A Tale of Two Fisheries: Exploring Angler Behaviour that Informs Different Management and Conservation Goals

by

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Abstract

Recreational fishing is an important activity primarily enjoyed for the purposes of pleasure or competition. Despite the many benefits of interacting with nature and harvesting wild food, recreational fishing presents a myriad of negative impacts to fish populations, thus requiring management interventions to ensure sustainability. Since management conservation measures typically involve angler compliance with regulations and voluntary adoption of proconservation behaviours, I analyzed social data from two fisheries facing contrasting conservation challenges to identify the prevalence of self-reported proconservation behaviours among recreational anglers. I further investigated the factors which influence such behaviours in an effort to dissect how certain desired behaviours may be encouraged to support management conservation goals and to contribute to knowledge surrounding angler behaviour. My results indicate high levels of participation in voluntary proconservation behaviours and may inform management strategies that would benefit from angler participation.

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Thesis Format and Contributions

This thesis includes a general introduction (Chapter 1), two co-authored manuscripts (Chapter 2 and 3) that are in preparation for submission to peer-reviewed journals, and a general discussion (Chapter 4). Most co-authors have provided guidance and suggestions to improve my work, and all co-authors will review each manuscript following the submission of this thesis. To account for the co-authors contributions, I use the pronoun "we" in Chapters 2 and 3. Contributions from co-authors are described below:

Chapter 2: Widespread dislike of pink salmon leads to calls for management among salmonid-targeting recreational anglers in Norway J.D. Guay, R.J. Lennox, E.B. Thorstad, K. Wiik Vollset, S. Stensland, E. Jaakko, V.M. Nguyen

While this study is my own, I was carefully guided by Nguyen and Lennox in every step. Nguyen, Lennox, Thorstad, Wiik Vollset, and Stensland each contributed to the development and refinement of our questionnaire. Wiik Vollset, Stensland, and Jaakko assisted in the translation of our questionnaire. Data analysis was conducted by Guay and Lennox with Nguyen's assistance. All writing was conducted by Guay. All co-authors have and will contribute to editing and revisions in preparation for submission.

Chapter 3: Understanding the hidden connections between information channel use and proconservation behaviour among recreational anglers of the shore-based

shark fishery in Florida, U.S. J.D. Guay, J.L. Brooks, J.M. Chapman, H. Medd, S.J. Cooke, V.M. Nguyen

While this study was conceptualized by Guay and carefully guided by Nguyen, the data used for this Chapter was part of a larger study which was conceptualized by all authors. All authors assisted in the questionnaire design, and Brooks and Medd piloted the questionnaire with recreational shark anglers in Florida, U.S.. All data analysis was conducted by Guay with Nguyen and Chapman's assistance. All writing was conducted by Guay. All co-authors will contribute to editing and revisions in preparation for submission.

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Chapter 1: General Introduction

Recreational fishing is a popular and important outdoor activity or sport primarily enjoyed for the purposes of pleasure or competition by anglers worldwide. Recreational anglers may also harvest their catch for personal consumption but should be distinguished from commercial or subsistence fishers who predominantly target fish to produce goods for sale, trade, or personal consumption to meet nutritional needs (Arlinghaus & Cooke 2009; Quimby et al. 2020). Despite the many benefits of interacting with nature and harvesting wild food, recreational fishing can have consequences on the local environment. Recreational fishing is commonly viewed as a benign activity in comparison to commercial fishing, particularly within marine fisheries (Gallagher et al. 2015; Danylchuk et al. 2017; French et al. 2019). However, evidence suggests recreational fishing may also contribute to fisheries collapse through over-exploitation due to the large number of individuals that access and participate in recreational fishing worldwide (Post et al. 2002; Cooke & Cowx 2006). Overfishing may lead to the decline or extirpation of some fish populations, thereby reducing genetic diversity and rendering the population vulnerable to disease, predation, or mortality (Post et al. 2002; Arlinghaus et al. 2005; Pinsky & Palumbi 2013).

Catch and release is a common form of recreational fishing which mainly began due to harvest limits and gained popularity in efforts to sustain fish populations (Policansky 2002). Nevertheless, catch and release fishing may still result in post-release mortality when fish are released in poor condition due improper handling or hooking by anglers (Nelson 1998). Fishing may also introduce non-native species by using live bait or failing to properly disinfect equipment, which could increase competition for resources

among native species (Davis & Darling 2017; Cole et al. 2019). Further, recreational fisheries may damage or disturb the environment and habitats through abandoned fishing gear, vegetation removal, as well as increased noise and turbidity from boat traffic by anglers (Lewin et al. 2006). Evidently, angler habits and behaviours play a significant role in the conditions of the local environment and fish populations of a recreational fishery. Thus, effective management of recreational fisheries through carefully tailored regulations is crucial to ensure sustainable habitats and fish populations. Typical recreational fishery management strategies from developed countries may include mandatory licences or permits to fish, harvest limits and prohibitions of vulnerable species, specific gear restrictions, and seasonal closures in efforts of reducing negative impacts listed above (Cochrane 2002). Oftentimes, the revenue generated by recreational fishing (e.g., license purchases) is used towards management and conservation efforts to maintain healthy habitats and fish populations (Granek et al. 2008; Arlinghaus & Cooke 2009; Tufts et al. 2015). Consequently, angler participation is important to maintain high revenue to support such efforts.

