental and social (hereafter psychosocial) decision-making processes for individuals and groups are under-investigated in explanations for fisher behaviour (Salas and Gaertner 2004; Chuenpadee and Jentoft 2009). Third, the implications for coastal and marine governance for more comprehensive conceptualizations and evidence-based explanations for fisher behaviour require attention to develop, implement, and evaluate fisheries policies (Fulton 2011; Shepperson et al. 2016).

Research that addresses criticisms in fisher behaviour is imperative given broader trends in fisheries governance. For example, the scope of objectives and factors considered in decision-making for coastal and marine fisheries is expanding (Stephenson et al. 2019a; Stephenson et al. 2019b). In North America, both Canada and the United States have embedded diverse objectives for ecosystems and coastal communities in major legislation, including Canada's newly amended Fisheries Act (1997), and the USA's Magnuson-Stevens Fishery Conservation and Management

Act (2006) in the United States. In Europe, fisheries policies have been proposed and implemented that necessitate an understanding of fisher behaviour including country-level policies (e.g., Johnsen 2017) and European-Union-level policies (e.g., European Common Fisheries Policy) (Garza-Gil & Varela-Lafuente 2015). Hence, fisher behaviour has emerged as an important subject of fisheries governance, and as a lens into contextual knowledge required to design effective policies at multiple scales (Bennett 2019).

This chapter presents results from a systematic scoping review of peer-reviewed scientific articles (n=104, 2012 to 2017) to assess how fisher behaviour is examined (i.e., methodologies, concepts, explanations) in relation to environmental, social (e.g., cultural, economic), and governance (e.g., political, institutional) change. The following research questions guide this systematic review: (1) what is the state of the literature that addresses directly fisher behaviour?; (2) how is fisher behaviour conceptualized?; (3) what goals (i.e., what fishers want) and factors (i.e., what they consider and/or experience in attempts to get what they want) are used to explain fisher behaviour?; and (4) what are the implications for governing coastal and marine fisheries given insights from the current state of the literature, and conceptualizations and explanations for behaviour?

In the following section, background is provided on the three criticisms in relation to opportunities and challenges to incorporate fisher behaviour in various types of models used to assess, anticipate, and plan for change in governance. Then, results are presented and discussed results in three sections. First, results include a characterization of the state of the literature on fisher behaviour in coastal and marine fisheries. Second, an assessment of how fisher behaviour was conceptualized in the literature is provided. Third, results involve an examination of the factors and goals used to explain fisher behaviour. Then, a discussion of the results highlights the

implications for governing coastal and marine fisheries given insights from the current state of the literature, and conceptualizations and explanations for fisher behaviour.

2.2. Conceptual background

Conceptual, theoretical, empirical, and simulation models provide key opportunities to strengthen governance with better integration of insights on fisher behaviour (Simons et al. 2015; Teh et al. 2012; Tidd et al. 2012). Conceptual models are implicit or explicit overviews of scientists and collaborators expect human behaviour to function in relation to other system elements, including drivers of change, social and environmental conditions, and outcomes (Brewer et al. 2005). Theoretical models are fine grained explanations for behaviour that depict theoretical relationships among different psychosocial, economic, socio-cultural, and governance motivations that inform behavioural change (Gifford 2014; Matsumori et al. 2019). Conceptual and theoretical models are often used to guide empirical research, policy discourse, and management evaluation and to understand, anticipate, and plan for change (Smith et al. 2016; van Putten et al. 2012).

Empirical models express relationships in conceptual models quantitatively and leverage assumptions in theoretical models to provide insight into new problems of change (Epstein, 2008). Empirical models also provide decision support about potential consequences of different policy interventions (Brewer 2007; Edmonds et al. 2019), including, for example, dynamic process models that assess data using statistical theory (Essington et al. 2017; e.g., Bieg et al. 2017) or agent-based models (Lindkvist et al. 2020). Empirical models are distinct from qualitative and quantitative empirical observation such as questionnaire studies or linear regressions using statistical theory (Essington et al. 2017). A further distinction can be made for simulation models that predict interactions and outcomes across fisheries often without empirical

validation (Edmonds et al. 2019; Essington et al. 2017). The descriptions and explanations for fisher behaviour shape assumptions and evidence in models, and hence the quality of governance recommendations and the design of institutions that advance sustainability through governance (Epstein et al. 2020). However, three criticisms about research on fisher behaviour have indicated opportunities to better describe and explain fisher behaviour within models, and to support stronger incorporation of fisher behaviour in governance.

First, there is limited accounting of a range of fisher behaviours, and how they manifest in response to change in different settings, including ecosystems and coastal communities (Bietl et al. 2014; Daw et al. 2012; Fulton et al. 2011). Research from systems or institutional design literature reveals that inter-related behaviours are multi-leveled (e.g., individuals, groups, communities) that shape systems dynamics and adaptive capacity at different scales (Epstein et al. 2020; Salas and Gaertner 2004; Yletyinen et al. 2018). 'Level' refers here to the "unit of analysis located at different positions on a scale", where scale refers to "the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon" (Gibson et al. 2000). Accounting for multi-faceted, -leveled, and -scaled fisher behaviours has practical implications to, as for example, ecosystem-based approaches to fisheries management that seek to understand relationships among human aspects in the fishery in ecosystems and communities that shape pressures on fish stocks (Hornborg et al. 2019; Fogarty 2014). Choices among variables including behaviours, explanations, level, and scale require guidance as those choices shape the validity and reliability of conceptual models and, hence their usefulness to inform empirical and simulation models and coastal and marine policy more broadly (Armitage et al. 2019; van Putten et al. 2012).

Second, insights are needed for theoretical models that explain fisher behaviours (Chuenpagdee and Jentoft 2009; Coulthard 2012; Fulton et al. 2011). Human behavioural research indicates that behaviour can be explained by goals intrinsic to individual and group decision-making processes, and factors or social and environmental conditions extrinsic to and reflected on during decision-making (Heimlich and Ardoin 2008; Kwasnicka et al. 2016). Fisheries researchers have criticized the reliance of rational choice and micro-economic theory to explain the goals for fishers, and the limited use of psychosocial and socio-cultural factors that shape action toward those goals in ecosystems and communities (Chuenpagdee and Jentoft 2009; van Putten et al. 2012). Human behavioural research has empirically supported alternatives to maximization of utilities and the focus on profit as the main goal for human behaviour (Kwan and Silva 2020). For instance, policy sciences research and environmental change literature has situated diverse human values as more reflective of resources users' goals, including individual goals such as profit, status, power, and affection (Clark 2012; Jones et al. 2015). Further, livelihoods research poses a theoretical alternative in which fishers pursue various human values in different settings that may reflect maximization, protection, or enjoyment, and the pursuit is shaped by a range of extrinsic contextual factors that shape the agency of fishers to move to action (Béné et al. 2019; Ellis 2000; Weeratunga et al. 2014). Other research areas, such as transportation literature, employs minimization or avoidance of certain outcomes expressed in random regret minimization theoretical approaches to discrete choice modelling (Chorus 2014).

Third, conceptual and empirical models that incorporate descriptions and explanations of behaviours at different levels and scales have practical challenges for use in the science, policy, and management processes in governance (Edmonds et al. 2019), and these challenges are under-examined in fisheries research (Shepperson et al. 2016). In the creation of conceptual models,

scientists, policy-makers, and fishers alone do not have access to the information needed to map and explain interactions with behaviour (Kooiman and Bavinck 2005). Empirical and simulation models also have considerable practical constraints (Carr and Heyman 2014; Shepperson et al. 2016). Empirical models have potential data access and intensiveness limitations and potential to increase error in models when depicting multi-faceted, -level, and -scale fisher behaviour (Shepperson et al. 2016). Further, new conceptual and empirical models imply often innovations in data collection and analyses used in governance, and often implicate new expertise or analytical capacities to interpret results for the development and implication of policy (Howlett 2009; Wu et al. 2015). Despite these practical challenges, the importance of fisher behaviour to change processes requires efforts to categorize, explain, and reflect on the new scientific opportunities to increase the quality of decision support and barriers and opportunities to use that support in governance.

3. Materials and methods

This chapters' results were derived from a systematic scoping review method that examined peer-reviewed articles related to fisher behaviour in coastal and marine fisheries contexts. The goal of a systematic scoping review is to investigate an emergent body of literature or a concept using systematic protocols (Levac et al. 2010). Hence, the types of studies examined in systematic scoping reviews can be diverse (i.e., different goals for conducting research and diverse methodologies to address those goals) as long as those studies share the emergent body of literature or concept (Arksey and O'Malley 2005). In contrast, conventional systematic reviews are typically used to examine well-defined literatures and evaluation of interventions (e.g., rules, programs, or recommendations) (Petticrew and Roberts 2006).

The systematic scoping review was conducted in four-phases: (1) development of research questions; (2) implementation of the search protocol; (3) screening of the search results to determine the 'sample'; and (4) analysis of included materials to discern critical patterns and insights in relation to the research questions. A similar process has been used for systematic reviews in the social sciences, including in the context of coastal and marine social sciences (e.g., Pittman and Armitage 2016; Plummer et al. 2012; Blythe et al. 2019). The four stages of this process were developed in consultation with librarian support (see Koffell 2015), and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines on mitigating and reporting potential sources of bias (Moher et al. 2009).

The review was initiated in 2018. The upper limit for years of publications was set to 2017 to ensure all relevant publications were included (Petticrew and Roberts 2006). A five-year range for year of publication was used to allow for deeper analysis on a manageable sample (Petticrew and Roberts 2006).

Search terms reflected fisher behaviour as a form of human behaviour more broadly, articulated various potential behavioural manifestations, and included behavioural concepts from other fields of study related to fisheries. Search terms were applied to titles, abstracts, and key words in Web of Science and SCOPUS. Search terms were revised to maximize sensitivity (i.e., proportion of all studies that were retrieved by a search) with selectivity (i.e., proportion of retrieved studies that were relevant). When a final list of search terms was developed, it was verified through three tests in the database to account for potential human error in creating the search term string. The search term string used in the Web of Science and SCOPUS is outlined below:

"human behav*" OR "fisher behav*" AND
fisher* OR marine OR coastal OR ocean AND
incentive OR motivation OR explanation OR factor OR driver AND
effort OR "fleet dynamic" OR métier OR regulation OR conflict OR trade-off OR place OR
"collective action" OR well-being OR capabilit* OR livelihood OR adaptation OR
cooperation OR rights OR exit OR diversify OR migrate

Two levels of screening were used to identify the sample from the search results. First, all returned abstracts were scanned, and articles were excluded that were not peer reviewed, in a language other than English, and did not discuss fisher behaviour in the context of coastal or marine fisheries, and were duplicates. A more fine-toothed screening was then applied during which entire articles were assessed based on the following criteria in Table 2.1. An initial search returned consistently 842 items in Web of Science (n=356) and SCOPUS (n=486). Initial screening excluded 548 items and final screening excluded 487 items (see Figure 2.1). Screening resulted in 104 peer reviewed articles from 36 different journals, where Six journals represented approximately 60% of the sample: *Marine Policy* (n=24), *Fisheries Research* (n=11), *Fish and Fisheries* (n=11), *PLoS One* (n=5), *Ocean & Coastal Management* (n=5), and *ICES Journal of Marine Science* (n=5). There was a slight increase in number of articles for the first four publishing years (2012, n=12; 2013, n=12; 2014, n=18; 2015, n=19) with a slight decrease in year five (2016, n=15), and sharp increase in year six (2017, n=28).

Table 2.1: Screening Criteria, their Descriptions and Examples of Exclusions

Criteria	Description	Example of Exclusions
Fisher behaviour as human behaviour	Must discuss fisher behaviour as the main focus or case study of human behaviour	Manager behaviour, or processor behaviour with no fulsome discussion of fisher behaviour
Coastal or marine fishery-based	Must include some emphasis on fisher behaviour in a coastal or marine fishery	In-land, freshwater, or high seas fishery-based literature
Commercial, artisanal, or subsistence fishery-based	Must include some reference to the flow of information, resources, capital, use, and benefits in a commercial, artisanal, or subsistence fishery context	Recreational fishery studies that involve fisher behaviour
Contemporary	Must include a temporal sc,arpe in analysis from the 1950s on	Pre-World War II fisheries

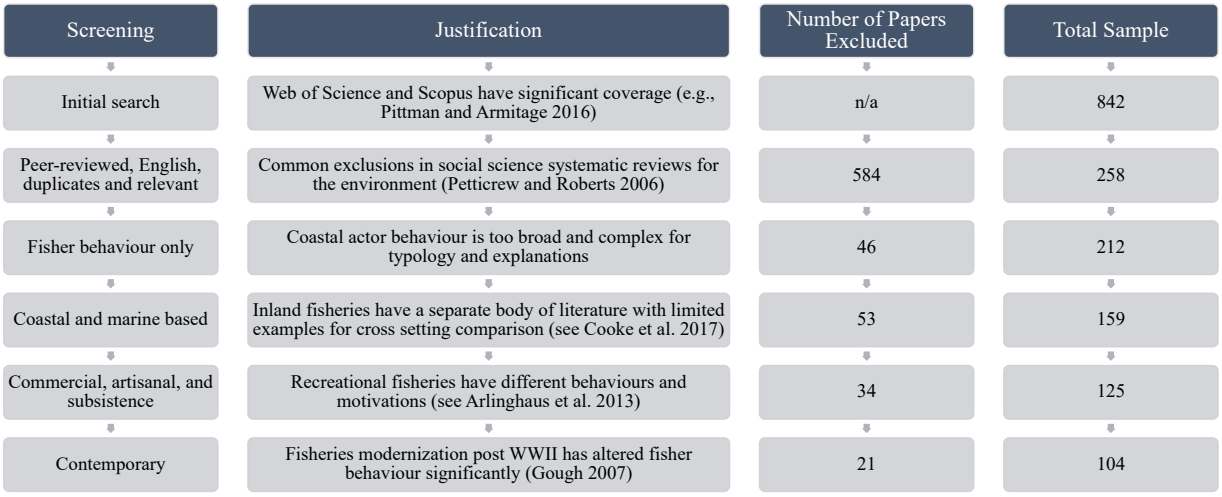


Figure 2.1. Flowchart of screening decisions, justifications, and sample size

Analysis first included qualitative coding to identify core aspects of fisher behaviour in the sample of publications (i.e., methodologies, concepts, explanations). Coding was combined inductive and deductive approaches (Palinkas et al. 2015). Deductive coding was used results for the state-of-the literature (Research Question 1), and inductive coding revealed concepts, explanations, and implications of fisher behaviour in coastal and marine fisheries (Research

Questions 2 to 4) (variables, description, and approach to coding described in Supplementary Material B). Variables identified were explicitly mentioned, including methodological elements, types of behaviour, and implications. Following guidance from the literature (Heimlich and Ardoin 2008; Kwasnicka et al. 2016), explanations were coded as goals (i.e., the intrinsic objective pursued by fishers and process that shaped that pursuit) and factors (i.e., extrinsic concepts that authors indicated were important or validated empirically that fishers considered in decision-making processes). Latent variables, such as implicit goals or factors were not assessed. Coding was conducted in QSR International's NVIVO 12 Software.

Social networks were used to visualize relationships among the explanatory variables and the number of times they co-occurred in the sampled publications. A social network is a tool to visualize and analyze relationships among societal elements, such as people, organizations, or ideas, where relationships are referred to as edges and elements as nodes (Brandes et al. 2014; Wellman and Berkowitz 1988). Recently, social networks have been used in systematic reviews to depict relationships among ideas, publications, or references (e.g., Pittman and Armitage 2016). In this chapter, analysis included unipartite networks to project relationships among behavioural types and among explanatory factors along with their co-occurrence with the frequency determined by the number of publications that validated the variable. Networks aided an assessment of the theoretical status of the field by visualizing answers to questions, such as: are publications considering more than one behavioural type and if so which ones? Which and at what frequency are variables verified as explanations for behaviour? Which factors seem to co-occur more often in the sample? What do relationships among types of behaviour or explanatory factors indicate about the comprehensiveness and extent of integration in research about fisher behaviour? Relationships and inferences from exploring these questions are discussed

qualitatively as strong or weak. Networks were created in R using a CRAN network package (R Core Team 2017).

The qualitative coding process revealed lists of behavioural types (n=9) and explanatory factors (n=46) for social network visualizations. We explored co-occurrence among explanatory factors across the entire sample (see Supplementary Material C). Then, we assessed the prevalence of co-occurrence for explanatory factors illustrating the 25% most commonly co-occurring relationships (Supplementary Material D). This was performed by setting a 75% threshold to reveal patterns in the network that are dominant across the sample of papers (Coscia and Neffke 2017). To provide another view of patterns among explanatory values, we combined explanatory factors into groups using a manual qualitative data reduction strategy (Guest et al. 2012). Grouping was based on examination of how authors used the factor in each publication and compared with literature about the groups. We indicate the groups and corresponding literature in the results.

2.4. Results

2.4.1. State of the Literature

The first research question was to identify the 'state of the literature' including the geographical locations of case studies, the methodological content (e.g., types of studies and methodologies, data, methods, and analyses used), and behavioural content (e.g., motivations for the study, level and context of behaviours described, and the extent of policy and management implications in the studies).

Of the 104 articles, 92 articles discuss 183 case studies, whether as major examples which draw heavily on secondary literature, or as subjects of empirical or modelling research. The 183 case studies, for example, include a focus on fisher behaviour from 64 countries and six of seven

continents with Antarctica not represented (Figure 2.2): Europe (69 case studies), Africa (34 case studies), North America (33 case studies), Asia (29 case studies), Oceania (13 case studies), and South America (5 case studies). The entire sample represents the work of 424 authors from 46 countries in six of seven continents. Of the 424, approximately 71% are affiliated primarily with universities (n=300), 20% with governments (n=86), 8% with non-governmental organizations (n=34), and 1% with industry (n=4).

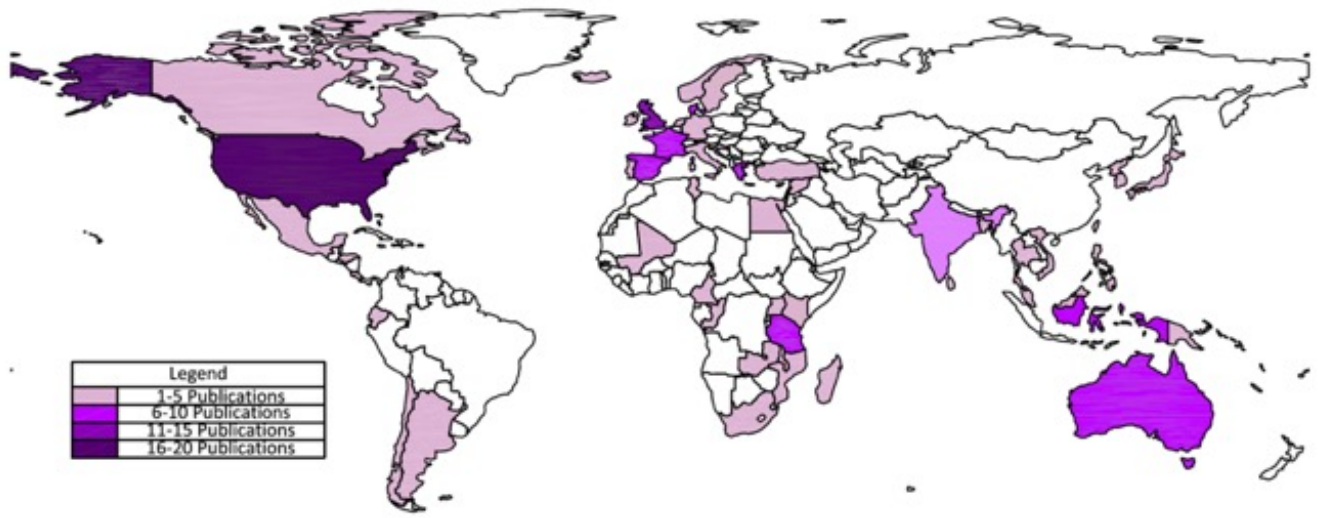


Figure 2.2. Geographical distribution of fisher behaviour and coastal fisheries publications: number of publications per country in which shading represents the frequency of case studies in that country

Figure 2.3. depicts an overview of methodological and behavioural content in the sampled literature. Over a third of studies were quantitative (37%), with qualitative (32%) and methodologies that mixed qualitative and quantitative methods (29%) representing each about a third of the sample. The majority of studies used multiple methods, as 75% of studies used two or more methods to collect data. Analyses generally reflected either an empirical approach (31%), modelling approach (29%), or a review of secondary sources (18%), or analyses that blended empirical and modelling approaches (22%).

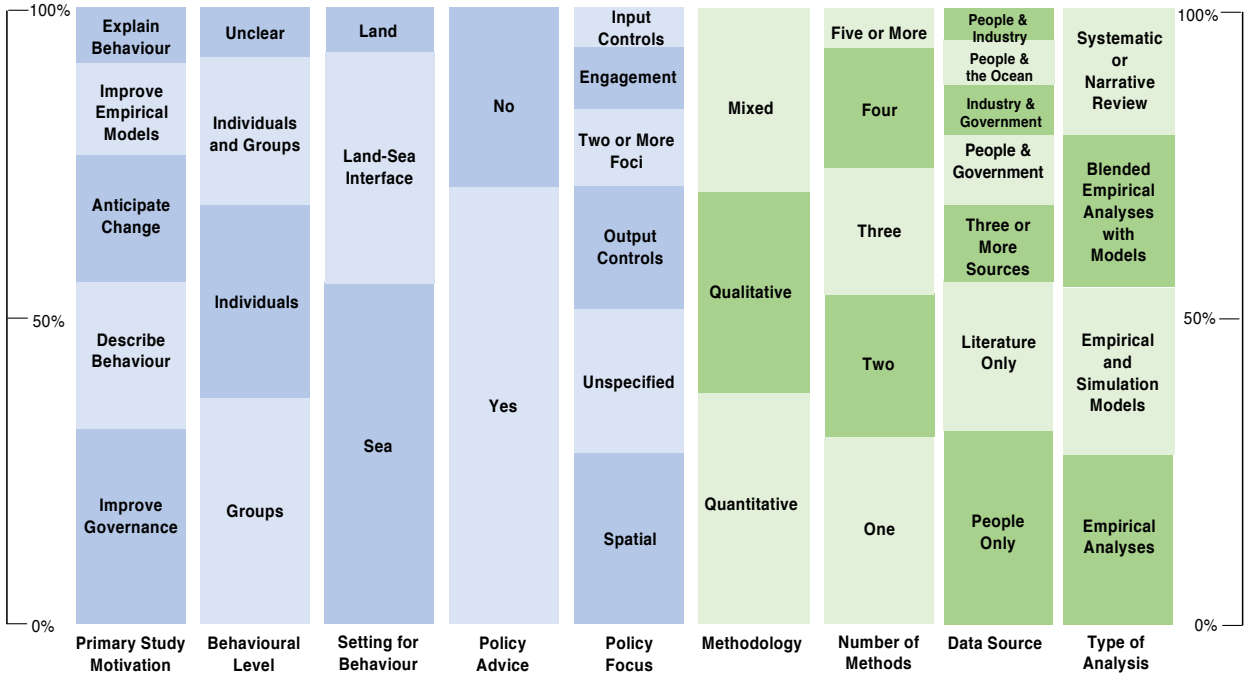


Figure 2.3. Overview of behavioural and methodological content

Results indicated five primary motivations for conducting research on fisher behaviour, including efforts to improve governance (30%), to better describe behaviour (25%), to better anticipate change (21%), to improve models of change (14%), and to better explain behaviour (10%). While only 30% of studies explicitly promoted improvements to management or governance as a motivation for conducting research on fisher behaviour, 78% of studies included at least one policy recommendation. Of the studies with policy recommendations, most recommendations related to a single management focus including spatial management such as MPAs or temporary closures (28%), output controls such as TACs or ITQs (19%), public referral or engagement mechanisms such as advisory boards or co-management (12%), and input controls such as gear or vessel restrictions (8%). Twelve percent of studies provided advice for two or more management foci.

Most research indicated the level of behaviour being analysed (87%) with the level of analysis left unspecified in remaining studies (13%). About one third of research assessed

behaviour either at the group level (33%), the individual level (30%), or multiple levels as, for example, with individual behaviour shaping group behaviour and vice versa (24%).

The decision-making setting in which fisher behaviour was examined emerged as a particularly interesting point. For example, 65% percent of all studies examined short-term tactics (e.g., effort, discarding, and compliance) as they originated in marine ecosystems (e.g., Tidd et al., 2012; Wise et al., 2012). 25% of studies examined fisher behaviour originated in coastal communities. Research in a coastal community setting has focused on the long-term strategies of fishers (i.e., recent entry, deciding to exit, recently investing, or the capacity to diversify) originated in households on the land (e.g., Coulthard, 2012; Pascoe et al., 2015). 10% of studies, described how both short-term tactics and long-term strategies originated individual and group decision-making in across the interfaces between ecosystems and communities (e.g., Wanyonyi et al., 2016).

2.4.2. A typology of behaviour

The second research question aimed to identify how fisher behaviour was conceptualized in the literature. Table 2.2 defined nine distinct types of behaviour identified in the sample representing 135 distinct instances in which fisher behaviour was discussed. This does not include 9% of those instances (n=14) in which the type of fisher behaviour was left unspecified. The most commonly studied types were effort (42%; 57 instances) and compliance (11%; 17 instances). The strong emphasis on effort and then compliance in the sample largely related to the ways in which effort is adapted after some management intervention (e.g., implementation of an MPA or other type of spatial closure or adjustment in output controls such as TACs), and whether fishers complied with those interventions. Investment (9%; 11 instances) and discarding (8%; 10 instances) represented just under 20% of the sample. Research highlighted investment

and discarding largely in relation to input controls, such as those established through policy including in the European Union's Common Fisheries Policy. Less frequently used behavioural types generally related to longer-term strategies such as migration (6%; 9 instances), exiting the fishery (5%; 8 instances), entry (4%; 7 instances), collective action (4%; 7 instances), and diversification (2%; 5 instances). Such concepts have been vital for understanding how fishers and their families respond to social and environmental change.

Table 2.2: A typology of behaviour, definition, and example references

Behaviour	Definition	Examples
Effort	The application of fishing techniques, gear, and vessels across space and time that affect the distribution of marine resources. Effort by groups of vessels is commonly referred to as fleet dynamics and the resultant exploitation patterns are métiers.	Girardin et al. 2017; Tidd et al. 2012
Compliance	The act of obeying regulations that enable monitoring (e.g., reporting and logbooks), constrain access to temporal or spatial regulations (e.g., no take zones in MPAs), control discarding (e.g., illegally landing fish species outside of those permitted in licenses), and limit catches or landings (e.g., landing more fish than in a quota)	Bergseth et al. 2015; Arias et al. 2015
Investment	Injecting new financial capital into fishing operations, often through the purchase of new gear, technology, or vessels. Investment is typically the responsibility of the vessel or licensing owner.	Macusi et al., 2017; van Dijk et al. 2017
Discarding	The act of not retaining certain species from the catch and throwing that portion of the catch back into the sea before landing the remainder of the catch. Unretained catch can be permitted or not through regulations.	Christou et al. 2017; Tsagarakis et al. 2014
Migration	Permanently or temporarily (e.g., seasonal) leaving coastal communities to pursue livelihoods elsewhere. This can involve exiting the fishery or it can mean living in another community to diversify individual or household incomes.	Hattam et al. 2014; Wanyoni et al. 2016
Exiting	The decision to leave the fishery in the role of fisher such as by selling off capital assets and access rights to the fishery. Exit is also referred to as egress.	Daw et al. 2012; Pascoe et al. 2015;
Entry	Participation in coastal fishery, whether for the first time or after leaving the fishery previously. Entry can refer to new or renewed access to fishing in general or in new fisheries, as for example, when new fish stocks become available to fish.	van Putten et al. 2013; Miñarro et al. 2016
Collective action	The leadership and cooperation associated with political action taken to make change in the governance of coastal fisheries.	Sutton and Rudd 2014; Tilman et al. 2017
Diversification	Expanding sources of individual income by participating in employment outside of the fishing. This can include employment within or outside of the fishery (e.g., processing).	Boonstra and Hahn 2015; Jaiteh et al. 2016

Across the sample, 24% of papers, or 25 papers, examined more than one behaviour simultaneously. Figure 2.4 illustrates that in these papers, behavioural concepts tended to co-

occur in relation to effort. The more common relationships were among tactical behaviours effort and compliance, and effort and discard. Less common ties existed between effort and individual long-term strategies such as entry, exit, and migration. The least common relationships existed among multiple long-term strategies.

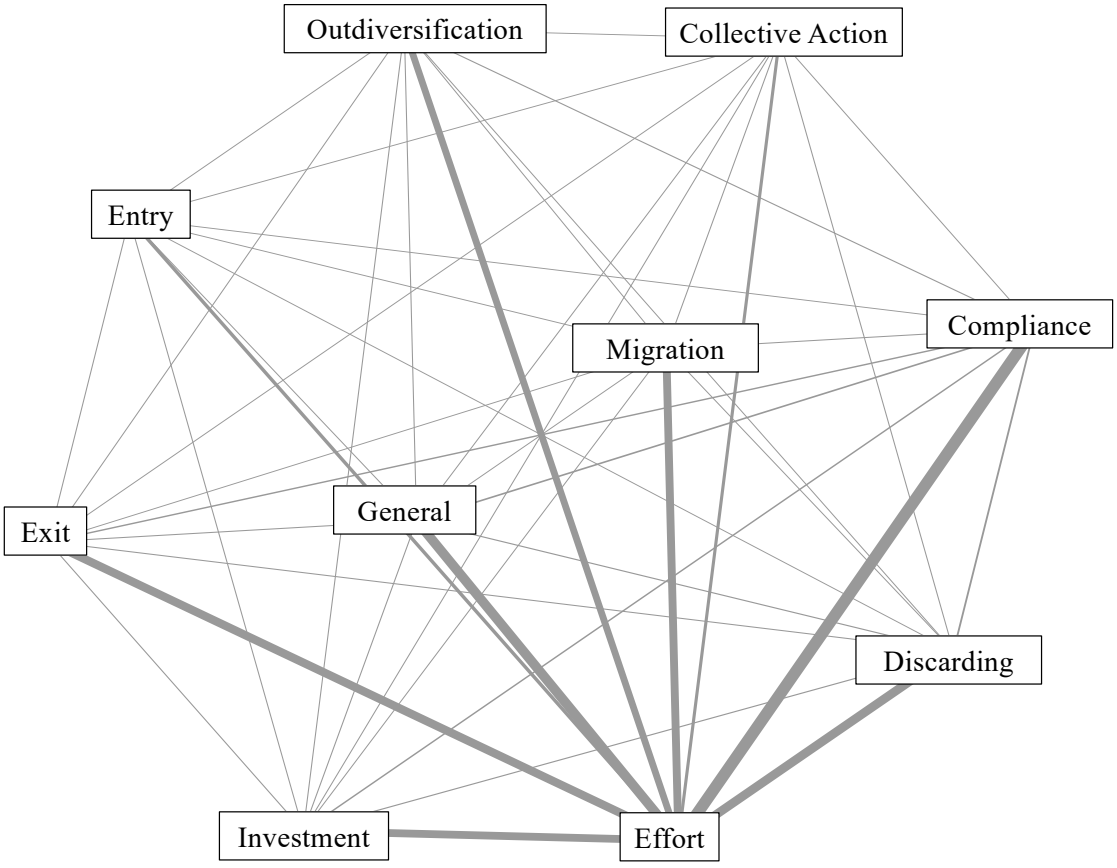


Figure 2.4. Unipartite network of the co-occurrence of behavioural types

2.4.3. Explaining behaviour: goals and factors

The third objective was to examine the goals and factors used to explain fisher behaviour. As a goal, fisher behaviour was predominantly explained through rational choice theoretical orientation related to profit maximisation (35%), catch maximisation (18%), and utility maximisation (16%). Using values (e.g., well-being, status, wealth) as a broad suite of goals was

represented in a small proportion of studies (7%). Just under a third of papers did not specify a goal or suite of goals to explain behaviour in their research (24%).

In addition to goals, there were 46 explanatory factors from 747 instances that were considered in the sample to influence behaviour. We categorized these in five groups, including demographic (35 instances), psychosocial (145 instances), environmental (150 instances), economic (173 instances), socio-cultural (126 instances), and governance (118 instances) factors (Table 2.3).

Table 2.3: Factors that shape fisher behaviour with categories of factors, types of factors, and frequency

Factor category	Types of factors and frequency
Demographic	Age (4 instances); formal education (7 instances); income (23 instances);
Psychosocial	Identity (6 instances); cognition (11 instances); moral norms (6 instances); preferences (11 instances);); values (18 instances); habit (17 instances); attitudes (8 instances); place attachment (10 instances); risk perception (22 instances); skills or appropriate knowledge (used interchangeably) (36 instances)
Environmental	Catchability (29 instances); stock conditions (42 instances); weather (16 instances); sea surface conditions (4 instances); habitat conditions (14 instances); seasonality (9 instances); distance to port (16 instances)
Economic	Vessel or gear (18 instances); trip cost (30 instances); poverty (8 instances); livelihood dependence (40 instances); occupational pluralism (21 instances); financial stake in operations (11 instances); access to technology (13 instances); expected values for landings (32 instances)
Socio-cultural	Tradition (30 instances); access to knowledge exchange (14 instances); relationships (17 instances); social capital (4 instances); power (8 instances); cooperation in communities (12 instances); conflict within communities (6 instances); community development (5 instances); social norms (22 instances); gender (1 instance)
Governance	Spatial design (17 instances); regulatory strength (12 instances); access to fishing groups (26 instances); input controls (12 instances); output controls (25 instances); legitimacy of rules (19 instances); incentives (20 instances).

The networks that depicted explanatory variables indicated that many relationships among socio-cultural, demographic, and psychosocial factors have limited traction in the sample (Supplementary Material D). Examples of socio-cultural factors with weakly related nodes include social capital, poverty, community development, and power. Demographic factors include factors such as age, income and education. Psychosocial factors include, as for example, attitudes, moral norms, place attachment, and emotions. A comparison of networks that depict explanatory variables (Supplementary Materials C & D) reveals that the research on fisher behaviour is dominated by theoretical explanations reflecting relationships among factors that are related to fishing tactics, and in particular effort. Relationships according to effort include the influence of costs and expected profits, catchability and conditions of fish stocks, perceptions that fishers are skilled, and the influence of access and allocation factors from the management category.

Figure 2.5 provides greater insight into the broad patterns among explanatory factors. Figure 2.5 illustrated co-occurrence across factor groups. This network indicates the strongest relationships among governance and environmental factors, and among psychological, economic and environmental factors. Weaker relationships exist among demographic and governance factors, socio-cultural and management factors, psychological and management factors.

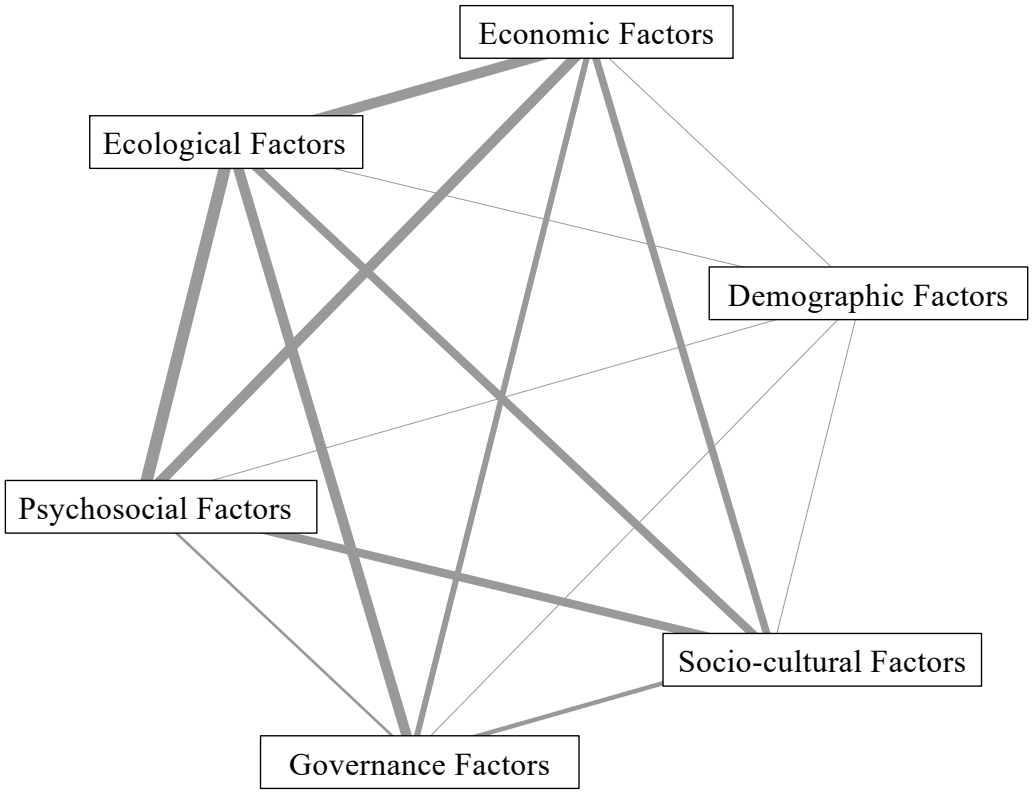


Figure 2.5. Unipartite network of grouped explanatory factors for fisher behaviour

2.5. Discussion

Fisher behaviour is a crucial variable for coastal and marine governance (Branch et al. 2006; Hilborn 2007; Fulton et al. 2011). However, critical synthetic and empirical research highlights that a comprehensive understanding of fisher behaviour remains elusive. This chapter featured results from a systematic scoping review that assessed literature employing the concept, 'fisher behaviour', in coastal and marine fisheries settings. The review addressed three major criticisms, including the need for: (1) guidance on characterizing multi-faceted, -level, and -scales fisher behaviour, as for example, in models; (2) an expanded evidence-base to explain fisher behaviour; and (3) implications for governance from incorporating new knowledge on fisher behaviour in different models.

This review had two limitations. First, some potentially relevant articles may not have been retrieved. For example, there may be some social science research areas related to coastal fisheries (e.g., livelihoods research, political ecology and common pool resource literature) that examines that examines fisher behaviour without using the concept 'behaviour' explicitly (e.g., Blythe et al. 2015). However, seven studies from these research areas were retrieved and included in the sample (e.g., Britton and Coulthard 2013; Coulthard 2012; Gurney et al. 2015). Second, qualitative systematic reviews include some subjectivity in the process of coding and interpretation of codes (Moher et al. 2009; Wharton 2015). For example, systematic scoping reviews are investigations that involve considerable interpretation of novel applications of a body of literature or concept. Studies included initially in the sample can reflect a bias due to an unfamiliarity those literatures or concepts (Landa 2011). Potential bias was mitigated by ensuring search terms retrieved a large sample of studies to support a sensitive sample, re-examining the eligibility of studies to advance a selective sample, and reviewing and confirming codes and interpretations.

Here, the review synthesized a typology of behaviour from the literature and visualised co-occurrence among behaviours using a social network. The typology reflects a list of fisher behaviours that can promote categorization of how fishers drive and respond to change. Our social network visualization assessed the typology across the sample. The network indicated that a multi-faceted understanding of fisher behaviour has had limited traction in the majority of studies. Weaker co-occurrence between short term tactical and long term strategic behaviours underrepresentted the interconnected ways behavioural change (e.g., investment, entering fisheries, and exiting fisheries) in communities affects tactical behaviours in ecosystems, such as effort and discarding (Daw et al. 2012; van Dyjk et al. 2017). Further, changes in patterns of

effort, such as fishing longer, harder, and further away from home ports, can necessitate behavioural responses in communities, such as outmigration or diversification (Beitl et al. 2014; Boonstra and Hahn 2015). Similarly, fishers that disapprove of rules can engage in collective actions in communities or take risks of non-compliance to landing or reporting obligations (Bergseth et al. 2015). However, the results indicated that long term strategic behaviours are underrepresented in research. Addressing this gap by examining long-term behaviors along with short term tactical behaviours can reveal insights into linked behaviours and implications for change processes. The typology therefore contributes a novel accounting of fisher behaviours, while the social network reveals opportunities for future research to examine fisher behaviour under conditions of social and environmental change (Bietl et al. 2014; Daw et al. 2012; van Putten et al. 2012).

Attention to level and scale, and the decision-making setting, are important to conceptual and empirical models that address multiple fisher behaviours (Salas and Gaertner 2004; Yletyinen et al. 2018). However, results from the state of the literature indicated that 13% of studies did not specify the level of analysis and only 24% of studies considered multi-level behaviour. Further, only 10% of studies considered broader spatial scale that incorporated ecosystems and communities together as the linked settings that foster fisher behaviour. These results highlight that conceptual and empirical models incorporating fisher behaviour can benefit from a better understanding of individual and group decision-making that precede behaviour at different scales (e.g., Bieg et al. 2017; Lade et al. 2015). Future empirical research can improve an understanding of scale and level by examining fisher behaviour from different temporal scales (Bietl et al. 2014; Thorson et al. 2017). For example, drivers of change, such as climate change are influencing cascading effects across ecosystems, coastal communities, and governance

(Rocha et al. 2018). Fishers respond to different changes that are at diverse speeds and intensities and are shaped by contextual conditions in ecosystems, communities, and governance (Hattam et al. 2014; Hilmi et al. 2017). The various paces and intensities of change and the conditions that shape change in different settings are therefore relevant for conceptual and empirical models that include fisher behaviour.

The results confirm and expand on criticisms that there is a limited evidence base on explanations that inform fisher behaviour (Chuenpagdee and Jentoft 2009; Fulton et al. 2011; Teh et al. 2012). In this review, explanations for fisher behaviour were first assessed as goals and the processes that undergird them. Approximately 69% of papers considered only one goal for fishers, often related to processes reflecting rational choice theory and economic maximization. Indeed, fishers' economic goals are important. Vaughan et al. (2017) noted that economic goals for fishers play considerable roles in fishing such as fishers' willingness to take risks to profit during unfavorable fishing conditions. However, fishers may hold other goals that inform their behaviour (Chuenpagdee and Jentoft 2009; Fulton et al. 2011). Yet, only 7% of papers demonstrate alternative goals for fishers, including the various human values that reflect goals at individual and community levels (e.g. Hicks et al. 2014; Teh et al. 2012). Moreover, the emphasis on maximisation processes in the results may not fully explain how and why fishers pursue their goals in community settings. Livelihood research reviewed in this analysis discussed how fishers act to protect and enjoy values held for themselves, their families, and their communities (Britton & Coulthard, 2013; Coulthard 2012; Gurney et al., 2015).

Then results were assessed as extrinsic explanatory factors. Results indicated that there were 46 distinct extrinsic factors that shape fishers' behaviours in response to change. For example, Cabral et al. (2017: 416) identified several environmental, economic, and governance factors that

caused fishers to respond differently to MPA implementation in ways that challenged "the usual simplified assumption that all extractive boats respond[ed] similarly to MPA establishment". In addition to environmental, economic, and governance factors, Eliasen et al. (2014) identified that psychosocial (e.g., perceptions and identity) and socio-cultural factors (e.g., access to knowledge exchange and social norms) influenced effort and discarding in three European fisheries. However, the social networks highlighted limited attention to the diverse factors that fishers consider in decision-making that preceded their behaviour in coastal and marine fisheries. For example, the networks indicated an emphasis on effort and the environmental, economic, and governance factors that have been verified as explanatory factors. Case study and synthetic research has revealed that effort is also driven by socio-cultural factors, such as gender, poverty, and social capital, and demographic factors, such as age and education (e.g., Harper et al. 2017; Power et al. 2014). Further, explanatory variables that were validated to explain strategic behaviours were under-examined. Socio-cultural factors have considerable importance for understanding the willingness to cooperate, the influence of family and fellow residents on different short term and long term tactics which influence well-being, and the importance of power and poverty on shaping the distribution of benefits and burdens in coastal communities (Daw et al. 2012; Naranjo-Madrigal et al. 2015).

There are practical implications in governance for using more comprehensive depictions and evidence-based explanations for fisher behaviour in conceptual and empirical models. The scope of objectives used in decision-making for coastal and marine governance are expanding (Stephenson et al. 2019a; Stephenson et al. 2019b). Insights about fisher behaviours can support this trend. However, depictions of fisher behaviour as multi-faceted, -leveled, and -scaled change phenomena indicates a more socially complex view of how fishers behave to adapt and cope to

change, and the outcomes of those behaviours to sustainability. Research can strengthen recommendations for governance with empirical insights that apply the typology across time and space, and guidance about how to understand and anticipate those behaviours. Further, the typology can be used to develop tools, such as indicators, that support assessments of multiple behaviour and their impacts in ecosystems, as for example, to support ecosystem-based management approaches or management strategy evaluations. Further, governance theories such as adaptive governance, network governance, interactive governance, and anticipatory governance each provide guidance to build decision processes capable of addressing and anticipating diverse fisher behaviours across different settings and scales (see Brunner et al. 2005; Kooiman et al. 2003; Pittman et al. 2015; Quay 2010).

Empirical and simulation models that anticipate change in coastal and marine governance draw on theoretical models of fisher behavioural change (Lindkvist et al. 2020). Our results point to two implications for theoretical models and by extension the predictive capacity and quality of recommendations to enhance governability. First, scientists can better support an understanding of the ability to govern by more critically investigating goals, and the individual and group decision-making processes that undergird them. Supporting this understanding, scientists can generate and incorporate evidence on the intrinsic psychosocial factors, such as values, perceptions, habit, identity, and emotions, into theoretical models of fishers' behavioural change (see Gifford 2014; Wolfe 2017; Wood and Rünger 2016). Second, while there are many different explanatory factors extrinsic to individual and group decision-making, modellers need to make choices about the variables they use to inform empirical and simulation models (Armitage et al. 2019; Neilsen et al. 2017). Opportunities exist to support rigor in those choices by using empirical observation to identify the contextual factors that shape fisher behaviour in different

settings, and incorporating those finding into participatory modelling approaches when assessing and anticipating behaviour (Essington et al. 2017; e.g., Lade et al. 2015; Teh et al. 2012).

Despite expanded governance objectives for coastal and marine fisheries around the world, addressing fisher behaviour across ecosystems and communities may be perceived by policy makers as outside capacities needed to govern (see Stephenson et al. 2019). While interdisciplinary social science about fisher behaviour is critical for successful models and policy interventions (Kittinger et al. 2014; Lubchenko et al. 2017), research needs to assess capacities in governance to cultivate social science expertise, and the decision-processes needed to assess, anticipate, and address fisher behaviours at different levels and scales (Barclay et al. 2017; Howlett 2009; Wu et al. 2015). Multi-stakeholder governance arrangements may provide opportunities to build that knowledge and attenuate methodological and organizational barriers to greater incorporation of fisher behaviour in coastal and marine governance (Young et al. 2018).

2.6. Conclusions

This research assessed peer-reviewed publications on fisher behaviour in coastal and marine settings. The review was motivated by the need for more comprehensive depictions of fisher behaviour in conceptual and empirical models for change, and empirical explanations of behaviour that better integrate different assumptions about how fishers respond to change. Given the relevance of fisher behaviour to the scientific and policy processes that advance governance objectives, the review also addressed the implications of different depictions and explanations of fisher behaviour for governance. The systematic scoping review revealed a novel typology of fisher behaviour, and insights into its status in the literature through social network

visualizations. Further, this review assessed the goals and factors used to explain fisher behaviour.

The systematic scoping review included several insights to guide future research and strengthen capacities in governance that asses, anticipate, and address fisher behaviour. First, scientists and policy-makers can use the typology of behaviour to examine the multi-faceted ways fisher respond to change at different spatial and temporal scales. Second, researchers can build new evidence on the psychosocial variables intrinsic to individual and group decision-making, and blend empirical observation and modelling to enhance a context-sensitive explanations for fisher behavior. Third, new social and policy science research can create opportunities to identify and overcome barriers, such as jurisdictional, methodological, and organizational, in governance for using novel depictions and evidence on fisher behaviour.

Chapter Three

Coastal fishers' livelihood behaviours and their psychosocial explanations: implications for fisheries policy

3.0. Chapter summary

In this chapter, empirical research aims to critically examine the behavioural foundations of livelihood pathways over a 50-year time period in a multispecies fishery in Newfoundland and Labrador, Canada. Fishers make difficult decisions to pursue, enjoy, and protect their livelihoods in response to environmental, social and governance change and uncertainty. An understanding of resultant behaviours from those decisions informs science, policy, and management approaches taken to address and anticipate fisher behaviour. However, there is limited evidence about fishers' behavioural changes over long time periods, and the psychosocial factors that underpin them, beyond what is assumed using neoclassical economic and rational choice framings. The analysis here draws upon 26 narrative interviews with fishers who pursued two or more fish species currently or formerly. Fishers were asked about their behavioural responses to change and uncertainty in coastal fisheries across their entire lifetimes. Their narratives highlighted emotional, perceptual, and values-oriented factors that shaped how fishers coped and adapted to change and uncertainty. The contributions to theory are two-fold. First, findings included variation in patterns of fisher behaviours. Those patterns reflected fishers prioritizing and trading-off material or relational well-being. Prioritizations and trade-offs of forms of well-being led to unexpected outcomes for shifting capacity and capitalization for fishers and in fisheries more broadly. Second, findings identified the influence of emotions as forms of subjective well-being. Furthermore, emotions and perceptions functioned as explanatory factors that shaped well-being priorities and trade-offs, and ultimately, behavioural change. Original and significant findings from this research emphasize the need for scientists, policy-makers, and

managers to incorporate psychosocial evidence along with social science about fisher behaviour into their models, policy processes, and management approaches. Doing so is likely to support efforts to anticipate impacts from behavioural change to capacity and capitalization in fleets and fisheries, and ultimately, lead to improved fisheries governance outcomes that incorporate social change processes.

3.1. Introduction

Fisher behaviour exists in a mutual relationship with fisheries policy (Cove 1973: Branch et al. 2006). Fisher behaviour here refers to fishers' actions as individuals and groups that reflect the mental processing and social exchange of information in coastal fisheries through decision-making (see Lynn et al. 2015), where decision-making represents the negotiation of values, emotions, perceptions, and various contextual factors that shape the individual and group capacities to choose and desires to move to action (Chuenpagdgee and Jentoft 2009; Ellis 2000; Pitcher and Chuenpagdee 1992). When decisions move to action in fisheries, the resultant behaviours reflect a typology of actions in marine environments, landing areas, and in coastal communities (Chapter Two).

Behaviour in marine environments and in landing areas includes effort, discarding, and compliance with landing and reporting obligations. Behaviour in coastal communities includes actions taken to enter and exit fisheries, invest in gear or vessels, diversify incomes, participate in individual or collective political action, and out-migrate from communities (Chapter Two). Behaviours in marine environments, landing areas, and coastal communities all influence the capacity and capitalization of individuals, fleets, and fisheries (Chapter Two). Actions such as effort, discarding, and entry and exit shape the capacity in fisheries by shifting the number fishers, vessels, and gear chasing the same fish stocks (Daw et al. 2012; van Putten et al. 2012).

Investment and diversification alter the financial capital and capacity in fisheries that, in turn, can make fisheries more or less vulnerable to collapse (van Dijk et al. 2017). Impacts to capacity and capitalization in fleets and fisheries require policy responses such as combinations of different management approaches, including input and output controls, temporary or permanent closures, or incentives (Fulton et al. 2011; Kittinger et al. 2014; Lubchenko et al. 2014).

In order to improve capabilities to address and anticipate change in models, planning, and policy, new knowledge is needed on how fishers express behaviour in response to change and uncertainty (see Armitage et al. 2019; Nielsen et al. 2017). A better understanding of fisher behaviour is critical because, as Fulton et al. (2011: 3) argued in their synthetic review, "a consistent outcome [of policy implementation] is that resource users behave in a manner that is often unintended by the designers of the management system". A recent systematic review on fisher behaviour in coastal fisheries identified two opportunities to strengthen an interdisciplinary evidence base about fisher behaviour (Chapter Two). First, assessments are needed on how fishers express behaviours over long time periods in relation to environmental, social, and policy changes and uncertainty. Research to date about fisher behaviour has tended toward empirical studies of tactical behaviours with shorter temporal scope in research designs (Chapter Two). For example, some research explores fisher behaviours through methods such as questionnaires on why fish harvesters "stay in or exit" the fishery (Pascoe et al. 2012), or through modelling when and why fish harvesters might invest under different policy interventions (van Dijk et al. 2017). Second, more psychosocial evidence is required to explain fishers' behaviour. Research reveals that psychosocial variables are likely a crucial aspect of understanding the environmental, social, economic, and governance factors that shape behaviour, as psychosocial factors are involved in the mental and social decision-making that is fundamental to fishers'

negotiation of change (Bender 2002; Song et al. 2013). Research to address these gaps reflects strengthening the evidence-base to explain behavioural change beyond neoclassical economic and rational choice framings (Chapter Two; Chuenpagdee and Jentoft 2009).

The purpose of research in this chapter is to build evidence-based insights about fisher behaviour in relation to uncertainty and change. Analysis involved examining and explaining the behavioural changes of fishers across a 50-year period in a multispecies fishery in Newfoundland and Labrador, Canada. Northern Newfoundland and Labrador's fishers have generations-long experiences responding to changes. These experiences include the dramatic impacts to their livelihoods, such as a unemployment, outmigration, and closure of schools and communities due to the collapse of the Atlantic cod (*Gadus morhua*) fishery (Bavington 2010), and many other rapid changes to access and licensed allocations, or entitlements (e.g., for groundfish, shellfish, forage fish, and marine mammal species) (Ommer and Team 2007). This chapter addresses two objectives. The first objective is to document and compare long-term patterns of fisher behaviour by examining their livelihood pathways from 1965 to 2015. The second objective is to examine behavioural change by assessing pyschosocial explanations based on emotions, perceptions, and values, such as well-being.

3.2. Literature Review

Empirical research here draws on theory and evidence from livelihoods research (de Haan and Zoomers 2003; Nayak 2017), and emotions research (Feldman Barrett 2017a; Maia and Hauber 2020). Each body of literature is addressed below.

3.2.1. Livelihoods research

Livelihoods research is a multi-strand body of literature that examines livelihoods, and the institutions and contexts that shape and are shaped by livelihoods (Nayak 2017). Livelihoods are

patterns of strategies, behaviours, and experiences by individuals, households, or groups to meet their economic and non-economic goals (Bebbington 1999; De Haan and Zoomers 2005). Livelihoods research is used to provide guidance and concepts related to how livelihoods emerge as patterns of behaviour known as livelihood pathways across time (de Haan and Zoomers 2003 & 2005). Livelihood pathways are a useful concept for this research because they help analyse how fishers navigate and express different livelihoods over their lifetimes in response to environmental, social, and governance changes. De Haan and Zoomers (2005: 44) discuss the utility by arguing livelihood pathways represent "historical routes" that enable a long term, systematic comparison of "actors' decisions in different geographical, socio-economic, cultural, or temporal contexts" (de Haan and Zoomers 2005: 44). To build new evidence about fishers' behavioural change as livelihood pathways, this research draws concepts from three livelihoods literature strands: sustainable livelihoods (Allison and Horemans 2006), resilience (Marshke and Berkes 2006), and well-being (Weeretunga et al. 2014).

Sustainable livelihoods draw attention to three concepts—strategizing, adapting, coping—that characterize how individuals and groups move from decision-making to behaviour change. Livelihood strategies comprise decisions that precede behaviour. Strategizing is about individuals, household, and groups beyond the household negotiating hardships and deciding to direct, alter or redistribute the intensity, direction, and focus of their efforts and resources (de Haan and Zoomers 2003 & 2005). Adapting involves behaviours that redirect human and financial resources toward different economic and non-economic opportunities (Ellis 2000). Redirecting resources constitutes an observable long-term behavioural change (Smit and Wandel 2006). As such, adapting is distinct from coping. Coping refers to short-term term behavioural responses that involve the use of existing resources to pursue, enjoy, or protect the same

opportunities (Møller et al. 2019). For example, expanding fishing effort using current resources within a fishing season can be considered as coping, whereas investing in a vessel to catch a different species or leaving a fishery can be considered adapting.

Resilience highlights that social and environmental uncertainties can produce dynamic and experimental adapting and coping that may or may not lead to results initially imagined or desired in individual and household strategies (Coulthard 2012; Marshke and Berkes 2006). According to this literature, uncertainty is a constant but problematic condition of fisheries shaped by multi-level environmental, social, economic, political, and governance factors, all of which can challenge the predictability of adapting and coping (Nayak 2017). For example, despite making decisions to act, fishers may fail to do so depending on the extent of anticipated risk or impact of change (Béné et al. 2019). Therefore, uncertainty can cause all sorts of delays and detours in how and why people cope and adapt (Nayak 2017; Smit and Wandel 2006).

Well-being indicates opportunities to understand patterns in livelihoods by focusing on various forms of material, relational, and subjective well-being as the values that are pursued through behaviour by fishers and fishing households (White 2008; e.g., Britton and Coulthard 2013). Forms of well-being provide reference points for assessing behavioural change that provide insight into the different ways that fishers "act meaningfully" to enjoy "a satisfactory quality of life" (Brueckner-Irwin et al. 2019: 1). According to the well-being strand, empirical research can leverage well-being as an important starting point for assessing behaviour, but interdisciplinary research on other psycho-social factors is needed for more comprehensive explanations (Weeratunga et al. 2014). Fishers may pursue and prioritize different forms of well-being, and experience different environmental, economic, social, political, and governance factors that make livelihood pathways heterogeneous among households, communities and

sectors (Béné and Twefik 2001; Coulthard et al. 2011). Important opportunities exist on clarity of how psychosocial factors that shape experiences of subjective well-being inform behaviour (Béné et al. 2019; Coulthard 2012). Clarity about the explanations (i.e., factors and values) for livelihood pathways can provide an understanding of the processes of change that shape social, environmental, and governance outcomes at multiple scales (see Nayak 2017). The next subsection includes discussions on emotions research's potential contributions in clarifying explanations of behavioural change.

3.2.2. Explaining fisher behaviour using emotions research

Emotions research is an interdisciplinary field of study that provides evidence, theory, and policy recommendations about the central influence of emotions in individual and group decision-making and behaviour, social life, and policy development (Feldman Barrett 2017a; Maia and Hauber 2020; Wolfe 2017). Emotions are socially constructed representations of affect, whereas affect refers to the neurological and chemical appraisals of new information (Feldman Barrett 2017a; Panskepp 2008). Emotions research can help explain behavioural changes within livelihood pathways by drawing on emotions, perceptions, and well-being.

Emotions research connects emotions with perceptions and values, and provides guidance for their use in empirical studies. Guidance draws on evidence about how the brain functions, and how humans experience and express emotions in their social, cultural, economic, and political behaviour (Maia and Hauber 2020; Peltola et al. 2018; Wolfe 2017). Emotions research includes two major implications for explaining the subjective dimension of fishers' behavioural change. First, emotions research suggests that behaviour manifests in individual and groups differently than is predicted by neoclassical economic and rational choice framings for behaviour. Rational choice theory here refers to a series of assumptions that individual

behaviour reflects a pursuit to maximize utilities (Kahneman 2003), often assumed to be material and economically-based such as goods and profit (Zafirovksy 1998). The decision-maker is presumed to have access to all necessary information to make optimal decisions by drawing on an infinite cognitive capacity to choose optimal bundles of rewards (Simon 1990). Moreover, decision-making is presumed to be conducted through a dispassionate decision-making process (Lowenstein and Lerner 2003). Emotions research indicates that emotions and affect influence individual and group behaviour in ways that discount and make implausible the dispassionate, strategic decision-making engendered in economic and rational choice assumptions (Bechara 2004; Cohen 2005).

Rather, emotions are socially constructed by the way humans express their experiences of affect through language, vocal patterns, and gestures (Feldman Barret 2017b). Emotions are psychosocial because people interpret their own and others' emotional expressions and discuss these interpretations in people's everyday lives (Franks 2010). Emotions span individual and group behaviours because emotions, or their biological counterpart, 'affect', that shapes individual cognition and group negotiation of emotion-based decisions (van Kleef 2016; Thagard 2006). Individual cognition involves affect, memory, and perceptions that function together to acquire, store, organize and recall sensory information that leads to behavioural change (Bechara 2004; Cohen 2005). In cognition, affect functions to appraise new stimuli as negative or positive, a property of described by the notion 'valence' (Shuman et al. 2013). Individuals draw on their memories to assess the familiarity of an experience, and use those memories to categorize the intensity of the affective experience (Shuman et al. 2013). If individuals appraise new stimuli as being negative and experience it intensely, they might attribute, recognize, and express this affective experience with emotional terms such as anger or fear. Expressions of anger or fear are

recognizable to other people because they relate that anger and fear to their own experiences (LeDoux 2012; LeDoux 2013). Individual and shared affective appraisals shape perceptions of new information in relation to goals that emotions researchers characterize as human values such as living well, making money, building relationships, or making sound decisions (Franks 2010; van Kleef 2016). However, under conditions of social and environmental uncertainty, the experiences of affect are heightened, and overall cognition is less reliable (Etzioni 1988; Feldman Barret et al. 2007). Heightened affective experiences and limited reliability in cognition lead to more intensely experienced and shared emotions (Cohen 2005). Group negotiation of emotions creates a feedback that can intensify emotional experiences across individuals in groups in ways that can harden individuals' perspectives or reprioritize their values (van Kleef 2016). Ultimately, hardening perspectives can reinforce behavioural patterns, or reprioritization of values can lead to behavioural change (van Kleef 2016).

Second, emotions research provides guidance on how to combine and assess emotions with other psychosocial variables such as perceptions and values, including forms of well-being. Self-reporting methods are promising ways to assess emotions that influence behaviour. Self-reporting is more valid when the reporter (e.g., interviewee) and interpreter (e.g., interviewer) share an understanding of the emotional term used (Feldman Barret 2017b). Emotions research includes two ways to assess self-reported emotions: by their valence (Shuman et al. 2013) and specific emotional terms such as fear, sadness, anger, hope, or pride (Cowen and Keltner 2017). Assessing valence is important to understand an individual's appraisal of specific situations as either positive or negative (Shuman et al. 2013). Self-reported emotions provide helpful language to understand and describe the people's experiences with valence and the resultant influence on behavioural change (Cowen and Keltner 2017). For example, hope is a self-reported and

positively valenced emotion that indicates fishers' expectation and aspiration for a beneficial outcome associated with behavioural change (Cohen-Chen et al. 2014). As another example, fear is a self-reported and negatively valenced emotion that indicates an individual perceives a threat to her or his goals or the goals of a group to which she or he belongs (Cohen-Chen et al. 2014).

Hope and fear are particularly power representations of affect that reflect how emotions research can be used at the frontier in fisheries science. In several studies, hope and fear have been associated with different patterns of behaviour. For example, in a study that compared the influence of hope and fear in processing information related to conflict, Cohen-Chen et al. (2014) found that hope was associated with people seeking information related to new opportunities for peace, whereas fear was associated with people seeking information that rejected new opportunities for peace. Further, emotions research has revealed hope and fear may have differential influence over behaviour, although using different theories of cognition (see Mobbs et al. 2019). Fear is a primary evolutionary affective response that takes precedence over hope in shaping behaviour (Jarymowicz and Bar-Tal 2006). Fear is a culmination of a lifetime of patterned affective responses shaped by perceiving and responding to threats to our values (LeDoux 2013) based on our memories and a projection of those memories onto new situations (Feldman Barrett 2018). Fear projections are immediate, whereas hope reflects a secondary affective response that requires conscious effort to manifest and therefore supplant fear projections (Jarymowicz and Bar-Tal 2006). Opportunities exist to more consistently link the ever-present influence of valence and emotions such as hope and fear to perceptions and values that shape decision-making and lead to fisher behaviour.

Emotions research includes various ways to assess these variables together, including through surveying emotional responses to images or video clips (Cowen and Keltner 2017),

assessing mental models (Wolfe 2012), or narratives (Vassilieva 2016). In this research, narratives are used because they allow for mapping self-reported emotions, perceptions, and values onto behavioural changes across time.

3.2.3. Conceptualizing behavioural change with livelihoods and emotions variable

Information from research on livelihoods and emotions can enhance understanding of the behaviour of individuals and groups (e.g., households, fleets), particularly under conditions of environmental and societal change and uncertainty (cf. Nayak 2017; Franks 2010). Livelihoods research and emotions research can therefore provide complementary concepts and guidance to help strengthen the evidence base of fisher behaviour by documenting how and why fishers' change their behaviour over time. This research uses 'livelihoods pathways' to document patterns of behavioural change. 'Adapting' and 'coping' were used to differentiate changes in behaviours. Material, relational, and subjective well-being were used as human values that inform fisher behaviour and livelihood pathways. Patterns of behavioural change were assessed by investigating the role of subjective well-being shaped by emotional valence, specific emotions, and perceptions related to downturns in the fishery, policy interventions, or trends in prices for landings. All variables used in analysis are defined below in Figure 3.2.

3.3. Research Approach

3.3.1. Study Setting

This research took place in small villages and towns along the coast of the Great Northern Peninsula, Newfoundland and Labrador. The Great Northern Peninsula is 270 km long and its northern half—a low-lying coastal area—is surrounded by key fishing grounds in the Gulf of St. Lawrence to its west, the Strait of Belle Isle on its north, and the Labrador Sea and White Bay on its East (Figure 3.1). Currently, the peninsula includes 69 distinct villages and towns (hereafter

communities), with populations ranging from 50 people on the peninsula's western and eastern coasts to 2250 in St. Anthony on the northern tip.

Commercial fishing is the primary industry in the St. Anthony-Port-au-Choix region followed by tourism, forestry, and oil and gas development and exploration. Typically, fishers belong to inshore (vessels 14' to 64') and offshore fleets (vessels 190' to 290')[6]. This research investigates behaviours related to the inshore fisheries. The inshore fishing fleets operate within an 80 km range of the coastline, and land their catches in local harbours (McCracken and MacDonald 1976; Sumaila et al. 2001). Landings are then processed by family members and other residents working in local processing plants, if a plant exists in that area (Ommer and Team 2007).

[6] It is common in Atlantic Canada to refer to fleets by the vessel size and vessel size in feet (as opposed to meters)

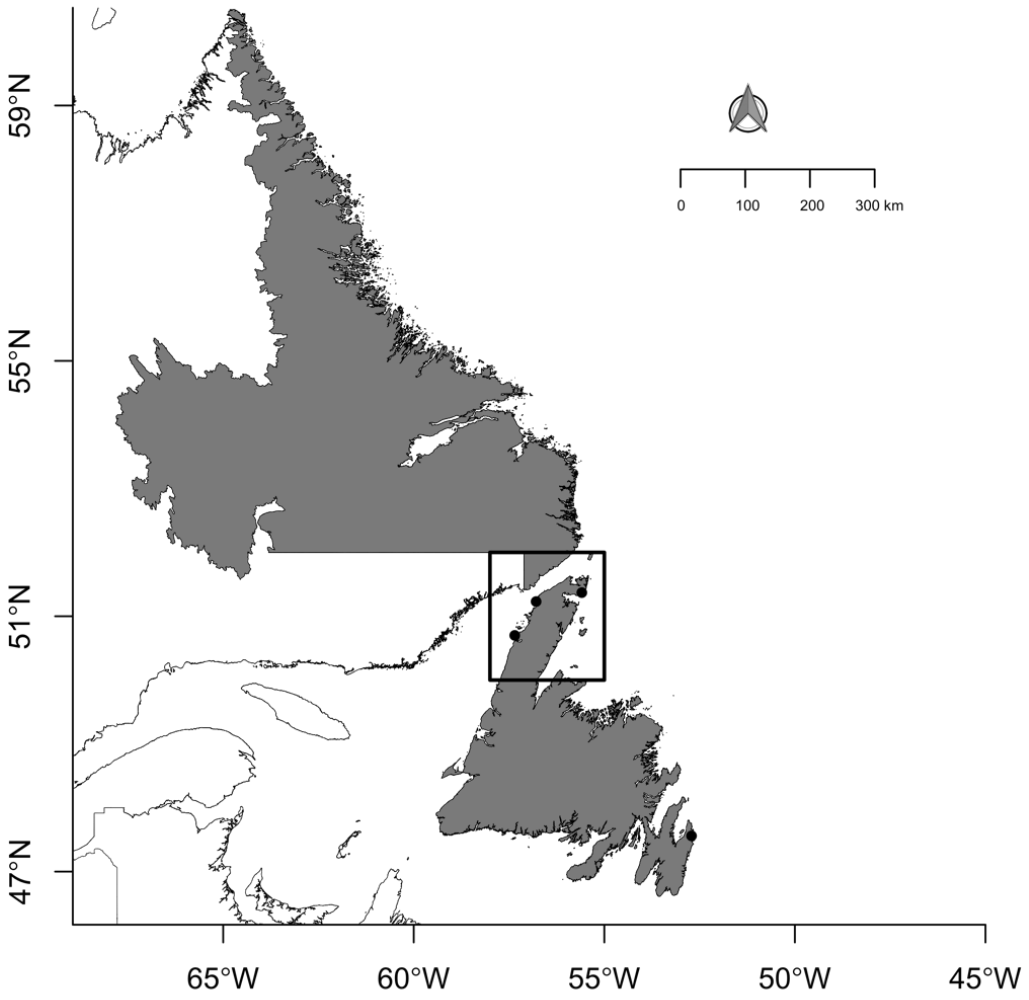


Figure 3.1. Map of Newfoundland and Labrador, Canada, with Great Northern Peninsula highlighted in black box and three examples of communities included in the research—Port au Choix, Green Island Brook, and St. Anthony—highlighted with black dots

The inshore fishers have lived through a number of marine crises including the commercial and near biological collapse of Atlantic cod [*Gadus morhua*] in 1992 (Kahn and Chuenpagdee 2014). To respond to the collapse, the Canadian federal government and its ministry responsible for fishing, Fisheries and Oceans, Canada (DFO), instituted a multi-year moratorium on commercial cod fishing initially intended to last two years. However, the cod fishery remains closed except for sentinel (scientific) fleets and commercial fleets with small allocations (Bavington 2010). Fishers who remained in the fishery were provided with retraining programs in the province's

capital, St. John's, and some were allotted temporary permits to harvest northern shrimp (*Pandulas borealis)*[7]. Others remained with allocations for shellfish, forage fish, and marine mammals.

The inshore fishery is primarily governed by DFO which coordinates with a labour union, Fish and Food Allied Workers (FFAW-Unifor) that represents fishers and processors, and with international partners such as the Northwest Atlantic Fisheries Organization. Governance for the inshore fishery is guided by economic, ecological, cultural and institutional objectives articulated in Canada's *Fisheries Act* (1985), *Ocean's Act* (1997), and *Species at Risk Act* (2002). Canada's *Fisheries Act'*s regulations and Canada's licensing policies further elaborate how fishers can enter, pass down or sell their enterprises, and exit the fishery. For example, after 1996, fishers discussed entry in terms of two regulatory categories (core v. non-core) introduced in that year with reference to a certification program with graduated entry (Apprentice, Level 1, and Level 2) introduced in 1997. The inshore fishers and their importance to Canada's Atlantic provinces including Newfoundland and Labrador are formally recognized in Cananda's *Fisheries Act* and policies goals that refer to 'fleet separation'. For example, a core fleet separation policy now enshrined as an 2019 amendment to Canada's Fisheries Act, the Preserving the Independence of the Inshore Fleet (2007), restricts vessel size, ensures individual ownership of fishing enterprises, and prevents the integration of enterprises with the processing sector.

3.3.2. Methodology

This research follows a qualitative case study approach. The research process followed three iterative phases: scoping, data collection, and analysis. First, scoping was conducted with five fisheries scientists that conduct research in the study area and meetings with 15 mayors of

[7] Some northern shrimp allocations were provided before the collapse as a part of an exploratory program implemented by DFO

villages and towns to identify key issues faced by inshore fishers and to receive guidance for recruiting and interviewing fishers.

Second, data collection began with participant recruitment using a snowball sampling strategy (Noy 2009), starting with referrals from mayors, and then subsequent referrals from inshore fishers. Recruitment included making phone calls, spending time at harbours and local coffee shops, and going to participants' houses to introduce the research. Persons making the referral were asked to contact the potential participant and to let them know that they would be approached for an interview, so as not to place undue pressure on the participant. Then, when approached the participant was provided a recruitment letter and if interested in an interview, the participant was provided an information letter and consent form (see Supplementary Materials H and I). Throughout the recruitment process, participants were ensured that their participation was voluntary and confidential.

Research participants included fishers who pursued two or more fish species currently or formerly in coastal waters off the Northern Peninsula (n=26). In this research, 21 fishers were male and five were female. Most interviews were conducted individually (n=17) and four interviews were conducted by household (n=8, four pairs). Only one female harvester was interviewed alone. Household interviews involved longer stories shared by wife and husband, and individual stories told from the experiences of wife or husband. The ages of inshore fishers that participated in this ranged from 41 to 88, although the majority were 55 years old and over.

A narrative interviewing method was used to collect data. Narrative interviewing elicits participants' stories about how they viewed and responded to events in their life (Jovchelvitch and Bauer 2000). Narrative interviews are contextual and often cover broad time scales and topics. Narrative interviews are therefore distinct from semi-structured interviews that tend to

focus on specific topics which may or may not be situated in their context (Jovchelovitch and Bauer 2000). Narrative interviews lasted anywhere from one to three hours and followed consistent structure. During the interview, themes were introduced using initial questions with framings such as, "Tell me about a time when…?" (see Jovchelovitch and Bauer 2000). Then, interviews allowed the participant to complete their story with little interruption to aide interpretation (see Junqueira Maylaert et al. 2014). Then interviews included probing questions such as, "Tell me more…?", or "Why do you think that happened?". Interviews were audio recorded, transcribed, and verified by participants. Verification involved a trip back to the field site, in which participants were presented with a pamphlet that highlighted the major themes in this chapter. Participants verified the behavioural patterns assessed below, and provided reminders about the importance of different types of fishers in the fishery, a theme that was highlighted through the grouped pathways according to different forms of well-being (see Subsection 3.4.1.). They were also keen to discuss how decisions were made, contributing to a better understanding of group emotional decision-making (see Subsection 3.4.2).

By the end of August 2018, recommendations for new participants began to overlap, newly recommended fishers were not interested or busy fishing, and time between interviews increased. Data collection was terminated in September 2019, and the data analysis stage began.

Third, data were analyzed using a content analysis technique that first guided assessment of individual or household fisher narrative themes, and then guided comparison of themes across different individuals and household livelihood pathways. Content analysis refers to the systematization of interview content by coding themes, and the relationships among those themes, all while reflecting, journaling, and diagramming those relationships iteratively (Clandinin 2006). Content analysis' balance between systematic coding and iterative reflection

was appropriate for analysing and interpreting the meaningful stories included in narrative interview data (Clandinin 2006).

Content analysis was conducted in four steps. First, data were segmented into single for fishers to provide individual chronology of behavioural events, an approach that follows a single-participant case design used in Murray et al. (2008). Second, coding assessed behavioural events and their explanations in each narrative. Third, narratives were compared as units of analyses, reflecting a narrative comparative analysis that allowed grouping of narratives based on their convergence and incongruence on codes for the second step (see Lal et al. 2012). Fourth, codes were re-applied to the entire dataset and assessing congruence and incongruence among fishers' behavioural explanations with particular attention to self-reported psychosocial variables in the dataset.

Variables, operational definitions, and example codes are included in Figure 3.2. Latent variables, such as implicit emotions demonstrated through voice or facial expressions were not assessed. Interview data were analyzed using *QSR International's NVivo 12*, a qualitative analytical software and codes, reflections and diagrams were created and housed in *Microsoft Excel (2012)*. This research was approved by The University of Waterloo Office of Research Ethics (ORE) (ORE# 22704) on January 31, 2018. Preliminary results were presented back to participants for verification.

This research had four limitations. First, snowball sampling was conducted during various harvesting seasons with a population that appeared to be fatigued by research, as the inshore fishers have been recruited for as participants for considerable number of research projects since the 1992 collapse of Atlantic Cod. The number of recruited participants was limited by fishers' availability and willingness, and the resultant sample may have skewed the

sample toward certain experiences and perspectives. Limitations were addressed by seeking recruitment advice from mayors, and by maintaining contact with potential participants to help increase comfortability and convenience with participation. Second, fishers were separated in different small communities each with its own socio-economic status. Attempts to stratify the sample were made by recruiting in several communities on an ongoing basis. Third, there were only five female fishers who participated, and four of them were interviewed with their husbands who were also fishers (i.e., household interviews). Efforts were made in household interviews to provide space for both female and male interviewees to share their stories. Fourth, behavioural events and their explanations were only tied to broad environmental, economic, and policy trends. More precise factors, such as fish stock biomass, habitat conditions, household debt, and trip costs over time have been determined to shape behaviour over time (Chapter Two). The discussion section highlights opportunities to use these factors in future research.

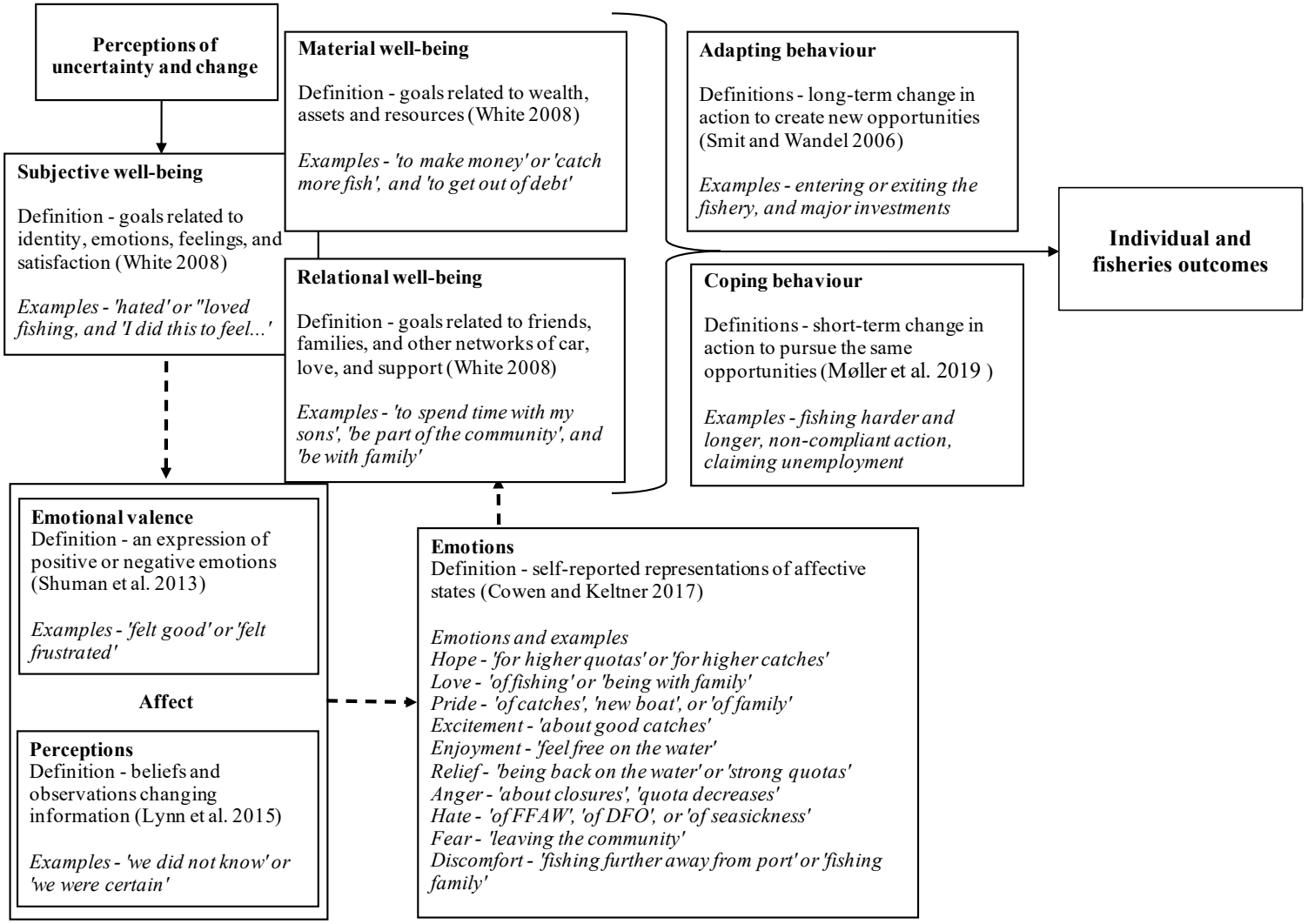


Figure 3.2. Variables, operational definitions, and example codes

3.4. Results

Our results address the two objectives: 1) to document and compare inshore fishers' (hereafter IFs) behavioural responses to change and uncertainty as livelihood pathways, and 2) to examine explanations of behavioural change by assessing the influence of emotions, perceptions, and well-being. Results are organized into two sections. First, results include a presentation of an analysis of IFs livelihood pathways that were grouped according to economic and relational well-being. Second, results included descriptions of emotions as forms of subjective well-being (i.e., emotional experiences as goals) and the roles of emotions and perceptions as explanatory factors for behavioural changes.

3.4.1. Documenting fisher behaviour as livelihood pathways

Livelihood pathways refers to patterns of behavioural change that manifest across time (de Haan and Zoomers 2003 & 2005). Five adapting and seven coping behaviours were recorded from analysis of livelihood pathways (see Table 3.1). Adapting behaviours were expressed largely in communities outside of fishing seasons, whereas coping behaviours were mostly expressed in marine environments and landing areas during fishing seasons, with some exceptions. Coping behaviours such as claiming employment insurance or calling DFO and FFAW occurred in communities during off seasons. Diversifying income occurred in and outside of local communities year-round. For example, some IFs pursued work in different sectors (e.g., tourism, logging), or outside of Newfoundland and Labrador for seasonal work (e.g., oil and gas sector in Alberta, Canada).

Table 3.1: Adapting and coping behaviours and their settings recorded in the results

Adapting behaviours	Coping behaviours
Entering or re-entering the fishery fulltime	Intensifying effort (i.e., fishing hard, fishing longer)
Investing in the fishery (in licenses or boats)	Extensifying effort (i.e., increasing range or going into different fishing grounds)
Exiting the fishery (the inshore fishery or as a fisher)	Choosing to fish more difficult species in portfolio in existing licensing (e.g., scallop)
Outmigration (temporarily)	Not complying with discarding, landing, and reporting rules
Taking advantage of governmental programming (i.e., experimental fisheries, retraining programs, or buyback programs)	Minor investments in gear, repairs, and material
	Diversifying work outside the fishery
Participating in individual or collective action (e.g., legal action, protesting)	Collecting employment insurance or waiting to collect old age pension

In some instances, adapting and coping were inter-related in that coping delayed adapting, and adapting created new coping opportunities (see Wandel and Smit 2006). For example, 21 IFs indicate that claiming employment insurance or considering claiming old age pensions were notable coping behaviours because they delayed adapting behaviours. For instance, under downturns in the fishery (i.e., weakened fish stocks, lower quotas, or low prices for catches), collecting employment insurance, referred to as "stamps" (12 IFs), or waiting until eligibility to claim old age pension (9 IFs) caused some fishers to, as described by IF1 "wait it out". IFs reported that strategizing for adapting behaviours largely took place in the household, whereas coping behaviours were decided on vessels, in landing areas, and in other aggregating sites, such as coffee shops.

A comparison of IFs' individual livelihood pathways revealed patterns in types, frequency, and forms of well-being associated with adapting and coping behaviours. Patterns were recorded as categories of livelihood pathways characterized by the well-being form most often associated with adapting and coping behaviours—a material well-being pathway (11 IFs)

and relational well-being pathway (13 IFs). IFs were categorized according to material or relational well-being pathways when those IFs expressed most adapting and coping behaviours in relation to material or relational well-being. Those patterns reflected a prioritization of that form of well-being. However, several IFs expressed behaviours related to a different form of well-being reflecting a trade-off of values at critical times in their lives and in the fishery, such as when they entered and exited during downturns in the fishery (e.g., during closures, lower quotas, or low values for landings). Some coping behaviours, such as intensifying and extensifying effort, claiming employment insurance, and making annual minor investments were attributed to both material and relational well-being pathways. Some adapting behaviours were attributed to subjective well-being, but no IF expressed their behaviour systemically for subjective well-being. Rather, IFs discussed one or two instances when they expressed adaptive behaviours for subjective well-being (see subsection 3.4.5). Two IFs did not indicate enough information about behaviour and its goals for categorization into a material or relational pathway.