Social data on the human dimensions of a fishery can lead to a more holistic and effective management process (Hunt et al. 2013; Skubel et al. 2019). Studying the human dimensions of fisheries is a growing field that focuses on understanding angler demographics, behaviours, motivations, preferences, willingness to pay, opinions on fisheries management, and much more (Hunt et al. 2013). This type of data can be beneficial for informing fisheries management by highlighting potential management pathways or factors that may need to be addressed (e.g., non-compliancy of regulations, harmful fishing practices, species experiencing heavier fishing pressure). The use of

social sciences has proven to be instrumental in managing natural resources even beyond fisheries, and is an important tool for solving environmental concerns (Partelow 2018), particularly by predicting proenvironmental or proconservation behaviour (Kaiser et al. 2005; Oreg & Katz-Gerro 2006). Since the severity of many conservation challenges surrounding recreational fishing may be linked to angler behaviours, one could argue that data on angler behaviour is among the most important tools for fishery managers.

Beyond simply quantifying behaviours, understanding factors that influence behaviour may be just as important by increasing the applicability of behaviour data to other fisheries as findings are typically context dependent. Additionally, recreational anglers are very diverse and do not often conform to specific groups (Capizzano et al. 2022), resulting in further potential inaccuracies should managers assume behaviour of one angler community due to evidence of behaviour in another. The use of social theories or frameworks which aim to explain behaviour can be very beneficial in allowing researchers or managers to predict angler behaviour (such as Theory of Planned Behaviour described in Chapter 2) based on other data should they only have access to social data which does not include angler behaviour. Exploring and predicting angler behaviour can be advantageous to researchers and managers in that they may be able to foresee and approximately quantify behaviours that do or do not align with management conservation goals (e.g., willingness to participate in conservation programs, level of compliancy of regulations, fishing handling techniques, etc.). With these data, managers could understand the level of stewardship and proconservation among the angling community and appropriately design management strategies that encourage or shape behaviours supportive of conservation priorities.

1.1 Research Objectives

The objective of my thesis is to investigate factors influencing recreational angler behaviours to identify how certain behaviours that support fisheries management and conservation goals may be encouraged. I aim to achieve this by learning from two fisheries with vastly different conservation goals: i) controlling populations of potentially invasive and nuisance species in Chapter 2, and ii) protecting and conserving threatened species in Chapter 3. In Chapter 2, I explore how behaviour change in response to the presence of potentially invasive pink salmon (*Oncorhynchus gorbuscha*) among recreational salmonid anglers in Norway may be predicted by variables within the theory of planned behaviour framework. In Chapter 3, I investigate how information channels, conservation knowledge, and support for fishery management may influence behaviours that support shark survival post-release among recreational anglers of the shore-based shark fishery in Florida, U.S.. The significant contextual difference between Chapters 2 and 3 presents opportunities such as allowing for comparison of findings and drawing lessons learned between different conservation goals, as well as increasing the applicability of my findings to other fisheries and similar activities with similar management challenges.

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Chapter 2: Widespread dislike of pink salmon leads to calls for management among salmonid-targeting recreational anglers in Norway

2.1 Abstract

Following their successful introduction in Russia in the 1900s, pink salmon expanded to Norwegian rivers and appeared at unprecedented numbers in rivers along the entire coastline in 2017. They have since returned in high abundance every odd-numbered year (2019, 2021), presenting potential threats to native biodiversity and ecosystem services, including major recreational fishing tourism for Atlantic salmon and sea trout in Norway. Presently, there exists a knowledge gap on angler perceptions and attitudes towards the presence of pink salmon in Norwegian rivers, resulting in difficulty assessing the socioeconomic repercussions of their invasion. We distributed an online questionnaire to salmonid-targeting recreational anglers who purchased a fishing license in Norway in 2020 to assess their perceptions of pink salmon and the potential resulting changes in angler behaviour. Our results revealed widespread negative perceptions of pink salmon in Norway, particularly among anglers who fished more frequently and had not pursued post-secondary education. Most anglers were only satisfied with catching 0 or 1 pink salmon per trip (80%) and rated pink salmon as their least preferred target species among a choice of four salmonids (97%). Decreased angler satisfaction as a result of pink salmon presence did not appear to impact angler participation as 51% of our participants would not modify their fishing habits in future years when pink salmon counts may be higher. Among those who would modify their habits, a significant majority would do so with the intention of catching more pink salmon to remove them from the rivers. This statement was further supported by the significant number of anglers

who reported they would volunteer in targeted efforts to remove pink salmon, highlighting stewardship among anglers towards maintaining the quality of freshwater salmon fisheries. These findings emphasize significant community support and desire for the management to lower pink salmon populations in Norway.

2.2 Introduction

The introduction of alien freshwater fish species is a common occurrence worldwide, dating back centuries (Emery 1985; Crawford & Muir 2008; Gozlan et al. 2010). Though species introductions can occur accidentally, intentional introductions are organized to support aquaculture, provide more fishing opportunities, or to tackle conservation challenges (e.g., supplementing natural populations, controlling harmful species) (Gozlan et al. 2010). While intentional fish introductions may provide solutions to cope with a changing climate or food security challenges, this strategy does not come without consequences. Alien species can negatively impact native species by introducing foreign pathogens or parasites, increasing predation or competition, allowing hybridization, and altering the natural habitat, all of which can contribute to species extinctions (Whitmore 1983; Krueger & May 1991; Bergersen & Anderson 1997; Latini & Petrere 2004; Reissig et al. 2006; Leonardos et al. 2007; Rasmussen et al. 2010; Taabu-Munyaho et al. 2016). These effects may be amplified should the alien fish become invasive or expand populations to wider regions from which they were originally introduced. Alien species expansions may be facilitated by the new environment lacking natural enemies (i.e., enemy release hypothesis), or by climate change as warming temperatures and changes in precipitation patterns alter aquatic ecosystems, expanding

habitable boundaries or species' range edges (Kvach & Stepien 2008; IPCC 2018; Spies et al. 2019).

Pink salmon (*Oncorhynchus gorbuscha*) were initially introduced as an alien species into the northern rivers of the Barents and White Seas in Russia as part of a stocking program between 1956 and 1979 (Niemela et al. 2016; Sandlund et al. 2019). These efforts resulted in high numbers of pink salmon expanding to Norwegian rivers as early as 1960, though populations failed to establish (Gordeeva et al. 2006; Gordeeva & Salmenkova 2011; Sandlund et al. 2019). Stocking efforts resumed in 1985 with an odd-year maturation, eventually resulting in the establishment of self-reproducing populations in the White Sea, which catalyzed the species' establishment in northern Norway, Finland, and now throughout the north Atlantic (Gordeeva et al. 2006; Sandlund et al. 2019). As a result, pink salmon were observed spawning in variable numbers in Norway, primarily in northern regions and with more frequent sightings during odd years (Sandlund et al. 2019). In 2017, the pink salmon population in Norway drastically increased and were found at unprecedented numbers in rivers along the entire coastline (Mo et al. 2017; Sandlund et al. 2019). The exceptional increase in pink salmon abundance has followed the broodline's odd-year life cycle pattern with further increasing numbers entering the rivers in 2019 and 2021 (Berntsen et al. 2020; personal communications). Climate change data may explain the boom in population size, as warming temperatures have been associated with increased success of odd-year pink salmon broods as well as spawning and fry production during initial pink salmon introductions in Russia (Irvine et al. 2014; Sandlund et al. 2019; Mustonen et al. 2021).

The exact impacts of the increased pink salmon abundance on native species and environmental conditions in Norwegian rivers are currently unknown, but a risk assessment concludes that an increasing abundance of reproducing pink salmon will likely present hazards to biodiversity and river ecosystems (VKM 2020). Moreover, while pink salmon in Norway have not officially been listed as an invasive alien species, they are listed as an alien species with a high invasion potential on the Norwegian Biodiversity Information Centre's list of alien species (NBIC 2018). These concerns are particularly alarming for wild Atlantic salmon populations in Norway as they are already facing threats from escaped farmed salmon and salmon lice (Forseth et al. 2017). Wild Atlantic salmon (*Salmo salar)* are a valued game species in Norway as they are larger in size compared to brown trout (*Salmo trutta)*, Arctic charr (*Salvelinus alpinus*), and now to pink salmon. Atlantic salmon support several culturally and economically important recreational fisheries in smaller communities (Liu et al. 2011) that may be at risk should pink salmon populations remain unregulated. More than 70,000 recreational anglers actively target Atlantic salmon, along with sea trout and Arctic char in Norwegian rivers each year and anglers spend approximately 1.26 billion NOK (142 million USD) per year on salmon fishing (Myrvold et al. 2019; Andersen & Dervo 2019). Pink salmon seem to be a valued part of the ecosystem in the Laurentian Great Lakes and in Russia, given the persistent attempts to establish the species and exploitation as a resource. As such, pink salmon may similarly be a resource to Norway, potentially providing commercial and recreational fishing opportunities. However, this depends largely on angler preferences, and should pink salmon cause declines in other highly targeted species such as Atlantic salmon, they may not necessarily provide more fishing opportunities.