3.4.1.a. The material well-being livelihoods pathway group

The material well-being livelihoods pathway group involved IFs' livelihoods characterized by adapting and coping behaviours driven by catching more and higher value fish stocks, and earning higher profits every year (Figure 3.3). Six IFs discussed material well-being as the only value informing their behaviours in the fishery. The other five IFs indicated material well-being was only a priority and indicated that one or two adapting behaviours in fishery were informed by relational or subjective well-being. Common to the material well-being pathway were adapting behaviours expressed to increase individual capacity: entering fulltime within five years and making (or trying to make) major investments in the enterprise every three to five years.

Moreover, each season IFs expressed coping behaviours to maintain or increase catches through intensifying and extensifying effort. Also common were actions taken against DFO and FFAW resources including phoning representatives regularly or even participating in legal actions and protests. Seven of the 11 IFs discussed how their behaviour led to growth of their enterprise in expected ways. For example, four of those IFs ended up upgrading out of the inshore fishery harvesting groundfish and forage fish, and into the midshore fishery exclusively for northern shrimp (*Pandalus borealis*) and snow crab (*Chionoecetes opilio*). One of those five IFs remained inshore harvesting groundfish and forage fish, and "felt good" that he was able to buy two enterprises after years of "living paycheck to paycheck" for several years after the cod moratorium (IF2). Two IFs discussed how they exited the fishery by selling their enterprises through a buy-back program. Five of the 11 IFs indicated their behaviours were often ill-timed and resulted in suboptimal personal outcomes. They remained in the inshore fishery despite considerable financial and health-related challenges. Next results include some examples from individual IFs to demonstrate how the 'material well-being' pathway can manifest over time.

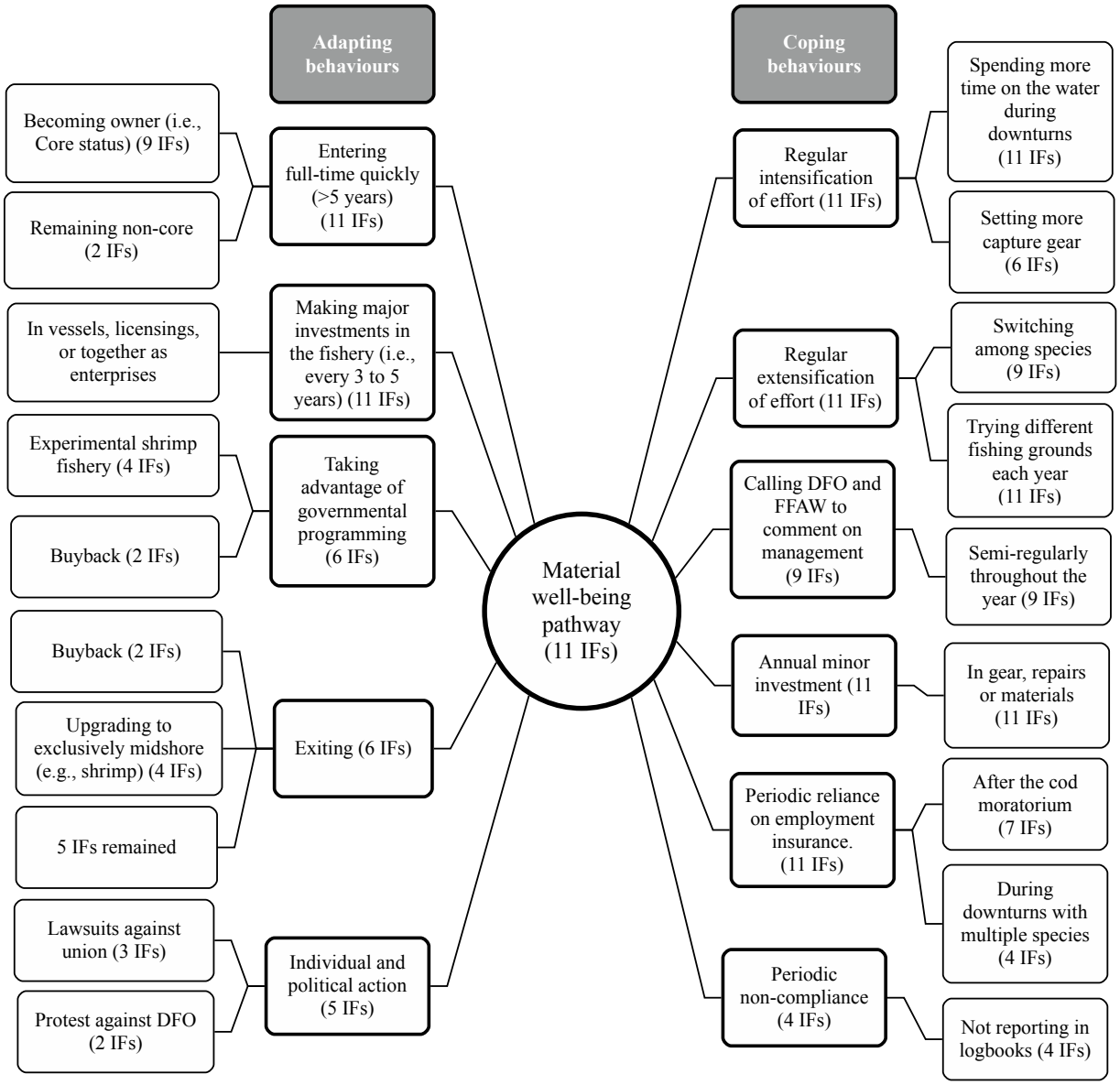


Figure 3.3. The material well-being pathway group

The stories of two brothers (IF2 and IF3) are indicative of the material well-pathway group. IF2 and IF3 invested considerably in the northern shrimp fishery and ended up upgrading out of the inshore fishery between 1988 and 2006 for the purpose of catching more fish and earning higher incomes:

IF2 and IF3 were both born in the 1960s. They grew up and lived all their life in the same fishing community. They both entered together as part time harvesters in the 1970s to fish with their father, who was harvesting fulltime. They quickly moved to fulltime fishers owning separate enterprises. In 1988, they fished through the moratorium because they had switched to shrimp when DFO tried an "experiment to open up the shrimp" fishery (IF2) and they fished "smaller and fewer cod" and "more gillnets" (IF3). In 1990, they invested in a new enterprise (i.e., 64' boat and license for shrimp) along with investing in new gear (i.e., moving from gillnets to otter trawls). In the late 1990s, they noticed a considerable return on their investment into the shrimp fishery, although they kept harvesting scallop to offset periodic "bad years" with shrimp (IF3). In the early 2010s, they discussed buying another enterprise, but as IF4 indicated, they "couldn't see any vision for it". Moreover, IF2 argued the regulations and quotas changed to make fishing less financially viable. However, both IF2 and IF3 indicated they will fish until they are no longer able. IF4 said, he will "fish till he gets sick". When that happens, both IFs state they will use a regulatory process to "let their sons take it over" and take a small cut from their income, which they admit would be a "small fraction of the value" for the enterprise (IF2).

IF2 and IF3 made, as both described, "good decisions in the fishery". To them, good decisions resulted from decades of strategizing about changes in fish stock status of cod and northern shrimp. They invested in new opportunities to take advantage of an experimental governmental program, and chose not to invest when they thought the low economic viability of the northern shrimp fishery was going to persist. By describing their 'good decisions' in relation to expected financial returns, the stories of IF2 and IF3 demonstrated a prioritization of material well-being. Outcomes from prioritizing material well-being included shifting their capacity and capital to

fisheries to the midshore fishery by moving partially to the shrimp fishery in 1988, and giving up fishing 'inshore' species like scallop in 2006. However, their decisions to 'fish till they get sick' despite declining shrimp stocks, and to transfer their enterprises to their sons for low financial returns represented trade-offs of material well-being associated with expected financial returns with relational well-being associated with promoting the goals of family members.

Not all IFs in this pathway group experienced positive or expected outcomes. For example, IF5, IF6, and IF7 remained in the fishery despite considerable hardships. They made several attempts to upgrade, but were unsuccessful. In the meantime, IF6 explained how they made attempts within fishing seasons to increase catches by increasing hours on the water fishing scallops, a very difficult stock to fish in a small boat. During this time, IF5 even lost a finger fishing scallops, and IF6 and IF7 discussed how their mental health rapidly deteriorated because as IF6 indicated, they felt "helpless". IF7 stated that they just fish now "for stamps", i.e., to qualify for employment insurance.

3.4.1.b. The relational well-being livelihoods pathway group

The relational well-being livelihoods pathway group involved 13 IFs' livelihoods characterized by behaviours informed by maintaining relationships with families (within and outside of households) and friends and neighbours in local communities (Figure 3.4). For example, relational well-being was expressed by choosing fishing as the main source of income despite downturns because it was an opportunity to spend time with family (7 IFs). Additionally, IFs discussed fishing as important for the survival of families and of local 'culture' in communities (6 IFs). Common to the relational well-pathway group were slow attempts at becoming a full-time fisher. A slow attempt reflected completing school or work before certification programs were introduced, or taking time to navigate requirements of certification while working in other

sectors. Also common were dynamic exiting and entering the fishery to seek work elsewhere to enable living in fishing communities longer term. Rapid exit and re-entry, along with diversifying incomes outside of Newfoundland and Labrador reflected a dynamic quality not found in the material well-being pathway. IFs in the relational well-being pathway group often made one or two major investments to enter or upgrade, and most had, at one time, built their own vessel. As such, investment behaviour was more sporadic than in the material well-being pathway. Rather, IFs in the relational pathway relied on a diverse suite of coping behaviours to sustain themselves financially: 11 IFs discussed in terms of making a modest living, expressed by phrases like “getting enough to get by” (IF8) or “just to make little living” (IF9). Some IFs indicated that a modest living was around 25,000 to 50,000 Canadian dollars annually.

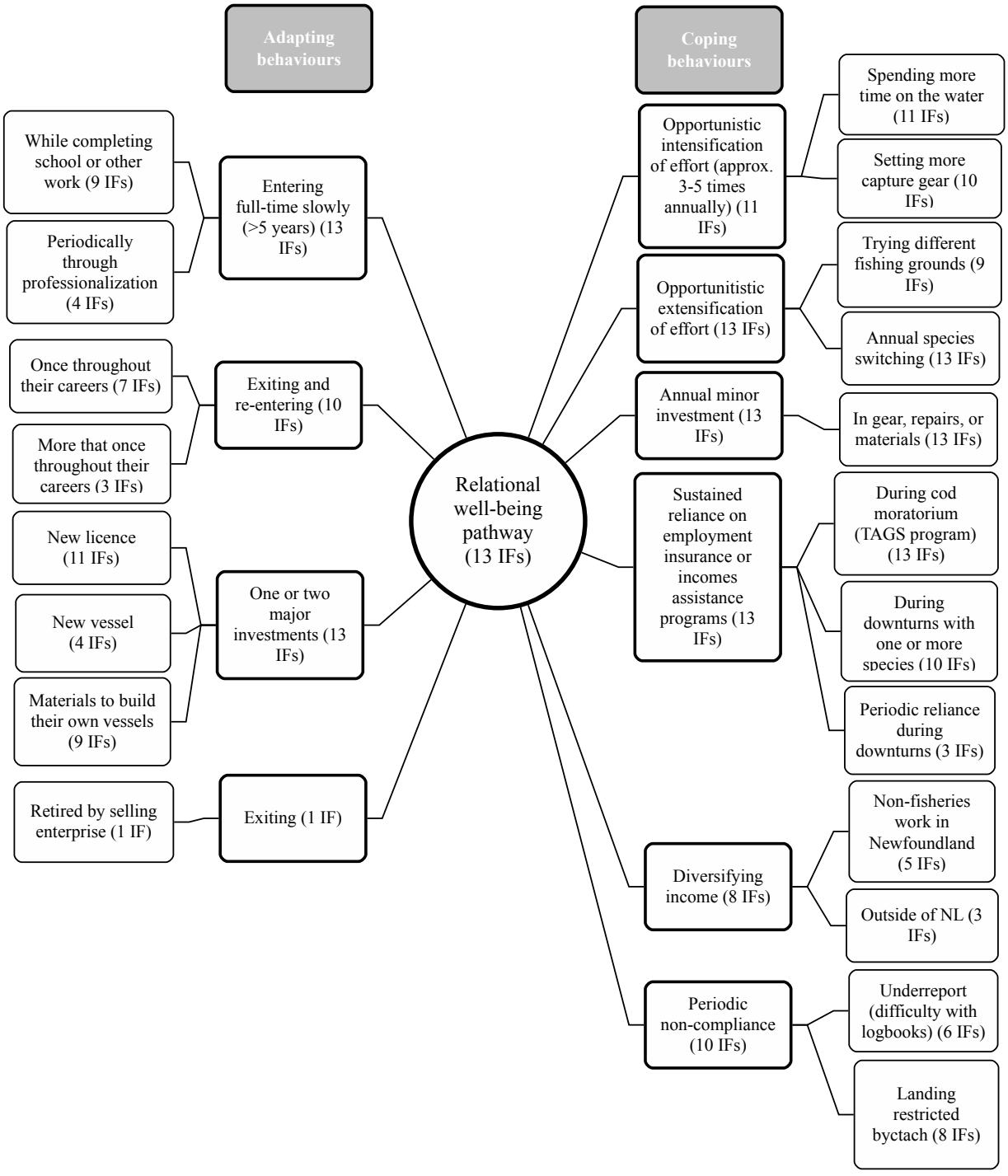


Figure 3.4. The relational well-being pathway group

The story of IF8 demonstrates the dynamic nature of adapting and coping behaviours reflected in the relational well-being pathway group. IF8 exited the fishery temporarily during the cod moratorium, and then re-entered and diversified income sources:

> IF8 entered the fishery as a teenager working in summers with his father while he finished high school before the cod moratorium. After the moratorium, he diversified his income by working in the oil and gas sector in Alberta in the winter, and harvesting groundfish and scallops in the summer. During this time, he would save his money to use for investment in gear upgrades performed before the fishing season opened. In 2001, he exited the fishery completely and spent four years working exclusively in Alberta. During this time, he saved enough to purchase a larger inshore vessel (64'11'') and licenses to harvest scallop and lobster knowing that scallop fishing was hard work and that catch rates and values for lobster, at that time, were low. He remarked that "it was good after the first paycheck, but then it was all down hill". He returned because he felt that "his mind was always back [in Newfoundland]" with his family. To supplement his income, he began building and selling new gear and is starting to build a tourism operation.

IF8's story illustrates a common adapting response to the cod moratorium: exiting the fishery to work outside of Newfoundland and Labrador (see Bavington 2010). Less common, however, was IF8's return after several years to re-enter and invest considerably in a fishery. IF8 believed entering into the scallop and lobster fisheries was difficult work and might not provide a financial return on his investment. His comment that his "mind as back" in Newfoundland with his family demonstrates relational well-being, and a willingness to potentially trade-off material well-being (or take financial risks) to be with his family.

12 of the 13 IFs remained in the inshore fishery, and were planning to fish while their health permitted (one IF retired). When their health declined, 3 IFs indicated they were going to sell their enterprise to retire, and 9 IFs stated that they were going to sell to their children. Three of those 13 IFs discussed how they were waiting for old age pension. At the time interviews were conducted, nine of 13 IFs remained in the inshore fishery with smaller enterprises (i.e., 28' and under and several groundfish and forage fish licenses). Four of 13 IFs remained or retired with larger enterprises and mixed licenses for groundfish and shellfish. The larger-scale IFs indicated that they were successful because of keeping costs low by building their own vessels and conducting their own repairs. However, the IFs that remained at a smaller capacity discussed how they made financial sacrifices staying with family or fishing with friends and family in their community. These IFs experienced considerable hardships brought on by decreasing allocations or fish stocks. IF9 discussed this "death by a thousand cuts" to his livelihoods. IF10 indicated that he "had nothin to catch". Yet, IF10 still planned to fish with his three sons despite the financial hardship:

> *We did not have much money to throw at our boat. We had to get along with what we had. Lots of times we were thinking to get out of it, but I got three boys [with whom he fishes] and they didn't seem to want to do [exit] yet and I didn't force em and I am glad I didn't because to have them there with you, I mean there is nothing any better. I'm proud. I'm blessed with that part of it I guess.*

IF10's comment indicates a trade-off of material well-being for relational well-being pathway. That trade-off resulted from difficult discussions about staying in his community with limited resources. This quotation also hints at the role of subjective well-being with his comment on "there is nothing any better" and the function of emotions related to 'feeling proud'.

In the next section, results include discussions the role of emotions as subjective well-being, and as factors that shaped behavioural change because of the presence of emotions in different decision-making settings.

3.4.2. Explaining fisher behaviour using emotions research

Emotions are socially constructed representations of affect that were linked, through cognition, to perceptions and values (Feldman Barrett 2017a). Results here indicated a range of positive and negative emotions that IFs associated with specific behaviours and the decision-making settings in which IFs negotiated their emotions with crew, friends, and family (Table 3.2). An analysis of emotions in relation to behaviour revealed two different functions important for understanding behavioural changes in livelihood pathways. First, emotions served as goals, recorded as attempts to advance subjective well-being. Second, perceptions, emotional valence, and self-reported emotions were related to behavioural changes or avoiding behavioural change.

Table 3.2: Recorded behaviours, settings for strategizing, and the emotional value and specific emotions associated with behaviour

Adapting behaviour	Setting for strategizing	Emotional valence – specific emotions	Coping behaviour	Setting for strategizing	Emotions
Entering or re-enter the fishery	Households	Positive – relief, enjoyment, hope, love Negative – anger, fear	Intensifying effort	On the water or dockside	Positive – enjoyment, love, pride Negative – frustration, discomfort, fear
Making major investments	Households	Positive – pride, excitement Negative – fear, discomfort, anger, greed	Extensifying effort	On the water, dockside	Positive – excitement Negative – fear, discomfort
Temporary or permanent exiting including outmigration	Households	Positive – relief Negative – sadness, discomfort, and fear	Minor investments	Households, on the water, dockside	Positive – pride, relief
Individual and political action	Households	Positive – pride, hope Negative – frustration, anger	Compliance (reporting and landing illegal bycatch)	On the water, docksides	Negative – frustration, anger
Taking governmental programming	Households	Positive – relief, hope Negative – frustration	Calling DFO and FFAW to comment on management	In households, dockside	Positive – pride Negative – frustration, anger, hate
			Diversifying employment	In households	Positive – hope, relief Negative – discomfort, fear
			Claiming employment insurance	In households	Positive – relief Negative – embarrassment, sadness

3.4.2.a. Emotions as subjective well-being goals

We recorded instances across IFs' livelihood pathway groups, when some behaviours were expressed to advance subjective well-being where subjective well-being was a positive emotional experience or avoiding a negative emotional experience (Figure 3.5). Positive emotions included pride, relief, hope, love, and excitement, whereas negative emotions included frustration, hate, anger, discomfort, and fear. For instance, IFs discussed how emotional experiences were a goal for entering or re-entering the fishery, making major investments in vessels and new licenses, and participating in political action, individually or collectively, such as protesting or suing the FFAW. Moreover, subjective well-being informed strategies to avoid certain behaviours and promote other forms of well-being. For example, 6 IFs expressed how they discouraged their children from entering the inshore fishery out of their anger or frustration with downturns in the fishery. These IFs indicated they discouraged their children so that they could have better economic opportunities. IF 12 indicated he wanted his children to have a "better go of it".

The function of emotions as subjective well-being goals were situational and sporadic. Economic opportunities and downturns in the fishery and in Newfoundland informed adapting behaviours related to entry and investment taken to advance subjective well-being. For example, four IFs were able to re-enter when a new vessel became available or when fish stocks for which they were licensed were, as IF17 indicated "doing well". Moreover, economic downturns, new fisheries policy announcements, and social opportunities shaped political action. For example, IFs indicated that they protested when DFO announced significant decreases to shrimp or crab quotas, and were mobilized by community leaders. In some cases, emotions as forms of subjective well-being emerged when IFs traded-off relational or material well-being. The brief

story from IF18's livelihood pathway highlights how a trade-off of material well-being for subjective well-being emerged over time and was informed by his financial situation and the economic viability of lobster fishing in the late 1990s and throughout the 2000s:

> In 2014, IF18 sold his enterprise for over a million dollars. He indicated he had over a decade of success in the lobster fishery due to high prices for lobster and some good years when catch rates and quotas were high. High prices and good years helped him stay out of debt and earn considerable annual incomes. In the next year, he got the opportunity to join with a friend as a crewmember. In the following offseason, he used some retirement savings for materials to build a smaller boat (28'), and to buy a groundfish license. IF18 remained in the inshore fishery fishing for several groundfish and forage fish, although he stated that he makes far less money than when he was fishing lobster. When asked why he came back to work as crewmember and then fulltime for money. He said, "I told you I loved it"

IF18's story is indicative of a trade-off of material well-being for subjective well-being that informed a behavioural change. The story indicates that IF18 used part of his retirement saving to come out of retirement and to re-enter for the 'love of fishing'. Although IF18's story highlights a trade-off, IF18's story does suggest that material well-being was not fully discounted, as IF18 had considerable savings from selling his enterprise. IF18s' behavioural change highlights the importance of the social and economic situation. He was able to re-enter as a crew member first because of an opportunity posed by his friend. Then, IF18 had the financial security and skills to build his own boat and spend part of his savings on a groundfish license. In addition to the function of emotions as subjective well-being goals, emotions functioned as psychosocial factors to inform other behavioural changes.

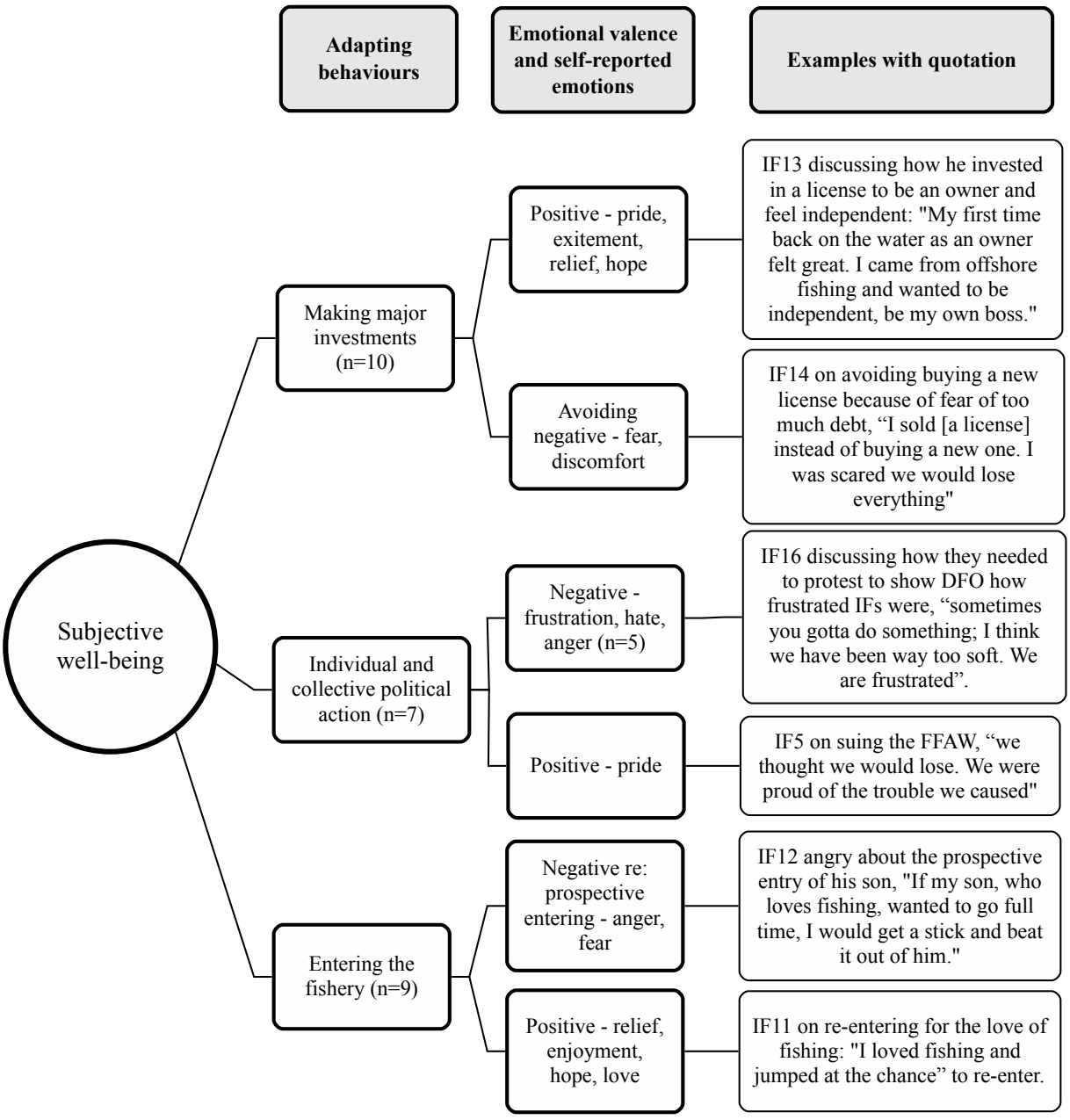


Figure 3.5. Emotions as subjective well-being goals for adapting behaviour

3.4.2.b. Emotions as psychosocial factors for behavioural change

We recorded how emotional valence and self-reported emotions factored into adapting behaviours by shaping why IFs chose to pursue different forms of well-being or not.

In all instances, perceptions of uncertainty played a mediating role when IFs indicated that emotions shaped their behaviours (see Lynn et al. 2015). Two patterns of emotional valence, self-reported emotions, perceptions of uncertainty and well-being were identified.

First, seven IFs associated adapting behavioural change with hope, a self-reported emotion of positive valence. Those IFs associated hope with potential but uncertain opportunities in the fishery to advance their material, relational, or subjective well-being. Opportunities related to uncertainty about whether the fishery was going to have stronger catches or whether DFO was going to increase the quotas for the following year. Three IFs discussed how they entered or re-entered in the fishery because they were uncertain the future of their quotas for crab, and hoped that DFO was going to reverse the trend of decreasing allocations. For example, IF13 discussed how the "fishery is really too unstable", and that they re-entered with buying a new license because he "hopes that [DFO] figures [the quotas] out". They hoped that quotas were going to be increased because of a limited availability of other work in their community, and they did not want to leave Newfoundland to make money with the cost of leaving their family. Four IFs indicated that they invested in the fishery by buying a new enterprise because they hoped for some positive change in the fishery to help them reach their goals. A quotation from IF19 explains how hope and uncertainty can turn out positively:

> *[F]ishing is a gamble. You are either going to do good or you might'n get any…. Right before you start fishing you have a good idea what you are going to end up with,... unless they for some reason… shut it down before you get your catch, but that don't happen every year…[but in that circumstance] we just hoped and hoped that we were going to do something. We were hoping that we were going to get a bit of mackerel. There is always*

something that comes along. You don't see it at the time when you are in the situation, but the road it seems like something always comes up.

In this quotation, IF19 connected the uncertainty of fishing as a type of 'gamble' in which suboptimal conditions in the fishery can be reversed by catch increases of mackerel. For example, IF19 indicated that "a good price" can improve how fishing went the past year.

IF20's comments provided another example of the role of hope and uncertainty. IF20 discussed how he bought a new vessel after years of making financially responsible decisions just to stay long-term in his community with his family. He had hoped cod would return. Several years later he realized that he made the wrong decision after "things started to go downhill". However, he stated he makes a living sufficient to stay in the fishery until he physically can no longer fish:

I am going to stick with the fishery, but I am probably going to end up losing the boat…that I got because I ain't got it paid for yet. So I am going to stick with the small boat… The biggest season I got was $145,000 and that gotta be shared with five men. Its not a big lot … if I make $300 dollars at the end of the week, oh boy that is good…The only bad part is that nobody put enough money away for a "rainy day" they calls [sic] it.

In addition to patterns of behavioural change associated with hope and uncertainty, a second pattern was recorded from 12 IFs in which fear drove the avoidance of adapting behaviour, namely investing and exiting the fishery. In all instances, exiting the fishery or investing were associated with outmigration from local communities, including temporarily leaving their families or permanently uprooting their families. Investing was associated with going into debt and having to exit the fishery, and leave their communities to find work outside of Newfoundland and Labrador.

Certainty and uncertainty played different roles. In each instance, IFs were certain that allocations were going to decrease or even close for respective fish stocks. IF1's comment described this form of certainty, by indicating, "you never hear of anyone saying we are going to try to open up another area. All you hear is about is closures". Uncertainty was associated with starting afresh in other provinces and cities more broadly. IFs that perceived certain continual downturn of the fishery expressed how fear over exiting the fishery for an uncertain life elsewhere. For example, three IFs discussed fear associated with avoided the risks in investment. Those IFs stated that they did not know how to make a living any other way while perceiving that DFO was going to continue to decrease access and allocations. IF22's demonstrated indicated that he had "nowhere to go, when you owe money like I do. I cannot do anything else. I put up with fishing up and down, but now it is not up and down: it is taken away". Nine IFs indicated that fear shaped choices on whether to exit or not exit the fishery. Those IFs knew that fishery quotas were going to decline but were scared to move to another place that was unfamiliar to them. A quotation from IF5, the material well-being IF who lost her finger to scallop fishing, talked about how fear of leaving her community for an uncertain future elsewhere shaped her decision to remain in the inshore fishery:

> *Where are we going to go? Unemployment is good though. No I cannot leave all together. My husband had to go away to work to Alberta, but when he came back he only had $3000. So what was the point of that? [When I think about leaving], it is the familiarity mostly. I do not like city life, and it is basically it. I just do not like hustle and bustle of cities... It is the fear of the unknown.*

This quotation demonstrates the power of perceptual uncertainty and the role of fear when IF5 states that her decision to remain in the fishery was shaped by "the fear of the unknown". Rather,

she and her family would remain in the fishery despite losing her finger and remaining on employment insurance.

The 20 IFs who expressed the two patterns of emotional valence, self-reported emotions, well-being, and perceptions of uncertainty indicated that their decisions resulted from lengthy emotional discussions with family members in the household. Additionally, ten IFs who similarly indicated changes in adapting behaviours, in which emotions were an explanatory factor, indicated that these behaviours resulted from emotionally-driven discussions. Often these discussions occurred across several fishing seasons and involved a negotiation of current outcomes, assets, and potential to advance well-being in the future. A quotation from IF20, who ended up investing considerably, describes how he and his wife talked about how they considered exiting the fishery:

> *Once [the fishery was] pretty bad and me and the wife talked about it, "jeez" we are going to have to go away and go to Alberta or something, and I said, "I don't know how life will go". I said, "I tell you one thing. If I [expletive] go, I am not coming back once I am gone, and it will be pretty sad. We talked about it over and over...it was pretty emotional."*

Ultimately, IF20's conversations led to a hope-driven investment that turned out to be unexpectedly suboptimal. The stories of IFs who were driven by emotions as subjective well-being, and who expressed adapting behaviours for material and relational well-being did not come to those decisions lightly or dispassionately. The resultant behaviours influenced whether or not new capital and capacity remained within, increased, or left the inshore fishery.

3.5. Discussion and conclusions

Since the early 1970s, fisheries researchers have highlighted the importance of fisher behaviours such as effort, investment, and entering or exiting the fishery for policies used to maintain levels

of capitalization and capacity in fisheries (Cove 1973; Chuenpagdee and Pitcher 1992; Branch et al. 2006). Research from the 2010s has emphasized the importance of strengthening the evidence base about human behaviour in fisheries to enhance the predictive capacity of models and decision-making around human activity in fisheries (Armitage et al. 2019; Fulton et al. 2011; Nielsen et al. 2017). Emergent fisheries research about fisher behaviour and its explanations has indicated two opportunities to strengthen this evidence base: (a) to conduct research that better understands fisher behaviours over long periods of time; and (b) to develop more psychosocial evidence to explain fisher behaviour. This chapter addressed these gaps by examining fishers' behaviours as livelihood pathways defined by the prioritization of certain forms of well-being associated with behaviours, and assessing those changes for their psychosocial explanations by drawing on emotions research.

Theoretical and evidentiary lessons from this research can enhance how scientists and policy-makers anticipate and address behaviour in three ways. First, the categorization of livelihoods pathways shed new light on the behavioural foundations of livelihoods and the importance of values, such as well-being, as goals for behaviour (Coulthard 2012; Weeratunga et al. 2014). The material wellbeing and relational pathways reflected patterns of adapting and coping behaviour in response to change and uncertainty expressed toward the same values. Moreover, those patterns led to similar types of individual and household outcomes, with significant implications for capacity and capitalization in fisheries. For example, IFs that more often pursued material well-being experienced either a boom or bust in their lives. 'Boom' outcomes involved IFs experiencing considerable success, and that success was concomitant with new forms of capacity—larger vessels, more licenses, and more gear—into midshore shrimp and crab fisheries or remaining at the upper regulatory limits (i.e., biggest boats, higher

allowable licenses) in the inshore fishery. ‘Bust’ outcomes resulted in suboptimal experiences in the fishery, including deprivations to physical and mental health and reliance on governmental assistance to sustain material well-being. IFs that pursued relational well-being more often stayed smaller by limiting their capacity and capitalization by making only one or two major investments in licenses or vessels, or by building their own boats. They, too, relied on employment insurance for governmental assistance but did so to prioritize their family life in local communities. Patterns of behaviour associated with single values and patterned outcomes revealed a reasonable approach to consider fishers diversity in a fishery. However, the categorizations did not fully explain all the behavioural changes discussed by the IFs in this study. Often, changes in adapting behaviour were informed by trade-offs in forms of well-being along with changes in the economic, environmental, and social conditions in fisheries. Future research can investigate outcomes from different livelihood pathways by examining how adapting and coping behaviours enrich or detract from fishery livelihood dependence in communities.

Second, evidence from emotions research helped explain behavioural change, including changes associated with trade-offs involving well-being. Research results described how IFs often changed adapting behaviours to experience positive emotions such as relief and enjoyment, and avoided adapting behaviours such as investing for themselves and entry for their children out of emotions such as anger and frustration with downturns in the fisheries. Moreover, emotions associated with the economic conditions of the fishery drove some IFs to protest the policies of DFO and to sue their union.

In addition to emotions as goals for fisher behaviour, emotions functioned as explanatory factors that shaped IFs’ pursuit of well-being during strategizing on the water, in aggregating

areas such as dockside, and in households. When emotions functioned as psychosocial factors, those emotions were linked to the negotiation of uncertainty. IFs indicated that when they were uncertain of future allocations, they held out hope for advancing their material or relational well-being in the future. Notably, those IFs acted on hope when they re-entered or invested, injecting new capacity and capitalization in the fishery. Some IFs who remained in the fishery avoided exiting out of fear for the uncertainty associated with moving out of Newfoundland and Labrador. Importantly, the negotiation of uncertainty happened over lengthy and emotional discussions with family that confronted trade-offs among values (see van Kleef 2016). Such examples contribute new evidence to an evolving understanding of how livelihood strategies lead to individual and household outcomes, and broader environmental and social changes, including those in governance (see Nayak 2017). Moreover, results provided a more nuanced understanding of rationality, in which fishers pursued, prioritized, and traded-off multiple goals and drew on emotions and perceptions as lenses to a range of economic, environmental, and governance changes. This depiction of change in inshore fisher behaviour demonstrates the futility of expecting fishers to behave in dispassionate ways to maximize their economic utility, as indicated by neoclassical economic and rational choice paradigms (see also Chuenpagdee and Jentoft 2009; Fulton et al. 2011; Teh et al. 2012).

Third, this research highlighted the importance of stories for understanding fishers' behavioural change and their psychosocial explanations. This study highlighted the power of narratives in drawing out the diverse experiences of fishers and the psychosocial factors associated with those experiences (see also Lowery and Chuenpagdee 2020). An analysis of fishers' narratives provided novel and context-sensitive knowledge about behavioural responses

to policy which can inform the use of combinations of policies and incentives (Kittinger et al. 2014; Lubchenko et al. 2014).

Developing lessons from narratives required concepts and analysis made possible by using psychological and social evidence theory and evidence together. For example, this research developed new integrative evidence about how and why fishers behave as they do under conditions of uncertainty by drawing on insights from emotions research (Etzioni 1998; Cohen 2005; Wolfe 2017) and livelihoods research (Marshke and Berkes 2006; Møller et al. 2019).

In this research, behavioural change was informed by economic, social, and policy situations in fisheries. Factors such as age and government programming, household financial status, gender and behaviour, interpersonal relations and norms highlighted by other research were not investigated in this analysis (e.g., Daw et al. 2012; Pascoe et al. 2012; Harper et al. 2020). Future research can include how these factors shift in meaning and importance over time in certain problem-contexts. Further, there is a need to assess governance arrangements around the world for strategies cultivate, communicate, and use knowledge on patterns of fisher behaviour, and psychosocial explanations. Results here revealed the necessity to better understand and explain fisher behaviour as a source of social complexity for fisheries governance, and its psychosocial motivations reflecting local context.

Chapter Four

Strategies to strengthen inshore fisheries governability in Atlantic canada

4.0. Chapter Summary

In this chapter, empirical research identifies strategies to strengthen the governability of Canada's Atlantic inshore fisheries based on empirical research about the capacity to address fisher behaviour. Analysis draws from theory and evidence about fisher behaviour, knowledge in fisheries management, and fisheries governance and governability to examine barriers and opportunities for the incorporation of fisher behaviour to advance governance objectives in Canada's recently amended Fisheries Act. A content analysis was used to assess 10 semi-structured interviews with senior regional employees from Fisheries and Oceans, Canada, 41 interviews with inshore fishers and community members in northern Newfoundland and Labrador, and 99 federal governmental scientific, policy, and planning documents. Results reveal that current governmental capacities to address and anticipate fisher behaviour require development in settings such as stock assessments, integrated fisheries management planning, and annual management decisions taken to address changing fish stocks. Furthermore, research identified methodological, organizational, and inter-organizational factors that highlight barriers and opportunities within governance. Development of capacities in ways that advance diverse governance objectives can be facilitated by giving these barriers and opportunities more attention. Three interrelated strategies for strengthening governability with fisher behaviour are provided, with novel recommendations to improve monitoring of behaviour to implement policies, create new context-sensitive approaches to anticipate behavioural change, and develop new governance arrangements that can help proactively address fisher behaviour.

4.1. Introduction

The purpose of this chapter is to empirically examine strategies to strengthen governability of the inshore fisheries in Atlantic Canada with fisher behaviour. Policies are key decisions in a given community or organization developed and implemented to enable and constrain human activity through rules (Lasswell 1971). Policies are therefore key tools to strengthen governability (Kooiman 2003). Policies can be constitutive, such as statutes and regulations, or intermediary including rule-making policies, or rules that constrain and enable access or allocations. Policies are then implemented through management, such as decisions and plans about when and with whom to intervene (Ostrom 1990). When new policies broaden the scope of objectives to address social complexity in environmental problems, those policies create demands for social science in management to implement policy in various local contexts (Howlett 2009; Sarewitz and Piekle Jr. 2007; Young et al. 2018). Social science reflects various theories, evidence, and methods that examine the study of human societies and social relationships in coastal fisheries by drawing from cognate academic disciplines including sociology, social anthropology, social psychology, economics, and human geography (Barclay et al. 2017; Bennet 2019).

In 2019, Canada's Fisheries Act (1985) was amended to enshrine an existing policy objective to preserve and promote the inshore fisheries in Atlantic Canada (hereafter inshore fisheries). Further, amendments defined a diverse suite of conservation, economic, cultural, and institutional objectives to be considered in decision-making for the inshore fisheries, and other coastal commercial fisheries. The inshore fisheries are enduring social structures organized around fishing and processing fish stocks off the Atlantic coast (McCracken and MacDonald 1976). The inshore fisheries are defined through fleet separation policies with rules that limit ownership of fishing enterprises (i.e., licenses and the vessels used to pursue allocations in those

licenses) to local fishers. Compared to most industrial fishing enterprises, inshore fishers operate at smaller scales with vessels ranging from 15' to 64', and historically fish close to the coastline, and landed their catches in local ports (Neis and Ommer 2014; Sumaila et al. 2001).

This chapter has two objectives that guide the development of strategies to strengthen governability with fisher behaviour. First, empirical research examines barriers and opportunities to incorporate fisher behaviour as an integrative and interdisciplinary subject of the social sciences to advance multiple objectives in Canada's recently amended Fisheries Act (1985). Second, this chapter contextualizes those barriers and opportunities with evidence about the current capacity to generate, communicate, and use social science knowledge about fisher behaviour in governmental science, policy, and management decisions.

Fisher behaviour is important for policy development and implementation (Chapters Two and Three). Fisher behaviour here refers to the individual fishers and groups of fishers' actions that result from the mental processing and social negotiation of change and uncertainty in coastal and marine environments, coastal communities, and governance (Fulton et al. 2011; see Lynn et al. 2015). Fisher behaviour is a focus of fisheries policies, such as policies with the purposes of advancing conservation, social, and economic outcomes through access and allocation, or with the aims of advancing integrative mandates through monitoring and addressing fishers' activity in coastal fisheries and communities (Fulton et al. 2011). Moreover, fisher behaviour is a catalyst for addressing and anticipating change. Knowledge of why and how fishers respond to different changes reflects evidence about the environmental, social, cultural, and economic changes that are important to fishers, their families, and Atlantic communities (Chapter Three). Yet, theory and evidence are underdeveloped about how governance can incorporate the twin opportunities

to fisher behaviour as a focus of policy, and as a lens into addressing and anticipating change (Fulton et al. 2011; Chapter Three).