Angler satisfaction, defined as the reward received from fishing experiences, has been shown to shape angler behaviour and depends on both catch and non-catch related components and on angler preferences being met (Beardmore et al. 2015; Birdsong et al. 2021). Thus, pink salmon could impact recreational fishing experiences via angler satisfaction should they cause changes in catch rates or species caught resulting in potential changes in angler participation and behaviours. Angler participation is important to maintain fisheries value as the revenue from the national fishing fee (required for all who wish to fish for anadromous fish in a river system in Norway) is used towards maintaining salmonid stocks to support recreational fishing (Norwegian Environment Agency 2019). Therefore, pink salmon may pose a challenge to managers should they cause significant declines in angler participation. The ability to explain or predict angler behaviour and participation would allow managers to prepare for such changes and adapt management.

Past studies have explained or predicted angler behaviour using the theory of planned behaviour, such as willingness to participate in fish stocking or intention to release their catch (e.g., von Lindern & Mosler 2014; Drake et al. 2015; Howell et al. 2015; Shaefe & Kamaruddin 2020). The theory of planned behaviour posits that people's behaviour may be predicted and explained by behavioural intent, which is influenced by a combination of their perceptions or attitudes towards the behaviour, subjective norms, and perceived behavioural control (Ajzen 1991). Attitude towards the behaviour is closely linked to personal values and lifestyle and involves how they feel about performing the behaviour or whether they perceive the outcome of the behaviour as favourable or unfavourable. Subjective norms reflect what actions they believe are

expected of them by others, and perceived behavioural control reflects how capable they believe they are of performing the behaviour (Ajzen 1991, von Lindern & Mosler 2014). An understanding of planned behaviour within heterogeneous groups such as recreational anglers can provide tools necessary to steer management.

Presently, there exists a knowledge gap on angler perceptions and attitudes towards the presence of pink salmon in Norwegian rivers, resulting in difficulty assessing the impacts to fishing experiences and participation. Given the invasion of pink salmon and the uncertain threats posed to the native salmonid fishery in Norway, understanding angler perceptions of pink salmon and how they might translate into behaviours are key in projecting how pink salmon may affect cultural and provisioning ecosystem services, which can inform managers in their efforts to maintain fisheries value (Shackleton et al. 2019a). In this study, our first objective was to investigate angler perceptions of the presence of pink salmon in Norwegian rivers following the increase in abundance, and to explore factors that may influence their perceptions. Our second objective was to evaluate the potential ensuing changes in reported angler behaviour and discuss impacts to fishing experiences and angler satisfaction. Lastly, we explored factors that may predict changes in angler behaviour using the theory of planned behaviour as a guiding framework.

2.3 Methods

Data Collection: Survey

We distributed an online survey via email to 19,510 recreational anglers who purchased a fishing license in Norway to fish for salmon, sea trout or Arctic char and had

previously agreed to be contacted for research purposes. While 19,510 is still a large database, we only had access to 50% of the entire fishing license database due to logistical constraints. The survey consisted of 36 questions addressing angler perceptions of pink salmon presence in Norwegian rivers, opinions of fishery management, angler behaviour, motivations, centrality of fishing to lifestyle, fishing specialization, and sociodemographic data (See Appendix A for the full questionnaire). We also included a question filtering for participants who have fished for Atlantic salmon, brown trout, or Arctic char in Norwegian freshwaters at any time to focus our questionnaire on salmonid-targeting recreational anglers. The license database that we accessed is administered by the Norwegian Environmental Directorate and is mandatory for any person to purchase that intends to fish for these anadromous fish in Norway. We offered our survey in four different languages (Norwegian, English, German, Finnish) to accommodate foreign anglers who have purchased a fishing license in Norway. Finally, we included the opportunity for participants to consent to receiving further communications from us such as additional questions or results of the study. Most of our survey questions were modelled based on similar studies, which included a combination of multiple choice, 7-point Likert scales, rank-order, and open-ended questions (e.g., Sutton et al. 2001; Stensland et al. 2015; Liberg & Stensland 2018). This strategy allowed us to maintain consistency with similar questions in other studies to enable comparative analyses and contribute relevant data to observe potential trends within the fishery.

We distributed the survey via Qualtrics XM (2020) on November 13th, 2020, followed by three reminder emails delivered three weeks apart to increase responses, before closing the survey on February 1st, 2021. From this list, 186 emails bounced and

50 email addresses were duplicates, resulting in a total of 19,274 individuals receiving the survey. Upon observation of the data, we discovered a minor technical error in our survey which hid ten questions from a subset of 1348 respondents. We minimized data loss by sending a follow up questionnaire on February 9th 2021, containing the ten hidden questions to the 865 respondents (of the 1348) who consented to follow up communications, which received correspondence from 583 respondents. All components of the survey and research methods were approved and conducted in adherence to both the Carleton University Research Ethics Board (CUREB-B Clearance #114520) and the (NSD case 352326 and 862568).

Data Analysis: Assessing Angler Perceptions of Pink Salmon Presence in Norwegian Rivers

We included four questions in the survey that broadly assessed angler perceptions of pink salmon in Norwegian rivers (Table 2-2). Two of these five questions were Likert scale questions, assessing anglers' level of agreement with statements on their opinions of pink salmon and of their management in Norway. Agreement levels were measured on a 7-point scale, ranging from "*Strongly disagree*" to "*Neither agree nor disagree*" to "*Strongly agree*". To quantify angler perceptions of pink salmon, we selected eight relevant statements (Figure 1) from these two questions to create a composite scale that measured angler perceptions, assigning each respondent a score measuring the degree of positive or negative perceptions. We labelled the scale "*perception scale*" and the individual scores within as "*perception scores*". To calculate the perception scores for each participant, we rated each response from one (*Strongly disagree*) to seven (*Strongly*

agree), except for one variable which was reverse coded to align with the rationale of the scale. We then took the sum of all eight variables, resulting in a minimum score of 8 and a maximum score of 56. We used the scale in this form for further analyses; however, for the purpose of direct interpretation we modified the scale to be reflected as a proportion between zero and one by dividing each respondent's score by the maximum value of 56. This allowed for easier interpretation in which lower perception scores (< 0.5) represented positive perceptions of pink salmon and higher perception scores (> 0.5) represented negative perceptions. If a participant obtained a score of 0.5, we assumed their opinion as being indifferent towards the presence of pink salmon in Norwegian rivers.

Prior to analyses, we conducted a Cronbach's alpha test with the eight variables used in the perception scale to test the construct reliability of combining all Likert items (Eisinga et al. 2013). Moreover, we validated the perception scale by conducting a multiple regression analysis using the scale as the response variable and two other of the five questions that assessed angler perceptions as predictor variables (Table 2-2). The purpose of the regression model was to ensure consistency of angler perceptions between external questions and the perception scale through the relationships found. The first predictor variable was a species preference question, coded to represent where pink salmon was ranked on a scale of 1 to 4 *(1= Most preferred, 4= Least preferred)* compared to *Atlantic salmon, sea trout, and sea-run char.* The second predictor variable was the *satisfactory pink:other salmon catch ratio* (see Table 2-2 for full question) and was coded as a numerical variable measured between 0 and 11, where 0= "*No catches are pink salmon"*, 10= "*All catches are pink salmon"*, and 11= "*It does not matter*". We

removed the "*It does not matter*" option from this predictor variable in the regression model to maintain an even and logical *satisfactory pink:other salmon catch ratio* scale.

Data Analysis: Exploring Factors Influencing Angler Perceptions of Pink Salmon

Once we had a reliable measure of each respondent's perceptions of pink salmon, we modelled the relationships between angler perceptions and both sociodemographic factors and fishing habits detailing fishing experience (e.g., years of fishing experience and fishing frequency) in a multiple linear regression analysis. We used the perception scale as the response variable, and our six predictor variables included: education, yearly household income, main fishing area, status as local or visitor to their main river, total years spent fishing, and days spent fishing in a year (Figure 2-1). Main fishing area was initially measured using ten regions evenly distributed across Norway (See questionnaire in Appendix A), which we collapsed into seven categories roughly based on pink salmon abundance (guided by Sandlund et al. 2019 and personal communications with NINA). Descriptions of the remaining predictor variables can be found in Table 2-3. We selected these predicting variables using the conceptual framework to explain people's perceptions of invasive alien species developed by Shackleton et al. (2019b) as a guide. The framework demonstrates that several factors may influence perceptions of invasive alien species at various levels; the individual (e.g., the angler), the species, the effects of the species, socio-cultural context, landscape context, and institutional or policy context (Shackleton et al. 2018). More specifically, we assessed factors at the level of the individual within this framework which may influence their perceptions (sociodemographic factors, sense of place, knowledge systems, and experience of the

species and effects) (Shackleton et al. 2019b). As mentioned above, pink salmon are not yet considered invasive alien species in Norway but considering their status on the Norwegian Biodiversity Information Centre's list of alien species, we found they sufficiently fit within this framework for interpretation (NBIC 2018).

Data Analysis: Exploring Changes in Angler Behaviour and the Influencing Factors

We included three questions assessing potential changes in angler behaviour under the condition of increased pink salmon presence in Norwegian rivers. The first question, labelled as the *behaviour change* variable, asked "*In future years where pink salmon counts may be high, would you modify your fishing habits to enhance or to avoid catching pink salmon while fishing?*". This variable had three response options: "*Yes to avoid catching pink salmon*", "*Yes to enhance catching pink salmon*", and "*No, I would not modify my habits*" (Figure 2-3). The remaining two questions assessing changes in behaviour explored the how and why for participants who indicated they would change their behaviours. Here, we merged both "*Yes*" responses due to the low number of responses in the "*Yes to avoid catching pink salmon*" response, resulting in a binary variable for *behaviour change*, with "*Yes*" and "*No*" categories.