Rapid social and environmental change has challenged the governability of the inshore fisheries. In particular, sea surface warming from climate change coupled with predation and fishing pressure have precipitated steep decreases in fish stocks vital for the viability of the inshore fisheries in Atlantic Canada, including Northern shrimp, snow crab [*Chionoecetes opilio*] and capelin [*Mallotus villosus*) (DFO 2018; DFO 2019b). In northern Newfoundland and Labrador, empirical research has revealed that fishers' values, emotions, and perceptions shape behaviour in response to, and in anticipation of anticipation of weakened fish stock abundance and reduced allocation decisions (Chapter Three). Inshore fisher behavioural change precipitated shifts in capacity and capitalization in inshore fleets and commercial fisheries more broadly (Chapter Three). As such, inshore fishers' behavioural change and the underlying psychosocial motivations provide a lens into changing environmental, social, economic, and governance conditions in fisheries (Chapter Three). Further, fishers' behavioural change therefore represents opportunities in governance to understand and address change by anticipating fisher behaviour in stock assessments, integrated fisheries management planning, and in annual management decisions for fish stocks (Chapter Two). However, the psychosocial motivations of fisher behaviour, different behavioural patterns, and the behavioural outcomes to those patterns implicates fisher behaviour as a key source of social complexity in the inshore fisheries that is not consistently and rigorously accommodated in Atlantic Canada and beyond (Chapters Two and Three). Rather, science, policy, and management have functioned to prioritize efficiency. The prioritization of efficiency is evidenced by an emphasis on rationalization, maximum sustainable yield, and administration of fisheries through centralized governance structures

(Bodiguel 2002; Davis and Wagner 2006; Finley 2011; Pinkerton 2017; Needler 1979; Wagner and Davis 2004). Further, promotion of efficiency over social complexity has included a reduced emphasis on diverse types of social science in favour for economics and public administrative sciences (see Andersen et al. 1978; Stephenson et al. 2019).

Analytical capacities in the governance of the inshore fisheries are needed to generate, communicate, and use knowledge about social complexity in governance (Andersen 1978; Charles 1989; Smith et al. 2014; McCracken and MacDonald 1976; Sabau and de Jong 2015). Analytical capacities here reflect social science analyses and models, social theories, interdisciplinary methods, integrative evaluation frameworks, and social science expertise (see Howlett 2009). Yet, longstanding calls for social science assessment of fisher behaviour suggest new insights are needed to cultivate analytical capacity of fisher behaviour to advance diverse governance objectives (Cove 1973; Andersen 1978; Stephenson et al. 2019). As such, by empirically developing strategies to strengthen the incorporation of fisher behaviour, this chapter contributes to theoretical and practical gaps. First, fisher behaviour provides theoretical insights for governance that can incorporate fisher behaviour and its motivations as a source of social complexity. Second, an investigation of fisher behaviour in the governance of the inshore fisheries provides novel and salient opportunities to incorporate social science into governmental science and management to implement policies, and to advance multiple governance objectives. This chapter's two contributions are described and contextualized in four remaining sections. Next, this chapter situates its research purpose in scientific literature. This chapter then describes the study setting and methodology and presents the results. Last, this chapter concludes with a discussion of main findings, and a description of three empirically-developed and inter-related strategies to strengthen governability for the inshore fisheries in Atlantic Canada.

4.2. Literature review

This research draws from three concepts and related areas of literature, including fisher behaviour (Fulton et al. 2011; Chapter Two), social science in environmental management and policy (Ascher et al. 2010; Howlett 2017), and governance and governability in coastal fisheries (Kooiman 2003; Jentoft 2007). Research opportunities and barriers in the three literature areas are used to guide analysis.

Research reveals that fisher behaviour is multi-faceted and dynamic. Fisher behaviours are expressed as tactics in marine environments and strategies in coastal fishing communities (Table 4.1). Tactical and strategic behaviours are interconnected as a suite of potential responses to change that are considered in fishers' decision-making to cope with and adapt to change and uncertainty (Chapter Three; Hauzer et al. 2014; Islam et al. 2017). However, most fisheries research emphasizes tactical behaviours, namely effort, as the means by which fishers cope with fish stock declines and management decisions that reduce access and allocations (Chapter Two). Knowledge and guidance are therefore needed on how scientists, policy-makers, and managers can address and anticipate more comprehensively tactical and strategic behaviours within stock assessments, policies, and management decisions that account for and steer behaviour and its outcomes to capacity and capitalization in fisheries.

Table 4.1: A typology of fisher behaviours and summary of key motivations

Behavioural Type	Definition	Reference
Tactical		
Effort	Application of fishing techniques, gear, and vessels across space and time in marine environments	Tidd et al. 2012
Discarding	Not retaining specific fish species or portions of catch	Christou et al. 2017
Compliance	Obeying rules, often related to landing, reporting, or spatial constraints	Bergseth et al. 2015
Strategic		
Entering	Participation in the fishery, whether for the first time or after exiting previously	Van Putten et al. 2013
Investing	Injecting new financial capital into fishing operations (e.g., new gear, licenses, or vessels)	Van Dijk et al. 2017
Diversification	Participating in employment outside fishing while continuing to fish	Jaiteh et al. 2016
Individual and collective political actions	Leadership and cooperation associated with political action taken by fishers to make change in governance	Sutton and Rudd 2014; Tilman et al. 2017
Exiting	Leaving the fishery by selling off capital assets and/or access rights to the fishery	Daw et al. 2012
Outmigration	Leaving coastal communities, permanently or temporarily, by selling or abandoning assets to pursue livelihoods elsewhere	Hattam et al. 2014
Motivations for behaviour		
Values	Desires, wants, and goals that guide decision-making that leads to behaviours	Lasswell 1971
Factors	The environmental, economic, socio-cultural, psychosocial, and governance variables experienced by fishers that shape their decisions to advance their values	Chapter Three

Social science knowledge reflects an underprioritized type of evidence in the management and policies related to inshore fisheries and environmental management and policy more broadly (Ascher et al. 2010; Howlett 2009; Howlett 2017). Social science capacities to generate, communicate, and use fisher behaviour can support more effective management if those capacities can anticipate effects on pressures and impacts to fish species that result from

the choices of individuals and groups (Fulton et al. 2011; van Putten et al. 2012). Yet, incorporating and anticipating individual or group behaviour, and its psychosocial motivations, in governance likely require new methodologies for fisheries scientists in governance (Chuenpagdee and Jentoft 2009). Further, the development of new methodologies may highlight the need for revised organizational priorities and investment to take stock of change with different methods, and develop new social science expertise to interpret findings for use in management and planning (Wu et al. 2015). For example, in a recent DFO Maritimes Region workshop to assess the cumulative impacts from fishing in an ecosystem-based management approach, workshop recommendations articulated changes to indicators, methodologies, and expertise from considering fishers decisions and strategies that lead to ecosystem impacts from fishing (Daly et al. 2020). Moreover, workshop participants considered some potential changes needed to DFO organizational structure, political implications of new methodologies, and new relationships needed to manifest long-lasting change (Daly et al. 2020). Workshop recommendations demonstrated some of the related governance changes needed when attempting to transform scientific processes from reactive to more adaptive and proactive forms using the social sciences (see Brunner et al. 2005; Howlett 2009; Ascher et al. 2010).

Canadian scholars have emphasized building social science knowledge into interdisciplinary research agendas so that the Canadian government can meet different governance objectives. Fletcher (1977), for example, argued for "interdisciplinary research" in Canadian fisheries management to "holistically integrate biological and social parameters" that "move beyond species management". Charles (1989) and Charles and Reed (1985) argued for more understanding of the dynamics among fishers, communities, and fish stocks to support balancing multiple objectives for inshore fisheries. Stephenson and Lane (1993; 2053) argued for

"fisheries management science" in which social science plays a role in strategic thinking about integrative evaluations of fish stocks and how objectives are clarified, prioritized, and communicated. In the 2000s, Canadian scholars used social sciences, including anthropology, sociology, and human geography to evaluate policies for their effectiveness in addressing behaviour. The resultant research included calls for a better understanding of community dynamics and patterns of fisher behaviour to develop and implement policies that fit local contexts (Bodiguel 2002; Davis 2000; Wagner and Davis 2004). Since the 2010s, calls have emerged for social science to develop, implement and monitor policies and practices with an integrative mandate in which the inshore fisheries are a key actor group, such as integrated fisheries management (VanderZwaag et al. 2012), ecosystem-based approaches (Koehn et al. 2020), and management strategy evaluation (Goethel et al. 2018). Present emphasis on economics and public administration sciences reflect limited progress to build social science knowledge (Stephenson et al. 2019). There remain opportunities for examination on the current and potential barriers and opportunities to incorporate social sciences on inshore fisher behaviour into the fisheries governance.

Governability reflects the overall capacity to govern (Kooiman 2003; Jentoft 2007), whereas governance here refers to people, processes, and rules that prevent, mitigate, foster, or adapt to change (Biermann et al. 2010; Brunner et al. 2005). Strategies to strengthen governability highlight that new sources of knowledge, such as fisher behaviour, need to be assessed in relation to the broader scientific, policy, and management processes in fisheries governance (Jentoft and Chuenpagdee 2015). The flow of new knowledge inputs through generation, communication, and use functions can be 'messy' because people are involved who live and work in different political realities with varying interests, backgrounds, capabilities, and

mandates (Gluckman 2016; Nursey-Bray et al. 2014). Governments include these challenges set on a backdrop of bureaucratic roles about how employees interact (Howlett 2017). For example, in an assessment of the science-policy interface of Canadian commercial fisheries, Soomai (2017a & 2017b) identified different underutilized sources of social knowledge required by policy and management practices, and organizational barriers related to how people communicate within and outside of DFO in hampering greater uptake of those knowledges. Organizational factors such as budgetary limitations, human resources, and workloads, both within and among organizations including the difficulties of working across actor groups resulting from different practices and resources all constitute governance challenges for incorporating new forms of evidence (see Bremer and Glavovic 2013; Carpenter 2009; Chaffin et al. 2016; Delaney and Hastie 2007). To address those factors, new governance arrangements may be necessary that involve different scientists, researchers, and fishers with the capacities to combine fisher behaviour with other forms of knowledge, communicate this information in relation to new problems, and make recommendations for policy and management.

This research uses fisher behaviour and its motivations, insights about social science in fisheries management and policy, and fisheries governability to analysis that informs strategies to strengthen governability of the inshore fisheries in Atlantic Canada with fisher behaviour. Specifically, a typology of fisher behaviour and behavioural motivations are used to assess current capacity in science and management to address and anticipate inshore fisher behaviour (Objective 2). Insights about the governance factors related to social sciences in fisheries management and policy (e.g., new methodologies and expertise) and about the broader governance changes required for new methods (e.g., human resources, interorganizational cooperation) are used to identify and examine barriers and opportunities for the incorporation of

fisher behaviour to advance multiple objectives in Canada's recently amended Fisheries Act (1985) (Objective 1). As such, empirical evidence about governance factors and the current capacities to address and anticipate fisher behaviour are used to reveal strategies to strengthen governability of the inshore fisheries.

4.3. Study setting and methodology

4.3.1. Study setting

DFO leads the strategic and operational aspects of inshore fisheries governance through a centralized governance structure organized by regions (Pitcher et al. 1998; Soomai 2017). This research examines governance of inshore fisheries in three Atlantic administrative regions—Gulf, Maritimes, and Newfoundland and Labrador (Figure 1). In these three regions, the Canadian government administers the inshore fisheries as commercial fisheries under the mandate of a federal ministry, Fisheries and Oceans, Canada (DFO). DFO's main authority is to administer and implement constitutive statutes, such as Canada's Fisheries Act (1985), Canada's Oceans Act (1996), and the Species at Risk Act (2002). In each region, department branches lead the stock assessments, policy interpretation, integrated fisheries management and rebuilding plans, and the development of annual management plans for stocks including several forage fish, groundfish, and shellfish species, including capelin, mackerel, cod, haddock, scallop, snow crab, lobster, and northern shrimp.

Figure 4.1. Fisheries and Oceans, Canada Regions Map (DFO 2010b)

Knowledge used in management is generated for stock assessments, economic profiles of fisheries for planning, and to monitor compliance. Knowledge generated for stock assessments is coordinated by the Canadian Science Advisory Secretariat (CSAS). CSAS is a governmental agency that coordinates peer-review processes about national science that is generated for stock assessments and in response to region-specific requests for natural scientific research (DFO 2020). Fisheries monitoring data are used in multi-annual integrated fisheries management plans, and annual management decisions about access and allocations (DFO 2019f; DFO 2019g). Knowledge communication about stock assessments and management decisions is conducted through system advisory committees, and a series of briefs, reports, and announcements available for inshore fishers (Soomai 2017; Soomai et al. 2013). For example, peer review

advisory committees include representatives from unions and civil society associations that represent inshore fishers constituted to review stock assessments and corresponding recommendations (DFO 2020). DFO also leads annual and biennial advisory committees to discuss and monitor integrated fisheries management plans that includes representatives from the fishing industry, Indigenous fisheries leaders, other civil society members, and operates working groups with varying representation to discuss fish stocks and fishing area management. The committees are constituted to offer perspectives of current and potential management interventions.

4.3.2. Methodology

This research uses a qualitative methodology including three methods: semi-structured interviewing, narrative interviewing, and a document analysis. First, semi-structured interviews were conducted over the telephone with 10 DFO employees working in the Gulf Region, the Maritimes Region, or the Newfoundland and Labrador region. Semi-structured interviewing is a method commonly used in qualitative case study research to collect rich data on participants' perspectives on a set of phenomena affecting a case (Morse and McIntosh 2015; Yin 2013). An interview protocol, or list of questions, provided a 'structure' to the interviews (see Supplementary Material E). DFO employees were recruited following a judgement sampling technique (Etikan 2016) that involved working with DFO leaders to create a list of senior employees that can speak to behaviour, policy, and governance issues across different species-specific inshore fisheries. That list was short. Recruitment involved e-mailing employees that held positions of Regional Director General, Director General, and Senior Advisor (see Supplementary Material J and K).

Second, narrative interviews were conducted with inshore fishers, and fishing community members tin the Great Northern Peninsula, Newfoundland and Labrador. Data collection, materials, and sampling procedures are described in Chapter Three (Section 3.3.2.).

Third, a document review (n=99) was conducted of stock assessments (n=36), policy documents (e.g., statutes, regulations, and policies) (n=34), plans (i.e., integrated fisheries management plans and rebuilding plans) (n=21), and organizational evaluations (n=8). Document review is an appropriate method to use with interviews. A document review helped to provide accessible, extensive, and less intrusive ways to gain perspectives on interview themes (Bowen 2009). However, documents sometimes do not reflect the current thinking of interviewees or organizational practices with limited relevance to current circumstances in organizations (Bowen 2009). To address this limitation, documents were included in the sample based on relevance to interview questions in Supplementary Material E and their timeliness. Relevance was determined by presence of concepts from the typology of behaviour, or key words such as 'behaviour', 'fishing activity', 'fishing impacts', and 'fishing pressure'. Timeliness was indicated in metadata (e.g., publishing or updated year) for the documents. However, some archival documents (e.g., integrated fisheries management plans that have since been updated) were included because those provided useful information about behavioural uncertainties, challenges, and methodologies across planning cycles.

Analyses of data from the three methods followed a simultaneous and convergent design. Specifically, three datasets were analysed separately (i.e., simultaneous analysis), and then together with emphasis on triangulating major themes (i.e., convergence analysis) (see Guest 2013). Datasets were analyzed separately using a content analysis technique. Content analysis refers to the empirical coding of themes, and interpreting relationships among themes through an

iterative process of coding, reflecting, journaling, and diagramming (Clandinin 2006). Content analyses of different datasets were appropriate because the approach allows for iterative rounds of coding and reinterpretation of themes across datasets (Clandinin 2006). Analysis followed deductive (i.e., applying pre-determined codes) and inductive approaches (i.e., identifying emergent themes) (Palinkas et al. 2013). Pre-determined codes were derived from a typology of fisher behaviour and terms related to motivations (Table 4.2)

Table 4.2: Deductive variables and example codes or coding approach

Variable	Example codes
Tactical behaviours	
Effort	'effort', 'fishing pressure', 'spreading effort'
Discarding	'discarding', 'not retaining catch', 'handling bycatch'
Compliance	'following rules', 'reporting obligations', and 'landing obligations', and 'high-grading'
Strategic behaviours	
Entering	'entering the fishery', 'registering in the fishery', 'professionalization'
Investing	'upgrading', 'purchasing new vessels or licenses', 'gearing up'
Diversification	'working outside of the fishery, 'occupational pluralism'
Individual and collective political actions	'protests', 'legal action', and 'cooperation'
Exiting	'buyback', 'leaving the fishery', 'transfers'
Outmigration	'migrating', 'leaving communities' 'leaving rural livelihoods'
Motivations for behaviour	
Values	Material well-being ('higher catches', 'larger profits'); relational well-being ('fishing with families', 'living in communities'); subjective well-being ('frustration', 'anger')
Factors	Environmental (e.g., 'catchability', 'ecosystem conditions'), economic (e.g., 'prices', 'landed values'), socio-cultural (e.g., 'community livelihoods', 'cultural practices'), pyschosocial (e.g., 'values', 'emotions', 'perceptions') and governance drivers (e.g., 'allocations', 'closures', 'quotas')

Triangulation of deductive and inductive themes was used for two purposes. First, triangulation was used to increase reliability of interpretation of themes from within datasets

(Curry et al. 2009). Deductive codes from an analysis of the interviews were compared with document analysis, and vice versa. A comparison revealed emergent themes about interpretations of governance factors, policies, and processes that shape how knowledge about fisher behaviour is and can be used to strengthen governability. Emergent themes were then applied across datasets. As well, triangulation was used to further contextualize themes by comparing DFO interviewee perspectives and statements with content in the documents and themes in the narrative interviews (see Farmer et al. 2006).

This research emphasized Atlantic regional perspectives about DFO's role in the governance of inshore fisheries. An emphasis on regional perspectives from DFO is appropriate because of the central role DFO's Atlantic regions have in the governance of inshore fisheries, and the novelty of including perspectives from DFO in research related to fisher behaviour. Perspectives about fisher behaviour are important from other organizational representatives, including other parts of DFO (e.g., National Headquarters in Ottawa), from other federal and provincial government departments, and from various union and civil society organizations that administer policies and programs that relate to the sustainability of the inshore fisheries, but may not have a federal regulatory obligation to them. Not including these representatives in the research design may be a limitation. We have highlighted opportunities for future research and policy practices that can incorporate perspectives from other actor groups including civil society, union, and governmental organizations.

4.4. Results

The results point to three central findings. First, there is very limited capacity in DFO's Atlantic regions to monitor fisher behaviour. As such, demands for fisher behavioural knowledge are not being met for DFO policies that have fisher behaviour as a focus (e.g., DFO's *Sustainable*

Fisheries Framework [2019d] and a suite of licensing policies for the Atlantic region). Second, new methodologies are needed to better anticipate and address fisher behaviour to support approaches such as ecosystem-based approaches to fisheries management (DFO 2009). Third, governance factors—methodological, organization, and inter-organizational—functioned as barriers and opportunities to develop capacities to monitor, anticipate, and address fisher behaviour in science, policy, and management. The findings draw attention to three strategies to strengthen the governability of the inshore fisheries with fisher behaviour. Results are organized to discuss those demands for knowledge on fisher behaviour, and then to examine the governance factors related to DFO operations that shape more consistent and comprehensive incorporation of fisher behaviour.

4.4.1. Knowledge demands for fisher behaviour in governmental policy

DFO policies make three types of demands for fisher behavioural knowledge. First, a review of policy documents (hereafter PDs) indicated that knowledge related to tactical behaviours, particularly effort, discarding, and compliance was needed to implement policies such as policies in the *Sustainable Fisheries Framework* (DFO 2019d) used to advance conservation objectives (Figure 2; PD5-17, PD27-28). Examples of policies under the Sustainable Fisheries Framework that address tactical behaviours include *A policy framework for incorporating the precautionary approach into fisheries management* (DFO 2009a), *Guidance for the developing of rebuilding plans using the precautionary approach* (DFO 2019h), and *A policy for managing the impacts of fishing on sensitive benthic areas* (DFO 2009b). The Sustainable Fisheries Framework's policies include demands for estimates of effort, discarding, and non-compliance in modelling and trend analyses to establish the precautionary approach, and to develop harvest control rules. In addition, *Fisheries Monitoring Policy* (DFO 2019f) explicitly

indicates the need for knowledge on discarding and compliance after management decisions are implemented (PD16-17).

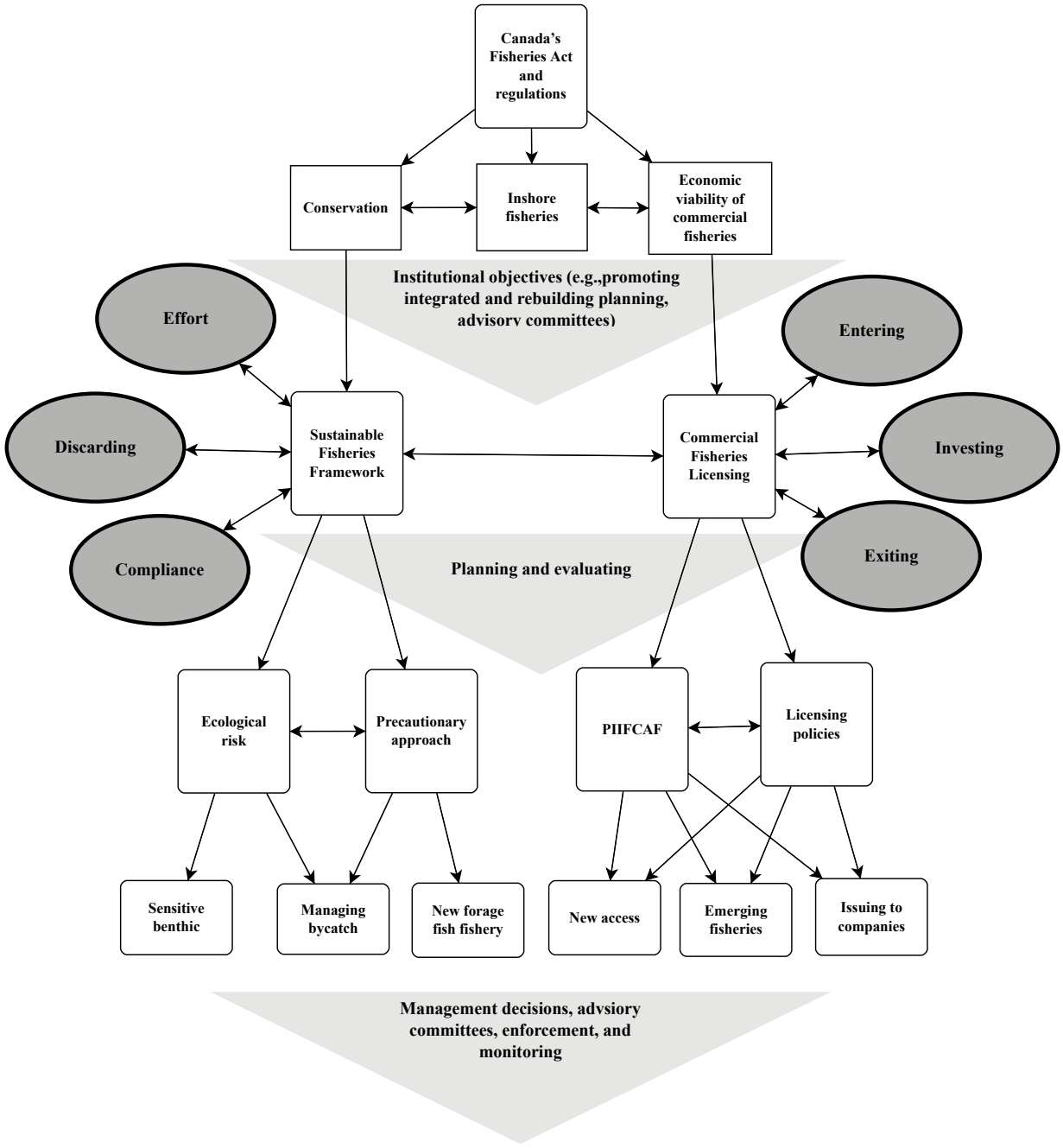


Figure 4.2. DFO policies and their relationships with inshore fisher behaviour

Second, demands for knowledge on strategic behaviours, namely entry, investment, and exiting, are made in licensing policies with the purpose of controlling access, capitalization, and capacity in fisheries (PD19-26; Figure 4.2). Examples of policies include the *Commercial Fisheries Licensing Policy for Eastern Canada* (1996) and region-specific licensing policies (e.g., *Commercial fisheries licensing policy for the Gulf region* [2010]). Knowledge on entry, investment, and exiting is used to develop profiles of fisheries for specific fish stocks in integrated fisheries management planning. DFO interviewees indicated knowledge on other strategic behaviours, such as diversification and outmigration, are demanded through policies outside their jurisdictions, such as Atlantic provincial policies and programs and federal policies related to employment insurance that shape the behaviour of fishers (see Chapter Three). DFO Interviewee 1 argued that diversification and outmigration fall into provincial and federal mandates for sustaining coastal communities. Interviewee 1 argued that diversification and outmigration are in "the realm of preserving communities…connect[s] to other government policy objectives… expressed through employment insurance and all that sort of thing". Interviewee statements indicate the need for cooperation with other federal and provincial government representatives for knowledge that reflects a fuller accounting of strategic behaviours

Third, a document review and themes from DFO interviewees indicated that new institutional objectives related to moving from species management to ecosystem-based approaches to fisheries management made demands for knowledge that supported the anticipation of fisher behaviour in stock assessments and addressing fisher behaviour through incentives. For instance, *Sustainable Fisheries Framework's* policies that discuss ecosystem-based approaches to fisheries management included statements that emphasized anticipating

behaviour to reduce the "ecological risks from fishing", mitigating "impacts from fishing" and finding ways to monitor and address the "cumulative fishing mortality across fisheries" (PD5, PD7-8, PD13). Evaluation documents (hereafter EDs) further described demands on fisher behaviour knowledge in the context of the development of management decisions to steer behaviour with incentives. For example, the *Atlantic Fisheries Policy Review* (2004) states:

> *Decisions about whether to harvest and how much to harvest must weigh the current social and economic benefits of harvesting a fish stock against the need to ensure future harvesting opportunities…positive incentives…must be adopted to support behaviour that fosters the conservation objectives and they must encourage resource users to go beyond mere compliance with the rules (Ed4).*

The emphasis on behaviour was therefore linked to institutional objectives, policies related to ecosystem-based management approaches, and their potential implementation through management.

4.4.2. *Factors that shape the current and potential capacities to incorporate and anticipate fisher behaviour*

Results indicated that current capacities, such as in fishery monitoring, to generate knowledge about fisher behaviour were limited to monitoring outcomes from behaviour (e.g., impacts from effort and discarding, compliance rates, numbers of enterprises in a given year that serve as proxies for entering and exiting behaviour). Tactical and strategic behaviours were linked to the key mandates in integrated fisheries management plans (hereafter FMPs) for building 'self-reliant' or 'self-sustaining' inshore fisheries (e.g., FMP12, FMP16-19, FMP21). Self-reliant referred to fisheries that were 'economically' or 'commercially viable', whereas 'self-sustaining' described the sustainability of fish stocks for future generations of inshore fishers. Yet, stock assessments (hereafter SAs) and FMPs across the three Atlantic regions

indicate that for many species the current focus on studying the outcomes to behaviour were insufficient (SADs 5, 11, 13, 16, 21-22, 27, 30; FMPs 1-4, 13, 14, 21) (Table 4.3). For example, three DFO interviewees representing the Policy and Economics sectors from each region argued that data on strategic behavioural outcomes was only used to contextualize and anticipate social and economic implications of decisions when new access was provided in fisheries and when allocations needed to be reduced. DFO Interviewee 2 argued:

> *I think the role [for that knowledge] is to set us straight. If you look at the impacts, what is the impact of allocations or the allocation of the cuts if a quota has to be lowered?... The picture becomes clearer whether the impact is severe or whether it's something that, you know, people will or won't like, but they can muddle through.*

DFO Interviewee 2's comment indicates that anticipation of social and economic impacts to management decisions is important context to understand the implications of management decisions after they are made using biophysical data largely.

Table 4.3. Current monitoring approaches for tactical and strategic behaviours, examples of limitations, and evidence source

Behavioural type	Monitoring approach	Limitation examples	Source of evidence
Effort	Generated from logbooks for Catch per Unit Effort indices	Challenges related to determining fishing pressure for cod, capelin, snow crab, and lobster (Newfoundland and Labrador Region)	SA10, SA12, SA14
Discarding	Generated from logbooks and 'on-board monitoring for trend analyses	Uncertainty of discarding behaviour for cod, lobster, and northern shrimp (Maritimes Region)	SAs29, 33, 35
Compliance	Patrols and inspections of conservation officers, data from vessel monitoring systems, and telephone surveys for various estimates in fishery monitoring	Challenges mitigating non-compliance to certain area closures for snow crab and promoting compliance for reporting obligations related to herring (Gulf Region)	FMP16, SA24
Entering	National online vessel registration system through registration of license	Limited to provide context; advisory committees used to anticipate shifts in entering	DFO interviews
Investment	National online vessel registration system through registration of gear and vessel	Limited to provide context; advisory committees used to anticipate shifts in entering	DFO interviews
Exiting	National online vessel registration system through registration of license	Limited to provide context; advisory committees used to anticipate shifts in entering	DFO interviews

DFO's emphasis on monitoring tactical and strategic behavioural outcomes reflects a post-hoc approach to studying behavioural changes as outcomes behaviours already occurred, an approach incongruent with the goal to anticipate the future environmental and social implications. Moreover, data on diversification and outmigration were not being considered, as monitoring those behaviours was perceived by DFO interviewees to fall under the jurisdiction of

Atlantic provincial governments and other federal governmental ministries including, as for example, Employment and Social Development Canada responsible for administering the employment insurance. To anticipate strategic behaviours, DFO interviewees indicated that advisory committee meetings were used to gauge responses of the fishing industry. However, anticipation of behavioural responses occurred largely after recommendations from stock assessments were made (e.g., recommended Total Allowable Catch) and specific management measures were decided preliminarily (e.g., season opening and closure dates, quota allocations for the inshore fishing fleets.

Analysis revealed six factors that shaped the current capacity to generate knowledge on fisher behaviour through DFO stock assessments and fishery monitoring, and use that knowledge in management, and the potential to more consistently and comprehensively incorporate and anticipate fisher behaviour (Table 4.4).

Table 4.4: Governance factors, type, and examples

Governance factors	Type	Examples in current approach
Concerns about disrupting biophysical data collection and analyses with fisher behavioural knowledge	Methodological	Methodological uncertainty about the types of information needed to understand fisher behaviour (Box 4.2)
Limited capacity for interdisciplinary science to address and anticipate fisher behaviour	Methodological	Fishers hold different values in fishing that shape their behaviour that are not well understood in DFO (Box 4.3)
Limited 'in-house' social science expertise for generating and evaluating knowledge on fisher behaviour and its diverse motivations	Organizational	Limited emphasis beyond outcomes, but calls in communities for more social science about behaviour
High workloads for DFO employees that constrain new scientific approaches	Organizational	Crisis orientation in DFO limits capacities to generate and use fisher behavioural knowledge
Multiple organizations needed to anticipate behaviour	Inter-organizational	Strategic behaviours are addressed by other federal and provincial agencies
New governance arrangements can facilitate knowledge generation, communication, and use of fisher behaviour	Inter-organizational	Advisory committee structure provides insight into new governance arrangements (Box 4.4)

4.4.2.a. Methodological factors

The first governance factor related to methodological concerns about incorporating behavioural knowledge into stock assessments and fishery monitoring. Three DFO interviewees argued that there was hesitancy by scientists in DFO to alter current methods and models by incorporating social science that monitors fisher behaviour, even though those interviewees identified issues in the current approach. DFO Interviewee 3 characterised factor as concerns for interrupting of a "consistent, sound ways of operating". DFO Interviewee 4, a senior employee that rejected the idea that fisher behavioural knowledge is important for stock assessments,

argued that predictability in monitoring fish stocks "is best achieved by a set of time series data" derived from collecting data and monitoring indicators "the same way annually". This hesitancy functions as prospective concern about disrupting biophysical data collection and trend analyses used to advance conservation objectives by adding evidence and methods for fisher behaviour to the precautionary approach and current indicators of fishing pressure.

In the Maritimes and Gulf regions, for example, three DFO interviewees discussed how data collection and analytical methods for effort, compliance and discarding can foster good indicators of fishing pressure. However, those interviewees argued that the current approach reflected a de-prioritization of this knowledge, and tactical behaviours were used only when other natural science indicators were missing or insufficient. Therefore, opportunities were missed to integrate knowledge on tactical behaviour with biophysical data. To demonstrate the de-prioritization of behavioural knowledge, Interviewee 5 compared the snow crab and lobster fishery for which management decisions incorporate tactical behavioural knowledge for snow crab but not lobster. Interviewee 5 explained:

> *[For the snow crab fishery], there's 100 percent dockside monitoring there at sea, observers measuring catches. There have been experiments on sort of mortality of discards and all kinds of things like that that we can provide really reliable estimates of total fishing pressure… [For the lobster fishery], there is no mandatory downside monitoring in our case. So, we're sort of beholden to sort of sales slips, which is at the buyer level. So that's not at the boat level or the individual captain level. And it's a roll up of what they reportedly have sold. We believe that there is a large undocumented catch that is not part of those sale slips.*

Interviewee 5 highlighted the limited use of tactical behavioural knowledge on the determination of fishing pressure in the snow crab fishery and under-addressed demands for tactical behavioural knowledge at the individual and group level for the lobster fishery by relying on sales slips and operating with the belief that there was a "large undocumented catch".

The second governance factor related to challenges of working with social science disciplines to anticipate fisher behaviour by focusing on human values beyond economic goals, or more broadly to better understand the social, cultural, and psychosocial factors that influence behaviour. In a comparison of DFO and community interviewees, divergent perspectives emerged about the role of social, economic, and psychosocial motivations such as human values, and their importance for anticipating behaviour. While six DFO interviewees thought human values were important to be considered in stock assessments and management decisions, four other DFO interviewees disagreed entirely that non-economic values, and other psychosocial motivations were important for anticipating behaviour. DFO Interviewee 6 stated, "I think [fishers] are motivated by their living and to make a time when they can…get out of it … You got to keep getting bigger, you know?".

In comparison, fourteen community interviewees pointed to a misrepresentation of their values in governance as a part of a broader governmental emphasis on implementing rationalization. Those interviewees argued that they have been pressured to upgrade or retire and that those pressures do account for goals for fishing with their family and friends and maintaining psychosocial benefits of fishing. For example, one community interviewee remarked, "every year they come around for rationalization; they are for the big boats and the offshore". That interviewee argued that rationalization policies helped some fishers thrive but others, like him, were "left behind". Eleven community interviewees perceived DFO

management as a concerted effort to reduce allocations for fishers and promotion of allocations for the offshore. For example, one community interviewee remarked that allocations were systematically being reduced, "[W]e just are going to get [our allocations] cut, cut, cut. The thing that got me is that you will never get it back. The word is the fishery is a complex issue. [Our government] has been selling us off ever since". Six community interviewees indicated that "DFO just simply does not understand how we want to operate." However, one of those argued that there was evidence for some accommodation of inshore fishing values reflected in novel governmental policies such as 'buddying-up' in which two license holders are allowed to temporarily use the same vessel and gear (see PD24).

Three DFO interviewees argued they were unsure whether it was DFO's responsibility to incorporate social, economic, and psychosocial factors and values to understand fisher behaviour. When discussing strategic behaviours such as entering, exiting, and migration, DFO Interviewee 1 remarked, "When you get into the benefits of keeping a rural lifestyle and traditional values and things, I don't think that is us." However, DFO Interviewee 1 contended that they were now mandated to consider cultural and social factors in relation to fishing impacts, and DFO interviewee 2 argued, "we now have to consider cultural factors in making decisions. That's got to be really hard. What does that mean? I mean, that's a whole other discipline".

These two factors point to specific methodological challenges, broader concerns about meeting those challenges through interdisciplinary research, and the existence of perspectives that suggesting interdisciplinary research is not needed. The challenges and desires for working across disciplines related to the second set of governance factors involving organizational capacities and barriers in DFO.

4.4.2.b. Organizational Factors

The third governance factor reflected the limited 'in house' expertise with social theory and evidence about behaviour and broader constraints on building social science and interdisciplinary research capacities in DFO (Six DFO interviewees). While discussing barriers to generate and use different forms of social science in DFO about behaviour within DFO, DFO Interviewee 7 argued, "there is barely any social science expertise in DFO. I think it's just the way the organization is made up …of mainly staff with biological background. And I feel like there isn't much dedicated effort to was understanding or collecting social and economic data in much of the long term". When social science was related to developing evidence on diverse motivations for behaviour, DFO Interviewee 8 stated simply, "we do not have that branch here".

Results from community interviewees demonstrated an appetite for social science methods to monitor tactical and strategic behaviour in the inshore fisheries in northern Newfoundland and Labrador. For example, 12 community interviewees called for greater monitoring effort and compliance, as for example, through monitoring of vessel movement across space and time, referred to as black boxes. Those interviewees wanted greater use of black boxes to provide evidence about different fleets operating illegally in fishing areas in Newfoundland and Labrador. More broadly, nine community interviewees indicated they wanted more "social assessments" used in the determination of quotas to build a better understanding of inshore fishers' values in management decisions about allocations. Calls for more social science from communities was particularly interesting, as those 12 interviewees also indicated that they did not believe or support the biophysical science produced in the region on key stocks such as northern shrimp. As such, while limited in-house social science expertise was identified, some support from community interviewees in NL indicate a unique opportunity to build fishery

monitoring with social science in the region. However, a review of evaluation documents indicated that the federal government has invested considerably in the current emphasis on biophysical science, and monitoring outcomes. For example, two departmental evaluations described considerable investments in surveillance and forensics to monitor non-compliance outcomes with the intent to improve compliance to landing obligations (E1-3; E-8).

The second theme related to heavy workloads and the reactive orientation of DFO. DFO interviewees indicated that many regional employees did not have the time to build their own social science and integrative capacities or work with social scientists outside of the government because they were busy dealing with crises. Five DFO interviewees discussed operating at the status quo was a barrier to integrate social science about inshore fisher behaviour. DFO Interviewee 9 argued, "You know sometimes you get stuck in doing the same things you have always done. You are so busy day to day to do what you do the normal way…could be a barrier for sure". DFO Interviewee 9's comment highlighted the notion of 'getting stuck' in the status quo as a barrier. Two interviewees who shared this perspective highlighted that regions were 'getting stuck' dealing with crises. DFO Interviewee 10 described crisis with metaphors that new ideas get put on the 'corners' of senior DFO employees' desks as many were busy 'putting out fires' related to crises in fish stocks and inshore fisheries. DFO Interviewee 10 stated:

> *We're kind of in the rut of maybe because of lack of time [and] resources. It seems that we're always firefighting. There's always a crisis. There's always something more important. There's like so everybody saying, "Okay, my desk is full of corners. Put that on a corner of my desk". So, we're always firefighting…We need to be proactive. But to be proactive, we need to be know what's happening [in the fisheries]. We need to monitor it.*

We need to be on top of what's going on. So that translates into having social data, and having…predictive tools.

DFO Interviewee 10 demonstrates that the organizational factors such as the workloads of senior officials managing crises in the inshore fisheries function as a barrier to move beyond reactive forms of governing, and to incorporate and anticipate new social sciences about inshore fisher behaviour in governance.

4.4.2.c. Interorganizational opportunities

Five DFO interviewees indicated that moving to better understand and anticipate inshore fisher behaviour more proactively requires working across organizations and actor groups. Those interviewees shared perspectives that DFO had limitations in jurisdictions for understanding and anticipating all tactical and strategic behaviours, as other federal ministries, provinces, and civil society groups and unions that represent inshore fishers have jurisdiction over behaviours that manifest in coastal communities. For example, DFO Interviewee 1 argued, there is a gray area between where we are and what our role would be in maintaining social fabric". Moreover, Interviewee 1 linked the need for other policy makers and scientists to help elucidate overlaps in policy jurisdictions. DFO Interviewee 2 argued that "significant portions of fisheries policy [are] actually created outside of the fisheries regulating regulator context…these factors are certainly social science opportunities for study". DFO interviewees argued, however, that currently efforts to anticipate behavioural responses to management decisions are conducted in advisory committee structures.

Results indicated that DFO often attempts to anticipate fisher behaviour in committee meetings designed for communication of management decisions. Interviewees and FMPs described how DFO anticipates behavioural responses to proposed allocation decisions through

committee meetings for annual decisions and biennial or multi-annual integrated management planning meetings. Perspectives on the responses to those decisions from fishers are generated after preliminary management decisions have been made, and before final recommendations are proposed to the Minister. In the advisory meetings, DFO representatives attempt to understand and anticipate behaviour by exploring how the inshore fishers responded to the previous years' decisions (FMPs 1, 7, 12, 21) and by anticipating how the inshore fishers are likely to respond in the upcoming fishing season (FMPs 13-14,18). Some interviewees indicated that this approach to understand and anticipate behaviour was sufficient. For example, DFO Interviewee 2 argued:

> *So you're making some decisions that will have a negative impact on their fishery. You pretty much know why and what their outcome will be or what their take on it will be during meeting. They're usually very little surprises at that level.*

Contrary to DFO Interviewee 2's perspective, results from other interviewees indicated that advisory committees were not designed nor functioned to generate rigorous knowledge of fisher behavioural change. Fourteen community interviewees argued that the committee structure was insufficient to anticipate fisher behavioural responses because the problems of some inshore fishers are not represented in these meetings. This was a particular issue in NL.

Several fishers argued that they had difficulty in communicating their perspectives because FFAW did fully represent their interests. One community interviewee argued that the "FFAW does not actually represent us. They says [sic] they do. They don't. No one is here to protect our livelihoods. The psychological effects…is bad, feeling like you do not count." In the Gulf and Maritime regions, DFO interviewees pointed to the strong political representation of inshore fishers. Those interviewees argued that the information provided in committee meetings was valuable for gauging perspectives about alternative management decisions desired by fishers, but

not reliable for deriving behaviour knowledge. For example, DFO Interviewee 3 argued DFO representatives made judgements about different perspectives and how decisions were likely to affect the inshore fishery. DFO Interviewee 3 contended, “you cannot get all the views and you need to think what's the best thing for the industry in the future as you should see it?”. Moreover, two DFO interviewees argued that they perceived a tendency for increasing the number of different stakeholders in those meetings, but that adding more people detracted from opportunities to participate and glean from those participants a more comprehensive understanding of fisher behaviour. These insights indicate advisory committee meetings were not set up for rigorous forms of knowledge generation about fisher behaviour, and highlighted the need for alternative mechanisms to anticipate fisher behavioural responses to management decisions.