We conducted a binary logistic regression to explore the relationship between angler perceptions and behaviours as well as sociodemographic variables and fishing habits as predictors of changes in behaviour. We used the binary *behaviour change* variable as the response variable to represent behavioural intent within the theory of planned behaviour. Predictor variables consisted of the *perception scale*, as well as the six predictor variables included in the previous multiple linear regression. We included

the same six predictor variables to both maintain consistency and because they (the six predictor variables) fit within the theory of planned behaviour framework (Figure 2-1). For instance, attitudes towards the behaviour may be sufficiently described by the perception scale, as it includes attitudes towards taking action to manage pink salmon populations, and by education, as there are strong links between knowledge systems (e.g., education) and pro-environmental behaviours. Next, perceived behavioural control may be described by income (e.g., do they have the means to modify their current habits), as well as by years spent fishing, days spent fishing, and whether they are a local or visitor to their main river (e.g., do they fish often enough and feel comfortable in their skills to be willing to modify their current habits). Lastly, while we have no direct measure for subjective norms, the main fishing area variable may provide insight to behavioural differences due to norms based on geographical region. Based on the theory of planned behaviour, we would expect at least one variable within each category (attitudes, perceived behavioural control, subjective norms) to significantly predict the *behaviour change* variable (behavioural intent).

2.4 Results

Survey Response Rate

A total of 2171 of 19,274 surveys were completed, resulting in an 11.3% response rate. As mentioned above, 1348 of these participants experienced a survey error, however we were able to recover 583 participants with the follow up survey resulting in a new total of 1406 completed surveys. We removed invalid and incomplete surveys (< 95% complete) using Qualtrics XM (64 duplicate or fraudulent responses, 44 incomplete

surveys) and filtered respondents for salmon anglers who have fished in Norway, providing us with a total of 1178 surveys included in the analysis.

Description of Sample Population

Socio-Demographic Information

The respondents were predominantly male and residents of Norway (various travel restrictions were in place in 2020 due to COVID-19 pandemic). Age distribution among anglers followed a normal distribution with birth years ranging between 1935 and 2002, and the average participant age being 54 years at the time of our survey. Education among anglers was relatively equally distributed across all levels, with the exception of primary and lower secondary education representing only a small percentage of respondents. Employment data revealed most anglers were employed full-time, with the second largest group in retirement. Gross annual household income (before taxes) data followed a right-skewed distribution, with a relatively even representation of angler households earning between EUR 20,000 – 120,000 / NOK (or SEK) 200,000 – 1,200,000. Most anglers lived with one another person, and the remaining majority lived either by themselves, or with two or three other people (Table 2-1).

Fishing Experience and Habits

Generally, respondents appeared to be experienced anglers with an average of 36.9 years of fishing experience (s=15.2 years, N=1084) for any species per angler, creating a normal distribution within the boundaries of "*less than one year*" to "*over 70 years"*. The anglers were significantly more experienced with salmonid fishing (*S. salar,*

S. trutta, Salvelinus alpinus) in Norway ($\bar{x}$= 30.5 years, s= 17 years, N=1170) than in other countries ($\bar{x}$= 6.3 years, s= 9.8 years, N=870). Approximately 70% (of 1178) of the anglers fished exclusively in Norway, yet only 58.9% (of 1159) of anglers stated they were local to their main fishing areas within the country indicating there is local travel involved. Lastly, 96.9% (of 1178) of anglers had fished for salmonids in Norway in 2020.

Anglers most commonly fished 26 – 50 days in the year (35.1% of 1178) for any species, followed by 11 – 25 days (26.9%) and 51 – 100 days (22.6%). The most common response for salmon fishing frequency in Norway specifically was 11 – 15 days in the year (32.7% of 1171), followed by 26 – 50 days (21.5%) and 6 – 10 days (18.9%). Most anglers fished for salmon in 2 – 4 different rivers (55.2% of 1146) or 1 river (29.5%). Among our participants, after removing one significant outlier, more salmonids were harvested ($\bar{x}$ = 8.5 salmon per angler, s= 18.68 salmon, N=1160), than released ($\bar{x}$ = 7.9 salmon per angler, s= 11.25 salmon, N=1167). Standard deviation values are high due to the variable nature of the data.

When asked to assess their fishing skill level on a 7-point scale (1= *Much lower than average*, 7= *Much higher than average*), the most common response was '*Average (4)*' (29.8% of 1174), followed closely by options five (27.7%) and six (22.2%), intermediate options between '*Average*' and '*Much higher than average'*. Additionally, the response 'Much higher than average' was chosen by significantly more anglers (15.2%) than all options below 'Average', combined (5%) indicating an above average experienced angling population. When we asked them to assess their knowledge of both "*Fishing*" in general and of "*Fishing management*", similar patterns were found, however

knowledge of "*Fishing management*" received lower self-ranking values than knowledge of "*Fishing*".