To build new social science functions across organizations, three interviewees argued for new governance arrangements capable of understanding and anticipating fisher behaviour. DFO Interviewee 7 envisioned this governance arrangement following CSAS operations, in which scientific peer review and advice are coordinated and evaluated with multiple stakeholders that can support the rigorous and systematic generation, communication, and use of social science across governance objectives. DFO Interviewee 7 reflected, “CSAS does not use social information... It's just set up for strictly biophysical science…This is just radical thinking, but if we had a similar process [like CSAS], or have CSAS amended in such a way that it can also have social science….I can see managers ask questions [of social science] that are relevant to decisions that have be made”. DFO Interviewee 7’s ‘radical thinking’ contributes an ideal governance arrangement that can attenuate some of the methodological and organizational

barriers, and therefore, reflects a useful recommendation for understanding and anticipating fisher behaviour using social science.

4.5. Discussion

Calls for social science and integrative frameworks in fisheries management are well established (Cove 1973; Andersen 1978; Charles 1989; Davis 2000; Pinkerton 2017; Gabau and de Jong 2018). However, Canada's recently amended Fisheries Act again highlights the need for integrative knowledge, including social science and theory about fisher behaviour in science, policy, and management used to advance diverse environmental, social, economic and institutional objectives (Stephenson et al. 2019). Fisher behaviour represents an integrative subject of social science that describes how and why fishers' tactical and strategic actions shape different conservation, economic, social, and governance outcomes, and the extent of fisheries livelihood dependence in the inshore fishery sector (Chapters Two and Three). This chapter's research developed strategies to strengthen governability of Canada's Atlantic inshore fisheries to address and anticipate inshore fisher behaviour. To develop strategies, we conducted a novel evidence-based assessment of current capacities and potential to generate, communicate, and use fisher behaviour in fisheries management decisions, including integrated fisheries management planning.

Three major findings resulted from the assessment. First, there is limited capacity in DFO's Atlantic regions to monitor fisher behaviour. Rather, monitoring focused on the outcomes of tactical and strategic behaviours demonstrated, as for example, in emphasizing impacts from effort, discarding and compliance rates, and numbers of enterprises registered annually that served as proxies for entering, investing, and exiting behaviours. As such, demands for fisher behavioural knowledge are not being met for DFO policies that have fisher behaviour as a focus

(e.g., DFO's Sustainable Fisheries Framework [2019b] and a suite of licensing policies for the Atlantic region). However, insights from FMPs and SAs, along with examples from DFO interviewees point to the need for stronger monitoring of behaviour in stock assessments and fishery monitoring before outcomes are produced, for example, as fishing impacts or discarding and compliance rates.

Second, new methodologies are needed to better anticipate and address fisher behaviour to support approaches such as ecosystem-based approaches to fisheries management. Current capacities indicate limited attention to consider diverse human values, and socio-cultural factors in the local context of inshore fisheries. Further, some DFO employees and governmental documents indicated a limited understanding of fishers' values was not needed due to the sufficiency of economic and rational choice framings for fisher behaviour.

Third, governance factors—methodological and organizational—functioned as barriers, whereas inter-organizational cooperation represented an opportunity to develop capacities to monitor, anticipate, and address fisher behaviour in science, policy, and management. Governance factors were linked, including the need for new interdisciplinary methodologies to monitor behaviour, social science expertise to generate behavioural knowledge for stock assessments and fishery monitoring, and social science expertise for evaluating that knowledge for use in management decisions. However, organizational barriers indicated that workloads to address fisheries crises and the current approach of anticipating behaviour in advisory committees constrained methodological innovation. Yet, results revealed that inter-organizational cooperation among DFO, other governmental departments that address fisher behaviour, and fishers organizations presents opportunities for new governance arrangements to attenuate those barriers. Insights about current capacities to incorporate fisher behaviour and the

governance factors that constrained improvements to becoming more comprehensive revealed three inter-related strategies to strengthen governability. Each strategy is discussed in turn.

4.5.1. The behavioural monitoring strategy

The behavioural monitoring strategy involves improving fisheries monitoring in Atlantic Canada with fisher behaviour. The review of policy documents revealed that, while addressing tactical and strategic behaviours is needed for policy (Section 4.4.1), the current approach involving monitoring outcomes to tactical behaviours has limitations and presents challenges for advancing conservation objectives through the precautionary approach (Table 4.1). Further, DFO interviewees described how entering, investment, and exiting behavioural outcomes were monitored and used a context for decisions made through integrated fisheries management plans, and not as sources of fishing pressure and impacts. Moreover, the interviewees discussed the importance of policies for other federal ministries and provincial governments to address behaviour. The limitations in the current approach, and the need to connect monitoring of behaviour with different jurisdictions point to the need to evaluate and revise fishery monitoring to provide a comprehensive understanding of fisher behaviour. A revised fishery monitoring policy can include a scientific and decision framework for how policies address fisher behaviour using social sciences to enhance current stock assessments approaches and decisions based on that science in integrated fisheries management planning and annual management decisions about fish stocks. Findings from this research suggest that clarifying and developing a scientific and decision framework for fisher behaviour can help organize the development of new analytical capacities (see Howlett et al. 2009; Wu et al. 2015).

4.5.2. The context-sensitive anticipation strategy

The context-sensitive anticipation strategy involves building capacities to generate, communicate, and use evidence and theory to anticipate behaviour by drawing from the psychosocial experiences of fisheries with environmental, socio-cultural, economic, and governance changes. Results pointed to the need for knowledge on the anticipation of fisher behaviour to meet new integrative approaches, including ecosystem-based approaches to fisheries management, and therefore, institutional objectives in Canada's amended Fisheries Act (1985). However, interest in a better understanding of diverse human values was limited in responses of some DFO interviewees, and other DFO interviewees pointed to a lack of clarity over how to incorporate into governance the social and cultural factors that shape fisher behaviour in local contexts. Yet, insights from community interviewees in Newfoundland and Labrador suggest the desirability of monitoring and 'social assessments' that can anticipate and address behaviour using evidence on fishers' diverse values, and contextual social and cultural factors, such as impacts of different access rules to conflict among fishing fleets, and the implications of quota reductions on Atlantic communities. Both implications point to the need for indicators, models, and decision processes that can anticipate behaviour particularly to implement integrative approaches in Canada's Fisheries Act.

If anticipation is desirable, DFO needs to more rigorously generate, communicate, and use evidence on goals and factors that shape fisher behaviour (Cove 1973). Further research can cultivate new evidence and guidance for decision-making to assess behaviour and its psychosocial motivations, and leverage behaviour and its motivations as a lens to the contextual factors that shape fisher behavioural change in Atlantic communities. For example, integrated fisheries management plans and evaluation documents referred to survey tools (e.g., annual

fishers surveys, sustainability surveys) that can be used to assess psychosocial variables and behaviour at fishing fleet and regional scales.

4.5.3. The proactive governance strategy

The proactive governance strategy involves bringing together key actor groups (i.e., governmental, non-governmental, and fishers) across Atlantic regions in new governance arrangements to coordinate, evaluate, and develop recommendations from research on fisher behaviour and the contextual factors and goals that shape behavioural change. The results pointed to a perceived trade-off by interviewees in which building new social science capacities to anticipate fisher behaviour could disrupt and distract from monitoring, planning, and decision-making in DFO's core scientific and management operations. For example, interviewees shared concerns about disrupting biophysical methods and models in order to monitor behaviour, and some interviewees suggested their present workloads related to addressing crises precluded innovating. Capacity for innovation might be found through creating a multi-stakeholder governance arrangement inclusive of cultivating and coordinating science and knowledge to better understand and anticipate fisher behaviour. For instance, future research could develop a 'roadmap' and create a 'pilot' governance arrangement that can draw from existing and past examples for guidance. In this research, for instance, one interviewee envisioned a CSAS with integrative and social science mandates

4.6. Conclusions

We discussed three strategies intended to strengthen the governability of inshore fisheries to better monitor, anticipate, and address fisher behaviour. Taking action along these strategies involves responding to growing calls for social science to be incorporated into knowledge, policy, and management, and moving into interdisciplinary and integrative research on fisher

behaviour in order advance multiple governance objectives. The three strategies and the findings upon which the strategies were based made two theoretical and practical contributions. First, insights for governance of the inshore fisheries examined opportunities and barriers to incorporate fisher behaviour and its motivations as a source of social complexity. Insights were novel because they provide described barriers and opportunities in the realities of governance to use fisher behaviour, and contextual-sensitive to strengthening science, policy, and management of change (Bennett 2019; Chuenpagdee and Jentoft 2009; Chapters Two and Three; Fulton et al. 2011). Second, an investigation of fisher behaviour in the governance of the inshore fisheries provides novel and salient opportunities to incorporate social science into governmental science and management to implement policies, and to advance multiple governance objectives. Fisher behaviour therefore provided opportunity to build and identify potential barriers and opportunities for a novel and salient systems of social science in the governance of inshore fisheries (Cove 1973; Andersen 1978; Charles 1989; Davis 2000; Pinkerton 2017; Gabau and de Jong 2018; Stephenson et al. 2019).

Chapter Five

Conclusions

5.0. Chapter summary

The goal of this chapter is to synthesize the significant and original contributions to knowledge made in this dissertation. This dissertation presented research findings in three individual empirical manuscripts (i.e., Chapters Two to Four). This final chapter begins with a review of the dissertation's purpose and objectives, and articulates the conceptual framework used to guide investigations in Chapters Two to Four. Key research findings from Chapters Two to Four are then summarized. Findings are synthesized into overall contributions to research and practice. This chapter then reviews the dissertations' research limitations and recommendations for future research, and concludes with reflections from conducting the research described in this dissertation.

5.1. Purpose, objectives, and conceptual framework

The purpose of this doctoral research was to advance a comprehensive understanding of fisher behaviour to strengthen governability of the inshore fisheries in Atlantic Canada. Chapter One introduced opportunities to develop social science insights on fisher behaviour to strengthen the governability of inshore fisheries in Atlantic Canada and coastal fisheries governability more broadly. A systematic review in Chapter Two and case study research in Chapter Three scoped and contextualized fisher behaviour and its motivations. A case study in Chapter Four used lessons and recommendations from previous chapters to propose strategies to strengthen governability of Canada's Atlantic inshore fisheries.

To guide research in Chapters Two to Four, this dissertation included three specific objectives:

1. To critically examine fisher behaviour reported in peer-reviewed scientific literature for theoretical characterizations and empirical explanations;
2. To cultivate evidence-based insights about fisher behaviour and its motivations in relation to change and uncertainty in Newfoundland and Labrador; and
3. To identify strategies to strengthen the governability of Atlantic Canada's inshore fisheries, including consideration of barriers and opportunities to incorporate fisher behaviour in science, policy, and management to advance multiple governance objectives.

This dissertation identified a core assumption that strong governability of coastal fisheries requires social science capacity to anticipate and address human behaviour through policy (Chuenpagdee and Jentoft 2009; Jentoft and Chuenpagee 2015b). As a subject of social science, information on fisher behaviour is required to meet the diverse governance objectives included in Canada's recently amended Fisheries Act (Stephenson et al. 2019). In Chapter One, this dissertation introduced a conceptual framework that guided critical examination of the relationships among fisher behaviour, context-sensitive policy, and governability.

The conceptual framework included three theoretical and empirical research opportunities. The first opportunity is that strengthening governability is likely to sustain coastal fisheries by anticipating and addressing social complexity (e.g., values, perceptions, behaviour) more effectively (Jentoft and Chuenpagdee 2015b; Johnsen et al. 2019; Jentoft 2019). The second opportunity is that the development and implementation of policies (e.g., rules about access and allocation) with knowledge about the local context (i.e., environmental, social, cultural, psychosocial, and economic conditions specific to a region) is key to strengthening governability in ways that embrace social complexity (Young et al. 2018; Steelman and Wallace

2001). The third opportunity is that fisher behaviour reflects an important focus of fisheries policies, including as a key variable to be considered in the implication of fishery policy, and a lens into the local context that can help anticipate policy effectiveness. For example, attempts to steer fisheries capacity and capitalization through licensing is unlikely to be successful without consideration of fishers' behavioural responses to those policies. Such responses involve the negotiation of environmental, economic, social, and governance factors that exist locally, and are prioritized in fishers' decision-making (Bennett 2019; Fulton et al. 2011). Arguments in the conceptual framework therefore theorized that examining fisher behaviour as a focus of policy and lens to contextual motivations can provide lessons for building context-sensitivity in policies and their implementation, and insights for strengthening governability that embraces social complexity in coastal fisheries.

5.2. Major findings

Empirical research was presented in three distinct but related manuscripts. Chapter Two presented a systematic scoping review that outlined opportunities for a more comprehensive evidence base on fisher behaviour with interdisciplinary research (Dissertation Objective 1). Chapter Three developed the evidence-base further by connecting livelihoods and emotions research to assess fisher behaviour and its motivations in response to social, environmental and policy changes, as well as uncertainty, in northern Newfoundland and Labrador (Dissertation Objective 2). Chapter Four assessed opportunities to strengthen the governability of coastal fisheries with empirical assessments of fisher behaviour in science, policy, and management (Dissertation Objective Three). Chapter Four concluded with three pathways to strengthen inshore fisheries governability in Atlantic Canada.

The systematic scoping review identified scientific characterizations and explanations of fisher behaviour. Decades of research on fisher behaviour has recognized the need for, and called for, consistent incorporation of fisher behaviour and its motivations into the governance of coastal fisheries (Hilborn 2007; Fulton et al. 2011), including for Canada's inshore fisheries (Branch et al. 2006; Cove 1973; Pitcher and Chuenpagdee 1993). Yet, systematic approaches to understand and address fisher behaviour have been limited to certain types of behaviour, and strong disagreement persists in the scientific literature about theories and evidence needed to understand motivations for fisher behaviour.

Three key insights to address and anticipate fisher behaviour were identified in Chapter Two. First, the review identified a paucity of theory and evidence in fisheries research on how different types of behaviour were connected across level, scale, and the applied settings for behaviour. Rather, research on fisher behaviour emphasized the tactical behaviours that manifested in marine environments, particularly effort, and underdeveloped strategic behaviours that manifested in coastal communities, such as entering and exiting fisheries. Second, the review highlighted the need for more nuanced explanations about fisher behaviour that drew on the diverse goals and factors that shape behaviour, and that reflected the fishers' pursuit of their livelihoods.

Much of the early research on fisher behaviour has drawn from neoclassical economic and rational choice framings. New research is needed on the role of psychosocial variables including human values that serve as goals for behaviour, and perceptions and emotions that shape experiences with environmental, social, and governance change. Third, the review argued for interdisciplinary development of conceptual and mathematical models for fisher behaviour that are sensitive to local context. Chapter Three addressed the three gaps identified in Chapter

Two with interdisciplinary research that explored and contextualized fisher behaviours, and expanded the evidence-base for explanations of fisher behaviour.

In Chapter Three, insights from the systematic review and concepts from livelihoods research and emotions research were used to examine and explain the specific behaviours of inshore fishers of the Great Northern Peninsula in Newfoundland and Labrador. Chapter Three sought to build new theoretical insights from inshore fishers' stories about their life-long experiences coping and adapting to environmental and social policy implementation and uncertainty in the governance of the inshore fisheries. Livelihoods research contributed concepts to document fisher behavioural change as livelihood pathways (de Haan and Zoomers 2005), and guidance for their application under conditions of change and uncertainty (e.g., Coulthard 2012; Nayak 2017; Weeratunga et al. 2014). Emotions research provided interdisciplinary guidance to identify and document the roles of emotions, perceptions, and human values, such as different forms of well-being, in shaping fisher behaviour (Feldman Barrett 2017; Cowen and Keltner 2017; van Kleef 2016).

Research in Chapter Three had two major findings. First, inshore fishers' behavioural changes can be understood as a function of prioritization and trade-offs among values, such as material, relational, and subjective well-beings. The influence of prioritization and trade-offs among forms of well-being resulted in unexpected outcomes for fishers, including significant financial loss, and for fisheries, including shifts in fleet capacity and capitalization. Second, results revealed the importance of emotions and perceptions in explaining inshore fisher behavioural changes, and mediating responses to other contextual factors such as changes and uncertainty related to fish stock abundance, prices for landings, and policies implemented to change access and allocations. Furthermore, Chapter Three provided insight into social

construction of emotions, perceptions, and values across individuals and groups of inshore fishers. The two major findings of this research presented a different theoretical model of fisher behaviour than is proposed by profit-seeking fishers proposed by economic and rational choice framings. Rather, the findings implicate a more nuanced understanding of rationality, and the importance of psychosocial variables for explaining behavioural change. A key outcome from Chapter Three is the potential to incorporate into governance the capacity to consider connections among fisher behaviours, and through the use of different social science theories and evidence, including novel psychosocial insights, to anticipate behaviour.

Chapter Four builds on the findings and insights of Chapter Three, and the recommendation to develop capacity to incorporate and anticipate fisher behaviour in the governance of the inshore fisheries in Atlantic Canada. An assessment was conducted of current and potential capacity in DFO to incorporate fisher behaviour in stock assessments, integrated fisheries management planning, and annual management decisions. Chapter Four connected perspectives from fisheries scientists, policy-makers, and management from DFO's Atlantic regions, perspectives from fishing community members in northern Newfoundland and Labrador, and insights from a document review. Those perspectives and insights described the barriers and opportunities to integrate fisher behaviour into governance. Research on the governance of inshore fisheries indicates limited use of social science (e.g., sociology, anthropology, human geography, social psychology) to understand fisher behaviour (Andersen 1978; Stephenson et al. 2019). Assessment of the current and potential capacities to address and anticipate fisher behaviour is needed to address demands for more diverse knowledge on behaviour to advance governance objectives detailed in Canada's amended Fisheries Act (1985).

Three major findings are outlined in Chapter Four. First, while policies address tactical and strategic behaviours, the capacities for understanding fisher behaviour are limited in stock assessments, integrated fisheries management planning, and annual management decisions taken to implement governance objectives. Second, knowledge used about fisher behaviour has been restricted to monitoring outcomes, with less emphasis on anticipating fisher behaviour by drawing on psychosocial motivations, namely fishers' diverse values, and empirical insights on social and cultural factors that fishers consider as they respond to management decisions. Third, methodological barriers (e.g., hesitancy to integrate behavioural knowledge with biophysical data, difficulty with interdisciplinary science) and organizational barriers (e.g., limited 'in-house' social science expertise in DFO, high workloads for DFO employees) constrained more comprehensive assessments, communication, and use of knowledge that can address and anticipate fisher behaviour. Inter-organizational cooperation presents opportunities for new governance arrangements to attenuate those barriers with emphasis on the generating knowledge about fisher behaviour and corresponding advice for decision-making. Those findings informed three evidence-based strategies to strengthen the coastal inshore fisheries governability with fisher behaviour that included:

1. The behavioural monitoring strategy – involves improving fisheries monitoring in Atlantic Canada, with the development of a governmental scientific and decision-making framework that describes how policies that affect or are affected by fisher behaviour are implemented. That framework can describe the generation of social science about fisher behaviour in stock assessments, the communication of fisher behavioural insights in advisory committee meetings, and use of fisher behaviour in integrated fisheries management planning and annual management decisions about fish stocks.

2. The context-sensitive anticipation strategy – involves building capacities to anticipate behavioural change by drawing from the psychosocial experiences of fishers and better understanding how fishers interpret and respond to environmental, socio-cultural, economic, and governance changes in a range of local contexts.
3. The proactive governance strategy – involves advancing cooperation among key actor groups (i.e., governmental, non-governmental, and fishers) across Atlantic regions to coordinate, evaluate, and develop recommendations from research on fisher behaviour and the contextual factors that shape behavioural change. Doing so is likely to attenuate methodological and organizational barriers that constrain the development of new interdisciplinary research frameworks and social science expertise, and to ultimately provide unique opportunities to build context-sensitivity into recommendations for management decisions. A more proactive governance arrangement can therefore be oriented toward anticipating, through a behavioural lens, the influence of social complexity in the inshore fisheries on decisions taken to implement conservation, social, cultural, economic, and institutional objectives.

5.3. Academic contributions to theory and practice

This research contributed theory and practical recommendations to address research gaps identified through the conceptual framework. Five related research gaps are identified. First, theoretical and empirical research is needed to clarify the multiple types of fisher behaviour and relationships among them at different levels and scales for more realistic conceptual and empirical (Beitl 2014). Second, the research on behavioural motivations requires new knowledge about theoretical models of behaviour beyond conventional neoclassical economic and rational choice framings (Chuenpagdee and Jentoft 2009). Third, research requires critical examination

of a tendency in coastal fisheries governance to study and address fisher behaviour as homogenous. Capacities to generate, communicate, and use rigorous knowledge about diversity of fisher behaviour and its motivations is required for effective management decisions (Fulton et al. 2011). Fourth, current theory and practice points to limited guidance to understand and use the local context to improve fisheries policy development and implementation (Young et al. 2018). Last, further guidance is needed to course-correct present coastal fisheries' governance that emphasizes efficiency over social complexity with approaches such as rationalization, maximum sustainable yield, and centralized governance structures (Finley 2011; Pinkerton 2017; Needler 1979). Contributions to these gaps are discussed in turn.

Clarifying fisher behaviour

The first major contribution of this research is to help clarify the meaning of 'fisher behaviour' amidst rapid change. Chapter Two contributed a novel typology organized by tactical and strategic categories that were further contextualized in Chapter Three. Chapter Three expanded on relationships among fisher behaviours with evidence that fishers expressed those behaviours to cope and adapt to change and uncertainty. While Chapter Two scoped the different behavioural variables, Chapter Three provided case specific evidence for how behaviours were connected in the experiences of inshore fishers. The clarity brought by Chapters Two and Three on fisher behaviour contributes significant new evidence and opportunities to develop theory and augment the limited research on the relationships among tactical and strategic behaviours, as they are expressed from fishers' perspectives (e.g., Bietl 2014; Boonstra and Hahn 2017). Moreover, clarifications to fisher behaviour have practical significance. A typology of behaviour and an understanding of how they may be expressed by fishers allows for a novel assessment of behaviour in fisheries science, policy, and management as demonstrated in Chapter Four.

New knowledge on behavioural motivations

The second major contribution reflected the various insights on the motivations for fisher behaviour. Findings from Chapter Two demonstrated a significant research gap related to the reliance on neoclassical economic and rational choice theory, often applied without empirical evidence that they are appropriate. The empirical identification of this gap was significant and original because the gap applied to the entire research area on fisher behaviour, whereas previous criticisms have been associated with empirical research on one or two behaviours (e.g., van Putten et al. 2012) or synthetic research more broadly (Chuenpagdee and Jentoft 2009; Fulton et al. 2011). Chapter Three provided significant insights into alternatives for neoclassical economic and rational choice theoretical assumptions. Using a novel interdisciplinary framework that connected livelihoods and emotions, Chapter Three contributes evidence of fishers' behavioural change related to multiple values, including material well-being, to a growing body of evidence on the importance of human values to fisher behaviour (Britton and Coulthard 2013; Coulthard 2012; Song et al. 2013). Furthermore, evidence about the rational pursuit of values, including positive emotional experiences in fishing, sheds new interdisciplinary light on the diverse ways that fishers advance, enjoy, and protect their livelihoods (Coulthard 2012; see Lerner and Lowenstein 2008).

This dissertation also provides a comprehensive perspective on the factors that may influence behaviour. Contributions from Chapter Two included the empirical identification of a range of contextual factors that may influence fisher behaviour. Furthermore, Chapter Two identified a literature gap that indicates the relationships among psychosocial, socio-cultural, and governance factors require empirical and theoretical development. Chapter Three includes novel

evidence of the role of emotions, perceptions, and values, to understand and anticipate fisher behaviour change.

Findings pointed to emotions as a crucial variable to explain fisher behaviour. To the author's knowledge this research is only the second study of emotions in fisheries (Bender 2002), and the first to identify emotions as a motivational factor and goal for fisher behaviour. Findings from Chapters Two and Three also have practical significance. Applying psychosocial factors and goals to a governance assessment in Chapter Four led to recommendations for new conceptual models of inshore fisher behaviour in science, policy, and management as recommended by previous research (Larrosa et al. 2016; Sogn-Grundvåg and Henriksen 2014).

Heterogeneity in fisher behaviour

The third contribution involves original and empirical findings about the ways fisher behaviour is heterogeneous, and highlights opportunities to accommodate that heterogeneity into science, policy, and management. Empirical knowledge to date is limited to sources of heterogeneity such as competing values and diverse experiences with behaviour (Chuenpagdee and Jentoft 2009; Jentoft and Cheunpagdee 2009; Mahon et al. 2008). Chapter Two indicates that combinations of values, motivational factors, and different tactical and strategic behavioural choices manifest as heterogeneity in fisher behaviour. Chapter Three demonstrates how forms of well-being are key opportunities to categorize heterogeneous fisher behaviours and to anticipate different outcomes for fishers. For example, Chapter Three revealed outcomes that largely reflect 'boom or bust' for inshore fishers that largely pursue material well-being. For fishers that primarily pursue relational well-being, behavioural outcomes led to enterprises that were smaller in capacity with limited capitalization. These findings have practical significance for coastal fisheries governance that uses the individualized allocation policies, such as individual transferrable quotas, or

individual quotas in Atlantic Canada. For example, findings from Chapter Four identify opportunities to better generate and use knowledge on the heterogeneity of fisher behaviour to support the implementation of individual allocation policies.

Context sensitivity in policies

This research provides guidance on how to define, understand, and use fisher behaviour as a focus of policy, including how policy shapes fisher behaviour and is affected by fisher behavioural change, and a lens to local context. Previous research had identified fisher behaviour as an underexamined focus of fisheries policies (e.g., Branch et al. 2006; Hilborn 2007; Fulton et al. 2011; Shepperson et al. 2016). Other research has highlighted the importance of developing and implementing fisheries policies that account for local context, and indicated various environmental, socio-cultural, economic, and political factors that form a context (Steelman and Wallace 2001; Berkes et al. 2011; Castillo et al. 2011; Young et al. 2018). By connecting those insights, this dissertation provides two significant and original empirical contributions to theory development on the relationships among fisher behaviour, policy, and context-sensitivity. First, Chapters Two to Four demonstrate that fisher behaviour is a crucial, but underexamined focus of fisheries policy. Examples include scoping connections and insights on the relationship between fisheries policies to fisher behaviour (Chapter Two), providing empirical evidence on behavioural responses to perceptions of policy change (Chapter Three), and revealing opportunities for clarity on the behavioural relevance in fisheries policy (Chapter Four). Second, this research contributed insights for fisher behaviour as a lens to context-sensitivity that can be incorporated to improve the effectiveness of management decisions. Through the original application of emotions research to fisher behaviour, Chapter Three showed that psychosocial variables are indispensable factors to explain fisher behavioural change. Moreover, psychosocial

variables interact with other contextual variables including environmental, socio-cultural, economic, and governance factors. As such, findings from Chapter Three contribute insights that articulate how fishers prioritize contextual factors through perceptual and emotional experiences that shape their behaviour.

Governability that embraces social complexity

The central and final contribution of this dissertation is that fisher behaviour is a multi-faceted source of social complexity crucial to advance governance objectives. Evidence about the explanations for fisher behaviour can provide a lens into the key contextual factors that shape effectiveness of policy used to implement those objectives. Fisheries research highlighted that policies and management decisions made to strengthen governability can adversely affect sustainability when those policies and management decisions were designed to promote efficiency (Song et al. 2018; Johnsen 2017). This dissertation's criticisms of governability for efficiency were situated in decades of political ecology and policy sciences research. That research pointed to adverse effects of efficiency-driven governance to natural resource communities (Agrawal 2005; Brunner et al. 2005; Lynch and Brunner 2010; Scott 1998). This dissertation revealed that fisher behaviour can be an entry point to develop governance arrangements that embrace social complexity and therefore, course-correct the long-standing efforts by the Canadian governments to promote the efficiency of governing inshore fisheries (Finley 2011; Pinkerton 2017; Needler 1979). This dissertation provided key strategies to leverage insights on fisher behaviour, and to advance socio-cultural, economic, institutional, and conservation objectives in ways that respond to the social complexity in the inshore fisheries.

5.4. Study limitations and future research

This section reviews this dissertation's research limitations and highlights opportunities for future research. Chapters Two to Four had specific objectives, theoretical grounding, methods, results, and limitations. Those limitations and relevant opportunities to address the limitations in future research are summarized in Table 1. Overall limitations associated with the dissertation's research design are further described below.

Table 5.1: Individual research limitations and opportunities for future research

Ch.	Limitations	Opportunities for future research
2	Peer-reviewed publications sample that may not have included research relevant to understanding and governing fisher behaviour	Case-study research that further scopes and contextualize fisher behaviours, proxies for behaviour (e.g., strategies, decisions), and their applications in governance
2	Bias in selection of sample and interpretation of results	Systematic review research that is repeated in five years to evaluate progress in characterizing and explaining fisher behaviour with emphasis on intercoder reliability
3	The potential influence of seasonality on recruitment of inshore fisheries	Methodological research that delves into the challenges and opportunities of engaging fishers in multispecies fisheries settings
3	The potential influence of community-specific dynamics on the fisher behaviour in regional fishing fleets	Cross-case comparison research that applies the typology of fisher behaviour and contextual factors across different coastal communities in the same region
3	Limited representation of women fishers in research	Gendered analysis on fisher behaviour and the influence of norms related to masculinity and femininity on fisher behaviour
3	Limited specificity on environmental, economic, and social contextual conditions that serve factors for behaviour	Quantitative research that connects behavioural change, psychosocial variables, and specific trends that fishers perceive to influence their behaviour.
4	Limited involvement of governmental and non-governmental organizations, and fishers in governability research in Canada	Collaborative research that brings together different actors to assess fisher behaviour in governance

This dissertation's research design had four major limitations. First, this dissertation emphasized fisher behaviour as a focus of policies and science, policy, and management that address and anticipated fisher behaviour as important to strengthen governance. Other behaviours are relevant to governability, such as the influence of fishing family members, industry leaders, community leaders, and managers on the effectiveness of interventions and can shape their development (Ram-Bidesi 2015; van Putten et al. 2013). For example, family members can influence fisher behaviour and through political action, and industry, community leaders, and managers can stall or block potentially beneficial interventions (Ommer et al. 2012; Perry et al. 2011). Second, this research assessed a core but limited suite of psychosocial variables to evaluate inshore behavioural change. Other research suggests the importance of beliefs, mental models, and attitudes to explain human behavioural change (Gifford 2014). Furthermore, this research did not develop socio-cultural factors that are also important in explaining fisher behaviour and its psychosocial motivations (see Feldman Barrett 2017), including social norms (Lade et al. 2015), technological practices (Lorenzi and Chuenpagdee 2020), gender (Harper et al. 2020) and social relations of power (Sogn-Grundvåg and Henricksen 2014). Third, this research focused on social science about fisher behaviour, and commented on limited capacity of advisory committees to generate social science. Moreover, this research posited social science and collaboration as distinct alternatives to strengthening governability. This research did not examine opportunities for collaborative mechanisms to generate social science. Examples exist through participatory research approaches that can be repurposed for use in governance (e.g., Teh et al. 2012; Wise et al. 2014). Fourth, this dissertation focused on opportunities to strengthen governability and only briefly commented on the promotion of efficiency as a source of weak governability. Analysis of those sources for the inshore fisheries in Atlantic Canada is likely to

have taken this dissertation into deeper questions of governmental and societal roles in manifesting inequity and neoliberalism in coastal fisheries (Johnsen 2017; Pinkerton 2017).

This chapter recommends three major opportunities for future research. First, new research can better understand human behaviour and governability by 'scaling up' the typology of fisher behaviour (Chapter Two) and building new knowledge of how perceptions and experiences of contextual factors that shape behaviour are shared, communicated, and negotiated across individuals, groups, and coastal communities (Chapter Three). A scaled-up analysis of human behaviour in fisheries is likely to involve the behaviour of other key actors as, for example, fishing families, processors, community members and leaders, and managers. Second, findings in this dissertation point to the need for a theory of fisher behaviour that is robust to a variety of different coastal fishery contexts. A theory of fisher behaviour can draw from insights in this dissertation, and case studies around the world, to articulate the parameters, variables, and research processes important to derive context-sensitivity in conceptual and mathematical models, fisheries policies, and research on fisher behaviour. Last, critical research is needed to strengthen the governability of the inshore fisheries in Atlantic Canada by further developing and implementing the strategies recommended in Chapter Four. Importantly, this research can be useful if it emphasizes the co-creation, piloting, and evaluation of a novel governance arrangement to coordinate and evaluate applied research to better address and anticipate fisher behaviour.

5.5. Reflections

My doctoral research journey began with very little academic and personal knowledge about fisheries, fisher behaviour, and the motivations for fisher behaviour discussed in this dissertation. Climbing of several steep learning curves was made possible because of three aspects of

graduate studies in the School of Environment, Resources, and Sustainability (SERS). First, the school encourages transdisciplinary approaches to sustainability problems. My doctoral journey was transdisciplinary, although the concept was not referred to explicitly in this dissertation. Following a definition from Nicolescu (2010), my research journey involved *seeking different perspectives, disciplines, and knowledge types* from colleagues, committee members, scholars from different academic communities, fisheries researchers in Newfoundland and Labrador, local mayors on the Great Northern Peninsula, fishers, and fishing families, historians in coastal communities, and federal government representatives. I worked on *transforming insights from these perspectives, disciplines, and knowledges* by reading broadly, reflecting constantly, and experimenting with different ways to write and talk across knowledge boundaries. The iterative processes of collecting, combining, and experimenting ultimately led to a dissertation that involved *changing the lens used to view problems* in fisheries research, *and changing how I viewed my own capacities* to advance solutions.

Second, my personal and professional emphasis on problem-based and solutions-oriented research was cultivated in SERS. My dissertation wove together twin imperatives of theoretical and practical outcomes, and trying to balance those imperatives was tricky. Learning how to properly speak and write about this balance remains an ongoing process that was accelerated because in my doctoral studies. Countless opportunities were provided to me in SERS to practice speaking and writing at the intersection of theory and practice. Opportunities that were particularly formative for me were made possible with meetings with colleagues in the Environmental Change and Governance Group, funding support from my supervisor and department to go to conferences, and the simple readiness of administrators to reserve space for

me to go practice presenting in meeting rooms. The importance of colleagues, faculty, committee members, and administrators takes me to my final reflection.

Third, a great quality of SERS is its people, and I was lucky enough to work with the best. Supportive supervisors, committee members, faculty, and administrators constituted a broad mentorship network for me that was critical for this research (see Andrews and Harper et al. 2020). In addition to the direct influence these people had on my doctoral studies, they also acknowledged and supported my pursuit of other goals. Never once did I feel unsupported or discouraged by people in SERS. This steadfast support continued during extraordinary times in the world, notably the COVID-19 pandemic and the spectre of death or illness for my family, friends, and myself. It was not the easiest time for someone to finish a dissertation, but it became opportune because of unprecedented 11th hour supports from my supervisor and advisory committee that gave me comfort and mental space to think and write. Expressing gratitude for a transdisciplinary process, mentorship networks, and 11th hour supports is not just fodder for acknowledgements. Rather, these aspects were mission-critical (see Pardo et al. 2020) for my efforts using diverse areas of scholarship to produce findings that were novel, and useful (or at least interesting) for fisheries researchers and scientists, policy-makers, and managers in the governance of the inshore fisheries in Atlantic Canada.

References

Abbot, J.K., & Haynie, A.C. 2012. What are we protecting? Fish harvester behavior and the unintended consequences of spatial closures as a management tool. *Ecological Applications*, 22(3), 762-777.

Adger, W. N. 2000. Social and ecological resilience: Are they related? *Progress in Human Geography*, *24*(3), 347–364.

Agrawal, A. 2005. *Environmentality: technologies of government and the making of subjects*. Durham: Duke University.

Allison, E. H., & Ellis, F. 2001. The livelihoods approach and management of small-scale fisheries. *Marine Policy*, *25*(5), 377–388.

Allison, E. H., & Horemans, B. 2006. Putting the principles of the Sustainable Livelihoods Approach into fisheries development policy and practice. *Marine Policy*, *30*(6), 757–766.

Anderies, J. M. 2015. Understanding the dynamics of sustainable social-ecological systems: human behavior, institutions, and regulatory feedback networks. *Bulletin of Mathematical Biology*, *77*(2), 259–280.

Andersen, R. 1978. The need for human sciences research in Atlantic Coast Fisheries. *Journal of the Fisheries Research Board of Canada*, *35*(7), 1031–1049.

Andersen, B. S., Ulrich, C., Eigaard, O. R., & Christensen, A.-S. 2012. Short-term choice behaviour in a mixed fishery: Investigating metier selection in the Danish gillnet fishery. *ICES Journal of Marine Science*, *69*(1), 131–143.

Andrews, E. J., & Harper, S., Cashion, T., Palacios-Abrantes, J., Blythe, J., Daly, J., Eger, S., Hoover, C., Talloni-Alvarez, N., Teh, L., Bennett, N., Epstein, G., Knott, C., Newell, S. L., & Whitney, C. K. 2020. Supporting early career researchers: Insights from interdisciplinary marine scientists. *ICES Journal of Marine Science*, *77*(2), 476–485.

Arbo, P., Knol-Kauffman, M., Linke, S., & St. Martin, K. 2018. The transformation of the oceans and the future of marine social science. *Maritime Studies* 17(3): 295–304.

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology* 8(1): 19-32.

Armitage, D. 2007. Governance and the commons in a multi-level world. *International Journal of the Commons* 2(1): 7-32.

Armitage, D., de Loë, R., & Plummer, R. 2012. Environmental governance and its implications for conservation practice. *Conservation Letters* 5:245-255.

Armitage, D. R., Okamoto, D. K., Silver, J. J., Francis, T. B., Levin, P. S., Punt, A. E., Davies, I. P., Cleary, J. S., Dressel, S. C., Jones, R. R., Kitka, H., Lee, L. C., MacCall, A. D., McIsaac, J. A., Poe, M. R., Reifenstuhl, S., Shelton, A. O., Schmidt, J. O., Thornton, T. F., … Woodruff, J. 2019. Integrating governance and quantitative evaluation of resource management strategies to improve social and ecological outcomes. *BioScience*, *69*(7), 523–532.

Ascher, W. 2017. Keeping the faith: policy sciences as gatekeeper. *Policy Sciences* 50(2): 157-162.

Ascher, W., Steelman, T., & Healy, R.G. 2010. *Knowledge and Environmental Policy: Re-Imagining the Boundaries of Science and Politics.* Cambridge: MIT Press.

Auer, M. 2017. Rescuing the decision process. *Policy Sciences* 50(4): 519-526.

Bailey, M., Favaro, B., Otto, S.P, Charles, A., Devillers, R., Metaxas, A., Tyedmers, P., Ban, N.C., Mason, T., Hoover, C., Duck, T.J., Fanning, L., Milley, C., Cisneros-Montemayor, A.M., Pauly, D., Cheung, W.W.L., Cullis-Suzuki, S., Teh, L., & Sumaila, U.R. Canada at a crossroad: the imperative for realigning ocean policy with ocean science. *Marine Policy* 63: 53-60.

Barclay, K., Voyer, M., Mazur, N., Payne, A. M., Mauli, S., Kinch, J., Fabinyi, M., & Smith, G. 2017. The importance of qualitative social research for effective fisheries management. *Fisheries Research*, *186*, 426–438.

Bavinck, M., & Kooiman, J. 2005. The governance perspective. In J. Kooiman, S. Jentoft, R. Pullin, & M. Bavinck (Eds.), *Fish for Life* (pp. 11–24). Amsterdam University Press.

Bavington, D. 2010. *Managed annihilation: an unnatural history of the Newfoundland cod collapse*. Vancouver: University of British Columbia.

Bebbington, A. 1999. Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. *World Development*, *27*(12), 2021–2044.

Bechara, A. 2004. The role of emotion in decision-making: evidence from neurological patients with orbitofrontal damage. *Brian and Cognition*, 55, 30-40.

Beitl, C. M. 2014. Navigating over space and time: fishing effort allocation and the development of customary norms in an open-access mangrove estuary in Ecuador. *Human Ecology*, *42*(3), 395–411.

Beitl, C. 2015. Mobility in the mangroves: catch rates, daily decisions, and dynamics of artisanal fishing in a coastal commons. *Applied Geography*, 59, 98-106.

Bender, A. 2002. Environmental Models, Cultural Values, and Emotions: Implications for Marine Use in Tonga. *International Research in Geographical and Environmental Education* 11(1): 58-62.

Béné, C., & Tewfik, A. 2001. Fishing effort allocation and fishermen's decision making process in a multi-species small-scale fishery: analysis of the conch and lobster fishery in Turks and Caicos Islands. *Human Ecology* 29(2): 157-186.

Béné, C., Frankenberger, T., Griffin, T., Langworthy, M., Mueller, M., & Martin, S. 2019. 'Perception matters': new insights into the subjective dimension of resilience in the context of humanitarian and food security crises. *Progress in Development Studies* 19(3): 196-210.

Bennett, N.J. 2019. Marine social science for the peopled seas. Coastal Management, 47(2): 244–252.

Bennett, N. J., Govan, H., & Satterfield, T. 2015. Ocean grabbing. *Marine Policy*, *57*, 61–68.

Benson, A. J., & Stephenson, R. L. 2018. Options for integrating ecological, economic, and social objectives in evaluation and management of fisheries. *Fish and Fisheries*, *19*(1), 40–56.

Bergseth, B.J., Russ, G.R., & Cinner, J.E. 2015. Measuring and monitoring compliance in no-take marine reserves. *Fish and Fisheries* 16: 240-258.

Berkes, F. (Ed.). 2001. *Managing small-scale fisheries: Alternative directions and methods*. Ottawa: International Development Research Centre.

Bieg, C., McCann, K. S., & Fryxell, J. M. 2017. The dynamical implications of human behaviour on a social-ecological harvesting model. *Theoretical Ecology*, *10*(3), 341–354.

Biermann, F., Betsill, M.M, Gupta, J., Kanie, N., Lebel, L., Liverman, D., Schroeder, H., Siebenhüner, B., & Zondervan, R. 2010. Earth system governance: a research framework. *International Environmental Agreements* 10: 277-298.

Blythe, J., Flaherty, M., & Murray, G. 2015. Vulnerability of coastal livelihoods to shrimp farming: insights from Mozambique. *AMBIO* 44(4): 275-284.

Blythe, J., Armitage, D., Alonso, G., Campbell, D., Esteves Dias, A.C., Epstein, G, Marschke, M., & Nayak, P. 2020. Frontiers in coastal well-being and ecosystem services research: a systematic review. *Ocean & Coastal Management:* 105028.

Bodiguel, C. 2002. Fishermen facing the commercial lobster fishery licensing policy in the Canadian Maritime Provinces: Origins of illegal strategies, 1960–2000. *Marine Policy*, *26*(4), 271–281.

Boonstra, W. J., & Hanh, T. T. H. 2015. Adaptation to climate change as social–ecological trap: A case study of fishing and aquaculture in the Tam Giang Lagoon, Vietnam. *Environment, Development and Sustainability*, *17*(6), 1527–1544.

Boonstra, W. J., Birnbaum, S., & Björkvik, E. 2017. The quality of compliance: Investigating fishers' responses towards regulation and authorities. *Fish and Fisheries*, *18*(4), 682–697.

Bowen, G. A. 2009. Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27–40.

Branch, T.A., Hilborn, R., Haynie, A.C., Fay, G., Flynn, L., Griffiths, J., Marshall, K.N, Randall, J.K., Scheuerell, J.M., Ward, E.J., & Young, M. 2006. Fleet dynamics and fishermen behavior: lessons for fisheries managers. *Canadian Journal of Fisheries and Aquatic Sciences* 63(7): 1647-1668.

Brandes, U., Freeman, L.C., & Wagner, D. 2014. Social networks. In R. Tamassia (Ed.), *Handbook of graph drawing visualization* (pp. 806-837). CRC Press.

Breitburg, D., Levin, L.A., Oschlies, A., Grégoire, M., Chavez, F.P., Conley, D.J., Garçon, V., *et al.* 2018. Declining oxygen in the global ocean and coastal waters. *Science,* 359(6371): eaam7240.

Bremer, S., & Glavovic, B. 2013. Mobilizing knowledge for coastal governance: re-framing the science–policy interface for integrated coastal management. *Coastal Management*, *41*(1), 39–56.

Brewer et al. 2005. *Decision-making of the environment: Social and behavioural science research priorities.* National Research Council.

Brewer, G. D. 2007. Inventing the future: Scenarios, imagination, mastery and control. *Sustainability Science*, *2*(2), 159–177.

Britton, E., & Coulthard, S. (2013). Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Marine Policy*, *37*, 28–36. doi.org/10.1016/j.marpol.2012.04.011.

Brown, A. 2013. Critical realism in social research: approach with caution. *Work, Employment and Society* 28(1): 112-123.

Brueckner-Irwin, I., Armitage, D., & Courtney, S. 2019. Applying a social-ecological well-being approach to enhance opportunities for marine protected area governance. *Ecology and Society* 24(3): 7.

Brunner, R.D. 2010. Adaptive governance as a reform strategy. *Policy Sciences* 43(4): 301-341.

Brunner, R.D., and Ascher, W. 1992. Science and social responsibility. *Policy Sciences* 25: 295-331.

Brunner, R.D., & Lynch, A.H. 2010. Adaptive governance and climate change. Chicago: University of Chicago.

Brunner, R. D., Steelman, T. A., Coe-Juell, L., Cromley, C. M, Edwards, C. M., & Tucker, D. W. 2005. *Adaptive Governance: Integrating Science, Policy, and Decision Making.* New York: Columbia University Press.

Cabral, R. B., Gaines, S. D., Johnson, B. A., Bell, T. W., & White, C. 2017. Drivers of redistribution of fishing and non-fishing effort after the implementation of a marine protected area network. *Ecological Applications*, *27*(2), 416–428.

Carpenter, S. R., Armbrust, E. V., Arzberger, P. W., Chapin, F. S., Elser, J. J., Hackett, E. J., Ives, A. R., Kareiva, P. M., Leibold, M. A., Lundberg, P., Mangel, M., Merchant, N., Murdoch, W. W., Palmer, M. A., Peters, D. P. C., Pickett, S. T. A., Smith, K. K., Wall, D. H., & Zimmerman, A. S. 2009. Accelerate synthesis in ecology and environmental sciences. *BioScience*, *59*(8), 699–701.

Carr, L. M., & Heyman, W. D. 2014. Using a coupled behavior-economic model to reduce uncertainty and assess fishery management in a data-limited, small-scale fishery. *Ecological Economics*, *102*, 94–104.

Castillo, D., Bousquet, F., Janssen, M. A., Worrapimphong, K., & Cardenas, J. C. 2011. Context matters to explain field experiments: Results from Colombian and Thai fishing villages. *Ecological Economics*, *70*(9), 1609–1620.

Catchpole, T. L., Enever, R., Maxwell, D. L., Armstrong, M. J., Reese, A., & Revill, A. S. 2011. Constructing indices to detect temporal trends in discarding. *Fisheries Research*, *107*(1–3), 94–99.

Chaffin, B. C., Garmestani, A. S., Gunderson, L. H., Benson, M. H., Angeler, D. G., Arnold, C. A. (Tony), Cosens, B., Craig, R. K., Ruhl, J. B., & Allen, C. R. 2016. Transformative environmental governance. *Annual Review of Environment and Resources*, *41*(1), 399–423.

Chambers, C., & Kokorsch, M. 2017. Viewpoint: The social dimension in Icelandic fisheries governance. *Coastal Management*, *45*(4), 330–337.

Charles, A. T. 1989. Bio-socio-economic fishery models: labour dynamics and multi-objective management. *Canadian Journal of Fisheries and Aquatic Sciences*, *46*(8), 1313–1322.

Charles, A. T. 1998. Living with uncertainty in fisheries: Analytical methods, management priorities and the Canadian groundfishery experience. *Fisheries Research*, 14

Charles, A. 2001. *Sustainable Fishery Systems*. Wiley-Blackwell: Oxford.

Charles, A. 2012. People, oceans and scale: Governance, livelihoods and climate change adaptation in marine social–ecological systems. *Current Opinion in Environmental Sustainability*, *4*(3), 351–357.

Charles, A. 2013. Governance of tenure in small-scale fisheries: key considerations. *Land Tenure Journal* 1:9-37.

Charles, A. 2014. Human dimensions in marine ecosystem-based management (pp.57-75). In Fogarty, M.J. & McCarthy, J.J. (Eds.), *The Sea*. Harvard University Press.

Chase, S. 2003. Closing the North American mixed-stock commercial fishery for wild atlantic salmon. In D. Mills (Ed.), *Salmon at the Edge* (pp. 84–92). Blackwell Science Ltd.

Cheung, W. W. L., Watson, R., & Pauly, D. 2013. Signature of ocean warming in global fisheries catch. *Nature*, *497*(7449), 365–368.

Chollett, I., Canty, S. W. J., Box, S. J., & Mumby, P. J. 2014. Adapting to the impacts of global change on an artisanal coral reef fishery. *Ecological Economics*, *102*, 118–125.

Chorus, C. G. 2014. A generalized random regret minimization model. *Transportation Research Part B: Methodological*, *68*, 224–238.

Christou, M., Haralabous, J., Stergiou, K. I., Damalas, D., & Maravelias, C. D. 2017. An evaluation of socioeconomic factors that influence fishers' discard behaviour in the Greek bottom trawl fishery. *Fisheries Research*, *195*, 105–115.

Chuenpagdee, R., & Jentoft, S. 2009. Governability assessment for fisheries and coastal systems: a reality check. *Human Ecology*, 37(1): 109-120.

Chuenpagdee, R., & Song, A.M. 2012. Institutional thinking in fisheries governance: broadening perspectives. *Current Opinion in Environmental Sustainability*, 4, 309-315.

Christiansen-Ruffman, L. 2002. Atlantic Canadian coastal communities and the fisheries trade: a feminist critique, revaluation and revisioning. *Canadian Woman Studies* 21(4): 56-63.

Christie, P. 2011. Creating space for interdisciplinary marine and coastal research: five dilemmas and suggested resolutions. *Environmental Conservation* 38(2): 172–186.

Cinner, J. E., & Bodin, Ö. 2010. Livelihood Diversification in Tropical Coastal Communities: A Network-Based Approach to Analyzing 'Livelihood Landscapes.' *PLoS ONE*, *5*(8), e11999.

Clandinin, D.J. 2006. *Handbook of Narrative Inquiry: Mapping a Methodology*. Thousand Oaks: Sage.

Clark, S.G. 2012. *A policy process: a practical guide for natural resource managers*. New Haven: Yale University.

Clark, S. G., & Wallace, R. L. 2015. Integration and interdisciplinarity: Concepts, frameworks, and education. *Policy Sciences*, *48*(2), 233–255.

Cohen, J.D. 2005. The vulcanization of the human brain: a neutral perspective on interactions between cognition and emotion. *Journal of Economic Perspectives* 19(4): 3-24.

Cohen-Chen, S., Halperin, E., Porat, R., & Bar-Tal, D. 2014. The differential effects of hope and fear on information processing in intractable conflict. *Journal of Social and Political Psychology*, *2*(1), 11–30.

Condie, H. M., Grant, A., & Catchpole, T. L. 2013. Does banning discards in an otter trawler fishery create incentives for more selective fishing? *Fisheries Research*, *148*, 137–146.

Coulthard, S. 2012. Can we be both resilient and well, and what choices do people have? incorporating agency into the resilience debate from a fisheries perspective. *Ecology and Society*, *17*(1): online.

Coulthard, S., Johnson, D., & McGregor, A. 2011. Poverty, sustainability, and human wellbeing: a social well-being approach to the global fisheries crisis. *Global Environmental Change* 21:453-463.

Coscia, M., & Neffke, F. 2017. Network backboning with noisy data. *ArXiv:1701.07336 [Physics]*.

Cove, J.J. 1973. Hunters, trappers, and gatherers of the sea: a comparative study of fishing strategies. *Journal of the Fisheries Research Board of Canada* 30: 249-259.

Danermark, B., Ekström, M., Jakobsen, L., & Karlsson, J.C. 2002. Critical realism in the social sciences. New York: Routledge.

Davis, R. 2014. A Cod Forsaken Place?: Fishing in an Altered State in Newfoundland. *Anthropological Quarterly*, *87*(3), 695–726.

Davis, A., & Wagner, J. 2006. A right to fish for a living? The case for coastal fishing people's determination of access and participation. *Ocean & Coastal Management*, *49*(7–8), 476–497.

Daw, T.M., Cinner, J.C., Mcclanahan, T.R., Brown, K., Stead, S.M., Graham, N.A.J., & Maina, J. 2012. To fish or not to fish: factors at multiple scales affecting artisanal fishers' readiness to exit a declining fishery. *PLoS One*, 7(2): e31460.

Deepananda, K. H. M. A., Amarasinghe, U. S., & Jayasinghe-Mudalige, U. K. 2016. Neither bust nor boom: Institutional robustness in the beach seine fishery of southern Sri Lanka. *Ocean & Coastal Management*, *128*, 61–73.

De Haan, L., & Zoomers, A. 2003. Development geography at the crossroads of livelihood and globalisation. *Tijdschrift Voor Economische En Sociale Geografie*, *94*(3), 350–362.

De Haan, L., & Zoomers, A. 2005. Exploring the Frontier of Livelihoods Research. *Development and Change*, *36*(1), 27–47.

Delaney, A., & Hastie, J.E., 2007. Lost in translation: differences in role identities between fisheries scientists and managers. *Ocean & Coastal Management* 50, 661-681.

Diduck, A., Reed, M., & George, C. 2015. Participatory approaches to resource and environmental management. In B. Mitchell (Ed.), *Resource and Environmental Management in Canada: Addressing Conflict and Uncertainty* (5th Ed.) (Pp. 142-170). Toronto: Routledge.

Dietz, T., Ostrom, E., & Stern, P.C. 2003. The struggle to govern the commons. *Science* 302: 1902-1912.

Ellis, F. 2000. The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics*, *51*(2), 289–302.

Eliasen, Søren Q., Papadopoulou, K.-N., Vassilopoulou, V., & Catchpole, T. L. 2014. Socio-economic and institutional incentives influencing fishers' behaviour in relation to fishing practices and discard. *ICES Journal of Marine Science*, *71*(5), 1298–1307.

Emery, T.J., Green, B.S., Gardner, C., & Tisdell, J. 2012. Are input controls required in individual transferable quota fisheries to address ecosystem based fisheries management objectives? *Marine Policy*, 36, 122-131.

Edmonds, B., Le Page, C., Bithell, M., Chattoe-Brown, E., Grimm, V., Meyer, R., Montañola-Sales, C., Ormerod, P., Root, H., & Squazzoni, F. 2019. Different modelling purposes. *Journal of Artificial Societies and Social Simulation*, *22*(3).

Epstein, J. M. 2008. Why model? *Journal of Artificial Societies and Social Simulation*, 11 (4), 12.

Epstein, G., Morrison, T. H., Lien, A., Gurney, G. G., Cole, D. H., Delaroche, M., Villamayor Tomas, S., Ban, N., & Cox, M. (2020). Advances in understanding the evolution of institutions in complex social-ecological systems. *Current Opinion in Environmental Sustainability*, *44*, 58–66.

Essington, T. E., Ciannelli, L., Heppell, S. S., Levin, P. S., McClanahan, T. R., Micheli, F., Plagányi, É. E., & van Putten, I. E. 2017. Empiricism and modeling for marine fisheries: advancing an interdisciplinary science. *Ecosystems*, *20*(2), 237–244.

Etikan, I. 2016. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1.

Farmer, T., Robinson, K., Elliott, S. J., & Eyles, J. (2006). Developing and implementing a triangulation protocol for qualitative health research. *Qualitative Health Research*, *16*(3), 377–394.

Feldman Barrett, L., Mesquita, B., Ochsner, K.N., & Gross, J.J. 2007. The Experience of emotion. *Annual Reviews of Psychology* 58: 373-403.

Feldman Barrett, L. 2017a. The theory of constructed emotion: An active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, nsw154.

Feldman Barrett, L. 2017b. *How emotions are made*. Boston: Mariner Books.

Fischer, J., Dyball, R., Fazey, J., Gross, C., Dovers, S., Erlich, P.R., Brulle, R.J., Christensen, C., & Borden, R. 2012. Human behavior and sustainability. *Frontiers in Ecology and the Environment*, 10(3), 153-160.

Finfgeld-Connett, D. 2014. Use of content analysis to conduct knowledge-building and theory-generating qualitative systematic reviews. *Qualitative Research* 14(3): 341-352.

Fisheries and Oceans, Canada [DFO]. 1996. *Commercial Fisheries Licensing Policy for Eastern Canada* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/licences-permis/index-eng.htm

Fisheries Act, RSC 1985, c F-14

Fisheries and Oceans, Canada [DFO]. 2009a. *A fishery decision-making framework for incorporating the precautionary approach* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm

Fisheries and Oceans, Canada [DFO]. 2009b. *Policy for managing the impacts of fishing on sensitive benthic areas* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/benthi-eng.htm

Fisheries and Oceans, Canada [DFO]. 2010a. Policy for preserving the independence of the inshore fleet in Canada's Atlantic fisheries. Retrieved from https://www.dfo-mpo.gc.ca/reports-rapports/regs/piifcaf-policy-politique-pifpcca-eng.htm

Fisheries and Oceans, Canada [DFO]. 2010b. DFO regions map [Online]. Retrieved from https://www.dfo-mpo.gc.ca/regions/index-eng.htm

Fisheries and Oceans, Canada [DFO]. 2018. *An assessment of northern shrimp (Pandalus borealis) in shrimp fishing areas 4-6 in 2017*. Ottawa: Author.

Fisheries and Oceans, Canada [DFO]. 2019a. A modernized Fisheries Act for Canada [online]. Retrieved from https://www.dfo-mpo.gc.ca/campaign-campagne/fisheries-act-loi-sur-les-peches/index-eng.html.

Fisheries and Oceans, Canada [DFO]. 2019b. Snow crab integrated fisheries management plan – Newfoundland and Labrador [online]. Retrieved from https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/index-eng.html.

Fisheries and Oceans, Canada [DFO]. 2019c. Fisheries and the Canadian economy [online]. Retrieved from http://www.dfo-mpo.gc.ca/stats/cfs-spc/tab/cfs-spc-tab2-eng.htm

Fisheries and Oceans, Canada [DFO]. 2019d. Sustainable fisheries framework. Retrieved from https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/overview-cadre-eng.htm

Fisheries and Oceans, Canada [DFO]. 2019e. Integrated fisheries management plans. Retrieved from https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/index-eng.html

Fisheries and Oceans, Canada [DFO]. 2019f. *Fishery monitoring policy.* Ottawa: Author. https://www.dfo-mpo.gc.ca/regions/index-eng.htm

Fisheries and Oceans, Canada [DFO]. 2019g. *Introduction to the procedural steps for implementing the fishery monitoring policy* [Online]. Ottawa: Author. Retrieved from https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/fmp-implementation-psp-mise-en-oeuvre-eng.htm

Fisheries and Oceans, Canada [DFO]. 2019h. *Guidance for the development of rebuilding plans under the precautionary approach framework: growing stocks out of the critical zone*. Ottawa: Author.

Fisheries and Oceans, Canada [DFO]. 2020. Canadian Science Advisory Secretariat [Online]. https://www.dfo-mpo.gc.ca/csas-sccs/about-sur/index-eng.html

Fogarty, M. J. 2014. The art of ecosystem-based fishery management. *Canadian Journal of Fisheries and Aquatic Sciences*, *71*(3), 479–490.

Foley, P., Mather, C., and Neis, B. 2015. Governing enclosure for coastal community: social embeddedness in a Canadian shrimp fishery. *Marine Policy* 61: 390-400.

Food and Agriculture Organization of the United Nations [FAO]. 2004. *A research agenda for small-scale fisheries*. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

Franks, D.D. 2010. *Neurosociology: the nexus between neuroscience and social psychology*. New York: Springer.

Fulton, E.A., Smith, A.D.M., Smith, D.C., & van Putten, I.E. 2011. Human behaviour: the key source of uncertainty in fisheries management. *Fish and Fisheries*, 12(1), 2-17.

Garza-Gil, M.D., & Varela-Lafuente, M.M. 2015. The preferences of the Spanish fishermen and their contribution on reform of the European Common Fisheries Policy. *Ocean & Coastal Management*, 116, 291-299.

Gezelius, S. S., & Hauck, M. 2011. Toward a theory of compliance in state-regulated livelihoods: a comparative study of compliance motivations in developed and developing world

fisheries: toward a theory of compliance in state-regulated livelihoods. *Law & Society Review*, *45*(2), 435–470.

Giddens, A. 1971. Max Weber: fundamental concepts of sociology. In *Capitalism and Modern Social Theory* (Pp. 145-168). Cambridge: Cambridge University Press.

Gifford, R. 2014. Environmental psychology matters. *Annual Review of Psychology* 65: 541-579.

Girardin, R., Hamon, K. G., Pinnegar, J., Poos, J. J., Thébaud, O., Tidd, A., Vermard, Y., & Marchal, P. 2017. Thirty years of fleet dynamics modelling using discrete-choice models: What have we learned? *Fish and Fisheries*, *18*(4), 638–655.

Glasbergen, P. 1998. The question of environmental governance. In P. Glasbergen (Ed.), *Co-operative Environmental Governance: Public-Private Agreements as a Policy Strategy.* Dordrecht: Kluwer Academic Publishers.

Gluckman, P. 2016. The science–policy interface. *Science*, *353*(6303), 969–969.

Gough, J. 2007. *Managing Canada's Fisheries*. Montreal: McGill-Queens University Press.

Greenwood, R., & Vodden, K. 2001. Rural-urban interaction in Newfoundland and Labrador: Understanding and managing functional regions. *Memorial Presents* 104(1): 38-40.

Guest, G. 2013. Describing mixed methods research: an alternative to typologies. *Journal of Mixed Methods Research*, *7*(2), 141–151.

Guest, G., MacQueen, K., & Namey, E.E. 2012. Data reduction techniques. Data reduction techniques. In Guest, G., MacQueen, K. M., & Namey, E. E. (Eds.), *Applied thematic analysis* (pp. 129-160). Thousand Oaks, CA: SAGE Publications, Inc.

Gunderson, L.H., Holling, C.S., & Peterson, G.D. 2002. Surprises and sustainability: cycles of renewal in the everglades. In L.H Gunderson and C.S. Holling (Eds.), *Panarchy: Understanding Transformation in Human and Natural Systems* (Pp. 315-322). Washington, D.C: Island Press.

Gurney, G.G., Cinner, J.E., Sartin, J., Pressey, R.L., Ban, N.C., Marshall, N.A., & Praduning, D. 2016. *Environmental Science & Policy*, 61, 212-220.

Harper, S., Grubb, C., Stiles, M., & Sumaila, U. R. 2020. Contributions by Women to Fisheries Economies: Insights from Five Maritime Countries. *Coastal Management*, *45*(2), 91–106.

Hattam, C. E., Mangi, S. C., Gall, S. C., & Rodwell, L. D. (2014). Social impacts of a temperate fisheries closure: Understanding stakeholders' views. *Marine Policy*, *45*, 269–278.

Hauzer, M., Dearden, P., & Murray, G. 2013. The effectiveness of community-based governance of small-scale fisheries, Ngazidja island, Comoros. *Marine Policy*, *38*, 346–354.

Heimlich, J. E., & Ardoin, N. M. 2008. Understanding behavior to understand behavior change: A literature review. *Environmental Education Research*, *14*(3), 215–237.

Hentati-Sundberg, J., Hjelm, J., Boonstra, W.J., & Österblom, H. 2015. management forcing increased specialization in a fishery system. *Ecosystems* 18(1): 45-61.

Hicks, C. C., Cinner, J. E., Stoeckl, N., & McClanahan, T. R. 2015. Linking ecosystem services and human-values theory. *Conservation Biology*, *29*(5), 1471–1480.

Hilborn, R. 2007. Managing fisheries is managing people: what has been learned? *Fish and Fisheries*, 8, 285-296.

Hilmi, N., Safa, A., Sumalia, U. R., & Cinar, M. 2017. Coral reefs management and decision making tools. *Ocean & Coastal Management*, *146*, 60–66.

Hornborg, S., van Putten, I., Novaglio, C., Fulton, E. A., Blanchard, J. L., Plagányi, É., Bulman, C., & Sainsbury, K. 2019. Ecosystem-based fisheries management requires broader performance indicators for the human dimension. *Marine Policy*, *108*, 103639.

Howlett, M. 2009. Policy analytical capacity and evidence-based policy-making: Lessons from Canada. *Canadian Public Administration*, *52*(2), 153–175.

Howlett, M. 2017. Policy analytical capacity: The supply and demand for policy analysis in government. *Policy and Society*, *34*(3–4), 173–182.

Imenda, S. 2014. Is there a conceptual difference between theoretical and conceptual frameworks? *Journal of Social Sciences*, *38*(2), 185–195.

Islam, M. M., Shamsuzzaman, M. M., Hoque Mozumder, M. M., Xiangmin, X., Ming, Y., & Abu Sayed Jewel, Md. 2017. Exploitation and conservation of coastal and marine fisheries in Bangladesh: Do the fishery laws matter? *Marine Policy*, *76*, 143–151.

Jaiteh, V. F., Lindfield, S. J., Mangubhai, S., Warren, C., Fitzpatrick, B., & Loneragan, N. R. 2016. Higher abundance of marine predators and changes in fishers' behavior following spatial protection within the world's biggest shark fishery. *Frontiers in Marine Science*, *3*.

Jentoft, S. 2007. Limits of governability: Institutional implications for fisheries and coastal governance. *Marine Policy*, *31*(4), 360–370.

Jentoft, S. 2019. Governing change in small-scale fisheries: theories and assumptions. In R. Chuenpagdee & S. Jentoft (Eds.), *Transdisciplinarity for small-scale fisheries governance: analysis and practice* (pp. 305-320). Amsterdam, NL: Springer.

Jentoft, S., & Chuenpagdee, R. 2005. Governance and governability. In J. Kooiman, M. Bavinck, S. Jentoft, & R. Pullin (Eds.), *Fish for life: interactive governance for fisheries*. Amsterdam: Amsterdam University Press.

Jentoft, S., & Chuenpagdee, R. 2009. Fisheries and coastal governance as a wicked problem. *Marine Policy*, *33*(4), 553–560.

Jentoft, S., & Chuenpagdee, R. 2015a. Enhancing the governability of small-scale fisheries through interactive governance. In S. Jentoft & R. Chuenpagdee (Eds.), *Interactive governance for Small-Scale Fisheries* (pp. 727-747). New York: Springer.

Jentoft, S., & Chuenpagdee, R. 2015b. Assessing the governability of small-scale fisheries. In S. Jentoft & R. Chuenpagdee (Eds.), *Interactive governance for Small-Scale Fisheries* (pp. 17-35). New York: Springer.

Jones, N. A., Shaw, S., Ross, H., Witt, K., & Pinner, B. 2016. The study of human values in understanding and managing social-ecological systems. *Ecology and Society*, *21*(1).

Johnsen, J. P. 2017. Creating political spaces at sea – governmentalisation and governability in Norwegian fisheries. *Maritime Studies*, *16*(1). doi.org/10.1186/s40152-017-0071-7.

Johnson, D.S., Lalancette, A., Lam, M.E., Leite, M. & Pálsson, S.K. 2019. The value of values for understanding transdisciplinary approaches to small-scale fisheries. In R. Chuenpagdee & S. Jentoft (Eds.), Transdisciplinarity for Small-Scale Fisheries Governance (pp. 35-54). New York: Springer.

Jovchelovitch, S., & Bauer, M.W. 2000. Narrative interviewing. In M.W. Bauer and G. Gaskell (Eds.), *Qualitative researching with text, image and sound* (Pp. 57-74). Thousand Oaks: Sage.

Junqueira Muylaert, C., Sarubbi Jr., V., Rogério Gallo, P., Rolim Neto, M.L., & Advincula Reis, A.O. 2014. Narrative interviews: an important resources in qualitative research. *Rev Esc Enferm USP* 48(esp2): 184-189.

Kahneman, D. 2003. A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist, 58*(9), 697–720.

Kerr, N.L., & Tindale, R.S. 2004. Group Performance and Decision-Making. *Annual Review of Psychology* 55: 623-655. 10.1146/annurev.psych.55.090902.142009.

Khan, A., & Chuenpagdee, R. 2014. An Interactive governance and fish chain approach to fisheries rebuilding: a case study of the northern gulf cod in Eastern Canada. *AMBIO*, *43*(5), 600–613.

Kittinger, J. N., Koehn, J. Z., Le Cornu, E., Ban, N. C., Gopnik, M., Armsby, M., Brooks, C., Carr, M. H., Cinner, J. E., Cravens, A., D'Iorio, M., Erickson, A., Finkbeiner, E. M., Foley, M. M., Fujita, R., Gelcich, S., Martin, K. S., Prahler, E., Reineman, D. R., … Crowder, L. B. 2014. A practical approach for putting people in ecosystem-based ocean planning. *Frontiers in Ecology and the Environment*, *12*(8), 448–456.

Knott, C., & Neis, B. 2017. Privatization, financialization and ocean grabbing in New Brunswick herring fisheries and salmon aquaculture. *Marine Policy*, *80*, 10–18.

Koffel, J.B. 2015. Use of recommended search strategies in systematic reviews and the impact of librarian involvement: a cross-sectional survey of recent authors. *PloS ONE* 10(5): e0125931.

Kooiman, J. 2003. Governing as governance. Thousand Oaks: Sage Publications.

Kooiman, J. 2008. Exploring the concept of governability. *Journal of Comparative Policy Analysis: Research and Practice* 10(2): 171-190.

Kooiman, J., & Bavinck, M. 2005. The governance perspective. In J. Kooiman, M. Bavinck, S. Jentoft, and R. Pullin (Eds.), *Fish for Life: Interactive Governance for Fisheries* (Pp.11-25). Amsterdam: Amsterdam University Press.

Kooiman, J., & Chuenpagdee, R. A synthesis. In Kooiman, M. Bavinck, S. Jentoft, & R. Pullin (Eds.), *Fish for life: interactive governance for fisheries* (pp. 325-350). Amsterdam: Amsterdam University Press.

Koontz, T.M., Steelman, T.A., Carmin, J., Korfmacher, K., Moseley, C., & Thomas, C.W. 2005. *Collaborative Environmental Management: What Roles for Government?* New York: Routledge.

Kurlansky, M. 1997. *Cod: A biography of the fish that changed the world.* Toronto: Vintage Canada.

Kwasnicka, D., Dombrowski, S. U., White, M., & Sniehotta, F. 2016. Theoretical explanations for maintenance of behaviour change: A systematic review of behaviour theories. *Health Psychology Review*, *10*(3), 277–296.

Kwon, H. R., & Silva, E. A. (2020). Mapping the landscape of behavioral theories: systematic literature review. *Journal of Planning Literature*, *35*(2), 161–179.

Lade, S. J., Niiranen, S., Hentati-Sundberg, J., Blenckner, T., Boonstra, W. J., Orach, K., Quaas, M. F., Österblom, H., & Schlüter, M. 2015. An empirical model of the Baltic Sea reveals the importance of social dynamics for ecological regime shifts. *Proceedings of the National Academy of Sciences*, *112*(35), 11120–11125.

Lambin, E., & Meyfroidt, P. 2010. Land-use transitions: socio-ecological feedback versus socio-economic change. *Land Use Policy*, 27(2), 108-118.

Lane, D.E. 1988. Investment decision making by fisheries. *Canadian Journal of Fisheries and Aquatic Sciences* 45: 782-793.

Landa, A.H., Szabo, I., Le Brun, L., Owen, I., & Fletcher, G. 2011. Evidence based scoping reviews. *The Electronic Journal Information Systems Evaluation* 14(1): 46-52.

Lansford, M., & Howorth, L. S. 1994. Legal Impediments to Limited Entry Fishing Regulation in the Gulf States. *Natural Resources Journal*, *34*, 33.

Larrosa, C., Carrasco, L.R., & Milner-Gulland, E.J. 2016. Unintended feedbacks: challenges and opportunities for improving conservation effectiveness. *Conservation Letters* 9(5): 316-326.

Lasswell, H.D. 1936. Politics: who gets what, when, and how. Chicago: University of Chicago.

Lasswell, H.D. 1970. The emerging conception of the policy sciences. *Policy Sciences* 1: 3-14.

Lasswell, H.D. 1971. *A pre-view of the policy sciences.* Oxford, UK: Elsevier.

Levac, D., Colquhoun, H., & O'Brien, K.K. 2010. Scoping studies: advancing the methodology. *Implementation Science* 5: 69.

Lasswell, H.D., & Kaplan, A. 1950. Power and society: a framework for political inquiry. New Haven: Yale University.

Lasswell, H.D., & McDougal, M.S. 1992. Jurisprudence for a free society: studies in law, science, and policy. New York: Springer.

Lear, W. H. 1998. History of fisheries in the Northwest Atlantic: The 500-year perspective. *Journal of Northwest Atlantic Fishery Science*, *23*: 41–73.

Lebel, L., Anderies, J.M., Campbell, C., Folke, C., Hattfield-Dodds, S., Hughes, T.P., & Wilson, J. 2006. Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society* 11(1): 19.

LeDoux, J.E. 2012. Rethinking the emotional brain. *Neuron* 73(4): 653-76.

LeDoux, J.E. 2013. The slippery slope of fear. *Trends in Cognitive Sciences* 17(4): 155-156.

Lemos, M.C., & Agrawal, A. 2006. Environmental governance. *Annual Review of Environmental Resources* 31: 297-325.

Li, T. 2007. *The will to improve: governmentality, development, and the practice of politics.* Durham: Duke University.

Lindkvist, E., Wijermans, N., Daw, T. M., Gonzalez-Mon, B., Giron-Nava, A., Johnson, A. F., van Putten, I., Basurto, X., & Schlüter, M. (2020). Navigating complexities: agent-based modeling to support research, governance, and management in small-scale fisheries. *Frontiers in Marine Science*, *6*.

Loewenstein, G., & Lerner J.S. 2003. The role of affect in decision making. In R.J. Davidson, K.R. Scherer., H.H. Goldsmith [Eds.], *Handbook of affective sciences* (pp.619 – 42). New York, NY: Oxford University Press.

Lubchenco, J., Cerny-Chipman, E. B., Reimer, J. N., & Levin, S. A. 2016. The right incentives enable ocean sustainability successes and provide hope for the future. *Proceedings of the National Academy of Sciences*, *113*(51), 14507–14514.

Lynn, S. K., Wormwood, J. B., Barrett, L. F., & Quigley, K. S. 2015. Decision making from economic and signal detection perspectives: Development of an integrated framework. *Frontiers in Psychology*, *6*.

Macusi, E. D., Katikiro, R. E., & Babaran, R. P. 2017. The influence of economic factors in the change of fishing strategies of anchored FAD fishers in the face of declining catch, General Santos City, Philippines. *Marine Policy*, *78*, 98–106.

Mahon, R., Bavinck, M., & Roy, R.M. 2005. Governance in action. In Kooiman, M. Bavinck, S. Jentoft, and R. Pullin (Eds.), *Fish for life: interactive governance for fisheries* (pp. 351-374). Amsterdam: Amsterdam University Press.

Mahon, R., McConney, P., & Roy, R. N. 2008. Governing fisheries as complex adaptive systems. *Marine Policy*, *32*(1), 104–112.

Maia, R.C.M., & Hauber, G. 2020. The emotional dimensions of reason-giving in deliberative forums. *Policy Sciences* 53:33-59.

Maina, I., Kavadas, S., Katsanevakis, S., Somarakis, S., Tserpes, G., & Georgakarakos, S. 2016. A methodological approach to identify fishing grounds: A case study on Greek trawlers. *Fisheries Research*, *183*, 326–339.

Marschke, M. J., & Berkes, F. 2006. Exploring strategies that build livelihood resilience: a case from Cambodia. *Ecology and Society*, *11*(1).

Matsumori, K., Iijima, K., Koike, Y., & Matsumoto, K. (2019). A decision-theoretic model of behavior change. *Frontiers in Psychology*, *10*.

McClanahan, T. R., Sebastián, C. R., & Cinner, J. E. 2016. Simulating the outcomes of resource user- and rule-based regulations in a coral reef fisheries-ecosystem model. *Global Environmental Change*, *38*, 58–69.

McCracken, F.D., & MacDonald, R.D.S. 1976. *Science for Canada's Atlantic inshore fisheries*. Ottawa, CA: Fisheries Research Board of Canada.

Meyfriodt, P. 2012. Environmental cognitions, land change and social-ecological feedbacks: an overview. *Journal of Land Use Science* 8(3): 341-367.

Miñarro, S., Navarrete Forero, G., Reuter, H., & van Putten, I. E. 2016. The role of patron-client relations on the fishing behaviour of artisanal fishermen in the Spermonde Archipelago (Indonesia). *Marine Policy*, *69*, 73–83.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & The PRISMA Group. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS ONE* 6(7): e1000097.

Møller, L. R., Smith-Hall, C., Meilby, H., Rayamajhi, S., Herslund, L. B., Larsen, H. O., Nielsen, Ø. J., & Byg, A. (2019). Empirically based analysis of households coping with unexpected shocks in the central Himalayas. *Climate and Development*, *11*(7), 597–606.

Muallil, R. N., Geronimo, R. C., Cleland, D., Cabral, R. B., Doctor, M. V., Cruz-Trinidad, A., and Aliño, P. M. 2011. Willingness to exit the artisanal fishery as a response to scenarios of declining catch or increasing monetary incentives. *Fisheries Research*, *111*(1–2), 74–81.

Naranjo-Madrigal, H., van Putten, I., & Norman-López, A. (2015). Understanding socio-ecological drivers of spatial allocation choice in a multi-species artisanal fishery: A Bayesian network modeling approach. *Marine Policy*, *62*, 102–115.

Nayak, P. K. 2017. Fisher communities in transition: Understanding change from a livelihood perspective in Chilika Lagoon, India. *Maritime Studies*, *16*(1).

Nayak, P.K., & Berkes, F. 2019. Interplay between local and global: change processes and small-scale fisheries. In R. Chuenpagdee & S. Jentoft (Eds.), *Transdisciplinarity for small-scale fisheries governance: analysis and practice* (pp. 203-220). Amsterdam, NL: Springer.

Needler, A.W.H. 1979. Evolution of Canadian fisheries management towards economic rationalization. *Journal of the Fisheries Research Board of Canada* 36(7): 716-724.

Neis, B., & Ommer, R.E. 2014. *Building economically, socially, and ecologically resilience fisheries and coastal communities: a policy booklet.* St. John's, CA: Community-University Research for Recovery Alliance.

Nicolescu, B. 2010. Methodology of Transdisciplinarity–Levels of Reality, Logic of the Included Middle and Complexity. *Transdisciplinary Journal of Engineering & Science*, *1*(1).

Nielsen, J. R., Thunberg, E., Holland, D. S., Schmidt, J. O., Fulton, E. A., Bastardie, F., Punt, A. E., Allen, I., Bartelings, H., Bertignac, M., Bethke, E., Bossier, S., Buckworth, R., Carpenter, G., Christensen, A., Christensen, V., Da-Rocha, J. M., Deng, R., Dichmont, C., … Waldo, S. 2018. Integrated ecological-economic fisheries models - Evaluation, review and challenges for implementation. *Fish and Fisheries*, *19*(1), 1–29

Norman, M., & Power, N.G. 2014. Stuck between 'the rock' and a hard place: rural crisis and re-imagining rural Newfoundland feminine subjectivities. *Gender, Place & Culture: A Journal of Feminist Geography* 22(1): 50-66.

Nursey-Bray, M. J., Vince, J., Scott, M., Haward, M., O'Toole, K., Smith, T., Harvey, N., & Clarke, B. 2014. Science into policy? Discourse, coastal management and knowledge. *Environmental Science & Policy*, *38*, 107–119.

Oakerson, R.J. 1992. *Analyzing the commons: a framework.* In D. Bromley (Ed.), *Making the commons work: theory, practice, and policy* (pp. 41-59). San Francisco, USA: ICS Press.

Oceans Act, SC 1996, c 31

Ojea, E., Pearlman, I., Gaines, S. D., & Lester, S. E. 2017. Fisheries regulatory regimes and resilience to climate change. *Ambio*, *46*(4), 399–412.

Ommer R. E. 1994. One hundred years of fishery crises in Newfoundland. Acadiensis, XXIII: 5-20.

Ommer, R. E., & Turner, N. J. 2004. Informal Rural Economies in History. *Labour / Le Travail*, *53*: 127.

Ommer, R.E., & the Coasts Under Stress Research Project Team. 2007. *Coasts Under Stress: Restructuring and Social-Ecological Health*. McGill-Queens University Press.

Ommer, R.E., Perry, R.I, Murray, G., and Neis, B. 2012. Social-ecological dynamism, knowledge, and sustainable coastal marine fisheries. *Current Opinion in Environmental Sustainability* 4(3): 316-322.

Ostrom, E. 1990. *Governing the Commons*. Cambridge: Cambridge University Press.

Ostrom, E., & Cox, M. 2010. Moving beyond panaceas: a multi-tiered diagnostic approach for social-ecological analysis. *Environmental Conservation* 37(4): 451-463.

Palinkas, L.A., Horowitz, S.M., Green, C.A., Wisdom, J.P., Duan, N., & Hoagwood, K. 2015. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research* 42(5): 533-544.

Panksepp, J. 2008. The affective brain and core consciousness. In M. Lewis, J.M. Maviland, and L. Feldman-Barrett, (Eds.), *The Handbook of Emotions* (3rd Ed.) (Pp. 47-67). New York: Guilford Press.

Pardo, J. C. F., Ramon, D., Stefanelli-Silva, G., Elegbede, I., Lima, L. S., & Principe, S. C. 2020. Advancing through the pandemic from the perspective of marine graduate researchers: challenges, solutions, and opportunities. *Frontiers in Marine Science*, *7*.

Pascoe, S., Cannard, T., Jebreen, E., Dichmont, C. M., & Schirmer, J. 2015. Satisfaction with fishing and the desire to leave. *Ambio*, *44*(5), 401–411.

Peltola, T., Åkerman, M., Bamberg, J., Lehtonen, P., & Ratamäki, O. 2018. Emergent publics and affects in environmental governance. *Journal of Environmental Policy & Planning*, *20*(2), 157–169.

Perry, I.R., Ommer, R.E., Barange, M., Jentoft, S., Neis, B., & Sumaila, R.U. 2011. Marine Social-ecological responses to environmental change and the impacts of globalization. *Fish and Fisheries* 12: 427-450.

Petticrew, M. & Roberts, H. (2006). *Systematic reviews in the social sciences*. Oxford: Blackwell.

Petrie, H.G. 1976. Do you see what I see? The epistemology of interdisciplinary inquiry. *Journal of Aesthetic Education* 10(1): 29-43.

Pinkerton, E. 2015. The role of moral economy in two British Columbia fisheries: Confronting neoliberal policies. *Marine Policy*, *61*: 410–419

Pinkerton, E. 2017. Hegemony and resistance: disturbing patterns and hopeful signs in the impact of neoliberal policies on small-scale fisheries around the world. *Marine Policy* 80: 1-9.

Pinkerton, E., Allain, M., Decker, D., & Carew, K. 2018. Atlantic and Pacific halibut co-management initiatives by Canadian fishermen's organization. *Fish and Fisheries* 19: 984-995.

Pitcher, T.J., & Chuenpagdee, R. 1993. Decision making by commercial fishermen. *Fisheries Centre Research Reports* 1(2). UBC.

Pittman, J., & Armitage, D. 2016. Governance across the land-sea interface: a systematic review. *Environmental Science and Policy* 64: 9-17.

Plummer, R., Crona, B., Armitage, D.R., Olsson, P., Tengo, M., & Yudina, O. 2012. Adaptive co-management: a systematic review and analysis. *Ecology and Society* 17(3): 11.

Polanyi, K. 1944. *The Great Transformation: The Political and Economic Origins of Our Time*. Boston, M.A.: Beacon Press.

Pomeroy, R. S., Ratner, B. D., Hall, S. J., Pimoljinda, J., & Vivekanandan, V. 2006. Coping with disaster: Rehabilitating coastal livelihoods and communities. *Marine Policy*, *30*(6), 786–793.

Pope, P.E. 2009. Historical archeology and the maritime cultural landscape. In A. MacEacern and W.J. Turkel (Eds.), Method and Meaning in Canadian Environmental History (pp. 36-54). Toronto: Nelson.

Power, N. G., M. E. Norman, & K. Dupré. 2014. "The fishery went away": The impacts of long-term fishery closures on young people's experience and perception of fisheries employment in Newfoundland coastal communities. *Ecology and Society,* 19(3): 6.