Fishing Motivations

Respondents were asked to rank the following statements on fishing motivations on a scale from 1-7 (1= strongly disagree, 7= strongly agree): "*To catch a big fish*", "*To catch as many fish as possible*", "*To master angling-related techniques and challenges*", "*To experience a challenging fight with the fish*", "*To catch fish for food to eat*", "*To experience nature*", "*To relax and get away from the regular routine*", and "*To socialize or be with friends and family*". All statements received relatively high agreement levels except for "*To catch as many fish as possible*" (34.4% disagree or strongly disagree of 1178). Two statements stood out with the highest agreement ratings: "*To experience nature*" (89.7% agree or strongly agree of 1178), and "*To relax and get away from the regular routine*" (89.3% agree or strongly agree of 1178) suggesting that this fishery attracts anglers who may prioritize fishing for leisure and relaxation rather than trophy fishing or food.

Pink Salmon Catch Rates and Locations

Just over half of our respondents (633 anglers, 56.3% of 1178) have caught or encountered pink salmon while fishing in Norway, of which 59.5% (of 663) reported catching them in the same rivers they caught Atlantic salmon. Over half of the rivers where anglers caught both species were in northern regions of Norway (Nordland and Troms and Finnmark counties) (59.9% of 394). Further, we asked these respondents

(N=663) to state approximately how many pink salmon they caught between 2017-2020, and 545 provided an answer. Three outliers were removed due to being significantly higher than the rest (one value at 2017, two values at 2019 catches), representing possible errors or misunderstandings of the question being asked although catches of this magnitude is possible from removal fishing programs. From the remaining 542 responses, a total of 2098 pink salmon catches were reported, resulting in an average of 4 pink salmon catches per angler between 2017-2020 ($\bar{x}$= 3.9 pink salmon, s= 14.5). Two hundred and four of these respondents reported catching zero pink salmon during this time, and the maximum number of catches reported was 200 pink salmon from one individual.

Angler Perceptions and Preferences Related to Pink Salmon in Norwegian Rivers

Most anglers demonstrated negative perceptions of pink salmon. Among statements related to perceptions of pink salmon, anglers most agreed on "*Pink salmon should not get established in Norwegian nature*", while most disagreed that "*I would eat pink salmon if I catch one*". The most agreed-upon statement regarding opinions of pink salmon management was "*I think pink salmon should be removed from the river*", closely followed by "*The implementation of pink salmon removal programs would increase my desire to fish in a river with high pink salmon counts*" and "*I believe pink salmon threaten the viability of Atlantic salmon, Sea trout, and Sea char*". The most disagreed-upon statement was "*I would pay an extra fee to support pink salmon removal*" (Table 2-2).

To assess species preferences among targeted salmonids, we asked the anglers to rank four species in order of preference. Atlantic salmon was most preferred by most anglers, followed by brown trout in second, Arctic char in third, and pink salmon as least preferred (Table 2-2). The majority who did not place pink salmon as least preferred selected Arctic char instead.

The average response to how many pink salmon anglers would be satisfied with catching was only 1.5 pink salmon out of 10 total catches per fishing trip (Table 2-2). For reference, 61.5% of 1173 anglers selected "*No pink salmon at all*", 18.2% selected "*1 out of 10 catches are pink salmon*", and 10.2% selected "*It does not matter*". Furthermore, we included five questions assessing whether they would fish more or less in their main river (i.e. river they go to most often) should the permit costs increase by 10%, accompanied by different scenarios relating to pink salmon abundance (Table 2-4, Figure 2-2). Responses revealed that anglers would be more likely to fish less often if the probability of catching pink salmon was higher than that of catching other salmonids.

Potential Factors Influencing Angler Perceptions of Pink Salmon

The *Perception scale* had a mean score of $\bar{x}$= 0.78 (s=0.14) out of 1, indicating general negative perceptions of pink salmon in Norwegian rivers among our participants. The Cronbach's alpha test yielded a score of 0.704, indicating strong reliable internal consistency among variables within the *Perception scale*. The multiple linear regression analysis further validated the scale, revealing both predictor variables (*pink salmon preference* and *satisfactory pink salmon: other salmon ratio*) as significant predictors of angler *Perception scores* (R^2 = 0.14, F(4,1004) = 42.77, p = <0.001). The regression

model demonstrated that anglers held negative perceptions of pink salmon when they did not prefer to catch pink salmon, as well as when their fishing trip satisfaction decreased with each pink salmon catch. Our model satisfied the assumptions for multiple regression analyses and confirmed the logic of the perception scale. With these results, we were confident the composite scale accurately represented the angler perceptions of pink salmon in Norwegian rivers.

Prior to performing our linear regression, we tested all predictor variables to verify there was no multicollinearity. Our multiple linear regression model (model 1) assessing the relationship between angler perceptions of pink salmon and various sociodemographic and fishing habit variables revealed two significant predictor variables: *education* and *days spent fishing* ($R^2 = 0.02$, $F(11,828)= 2.805$, $p = 0.001$, Table 2-3). Perception scores increased in value (anglers possessed more negative perceptions) as anglers spent more days fishing and among those that did not complete post-secondary education. The distribution of the residuals was negatively skewed but followed the distribution of the response variable (perception scale). Exponential transformation of the response variable yielded normally distributed residuals with identical results, and as such we retained the non-transformed model for interpretation. The low R^2 value may be due to the variable nature of the anglers within this fishery.