Prowse, D.W. 1895. The history of Newfoundland. Amsterdam: Meridian Publishing.

Ricketts, P., & Harrison, P. 2007. Coastal and ocean management in Canada: moving into the 21st century. *Coastal Management* 35: 5-22.

Ram-Bidesi, V. 2015. Recognizing the role of women in supporting marine stewardship in the Pacific Islands. *Marine Policy*, *59*: 1–8.

Reid, J. G. 2016. Immigration to Atlantic Canada: Historical Reflections. *Journal of the Royal Nova Scotia Historical Society 19*(17): 38-53.

Rhodes, R.W.A. 1997. *Understanding Governance: Policy Networks, Governance, Reflexivity and Accountability*. Buckingham: Open University Press.

Said, A. 2019. The principles of transdisciplinary research in small-scale fisheries. In R. Chuenpagdee and S. Jentoft (Eds.), Transdisciplinarity for Small-Scale Fisheries Governance (pp. 411-431). New York: Springer.

Saila, S.B., & Galluci, V.F. 1996. Overview and background. In V.F. Galluci, S.B. Saila, D.J. Gustafson, & B.J. Rothschild (Eds.), *Stock Assessment: Quantitative Methods and Applications for Small-Scale Fisheries* (Pp. 1-9). New York: Lewis Publishers.

Salas, S., & Gaertner, D. 2004. The behavioural dynamics of fishers: Management implications. *Fish and Fisheries*, *5*(2), 153–167.

Saldaña, A., Salas, S., Arce-Ibarra, A.M., & Torres-Irineo, E. 2017. Fishing operations and adaptive strategies of small-scale fishers: insights for fisheries management in data poor situations. *Fisheries Management and Ecology*, 24, 19-32.

Species at Risk Act, SC 2002, c 29

Sarewitz, D. 2004. How science makes environmental controversies worse. *Environmental Science & Policy* 7(5): 385-403.

Sarewitz, D., & Pielke, R. A. 2007. The neglected heart of science policy: Reconciling supply of and demand for science. *Environmental Science & Policy*, *10*(1), 5–16.

Scott, J.C. 1999. *Seeing like a state: how certain schemes to improve the human condition have* failed. New Haven: Yale University.

Shepperson, J., Murray, L. G., Mackinson, S., Bell, E., & Kaiser, M. J. 2016. Use of a choice-based survey approach to characterise fishing behaviour in a scallop fishery. *Environmental Modelling & Software*, *86*, 116–130.

Shuman, V., Sander, D., & Scherer K.R. 2013. Levels of valence. *Frontiers in Psychology* 4(261): 1-17.

Simon, H.A. 1990. Invariates of human behaviour. *Annual Review of Psychology* 41: 1-20.

Smit, B., & Wandel, J. 2006. Adaptation, adaptive capacity, and vulnerability. *Global Environmental Change* 16(3): 282-292.

Smith, D. A., Vodden, K., Woodrow, M., Khan, A., & Fürst, B. 2014. The last generation? Perspectives of inshore fish harvesters from Change Islands, Newfoundland. *The Canadian Geographer / Le Géographe Canadien*, *58*(1): 95–109.

Sogn-Grundvåg, G., & Henriksen, E. 2014. The influence of human rationality and behaviour on fish quality. *Ocean & Coastal Management*, *87*, 68–74.

Song, A.M., Chuenpagdee, R., & Jentoft, S. 2013. Values, images, and principles: what they represent and how they may improve fisheries governance. *Marine Policy* 40, 167-175.

Soomai, S. 2017a. Understanding the science-policy interface: case studies on the role of information in fisheries management. *Environmental Science & Policy* 72: 65-75.

Soomai, S. 2017b. The science-policy interface in fisheries management: insights about the influence of organizational structure and culture on information pathways. *Marine Policy* 81:53-63.

Soomai, S., MacDonald, B.H., & Wells, P.G. 2013. Communicating environmental information to the stakeholders in coastal and marine policy-making: case studies from Nova Scotia and the Gulf of Maine/Bay of Fundy Region. *Marine Policy* 40: 176-186.

Steelman, T.A., & Wallace, R.L. 2001. Property rights and property wrongs: why context matters in fisheries management. *Policy Sciences* 34: 357-379.

Stephenson, R.L, & Lane, D.E. 1995. Fisheries management sciences: a plea for conceptual change. *Canadian Journal of Fisheries and Aquatic Sciences* 52(9): 2051–2056.

Stephenson, R.L., Wiber, M., Stacey, P., Angel, E., Benson, A., Charles, A., Chouinard, O., Edwards, D., Foley, P., Lane, D., McIsaac, J., Neis, B., Parlee, C., Pinkerton, E., Saunders, M., Squires, K., & Sumaila, U.R. 2019a. Integrating diverse objectives for sustainable fisheries in Canada. *Canadian Journal of Fisheries and Aquatic Sciences* 76, 480-496.

Stephenson, R.L., Hobday, A.J., Cvitanovic, C., Alexander, K.A., Begg, G.A., Bustamante, R.H., Dunstan, P.K., Frusher, S., Fudge, M., Fulton, E.A., Haward, M., Macleod, C., McDonald, J., Nash, K., Ogier, E., Pecl. G., Plagányi, É.E., van Putten, I., Smith, T., & Ward, T.M. 2019b. A practical framework for implementing and evaluating integrated management of marine activities. *Ocean and Coastal Management*, 177, 127-138.

Stone, D. 2002. The policy paradox: the art of political decision-making. New York: WW Norton & Co.

Sumaila, U.R., Liu, Y., & Tydemers, P. 2001. Small versus large-scale fishing operations in the North Atlantic. In T. Pitcher, U.R. Sumaila, and D. Pauly (Eds.), *Fisheries impacts on North Atlantic ecosystems: evaluations and policy exploration*. Vancouver, CA: Fisheries Centre Research Reports.

Sumaila, U.R., Tai, T.C., Lam, V.W.Y., Cheung, W.W.L., Bailey, M., Cisneros-Montemayor, A.M., Chen, O.L., & Gulati, S.S. 2019. Benefits of the Paris Agreement to ocean life, economies, and people. Science Advances, 5(2), eaau3855.

Sutton, A. M., & Rudd, M. A. 2014. Deciphering contextual influences on local leadership in community-based fisheries management. *Marine Policy*, *50*, 261–269.

Symes, D., & Hoefnagel, E. 2010. Fisheries policy, research and the social sciences in europe: challenges for the 21st century. *Marine Policy* 34(2): 268-275.

Teh, L.C.L., Teh, L.S.L., & Meitner, M.J. 2012. Preferred resource spaces and fish harvester flexibility: implications for spatial management of small-scale fisheries. *Human Ecology*, 40(2), 213-226.

Thagard, P. 2006. *Hot thought: Mechanisms and applications of emotional contagion*. Cambridge: MIT Press.

Tidd, A. N., Hutton, T., Kell, L. T., & Blanchard, J. L. 2012. Dynamic prediction of effort reallocation in mixed fisheries. *Fisheries Research*, *125–126*, 243–253.

Tillman, A.R., Watson, J.R., & Levin, S. 2017. Maintaining cooperation in social-ecological systems. *Theoretical Ecology*, 10, 155-165.

Tsagarakis, K., Palialexis, A., & Vassilopoulou, V. 2014. Mediterranean fishery discards: Review of the existing knowledge. *ICES Journal of Marine Science*, *71*(5), 1219–1234.

Van Dijk, D., Hendrix, E. M. T., Haijema, R., Groeneveld, R. A., & van Ierland, E. C. 2017. An adjustment restriction on fish quota: resource rents, overcapacity and recovery of fish stock. *Environmental and Resource Economics*, *67*(2), 203–230.

Van Gigch, J.P. 2002. Comparing the epistemologies of scientific disciplines in two distinct domains: modern physics versus social sciences. *Systems Research* 19: 551-562.

Van Kleef, G.A. 2016. The interpersonal dynamics of emotion: toward an integrative theory of emotions as social information. Cambridge University Press.

Van Putten, I.E., Kulmala, S., Thébaud, O., Dowling, N., Hamon, K.G., Hutton, T., & Pascoe, S. 2012. Theories and behavioural drivers underlying fleet dynamics models. *Fish and Fisheries*, 13(2), 261-235.

Van Putten, I., Lalancette, A., Bayliss, P., Dennis, D., Hutton, T., Norman-López, A., Pascoe, S., Plagányi, E., & Skewes, T. 2013. A Bayesian model of factors influencing indigenous participation in the Torres Strait tropical rocklobster fishery. *Marine Policy*, *37*, 96–105.

Vaughan, D. 2017. Fishing effort displacement and the consequences of implementing Marine Protected Area management – An English perspective. *Marine Policy*, *84*, 228–234.

Vassilieva, J. 2016. *Narrative psychology: identity, transformation and ethics.* Palgrave MacMillan.

Wagner, J., & Davis, A. 2004. Property as a social relation: rights of "kindness" and the social organization of lobster fishing among northeastern Nova Scotian Scottish Gaels. *Human Organization* 63(3), 320-333.

Wanyonyi, I. N., Wamukota, A., Tuda, P., Mwakha, V. A., & Nguti, L. M. 2016. Migrant fishers of Pemba: Drivers, impacts and mediating factors. *Marine Policy*, *71*, 242–255.

Webster, D.G. 2009. *Adaptive governance: the dynamics of Atlantic fisheries management*. MIT Press: Cambridge.

Weeratunge, N., Béné, C., Siriwardane, R., Charles, A., Johnson, D., Allison, E. H., Nayak, P. K., & Badjeck, M.-C. 2014. Small-scale fisheries through the wellbeing lens. *Fish and Fisheries*, *15*(2), 255–279.

Wellman, B., & Berkowitz, S. D. (Eds.). 1988. *Structural analysis in the social sciences, Vol. 2. Social structures: A network approach.* Cambridge University Press.

Wharton, T. 2015. Rigor, transparency, and reporting social science research: why guidelines don't have to kill your story. *Research on Social Work Practice* 27(4): 487-493.

White, S.C. 2008. But what is wellbeing? A framework for analysis in social and development policy and practice. WeD Working Paper No. 2143. Wellbeing in Developing Countries ESRC Research Group, University of Bath.

Wiener, A. 2016. Contested norms in inter-national encounters: the 'Turbot War' as a prelude to fairer fisheries governance. *Politics and Governance*, *4*(3): 20.

Wise, L., Murta, A. G., Carvalho, J. P., & Mesquita, M. 2012. Qualitative modelling of fishermen's behaviour in a pelagic fishery. *Ecological Modelling*, *228*, 112–122.

Wolfe, S.E. 2012. Water cognition and cognitive affective mapping: identifying priority clusters within a Canadian water efficiency community. *Water Resources Management* 26(1): 2991-3004.

Wolfe, S.E. 2017. Fear, anger, and responsibility: using emotions and terror management theory to assess historic speeches about water and policy. *Water History* 9: 317-336.

Wood, W., & Rünger, D. 2016. Psychology of habit. *Annual Review of Psychology*, *67*(1), 289–314.

Worm, B., Hilborn, R. Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R., & Zeller, D. 2009. Rebuilding global fisheries. *Science* 325: 578-584.

Wu, X., Ramesh, M., & Howlett, M. 2015. Policy capacity: A conceptual framework for understanding policy competences and capabilities. *Policy and Society*, *34*(3–4), 165–171.

Yletyinen, J., Hentati-Sundberg, J., Blenckner, T., & Bodin, Ö. 2018. Fishing strategy diversification and fishers' ecological dependency. *Ecology and Society*, *23*(3).

Young, O.R. 2009. Governance for sustainable development in of rising interdependencies. In M.A. Delmas & O.R. Young (Eds.), *Governance for the Environment: New Perspectives* (12-40). Cambridge University Press: Cambridge.

Young, O.R., Webster, D.G., Cox, M.E., Raakjær, J., Blaxekjær, L.O., Einarsson, N., Virginia, R.A., Acheson, J., Bromley, D., Cardwell, E., Carothers, Eythórsson, E., Howard, R.B., Jentoft, S., McCay, B., McCormack, F., Osherenko, G., Pinkerton, E., van Ginkel, R., Wilson, J.A., Rivers III, L., & Wilson, R.S. 2018. Moving beyond panaceas in fisheries governance. *PNAS* 115(35): 9065-9073.

Zafirovski, M. 1998. Socio-economics and rational choice theory: specification of their relations. *Journal of Socio-Economics* 27(2): 165-205.

Appendix

Supplementary Material A: The sample of peer-reviewed publications for a systematic scoping review

Abbott, J. K., & Haynie, A. C. 2012. What are we protecting? Fisher behavior and the unintended consequences of spatial closures as a fishery management tool. *Ecological Applications*, *22*(3), 762–777.

Anderies, J. M. 2015. Understanding the Dynamics of Sustainable Social-Ecological Systems: Human Behavior, Institutions, and Regulatory Feedback Networks. *Bulletin of Mathematical Biology*, *77*(2), 259–280.

Andersen, B. S., Ulrich, C., Eigaard, O. R., & Christensen, A.-S. 2012. Short-term choice behaviour in a mixed fishery: Investigating metier selection in the Danish gillnet fishery. *ICES Journal of Marine Science*, *69*(1), 131–143.

Arias, A., Cinner, J. E., Jones, R. E., & Pressey, R. L. 2015. Levels and drivers of fishers compliance with marine protected areas. *Ecology and Society*, *20*(4).

Arias, A., Pressey, R. L., Jones, R. E., Álvarez-Romero, J. G., & Cinner, J. E. 2016. Optimizing enforcement and compliance in offshore marine protected areas: A case study from Cocos Island, Costa Rica. *Oryx*, *50*(01), 18–26.

Bacalso, R. T. M., Juario, J. V., & Armada, N. B. 2013. Fishers' choice of alternative management scenarios: A case study in the Danajon Bank, Central Philippines. *Ocean & Coastal Management*, *84*, 40–53.

Barnes, M. L., Arita, S., Kalberg, K., & Leung, P. 2017. When does it pay to cooperate? Strategic information exchange in the harvest of common-pool fishery resources. *Ecological Economics*, *131*, 1–11.

Barrowclift, E., Temple, A. J., Stead, S., Jiddawi, N. S., & Berggren, P. 2017. Social, economic and trade characteristics of the elasmobranch fishery on Unguja Island, Zanzibar, East Africa. *Marine Policy*, *83*, 128–136.

Bartelings, H., Hamon, K. G., Berkenhagen, J., & Buisman, F. C. 2015. Bio-economic modelling for marine spatial planning application in North Sea shrimp and flatfish fisheries. *Environmental Modelling & Software*, *74*, 156–172.

Batista, M. I., Horta e Costa, B., Gonçalves, L., Henriques, M., Erzini, K., Caselle, J. E., Gonçalves, E. J., & Cabral, H. N. 2015. Assessment of catches, landings and fishing effort as useful tools for MPA management. *Fisheries Research*, *172*, 197–208.

Beitl, C. M. 2014. Navigating over space and time: fishing effort allocation and the development of customary norms in an open-access mangrove estuary in ecuador. *Human Ecology*, *42*(3), 395–411.

Beitl, C. M. 2015. Mobility in the mangroves: Catch rates, daily decisions, and dynamics of artisanal fishing in a coastal commons. *Applied Geography*, *59*, 98–106.

Bergseth, B. J., Russ, G. R., & Cinner, J. E. 2015. Measuring and monitoring compliance in no-take marine reserves. *Fish and Fisheries*, *16*(2), 240–258.

Bieg, C., McCann, K. S., & Fryxell, J. M. 2017. The dynamical implications of human behaviour on a social-ecological harvesting model. *Theoretical Ecology*, *10*(3), 341–354.

Boonstra, W. J., Birnbaum, S., & Björkvik, E. 2017. The quality of compliance: Investigating fishers' responses towards regulation and authorities. *Fish and Fisheries*, *18*(4), 682–697.

Boonstra, W. J., & de Boer, F. W. 2014. The historical dynamics of social–ecological traps. *AMBIO*, *43*(3), 260–274.

Boonstra, W. J., & Hanh, T. T. H. 2015. Adaptation to climate change as social–ecological trap: A case study of fishing and aquaculture in the Tam Giang Lagoon, Vietnam. *Environment, Development and Sustainability*, *17*(6), 1527–1544.

Breen, B., Kelley, H., & Hynes, S. 2016. The impact of precautionary quota constraints on the composition of multispecies harvest portfolios. *Marine Policy*, *69*, 13–23.

Breen, M., Graham, N., Pol, M., He, P., Reid, D., & Suuronen, P. 2016. Selective fishing and balanced harvesting. *Fisheries Research*, *184*, 2–8.

Britton, E., & Coulthard, S. 2013. Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Marine Policy*, *37*, 28–36.

Cabral, R. B., Gaines, S. D., Johnson, B. A., Bell, T. W., & White, C. 2017. Drivers of redistribution of fishing and non-fishing effort after the implementation of a marine protected area network. *Ecological Applications*, *27*(2), 416–428.

Campbell, S. J., Hoey, A. S., Maynard, J., Kartawijaya, T., Cinner, J., Graham, N. A. J., & Baird, A. H. 2012. Weak compliance undermines the success of no-take zones in a large government-controlled marine protected area. *PLoS ONE*, *7*(11), e50074.

Carr, L. M., & Heyman, W. D. 2014. Using a coupled behavior-economic model to reduce uncertainty and assess fishery management in a data-limited, small-scale fishery. *Ecological Economics*, *102*, 94–104.

Cepić, D., & Nunan, F. 2017. Justifying non-compliance: The morality of illegalities in small scale fisheries of Lake Victoria, East Africa. *Marine Policy*, *86*, 104–110.

Chambers, C., & Kokorsch, M. 2017. Viewpoint: The social dimension in Icelandic fisheries governance. *Coastal Management*, *45*(4), 330–337.

Chollett, I., Canty, S. W. J., Box, S. J., & Mumby, P. J. 2014. Adapting to the impacts of global change on an artisanal coral reef fishery. *Ecological Economics*, *102*, 118–125.

Christou, M., Haralabous, J., Stergiou, K. I., Damalas, D., & Maravelias, C. D. 2017. An evaluation of socioeconomic factors that influence fishers' discard behaviour in the Greek bottom trawl fishery. *Fisheries Research*, *195*, 105–115.

Condie, H. M., Grant, A., & Catchpole, T. L. 2013. Does banning discards in an otter trawler fishery create incentives for more selective fishing? *Fisheries Research*, *148*, 137–146.

Coulthard, S. 2012. Can we be both resilient and well, and what choices do people have? incorporating agency into the resilience debate from a fisheries perspective. *Ecology and Society*, *17*(1).

Davies, T. K., Mees, C. C., & Milner-Gulland, E. J. 2014. Modelling the spatial behaviour of a tropical tuna purse seine fleet. *PLoS ONE*, *9*(12), e114037.

Davies, T. K., Mees, C. C., & Milner-Gulland, E. J. 2015. Second-guessing uncertainty: Scenario planning for management of the Indian Ocean tuna purse seine fishery. *Marine Policy*, *62*, 169–177.

Daw, T. M., Cinner, J. E., McClanahan, T. R., Brown, K., Stead, S. M., Graham, N. A. J., & Maina, J. 2012. To fish or not to fish: factors at multiple scales affecting artisanal fishers' readiness to exit a declining fishery. *PLoS ONE*, *7*(2), e31460.

Deepananda, K. H. M. A., Amarasinghe, U. S., & Jayasinghe-Mudalige, U. K. 2016. Neither bust nor boom: Institutional robustness in the beach seine fishery of southern Sri Lanka. *Ocean & Coastal Management*, *128*, 61–73.

Eliasen, Søren Q., Papadopoulou, K.-N., Vassilopoulou, V., & Catchpole, T. L. 2014. Socio-economic and institutional incentives influencing fishers' behaviour in relation to fishing practices and discard. *ICES Journal of Marine Science*, *71*(5), 1298–1307.

Eliasen, Søren Qvist. 2014. Cod avoidance by area regulations in Kattegat – experiences for the implementation of a discard ban in the EU. *Marine Policy*, *45*, 108–113.

Emery, T. J., Green, B. S., Gardner, C., & Tisdell, J. 2012. Are input controls required in individual transferable quota fisheries to address ecosystem based fisheries management objectives? *Marine Policy*, *36*(1), 122–131.

Emery, T. J., Hartmann, K., Green, B. S., Gardner, C., & Tisdell, J. 2014a. Does 'race to fish' behaviour emerge in an individual transferable quota fishery when the total allowable catch becomes non-binding? *Fish and Fisheries*, *15*(1), 151–169.

Emery, T. J., Hartmann, K., Green, B. S., Gardner, C., & Tisdell, J. 2014b. Fishing for revenue: How leasing quota can be hazardous to your health. *ICES Journal of Marine Science*, *71*(7), 1854–1865.

Emery, T. J., Tisdell, J., Green, B. S., Hartmann, K., Gardner, C., & León, R. 2015. An experimental analysis of assignment problems and economic rent dissipation in quota managed fisheries. *Ocean & Coastal Management*, *106*, 10–28.

Frost, H. S., & Hoff, A. 2017. The landing obligation in view of different management regimes. *Fisheries Research*, *195*, 202–213.

Garza-Gil, M. D., & Varela-Lafuente, M. M. 2015. The preferences of the Spanish fishermen and their contribution on reform of the European Common Fisheries Policy. *Ocean & Coastal Management*, *116*, 291–299.

Girardin, R., Hamon, K. G., Pinnegar, J., Poos, J. J., Thébaud, O., Tidd, A., Vermard, Y., & Marchal, P. 2017. Thirty years of fleet dynamics modelling using discrete-choice models: What have we learned? *Fish and Fisheries*, *18*(4), 638–655.

Girardin, R., Vermard, Y., Thébaud, O., Tidd, A., & Marchal, P. 2015. Predicting fisher response to competition for space and resources in a mixed demersal fishery. *Ocean & Coastal Management*, *106*, 124–135.

Gurney, G. G., Cinner, J. E., Sartin, J., Pressey, R. L., Ban, N. C., Marshall, N. A., & Prabuning, D. 2016. Participation in devolved commons management: Multiscale socioeconomic factors related to individuals' participation in community-based management of marine protected areas in Indonesia. *Environmental Science & Policy*, *61*, 212–220.

Hadjimichael, M., Kaiser, M. J., & Edwards-Jones, G. 2013. The impact of regulatory obligations on fishers' income: Identifying perceptions using a market-testing tool. *Fisheries Research*, *137*, 129–140.

Hallwass, G., Lopes, P. F. M., Juras, A. A., & Silvano, R. A. M. 2013. Behavioral and environmental influences on fishing rewards and the outcomes of alternative management scenarios for large tropical rivers. *Journal of Environmental Management*, *128*, 274–282.

Hamon, K. G., Frusher, S. D., Little, L. R., Thébaud, O., & Punt, A. E. 2014. Adaptive behaviour of fishers to external perturbations: Simulation of the Tasmanian rock lobster fishery. *Reviews in Fish Biology and Fisheries*, *24*(2), 577–592.

Hattam, C. E., Mangi, S. C., Gall, S. C., & Rodwell, L. D. 2014. Social impacts of a temperate fisheries closure: Understanding stakeholders' views. *Marine Policy*, *45*, 269–278.

Hauzer, M., Dearden, P., & Murray, G. 2013. The effectiveness of community-based governance of small-scale fisheries, Ngazidja island, Comoros. *Marine Policy*, *38*, 346–354.

Helmond, A. T. M. van, Chen, C., Trapman, B. K., Kraan, M., & Poos, J. J. 2016. Changes in fishing behaviour of two fleets under fully documented catch quota management: Same rules, different outcomes. *Marine Policy*, *67*, 118–129.

Hicks, C. C., Cinner, J. E., Stoeckl, N., & McClanahan, T. R. 2015. Linking ecosystem services and human-values theory: Ecosystem services and human values. *Conservation Biology*, *29*(5), 1471–1480.

Hicks, C. C., Stoeckl, N., Cinner, J. E., & Robinson, J. 2014. Fishery benefits and stakeholder priorities associated with a coral reef fishery and their implications for management. *Environmental Science & Policy*, *44*, 258–270.

Hicks, J. S., Burgman, M. A., Marewski, J. N., Fidler, F., & Gigerenzer, G. 2012. Decision making in a human population living sustainably: decision making and sustainability. *Conservation Biology*, *26*(5), 760–768.

Hilmi, N., Safa, A., Sumalia, U. R., & Cinar, M. 2017. Coral reefs management and decision making tools. *Ocean & Coastal Management*, *146*, 60–66.

Horta e Costa, B., Batista, M. I., Gonçalves, L., Erzini, K., Caselle, J. E., Cabral, H. N., & Gonçalves, E. J. 2013. Fishers' behaviour in response to the implementation of a marine protected area. *PLoS ONE*, *8*(6), e65057.

Hynes, S., Gerritsen, H., Breen, B., & Johnson, M. 2016. Discrete choice modelling of fisheries with nuanced spatial information. *Marine Policy*, *72*, 156–165.

Islam, M. M., Shamsuzzaman, M. M., Hoque Mozumder, M. M., Xiangmin, X., Ming, Y., & Abu Sayed Jewel, M. 2017. Exploitation and conservation of coastal and marine fisheries in Bangladesh: Do the fishery laws matter? *Marine Policy*, *76*, 143–151.

Jaiteh, V. F., Lindfield, S. J., Mangubhai, S., Warren, C., Fitzpatrick, B., & Loneragan, N. R. 2016. Higher abundance of marine predators and changes in fishers' behavior following spatial protection within the world's biggest shark fishery. *Frontiers in Marine Science*, *3*.

Jannot, J. E., & Holland, D. S. 2013. Identifying ecological and fishing drivers of bycatch in a U.S. groundfish fishery. *Ecological Applications*, *23*(7), 1645–1658.

Johnsen, J. P. 2017. Creating political spaces at sea – governmentalisation and governability in Norwegian fisheries. *Maritime Studies*, *16*(1).

Kittinger, J. N., Koehn, J. Z., Le Cornu, E., Ban, N. C., Gopnik, M., Armsby, M., Brooks, C., Carr, M. H., Cinner, J. E., Cravens, A., D'Iorio, M., Erickson, A., Finkbeiner, E. M., Foley, M.

M., Fujita, R., Gelcich, S., Martin, K. S., Prahler, E., Reineman, D. R., … Crowder, L. B. 2014. A practical approach for putting people in ecosystem-based ocean planning. *Frontiers in Ecology and the Environment*, *12*(8), 448–456.

Klein, E. S., Barbier, M. R., & Watson, J. R. 2017. The dual impact of ecology and management on social incentives in marine common-pool resource systems. *Royal Society Open Science*, *4*(8), 170740.

Kraak, S. B. M., Reid, D. G., & Codling, E. A. 2014. Exploring the RTI (real-time incentive) tariff-based approach to single-species fisheries management. *Fisheries Research*, *155*, 90–102.

Lade, S. J., Niiranen, S., Hentati-Sundberg, J., Blenckner, T., Boonstra, W. J., Orach, K., Quaas, M. F., Österblom, H., & Schlüter, M. 2015. An empirical model of the Baltic Sea reveals the importance of social dynamics for ecological regime shifts. *Proceedings of the National Academy of Sciences*, *112*(35), 11120–11125.

Lubchenco, J., Cerny-Chipman, E. B., Reimer, J. N., & Levin, S. A. 2016. The right incentives enable ocean sustainability successes and provide hope for the future. *Proceedings of the National Academy of Sciences*, *113*(51), 14507–14514.

Macusi, E. D., Katikiro, R. E., & Babaran, R. P. 2017. The influence of economic factors in the change of fishing strategies of anchored FAD fishers in the face of declining catch, General Santos City, Philippines. *Marine Policy*, *78*, 98–106.

Maina, I., Kavadas, S., Katsanevakis, S., Somarakis, S., Tserpes, G., & Georgakarakos, S. 2016. A methodological approach to identify fishing grounds: A case study on Greek trawlers. *Fisheries Research*, *183*, 326–339.

Mallol, S., & Goñi, R. 2017. Unintended changes of artisanal fisheries métiers upon implementation of an MPA. *Marine Policy*.

Maravelias, C. D., Haralabous, J., & Tsitsika, E. V. 2014. Fishing strategies and the Ecosystem Approach to Fisheries in the eastern Mediterranean Sea. *Scientia Marina*, *78*(S1), 77–85.

McClanahan, T. R., Sebastián, C. R., & Cinner, J. E. 2016. Simulating the outcomes of resource user- and rule-based regulations in a coral reef fisheries-ecosystem model. *Global Environmental Change*, *38*, 58–69.

Metcalfe, K., Collins, T., Abernethy, K. E., Boumba, R., Dengui, J.-C., Miyalou, R., Parnell, R. J., Plummer, K. E., Russell, D. J. F., Safou, G. K., Tilley, D., Turner, R. A., VanLeeuwe, H., Witt, M. J., & Godley, B. J. 2017. Addressing uncertainty in marine resource management; combining community engagement and tracking technology to characterize human behavior: small-scale fisheries. *Conservation Letters*, *10*(4), 460–469.

Miñarro, S., Navarrete Forero, G., Reuter, H., & van Putten, I. E. 2016. The role of patron-client relations on the fishing behaviour of artisanal fishermen in the Spermonde Archipelago (Indonesia). *Marine Policy*, *69*, 73–83.

Moura, T., Fernandes, A., Alpoim, R., & Azevedo, M. 2016. Unravelling the dynamics of a multi-gear fleet – Inputs for fisheries assessment and management under the Common Fisheries Policy. *Marine Policy*, *72*, 219–230.

Naranjo-Madrigal, H., van Putten, I., & Norman-López, A. 2015. Understanding socio-ecological drivers of spatial allocation choice in a multi-species artisanal fishery: A Bayesian network modeling approach. *Marine Policy*, *62*, 102–115.

Ojea, E., Pearlman, I., Gaines, S. D., & Lester, S. E. 2017. Fisheries regulatory regimes and resilience to climate change. *Ambio*, *46*(4), 399–412.

Pascoe, S., Cannard, T., Jebreen, E., Dichmont, C. M., & Schirmer, J. 2015. Satisfaction with fishing and the desire to leave. *Ambio*, *44*(5), 401–411.

Plank, M. J., Kolding, J., Law, R., Gerritsen, H. D., & Reid, D. 2017. Balanced harvesting can emerge from fishing decisions by individual fishers in a small-scale fishery. *Fish and Fisheries*, *18*(2), 212–225.

Raemaekers, S., Hauck, M., Bürgener, M., Mackenzie, A., Maharaj, G., Plagányi, É. E., & Britz, P. J. 2011. Review of the causes of the rise of the illegal South African abalone fishery and consequent closure of the rights-based fishery. *Ocean & Coastal Management*, *54*(6), 433–445.

Ram-Bidesi, V. 2015. Recognizing the role of women in supporting marine stewardship in the Pacific Islands. *Marine Policy*, *59*, 1–8.

Reddy, S. M., Wentz, A., Aburto-Oropeza, O., Maxey, M., Nagavarapu, S., & Leslie, H. M. 2013. Evidence of market-driven size-selective fishing and the mediating effects of biological and institutional factors. *Ecological Applications*, *23*(4), 726–741.

Robinson, J., Graham, N. A. J., Cinner, J. E., Almany, G. R., & Waldie, P. 2015. Fish and fisher behaviour influence the vulnerability of groupers (Epinephelidae) to fishing at a multispecies spawning aggregation site. *Coral Reefs*, *34*(2), 371–382.

Romero, M. A., Reinaldo, M. O., Williams, G., Narvarte, M., Gagliardini, D. A., & González, R. 2013. Understanding the dynamics of an enclosed trawl demersal fishery in Patagonia (Argentina): A holistic approach combining multiple data sources. *Fisheries Research*, *140*, 73–82.

Russo, T., Pulcinella, J., Parisi, A., Martinelli, M., Belardinelli, A., Santojanni, A., Cataudella, S., Colella, S., & Anderlini, L. 2015. Modelling the strategy of mid-water trawlers targeting small pelagic fish in the Adriatic Sea and its drivers. *Ecological Modelling*, *300*, 102–113.

Saldaña, A., Salas, S., Arce-Ibarra, A. M., & Torres-Irineo, E. 2017. Fishing operations and adaptive strategies of small-scale fishers: Insights for fisheries management in data-poor situations. *Fisheries Management and Ecology*, *24*(1), 19–32.

Samy-Kamal, M., Forcada, A., & Sánchez Lizaso, J. L. 2015. Daily variation of fishing effort and ex-vessel prices in a western Mediterranean multi-species fishery: Implications for sustainable management. *Marine Policy*, *61*, 187–195.

Shepperson, J., Murray, L. G., Mackinson, S., Bell, E., & Kaiser, M. J. 2016. Use of a choice-based survey approach to characterise fishing behaviour in a scallop fishery. *Environmental Modelling & Software*, *86*, 116–130.

Simons, S. L., Döring, R., & Temming, A. 2015. Modelling fishers' response to discard prevention strategies: The case of the North Sea saithe fishery. *ICES Journal of Marine Science*, *72*(5), 1530–1544.

Sogn-Grundvåg, G., & Henriksen, E. 2014. The influence of human rationality and behaviour on fish quality. *Ocean & Coastal Management*, *87*, 68–74.

Sutton, A. M., & Rudd, M. A. 2014. Deciphering contextual influences on local leadership in community-based fisheries management. *Marine Policy*, *50*, 261–269.

Teh, L. C. L., Teh, L. S. L., & Meitner, M. J. 2012. Preferred resource spaces and fisher flexibility: implications for spatial management of small-scale fisheries. *Human Ecology*, *40*(2), 213–226.

Thorson, J. T., Fonner, R., Haltuch, M. A., Ono, K., & Winker, H. 2017. Accounting for spatiotemporal variation and fisher targeting when estimating abundance from multispecies fishery data. *Canadian Journal of Fisheries and Aquatic Sciences*, *74*(11), 1794–1807.

Tidd, A., Brouwer, S., & Pilling, G. 2017. Shooting fish in a barrel? Assessing fisher-driven changes in catchability within tropical tuna purse seine fleets. *Fish and Fisheries*, *18*(5), 808–820.

Tidd, A. N., Hutton, T., Kell, L. T., & Blanchard, J. L. 2012. Dynamic prediction of effort reallocation in mixed fisheries. *Fisheries Research*, *125–126*, 243–253.

Tilman, A. R., Watson, J. R., & Levin, S. 2017. Maintaining cooperation in social-ecological systems: Effective bottom-up management often requires sub-optimal resource use. *Theoretical Ecology*, *10*(2), 155–165.

Torres-Irineo, E., Dreyfus-León, M., Gaertner, D., Salas, S., & Marchal, P. 2017. Adaptive responses of tropical tuna purse-seiners under temporal regulations. *Ambio*, *46*(1), 88–97.

Tsagarakis, K., Palialexis, A., & Vassilopoulou, V. 2014. Mediterranean fishery discards: Review of the existing knowledge. *ICES Journal of Marine Science*, *71*(5), 1219–1234.

Turner, R. A., Gray, T., Polunin, N. V. C., & Stead, S. M. 2013. Territoriality as a Driver of Fishers' Spatial Behavior in the Northumberland Lobster Fishery. *Society & Natural Resources*, *26*(5), 491–505.

van Dijk, D., Haijema, R., Hendrix, E. M. T., Groeneveld, R. A., & van Ierland, E. C. 2013. Fluctuating quota and management costs under multiannual adjustment of fish quota. *Ecological Modelling*, *265*, 230–238.

van Dijk, D., Hendrix, E. M. T., Haijema, R., Groeneveld, R. A., & van Ierland, E. C. 2017. An Adjustment Restriction on Fish Quota: Resource Rents, Overcapacity and Recovery of Fish Stock. *Environmental and Resource Economics*, *67*(2), 203–230.

van Putten, I. E., Kulmala, S., Thébaud, O., Dowling, N., Hamon, K. G., Hutton, T., & Pascoe, S. 2012. Theories and behavioural drivers underlying fleet dynamics models: Theories and behavioural drivers. *Fish and Fisheries*, *13*(2), 216–235.

van Putten, I., Lalancette, A., Bayliss, P., Dennis, D., Hutton, T., Norman-López, A., Pascoe, S., Plagányi, E., & Skewes, T. 2013. A Bayesian model of factors influencing indigenous participation in the Torres Strait tropical rocklobster fishery. *Marine Policy*, *37*, 96–105.

Vaughan, D. 2017. Fishing effort displacement and the consequences of implementing Marine Protected Area management – An English perspective. *Marine Policy*, *84*, 228–234.

Wanyonyi, I. N., Wamukota, A., Tuda, P., Mwakha, V. A., & Nguti, L. M. 2016. Migrant fishers of Pemba: Drivers, impacts and mediating factors. *Marine Policy*, *71*, 242–255.

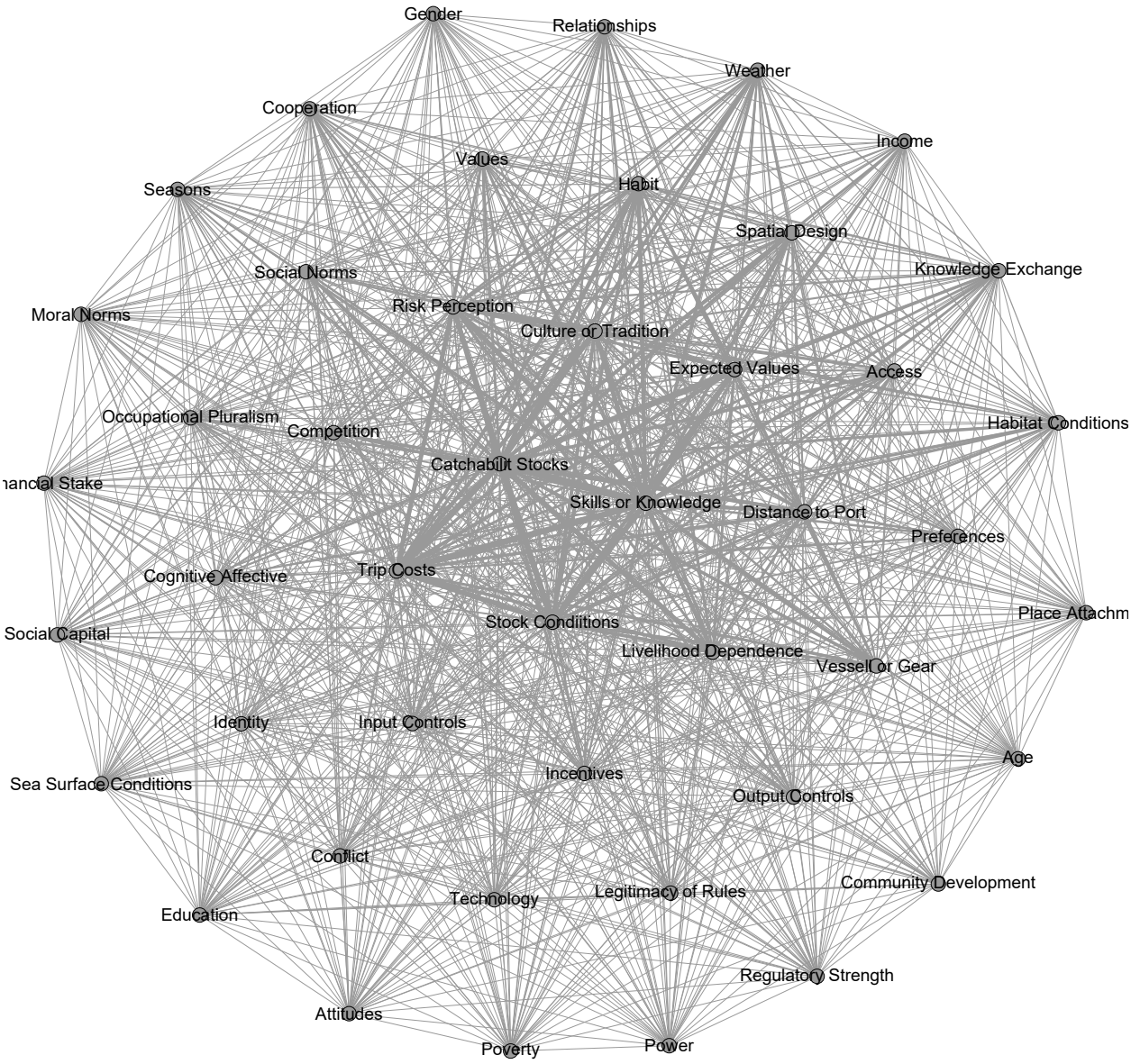
Wise, L., Murta, A. G., Carvalho, J. P., & Mesquita, M. 2012. Qualitative modelling of fishermen's behaviour in a pelagic fishery. *Ecological Modelling*, *228*, 112–122.

Supplementary Material B: Variables, descriptions, and approach to coding for a systematic scoping review

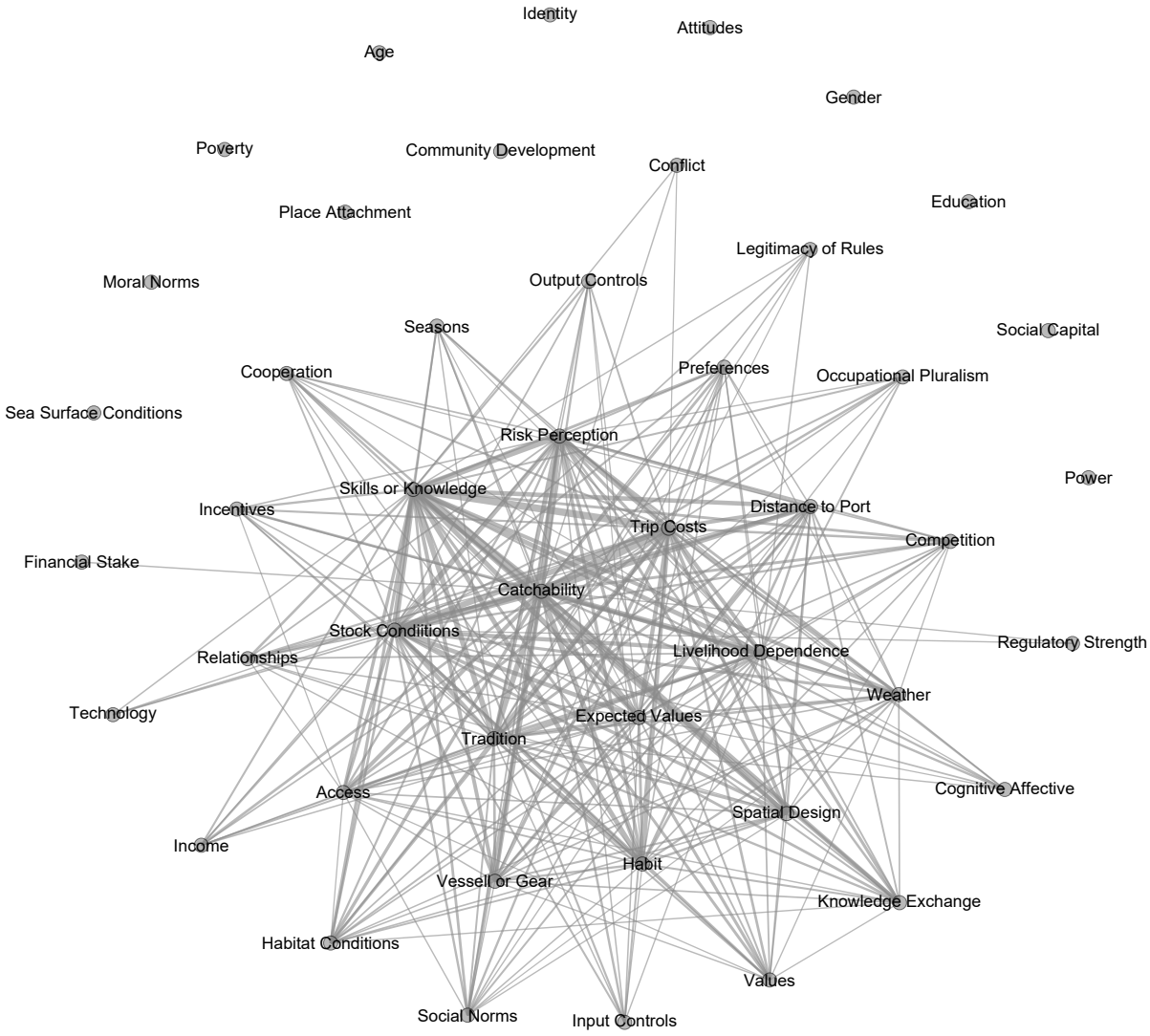
Variable	Description	Approach to Coding
Geographical distribution of case studies	Number of publications and case study (i.e., coastal not fishing area) per country	Counting case study coastal areas in each publication and summing for each country
Methodology	Qualitative, quantitative, and mixed	Coding key terms in research purpose statement or in sentences within research purpose paragraph; Coded only one per publication.
Data source	Insights from people (e.g., fishers), literature, ocean, and industry partners (i.e., organizations and not fishers)	Coded all data sources across sample; Summed them according to codes.
Methods	Number of methods used in each study	Counted the number of distinct methods in each publication; Summed number of methods per publication.
Analysis	Empirical, modelling, review, or blended	Coded analytical approach in key paragraphs in method sections following framework of Essington et al. 2017 (see References)
Motivations for study	Bottom up variable of primary reason for conducting research (e.g., anticipate change, improve management)	Coding key terms in research purpose statement or in sentences within research purpose paragraph; Coded only one per publication. Some publications listed more then one motivation. Primacy was derived by closest motivation to the research purpose statement.
Level of behaviour	The analytical unit for behaviour (e.g., individual, groups, multi-level)	Coded behavioural level from key paragraphs in method sections following similar descriptions of theories in van Putten et al. 2012 (see References)
Behavioural context	The social or environmental setting in which behaviour was studied (i.e., ocean, land and ocean, or land)	Coded setting from key paragraphs in method sections
Policy recommendations	Whether or not recommendations were made to make different decisions in governance	Coded presence or absence of policy recommendations from entire publications.
Management foci	The explicit regulatory controls used to steer behaviour (e.g., output, input, spatial)	Coded specific regulatory controls from entire publicatons (e.g., MPAs, TACs, ITQs). Use category of controls when explicitly listed (e.g., output, input, spatial). When unspecified, binned specific controls to commonly understood categories. Multiple controls were found in many publications. Those were identified as ‘two or more’.

Behavioural types	Schema of behavioural types (i.e., how behaviour was expressed by fishers)	Coded each behavioural type that were examined directly in publications (e.g., identified in methods, results, synthesis, but not introduction or literature review). This was more clear in case studies. For synthetic publications, coding was associated with sections related to substantive insights (e.g., discussion). Some behavioural types were unspecified. These were coded as general. 'General behaviour' was used in networks but not in other descriptions of typology (e.g., Table 2). Sometimes similar behavioural types indicated by different terms (e.g., participation and entry; egress and exit). These were collapsed under one term. Sometimes behavioural types were similar in use and were binned (e.g., effort and fleet dynamics; leadership and cooperation as forms of collective action)
Explanatory goals	Schema of goals authors indicated influenced behaviour	Coded for description of goals explicitly applied in methods, results, and discussion. These presented as theories or as outcomes being pursued by fishers. Some publications did not list goals.
Explanatory factors	Schema of individual factors used to explain behaviour	Coded for explanatory factors that were associated and/or correlated with behaviours. Only coded factors that were validated directly or assumed to be validated in relation to behaviour. Many papers included multiple factors. Factors were summed and presented across the entire dataset. Some overlap in factors may exist as no collapsing of factors was conducted in larger list. Conducted a binning by examining the context in which the factor was described. Often bins were explicitly described in methods and results.

Supplementary Material C: Unipartite network of explanatory factors validated to explain fisher behaviour



Supplementary Material D: Unipartite network of explanatory factors validated to explain fisher behaviour featuring 25% of most commonly co-occurring variables



Supplementary Material E: Semi-structured interview protocol

1. Fishers respond to fisheries management interventions (e.g., adjusting licensing conditions, changing quotas, seasonal closures) in different ways. In your role, how do you plan for the responses of fishers as you develop and guide the implementation of management interventions? In what decision-making contexts is the planning conducted?

2. In your role, what do you do when fishers respond unexpectedly to fisheries management interventions?

3. What are the main barriers to better understand fisher behaviour and the implications for management? Why?

4. What opportunities exist to better understand fisher behaviour and the implications for management? Why?

5. What improvements could be made in the fisheries management process to their practices to better anticipate human behaviour?

Supplementary Material F: List of documents reviewed with codes and references

Code	Document Description	Reference
FMP1	Integrated fisheries management plan for groundfish in the Newfoundland and Labrador region (NAFO Division 3P)	DFO. 2016. *Groundfish (NAFO) Division 3Ps – updated 2016*. Ottawa: Author.
FMP2	Integrated fisheries management plan for groundfish in the Newfoundland and Labrador region (NAFO Subarea 2 + Divisions 3KLMNO)	DFO. 2019. *Groundfish Newfoundland and Labrador region NAFO Subarea 2 + Divisions 3KLMNO*. Ottawa: Author.
FMP3	Integrated fisheries management plan for groundfish in the Newfoundland and Labrador region (4VWX5 groundfish – Maritimes region)	DFO. 2018. *4VWX5 groundfish – Maritimes region*. Ottawa: Author.
FMP4	Integrated fisheries management plan for herring in the Newfoundland and Labrador region (4R3PN)	DFO. 2017. *Herring – Newfoundland and Labrador region 4RSPn*. Ottawa: Author
FMP5	Integrated fisheries management plan for herring in the Newfoundland and Labrador region (2+3 - Herring Fishing Areas 1-11)	DFO. 2019. *Herring – Newfoundland and Labrador region 2+3 (herring fishing areas 1-11).* Ottawa: Author.
FMP6	Rebuilding plan for herring in the Maritimes region (SWNS)	DFO. 2013. *Canadian Atlantic herring (Clupea harengus) – SWNS rebuilding plan – Atlantic Canada – 2013.* Ottawa: Author.
FMP7	Integrated fisheries management plan for Atlantic Mackerel in all Atlantic regions	DFO. 2007. *Integrated fisheries management Atlantic mackerel*. Ottawa: Author.
FMP8	Rebuilding plan for Atlantic cod in the Maritimes region (NAFO Division 5Z)	DFO. 2019. *Rebuilding plan for Atlantic cod – NAFO Division 5Z.* Ottawa: Author.
FMP9	Rebuilding plan for Atlantic cod in the Maritimes region (NAFO Division 4X5Y)	DFO. 2019. *Rebuilding plan for Atlantic cod – NAFO Division 4X5Y.* Ottawa: Author.
FMP10	Integrated fisheries management plan for lobster in the Southern Gulf of St. Lawrence	DFO. 2015. *Lobster in the Southern Gulf of St. Lawrence*. Ottawa: Author.
FMP11	Integrated fisheries management plan for lobster in the Newfoundland and Labrador region (LFA 3-14C)	DFO. 2019. *American lobster - Lobster fishing area 3-14C.* Ottawa: Author.
FMP12	Integrated fisheries management plan for capelin in the Newfoundland and Labrador Regions 2+3 (Capelin Fishing Areas 1-11)	DFO. 2019. *Capelin (Mallotus villosus) Newfoundland & Labrador region Divisions 2+3 (Capelin Fishing Areas 1-11).* Ottawa: Author

FMP13	Integrated fisheries management plan for inshore scallops in the Maritimes region.	DFO. 2017. *Inshore scallop – Maritimes region 2015*. Ottawa: Author.
FMP14	Integrated fisheries management plan for scallop in the Newfoundland and Labrador region	DFO. 2019. *Scallop – Newfoundland and Labrador*. Ottawa: Author.
FMP15	Integrative fisheries management plan for snow crab in the Maritimes region (Eastern Nova Scotia and 4X)	DFO. 2016. *Eastern Nova Scotia and 4X Snow Crab (Chionoecetes Opillio) – Effective as of 2013*. Ottawa: Author.
FMP16	Integrated fisheries management plan for snow crab in the Southern Gulf of St. Lawrence (Crab Fishing Areas 12, 12E, 12F, 19)	DFO. 2014. *Snow crab in the Southern Gulf of Saint Lawrence: Crab Fishing Areas 12, 12E, 12F, 19.* Ottawa: Author.
FMP17	Integrated fisheries management plan for Northern shrimp in the Newfoundland and Labrador region (Shrimp Fishing Areas 0-7 and the Flemish Cap).	DFO. 2009. *Northern shrimp (SFAs) 0-7 and the Flemish Cap*. Ottawa: Author.
FMP18	Integrated fisheries management plan for northern shrimp and striped shrimp in the Newfoundland and Labrador region (Shrimp Fishing Areas 0,1, 4-7, the Eastern and Western Assessment Zones, and NAFO Division 3).	DFO. 2018. *Northern shrimp and striped shrimp – Shrimp fishing areas 0,1,4-7, the Eastern and Western Assessment Zones, and North Atlantic Fisheries Organization (NAFO) Division 3M*. Ottawa: Author.
FMP19	Integrated fisheries management plan for shrimp in the Maritimes region (Scotian Shelf)	DFO. 2014. *Shrimp (Pandalus borealis) – Scotian Shelf – as of 2013*. Ottawa: Author
FMP20	Integrated fisheries management plan for lobster in the Maritimes region (Lobster Fishing Areas 27-38).	DFO. 2020. *Lobster fishing areas – 27-38: Integrated fisheires management plan*. Ottawa: Author.
FMP21	Integrated fisheries management plan for snow crab in the Newfoundland and Labrador region	DFO. 2019. *Snow crab – Newfoundland and Labrador region*. Ottawa: Author.
SA1	Questions and summary results from the sustainability survey in 2017	DFO. 2019. *Summary of 2017 sustainability survey for fisheries*. Ottawa: Author
SA2	Questions and summary results from the sustainability survey in 2018	DFO. 2019. *Summary of 2017 sustainability survey for fisheries*. Ottawa: Author
SA3	Statistical and economic analysis of individual transferrable quotas in Canada	Economic Analysis and Statistics Branch, DFO. 2012. IQ fisheries in Canada: linking business outcomes to management practices. In Statistical and economic analysis series: economic analysis. Ottawa: Author.

SA4	Stock assessment of Northern shrimp in Newfoundland and Labrador region (Shrimp Fishing Areas 4-6) in 2017	DFO. 2019. *An assessment of Northern Shrimp (Pandalus borealis) in shrimp fishing areas 4-6 in 2017*. Ottawa: CSAS.
SA5	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Divisions 2JKL) in 2016	DFO. 2016. *Stock assessment of Northern cod (NAFO divs. 2J3KL) in 2016*. Ottawa: CSAS.
SA6	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Subdivision 3Ps) in 2016	DFO. 2016. *Stock assessment of NAFO subdivision 3Ps cod*. Ottawa: CSAS.
SA7	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Subdivision 3Ps) in 2017	DFO. 2017. *Stock assessment of NAFO subdivision 3Ps cod*. Ottawa: CSAS.
SA8	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Divisions 2JKL) in 2018	DFO. 2018. *Stock assessment of Northern cod (NAFO divs. 2J3KL) in 2018*. Ottawa: CSAS.
SA9	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Subdivision 3Ps) in 2019	DFO. 2019. *Stock assessment of NAFO subdivision 3Ps cod*. Ottawa: CSAS.
SA10	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Divisions 2JKL) in 2019	DFO. 2019. *Stock assessment of Northern cod (NAFO divs. 2J3KL) in 2019.* Ottawa: CSAS.
SA11	Stock assessment of Atlantic cod in the Newfoundland and Labrador region (NAFO Subdivision 3Ps) in 2020	DFO. 2020. *Stock assessment of NAFO subdivision 3Ps cod*. Ottawa: CSAS.
SA12	Stock assessment of capelin in the Newfoundland and Labrador region (SA2 and DIVs3Kl) in 2017	DFO. 2018. *Assessment of capelin in SA2 and divs 3KL in 2017.* Ottawa: CSAS.
SA13	Stock assessment of capelin in the Newfoundland and Labrador region (SA2 and DIVs3Kl) in 2018	DFO. 2019. *Assessment of capelin in SA2 and divs 3KL in 2018.* Ottawa: CSAS.
SA14	Stock assessment for snow crab in the Newfoundland and Labrador region (Divisions 2HJ3KLNOP4R) in 2016	DFO. 2016. *Assessment of Newfoundland and Labrador (divisions 2H3KLNOP4R) snow crab.* Ottawa: CSAS.
SA15	Stock assessment for snow crab in the Newfoundland and Labrador region (Divisions 2HJ3KLNOP4R) in 2018	DFO. 2018. *Assessment of Newfoundland and Labrador (divisions 2H3KLNOP4R) snow crab.* Ottawa: CSAS.

SA16	Stock assessment for snow crab in the Newfoundland and Labrador region (Divisions 2HJ3KLNOP4R) in 2019	DFO. 2019. *Assessment of Newfoundland and Labrador (divisions 2H3KLNOP4R) snow crab.* Ottawa: CSAS.
SA17	Stock assessment of herring in the Newfoundland and Labrador region (east and south coast) up to 2016	DFO. 2017. *Assessment of Newfoundland east and south coast herring to the spring of 2016.* Ottawa: CSAS.
SA18	Stock assessment of herring in the Newfoundland and Labrador region (east and south coast) for 2017 and 2018	DFO. 2019. *Assessment of Newfoundland east and south coast herring in 2017 and 2018.* Ottawa: CSAS.
SA19	Stock assessment of American lobster in the Newfoundland and Labrador region for 2016	DFO. 2016. *Assessment of American lobster in Newfoundland.* Ottawa: CSAS.
SA20	Stock assessment of redfish in Newfoundland and Labrador region (Units 1 and 2) in 2015	DFO. 2016. *Assessment of redfish stocks (Sebastes fasciatus and S. mentella) in units 1 and 2 in 2015*. Ottawa: CSAS.
SD21	Stock assessment of redfish in Newfoundland and Labrador region (Units 1 and 2) in 2019	DFO. 2020. *Assessment of redfish stocks (Sebastes fasciatus and S. mentella) in units 1 and 2 in 2019*. Ottawa: CSAS.
SA22	Stock assessment of Northern shrimp (Shrimp Fishing Areas 4-6) and striped shrimp (Shrimp Fishing Area 4) in Newfoundland and Labrador region in 2018	DFO. 2019. *An assessment of northern shrimp (Pandalus borealis) in shrimp fishing areas 4-6 and of striped shrimp (Pandalus montagui) in shrimp fishing area 4 in 2018*. Ottawa: CSAS.
SA23	Stock assessment of Atlantic herring in the Southern Gulf of Lawrence (spring and fall components in NAFO div. 4T). for 2016 and 2017.	DFO. 2016. *Assessment of the Southern Gulf of St. Lawrence (NAFO div. 4t) spring and fall spawner components of Atlantic herring (Clupea harengus) with advice for the 2016 and 2017 fisheries.* Ottawa: CSAS.
SA24	Stock assessment of Atlantic herring in the Southern Gulf of Lawrence (spring and fall components in NAFO div. 4T). for 2016 and 2017.	DFO. 2018. *Assessment of the Southern Gulf of St. Lawrence (NAFO div. 4t) spring and fall spawner components of Atlantic herring (Clupea harengus) with advice for the 2018 and 2019 fisheries.* Ottawa: CSAS.
SA25	Stock assessment of snow crab in the Southern Gulf of Lawrence (Areas 12, 19, 12E and 12F) to 2016 and advice for 2017	DFO. 2016. *Assessment of snow crab (Chionoecetes opilio) in the Southern Gulf of St. Lawrence (areas 12, 19, 12E and 12F) to 2016 and advice for the 2017 fishery*. Ottawa: CSAS.

SA26	Stock assessment of snow crab in the Southern Gulf of Lawrence (Areas 12, 19, 12E and 12F) to 2017 and advice for 2018	DFO. 2017. *Assessment of snow crab (Chionoecetes opilio) in the Southern Gulf of St. Lawrence (areas 12, 19, 12E and 12F) to 2017 and advice for the 2018 fishery*. Ottawa: CSAS.
SA27	Stock assessment of snow crab in the Southern Gulf of Lawrence (Areas 12, 19, 12E and 12F) to 2016 and advice for 2019	DFO. 2018. *Assessment of snow crab (Chionoecetes opilio) in the Southern Gulf of St. Lawrence (areas 12, 19, 12E and 12F) to 2018 and advice for the 2019 fishery*. Ottawa: CSAS.
SA28	Stock assessment of Atlantic cod in the Southern Gulf of Lawrence (NAFO Div. 4T-4VN) for November to April 2018.	DFO. 2019. A*ssessment of Atlantic cod (Gadus morhua) in the Southern Gulf of St. Lawrence (NAFO div. 4t-4vn (nov. – april)) to 2018.* Ottawa: CSAS.
SA29	Stock assessment of Atlantic cod in the Maritimes region (NAFO Divisions 4X5Y) for 2019	DFO. 2019. Stock assessment of Atlantic cod (Gadus morhua) in NAFO divisions 4X5Y. Ottawa: CSAS.
SA30	Stock assessment of snow crab in the Maritimes region (Nova Scotia 4VWX) for 2017	DFO. 2017. A*ssessment of Nova Scotia (4VWX) snow crab 2017.* Ottawa: CSAS.
SA31	Stock assessment of snow crab in the Maritimes region (Scotian Shelf) for 2019	DFO. 2019. *Assessment of Scotian Shelf snow crab*. Ottawa: CSAS.
SA32	Stock assessment of snow crab in the Maritimes region (Nova Scotia 4VWX) for 2018	DFO. 2018. A*ssessment of Nova Scotia (4VWX) snow crab 2018.* Ottawa: CSAS.
SA33	Stock assessment of lobster in the Maritimes region (LFA33) for 2018	DFO. 2020. A*ssessment of lobster (Homarus americanus) in lobster fishing area 33 for 2018.* Ottawa: CSAS.
SA34	Stock assessment of Northern shrimp in the Maritimes region (Eastern Scotian Shelf, SFAs 13-15) for 2017	DFO. 2017. *Assessment of northern shrimp on the Eastern Scotian shelf (SFAs 13-15).* Ottawa: CSAS.
SA35	Stock assessment of Northern shrimp in the Maritimes region (Eastern Scotian Shelf, SFAs 13-15) for 2019	DFO. 2019. *Assessment of northern shrimp on the Eastern Scotian shelf (SFAs 13-15).* Ottawa: CSAS.
SA36	Stock assessment of scallops in the Maritimes region (scallop production areas 1 to 6, Bay of Fundy) for 2016	DFO. 2016. A*ssessment of scallops (Placopecten magellanicus) in scallop production areas 1 to 6 in the Bay of Fundy.* Ottawa: CSAS.
PD1	A framework for incorporating social and economic impacts into MPA design for 2016; involves discussion of inshore fishers	Economic Policy and Research, DFO. 2016. *Framework for integrating socio-economic analysis in the marine protected areas designation process.*

		Ottawa: Economic Analysis and Statistics Directorate.
PD2	Guidance on incorporating economic impacts into MPA design for 2016; involves discussion of inshore fishers	Economic Policy and Research, DFO. 2017. *Guidance on incorporating economic use information in the marine protected area network design.* Ottawa: Economic Analysis and Statistics Directorate.
PD3	Policy document that outlines the principles of ecosystem-based approaches to fisheries management	DFO. 2009. *Principles of ecosystem-based management* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/ecosys-back-fiche-eng.htm
PD4	An overview of projects, principles, and publications that involve economic analyses for fisheries management	DFO 2020. *Economic analysis* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/ea-ae/economic-analysis-eng.htm
PD5	A policy document that outlines sustainable fisheries framework that includes principles commercial fisheries and policies under the framework	DFO. 2019. *Sustainable fisheries framework* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/overview-cadre-eng.htm
PD6	A backgrounder for a policy on new fisheries for forage fish species fisheries	DFO. 2009. *Backgrounder: policy on new fisheries for forage species* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/forage-back-fiche-eng.htm
PD7	A policy with principles and objectives for managing new forage fish species fisheries	DFO. 2009. *Policy on new fisheries for forage species* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/forage-eng.htm
PD8	Guidance on implementing a policy on managing bycatch	DFO. 2019. *Guidance on implementation of the policy on managing bycatch*. Ottawa: Author.
PD9	A policy on managing bycatch	DFO. 2019. *Policy on managing bycatch.* Ottawa: Author.
PD10	A description on how the sustainable fisheries framework is to be implemented through integrated fisheries management planning.	DFO 2009. *Application of the sustainable fisheries framework through the integrated fisheries management planning process* [Online]. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/ifmp-pgip-back-fiche-eng.htm

PD11	A policy for managing the impacts of fishing on sensitive benthic areas	DFO. 2009. *Policy for managing the impacts of fishing on sensitive benthic areas* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/benthi-eng.htm
PD12	A policy framework for incorporating the precautionary approach into fisheries management	DFO. 2009. *A fishery decision-making framework for incorporating the precautionary approach* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm
PD13	A framework for determining ecological risk in the application of the policy to manage the impacts of fishing on sensitive benthic areas.	DFO. 2019. *Ecological risk assessment framework for coldwater corals and sponge dominated communities.* Ottawa: Author.
PD14	An example of a harvest strategy (management decision) for fisheries that is compliant with the precautionary approach	DFO. 2006. *A harvest strategy compliant with the precautionary approach*. Ottawa: CSAS.
PD15	Guidance for the developing of rebuilding plans using the precautionary approach	DFO. 2019. *Guidance for the development of rebuilding plans under the precautionary approach framework: growing stocks out of the critical zone*. Ottawa: Author.
PD16	A policy that describes how fisheries are monitored	DFO 2019. *Fishery monitoring policy.* Ottawa: Author.
PD17	Guidance on the specific steps take to implement the fishery monitoring policy	DFO. 2019. *Introduction to the procedural steps for implementing the fishery monitoring policy* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/fmp-implementation-psp-mise-en-oeuvre-eng.htm
PD18	A policy and implementation framework for the integrated management	DFO**.** 2002/2016. *Policy and operational framework for integrated management of estuarine, coastal and marine environments in Canada.*
PD19	A framework for making decisions on access to fisheries that are emerging and have undergone increases to abundance or landed value in the Atlantic Canada	DFO. 2002. *New access framework* [Online]. Ottawa; Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/access-acces-eng.htm
PD20	A policy that sets priorities for preserving the inshore fisheries	DFO. 2010. *Policy for preserving the independence of the inshore fleet in Canada's Atlantic fisheries* [Online].

		https://www.dfo-mpo.gc.ca/reports-rapports/regs/piifcaf-policy-politique-pifpcca-eng.htm
PD21	A policy on that constrains issuing licences to companies in the inshore fisheries for Atlantic Canada	DFO. 2017. *Policy on issuing licenses to companies for Canada's inshore Atlantic fisheries* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/ilc-dpe/pol-eng.htm
PD22	A policy that prescribes access and allocation principles for new emerging fisheries	DFO. 2008. *New emerging fisheries policies* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/efp-pnp-eng.htm
PD23	A policy that defines, prescribes, and guides commercial fishing licensing for Atlantic fisheries, known as either the Atlantic Fisheries Licensing Policy or the Commercial Fisheries Licensing Policy for Eastern Canada	DFO. 1996. *Commercial Fisheries Licensing Policy for Eastern Canada* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/licences-permis/index-eng.htm
PD24	A policy that specifies application of the Atlantic Fisheries Licensing policy in the Newfoundland and Labrador region	DFO. 2019. *Fisheries licensing policy Newfoundland and Labrador* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/licences-permis/index-nfld-Labrador-tn-labrador-eng.htm
PD25	A policy that specifies application of the Atlantic Fisheries Licensing policy in the Gulf region	DFO. 2010. *Commercial fisheries licensing policy for the Gulf region.* Ottawa: Author.
PD26	A policy that specifies application of the Atlantic Fisheries Licensing policy in the Maritimes region	DFO. 2020. *Maritimes region commercial fisheries licensing policy* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/licences-permis/maritimes/licensing-pol-permis-peche-eng.htm
PD27	Canada's Fisheries Act that sets the regulatory foundation for fisheries management in Canada	Fisheries Act, RSC 1985, c F-14
PD28	Canada's Oceans Act that sets the regulatory foundation for managing Canada's oceans	Oceans Act, SC 1996, c 31
PD29	The Species at Risk Act that sets the regulatory foundation for protecting wildlife fish species in Canada	Species at Risk Act, SC 2002, c 29

PD30	A set of regulations for managing fisheries in Canada (Canada's Fisheries Act)	Fishery (General) Regulations, SOR/93-53
PD31	A set of regulations for managing the maritime provinces fisheries (Canada's Fisheries Act)	Maritime Provinces Fishery Regulations, SOR/93-55
PD32	A set of regulations for managing the Newfoundland and Labrador fisheries	Newfoundland and Labrador Fishery Regulations, SOR/78-443
PD33	A set of regulations for managing fisheries in the Atlantic	Atlantic Fishery Regulations, 1985, SOR/86-21
PD34	Principles outlined to implement ecosystem-based approaches to fisheries management	DFO. 2009. *Principles of ecosystem-based management* [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/ecosys-back-fiche-eng.htm
E1	An evaluation of the compliance and enforcement program in fisheries management in 2016	DFO. 2016. *Evaluation of compliance and enforcement program*. Ottawa: Evaluation Directorate.
E2	An evaluation of science funding in DFO	DFO. 2019. *Evaluation of science funding*. Ottawa: Evaluation Directorate. Ottawa: Evaluation Directorate.
E3	An evaluation of CSAS	DFO. 2019. *Evaluation of the Canadian Science Advisory Secretariat (CSAS)*. Ottawa: Evaluation Directorate.
E4	A review of fisheries policies and policy framework for fisheries in Atlantic Canada	DFO 2004. Atlantic fisheries policy review – A policy framework for the management of fisheries on Canada's Atlantic Coast [Online]. Ottawa: Author. https://www.dfo-mpo.gc.ca/reports-rapports/regs/afpr-rppa/framework-cadre-eng.htm
E5	Plans and results for various DFO departments from 2017-2018	Minister of Fisheries, Oceans, and the Canadian Coast Guard. 2016/2018. *2017-2018 Departmental plan*. Ottawa: Author.
E6	Plans and results for various DFO departments from 2018-2019	Minister of Fisheries, Oceans, and the Canadian Coast Guard. 2017/2019. *2018-2019 Departmental plan*. Ottawa: Author.
E7	Plans for various DFO departments from 2019-2020	Minister of Fisheries, Oceans, and the Canadian Coast Guard. 2018. *2019-2020 Departmental plan*. Ottawa: Author

E8	Plans for various DFO departments from 2020-2021	Minister of Fisheries, Oceans, and the Canadian Coast Guard. 2019. *2020-2021 Departmental plan*. Ottawa: Author

Supplementary Material G: Referral Letter (Narrative Interviews)

Evan Andrews
School of Environment, Resources and Sustainability
University of Waterloo
Ontario
[redacted]

I have asked the person who contacted you to identify potential participants for my study on the Shrimp fishery in Newfoundland. I am a doctoral researcher in the School of Environment, Resources and Sustainability at the University of Waterloo in Ontario under the supervision of Dr. Derek Armitage. As someone residing and working in a community with a large number of shrimp fishers, your perspective can make an important contribution to understanding how the fisheries management could be improved. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

The shrimp fishery in Newfoundland has been one of the most important fisheries in Atlantic Canada. However, recent years have seen significant changes to the fishery and its management, including major declines in the size of shrimp quotas. The purpose of this study is to understand (1) how fishers and other stakeholders think and feel about change to the fishery and its management, (2) how you have responded to changes to the fishery and its management in the past, and (3) how fisheries management might be changed to better address your thoughts, feelings, and responses to change to the fishery and its management. A later phase of the study involves asking fisheries managers about whether and how they consider your perspectives.

Participation in this study is voluntary. I would like to interview you to better understand your thoughts, feelings, and responses to fishery and fisheries management changes. As a part of the interview you will be asked to share stories important to you about your experiences with change. With your permission, I would like to video record your stories. This allows me to analyze the video, audio and transcript of the interview.

The completion of the interview is expected to take about ninety minutes, although you can share as little or as many stories as you wish. As such, you may decline to share stories about certain themes if you wish. Further, you may decide to withdraw from this study at any time without any negative consequences. Shortly after the interview has been completed, I will send you a summary of the interview and a digital copy of the interview to give you an opportunity to determine (a) if the video recording accurate represents our conversation, and (b) whether there are some parts of the interview you wish to change or exclude. In addition, you will have **six months** to change your mind about your participation in the study. For example, you may choose to withdraw from the study, not have your interview video or audio recorded at the time of the interview or to have only the transcript or notes of your interview included in the study and report of results.

You may choose to have your participation confidential, in which case the video or audio recordings of the interview will not be used in the reporting of the results. The dataset without identifiers may be shared publicly. Your identity will be confidential if you choose. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. All information that could identify you will be removed from the data I have collected **within 6 weeks** and stored separately in an encrypted document.

Some anticipated risks to your participation might include: 1) psychological or emotional risks, since I will be asking you to share their thoughts, feelings, and responses to events in their past and you may experience some discomfort participating in a video recorded interview; 2) social risks, since I will be asking you about your relationships with others; and 3) economic risks, since you may end up discussing people who influence your employment in the fishing industry. To mitigate these risks, we encourage you to openly indicate discomfort and to express concerns that you may have at any time.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at [redacted] or by e-mail at [redacted]. You can also contact my supervisor, Professor Derek Armitage at [redacted] or email [redacted]. I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. The final decision about participation is yours.

Thank you in advance for your interest in this project.

Yours sincerely,

Evan Andrews

Supplementary Material H: Information Letter and Consent Form (Narrative Interviews)

(Insert date)

Dear ***(Insert Name of Participant),***

This letter is an invitation to consider participating in a study I am conducting as part of my doctoral degree in the School of Environment, Resources, and Sustainability at the University of Waterloo under the supervision of Professor Derek Armitage. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

The shrimp fishery in Newfoundland has been one of the most important fisheries in Atlantic Canada. However, recent years have seen significant changes to the fishery and its management, including major declines in the size of shrimp quotas. The purpose of this study is to understand (1) how fishers and other stakeholders think and feel about change to the fishery and its management, (2) how you have responded to changes to the fishery and its management in the past, and (3) how fisheries management might be changed to better address your thoughts, feelings, and responses to change to the fishery and its management. As someone residing and working in a community with a large number of shrimp fishers, your thoughts, feelings and responses to change can make an important contribution to understanding how the fisheries management could be improved. A later phase of the study involves asking fisheries managers about whether and how they consider your perspective.

Participation in this study is voluntary. I would like to interview you to better understand your thoughts, feelings, and responses to fishery and fisheries management changes. As a part of the interview you will be asked to share stories important to you about your experiences with change. With your permission, I would like to video record your stories. This allows me to analyze the video, audio and transcript of the interview.

The completion of the interview is expected to take about ninety minutes, although you can share as little or as many stories as you wish. As such, you may decline to share stories about certain themes and skip any question you prefer not to answer. Further, you may decide to withdraw from this study at any time without any negative consequences. Shortly after the interview has been completed, I will send you a summary of the interview and a digital copy of the interview to give you an opportunity to determine (a) if the video recording accurate represents our conversation, and (b) whether there are some parts of the interview you wish to change or exclude. In addition, you will have six months (Date: _____) to change your mind about your participation in the study. For example, you may choose to withdraw from the study, not have your interview video or audio recorded at the time of the interview or to have only the transcript or notes of your interview included in the study and report of results.

You may choose to have your participation confidential, in which case the video or audio recordings of the interview will not be used in the reporting of the results. Your name will not appear in any thesis or reports resulting from this study. However, with your permission

anonymous quotations may be used. Instead of your name, quotations you provided will be accompanied by an identifier such as 'Fisher', 'Fishing Industry Worker', 'Resident' or 'Community Leader'. The dataset without identifiers may be shared publicly. Your identity will be confidential if you choose. All information that could identify you will be removed from the data I have collected within 6 weeks (Date: _____) and stored separately in an encrypted document. You may also opt to have your face blurred in any video segments used in results reporting. All information will be password protected. Identifying information and study records will be retained for a minimum of 7 years in my supervisor's locked office. Only my supervisor and I will have access.

Your decision whether or not to participate in this study will not affect your membership with the Northern Newfoundland inshore Shrimp Fishery. However, some anticipated risks to your participation might include: 1) psychological or emotional risks, since I will be asking you to share their thoughts, feelings, and responses to events in their past and you may experience some discomfort participating in a video recorded interview; 2) social risks, since I will be asking you about your relationships with others; and 3) economic risks, since you may end up discussing people who influence your employment in the fishing industry. To mitigate these risks, we encourage you to openly indicate discomfort and to express concerns that you may have at any time. In addition, these risks may be further mitigated by choosing to keep your identity confidential.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at [redacted] or by e-mail at [redacted] You can also contact my supervisor, Professor Derek Armitage at [redacted] or email [redacted]

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #22704). If you have any comments or concerns resulting from your participation in this study, please contact the Chief Ethics Officer, Office of Research Ethics at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca

I hope that the results of my study will be of benefit to the inshore shrimp shrimp fishery in Newfoundland and fisheries management by providing insights and recommendations about how to better address through fisheries management the thoughts, feelings, and responses of fishers, fish processors, fish industry leaders, and their communities. I also hope that the results of my study will be of benefit to the broader research community by providing information on the relationship human behaviour, emotions, and fisheries management.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Evan Andrews

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Evan Andrews of the School of Environment, Resources and Sustainability at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be video recorded to ensure an accurate recording of my responses.

With permission, I am also aware that excerpts from the interview may be included in the thesis, publications, and other presentations or outputs to come from this research.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher until a six month (Date: _____) period after receiving a summary of my interview.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #22704). If you have any comments or concerns resulting from your participation in this study, please contact the Chief Ethics Officer, Office of Research Ethics at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca

With full knowledge of all foregoing, I agree, of my own free will, to participate in an interview for this study.

☐YES ☐NO

I agree to have my interview video recorded.

☐YES ☐NO

If no, I agree to have my interview audio recorded only.

☐YES ☐NO

I agree to the use of video clips from my interview in research results reporting.

☐YES ☐NO

If yes, I wish to have my face blurred in research results reporting.

☐YES ☐NO

I agree to the use of audio clips from my interview in research results reporting.

☐YES ☐NO

I agree to the use of anonymous quotations in any research results reporting.

☐YES ☐NO

I agree to be contacted with a summary of my interview transcript by the following method. I understand that the confidentiality of the summary cannot be guaranteed over e-mail.

☐E-MAIL ☐LETTER MAIL ☐TELEPHONE

Participant Contact: _____ (Please choose one)

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

Date: _____

Supplementary Material I: Recruitment Letter (Semi-structured Interviews)

Evan Andrews
School of Environment, Resources and Sustainability
University of Waterloo
Ontario
[redacted]

(Insert date)

Dear ***(Insert Name of Participant),***

I have asked the person who contacted you to identify potential participants for my study on the Shrimp fishery in Newfoundland. I am a doctoral researcher in the School of Environment, Resources and Sustainability at the University of Waterloo in Ontario under the supervision of Dr. Derek Armitage. As someone involved in the management of the shrimp fishery, your perspective can make an important contribution to understanding how the fisheries management could be improved. If you are interested in participating in this study, please read the following details about this research project and contact me at [redacted] or [redacted].

The shrimp fishery in Newfoundland has been one of the most important fisheries in Atlantic Canada. However, recent years have seen significant changes to the fishery and its management, including major declines in the size of shrimp quotas. The purpose of this study is to understand (1) how fishers and other stakeholders think and feel about change to the fishery and its management, (2) how they have responded to changes to the fishery and its management in the past, and (3) how fisheries management might be changed to better address their thoughts, feelings, and responses to change to the fishery and its management. An earlier phase of this study involved video recorded interviews with fishers, fish processors, fish industry leaders, and fishing community members about their thoughts, feelings, and behavioural responses to change.

Participation in this study is voluntary. I would like to interview you for approximately one hour to better understand your perspectives about fisher and other stakeholder behaviour, changes to the fishery, and fisheries management. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time until six months after you receive a summary of your interview without any negative consequences by advising the researcher. Participation in this project is voluntary and may be confidential depending on your preference.

If after reading this letter, you have any questions about this study, or would like additional information to assist you in reaching a decision about participation, please feel free to contact me at [redacted] or [redacted] or Dr. Derek Armitage at [redacted] or [redacted]. I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. The final decision about participation is yours.

Thank you in advance for your interest in this project.

Yours sincerely,

Evan Andrews

Supplementary Material J: Information Letter and Consent Form (Semi-structured Interviews)

(Insert date)

Dear ***(Insert Name of Participant),***

This letter is an invitation to consider participating in a study I am conducting as part of my doctoral degree in the School of Environment, Resources, and Sustainability at the University of Waterloo under the supervision of Professor Derek Armitage. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

The shrimp fishery in Newfoundland has been one of the most important fisheries in Atlantic Canada. However, recent years have seen significant changes to the fishery and its management, including major declines in the size of shrimp quotas. The purpose of this study is to understand (1) how fishers and other stakeholders think and feel about change to the fishery and its management, (2) how they have responded to changes to the fishery and its management in the past, and (3) how fisheries management might be changed to better address their thoughts, feelings, and responses to change to the fishery and its management. As someone involved in the management of the shrimp fishery, your perspective can make an important contribution to understanding how the fisheries management could be improved. An earlier phase of this study involved video recorded interviews with fishers, fish processors, fish industry leaders, and fishing community members about their thoughts, feelings, and behavioural responses to change. Participation in this study is voluntary. I would like to interview you for approximately one hour to better understand your perspectives about fisher and other stakeholder behaviour, changes to the fishery, and fisheries management. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time until six months (Date: _____) after you receive a summary of your interview without any negative consequences by advising the researcher. With your permission, the interview will be audio recorded to facilitate collection of information, and for transcription and analysis purposes. In these audio recordings, your name will not be used, but your voice will be heard. Shortly after the interview has been completed, I will send you a summary of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

Your decision whether or not to participate in this study will not affect your role in the governance of the Northern Newfoundland inshore Shrimp Fishery. Some anticipated risks to your participation might include: 1) psychological and emotional risks, since I will be asking you questions about your role in fisheries management; 2) emotional and social risks, since I will be asking you about your relationships with others; and 3) economic risks, since you may end up discussing people who influence your ability to perform your duties in fisheries management. To mitigate these risks, we encourage you to openly indicate discomfort and to express concerns that you may have at any time. In addition, these risks may be further mitigated by choosing to keep your identity confidential.

The dataset without identifiers may be shared publicly. Your identity will be confidential if you choose. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Instead of your name, quotations you provided will be accompanied by an identifier such as 'Fisheries Governance Member'. All information that could identify you will be removed from the data I have collected within six weeks (Date: _____) and stored separately in an encrypted document. Additionally, all information will be password protected. Identifying information and study records will be retained for a minimum of 7 years in my supervisor's locked office. Only researchers associated with this project will have access. It is not possible to withdraw your consent after six months from the date you receive the summary. All records will be destroyed according to University of Waterloo policy.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at [redacted] or by e-mail at [redacted]. You can also contact my supervisor, Professor Derek Armitage at [redacted] or email [redacted]

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #22704). If you have any comments or concerns resulting from your participation in this study, please contact the Chief Ethics Officer, Office of Research Ethics at [redacted] or [redacted].

I hope that the results of my study will be of benefit to the inshore shrimp shrimp fishery in Newfoundland and fisheries management by providing insights and recommendations about how to better address through fisheries management the thoughts, feelings, and responses of fishers, fish processors, fish industry leaders, and their communities. I also hope that the results of my study will be of benefit to the broader research community by providing information on the relationship human behaviour, emotions, and fisheries management.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Evan Andrews

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Evan Andrews of the School of Environment, Resources and Sustainability at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

With permission, I am also aware that excerpts from the interview may be included in the thesis, publications, and other presentations or outputs to come from this research.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher until a six month period (Date: _____) after receiving a summary of my interview.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #22704). If you have any comments or concerns resulting from your participation in this study, please contact the Chief Ethics Officer, Office of Research Ethics at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

With full knowledge of all foregoing, I agree, of my own free will, to participate in an interview for this study.

☐YES ☐NO

I agree to have my interview audio recorded.

☐YES ☐NO

I agree to the use of anonymous quotations in the thesis, publications, and other presentations or outputs to come from this research.

☐YES ☐NO

I agree to be contacted with a summary of my interview transcript by the following method. I understand that the confidentiality of the summary cannot be guaranteed over e-mail.

☐E-MAIL ☐LETTER MAIL ☐TELEPHONE

Participant Contact: _____ (Please choose one)

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

Date: _____