Angler Behaviour as a Result of Increased Pink Salmon Populations

Over half of the respondents stated they would *not modify* their fishing behaviours with the presence of pink salmon, 41% stated they would modify their behaviours to *enhance* catching pink salmon, and only 7.6% reported they would modify their

behaviours to *avoid* catching pink salmon (Figure 2-3). Among those who stated they would like to enhance catching pink salmon (N=478), 70.9% reported they would do so to help remove pink salmon from the river, while the other 26.4% stated they would do so to both help remove pink salmon from the river and a combination of one of the following: for food, for the thrill of the catch, or for other reasons. The remaining 2.7% of anglers who would enhance catching pink salmon stated they would do so for a combination of food, thrill of the catch, or for other reasons.

Among the anglers who stated they would modify their behaviours to avoid catching pink salmon (N=89), 34.1% stated it was because they disliked pink salmon, 12.5% because pink salmon is not fun to catch, and 10.2% due to other reasons. Only 1% stated they would avoid pink salmon because they did not like the taste of pink salmon, and 42% explained their behaviour to be a combination of the four reasons listed (i.e., disliked pink salmon, not fun to catch, did not like the taste, and other). All respondents who reported they would modify their behaviours were directed to a Likert scale question assessing how certain behaviours would change in frequency performed using a 7-point scale (1= Do much less, 4= About the same, 7= Do much more). The behaviours measured included "*Time spent fishing overall*" ($\bar{x}$=4.42, s=1.37), "*Time spent fishing in a river that has pink salmon*" ($\bar{x}$=3.86, s=1.72), "*Plan trips to/in Norway in general*" ($\bar{x}$=4.11, s=1.24), "*Plan trips to/in Norway specifically during even-numbered years when pink salmon are less prevalent*" (3.75, s=1.48), and "*Use specific gear to avoid catching pink salmon*" ($\bar{x}$=3.51, s=1.92).

Potential Factors Influencing Changes in Angler Behaviour

Our binary logistic regression (model 2) assessing the relationship between changes in behaviour and perceptions of pink salmon, sociodemographic variables and fishing habits revealed three significant predictors of changes in behaviour. Angler perceptions (z value = 2.998, p = 0.003) and two northern main fishing areas, Troms county (z value = 2.202, p = 0.028) and the eastern part of Finnmark county (z value = 2.646, p = 0.008), were positively associated with the behaviour change variable, and visitors (from residency variable, z value = -3.180, p = 0.001) were negatively (inversely) associated with the behaviour change variable (Table 2-3, Figure 2-4).

2.5 Discussion

Our study evaluated the angler perceptions and social consequences of the presence of abundant pink salmon in Norwegian rivers and found that most salmonid-targeting recreational anglers held negative perceptions of pink salmon. With the near-certain probability that pink salmon would continue to return every other year and the four-fold increase in abundance from 2019 to 2021 (personal communications with the Norwegian Institute for Nature Research (NINA)), their presence may significantly impact fishing experiences seeing as most anglers reported they would only be satisfied with one or zero pink salmon catches per trip. We also investigated the potential resulting changes to angler behaviour and found that almost half of the participants would modify their fishing habits to enhance pink salmon catches to remove them from the rivers. There was general consensus that anglers would spend their time volunteering to remove pink salmon but not their money to manage the pink salmon invasion in Norwegian rivers. In

general, our work demonstrates potential for disruption of angler satisfaction as a result of increased pink salmon abundance, but not participation. Indeed, our results actually show potential for stewardship action among anglers to manage pink salmon invasion through enhanced fishing.

A) Factors Influencing Angler Perceptions of Pink Salmon

Past research has shown that perceptions of invasive alien species vary widely, ranging from positive perceptions and preferences for alien species to negative perceptions and desires to protect native species (Banha et al. 2017; Edwards et al. 2016; Bravos-Vargas et al. 2019; Crowley et al. 2019; Potgieter et al. 2019). As mentioned previously, pink salmon are not officially listed as invasive, however due to their high invasion potential, we interpret our findings with an invasive species lens. The diversity in perceptions of invasive alien species may be explained by many factors that influence perceptions at various levels, ranging from individual demographic characteristics and values to socio-cultural factors, to even how policies can influence and shape perceptions (Shackleton et al. 2019b). For instance, the predominantly negative perceptions among our participants were presumably towards the species' presence in Norway rather than negative sentiments of the species itself as more anglers agreed that pink salmon should not get established in Norway or should be removed from the rivers than those that reported having always disliked pink salmon. As such, these findings suggest that perceptions may primarily be influenced by factors at the level of the angler and at the level of the *effects* imposed by the species rather than at the level of the species (Shackleton et al. 2019b). These findings are complicated by a lack of biological data

about the potential impacts of pink salmon on native ecosystems in Norway, such that concepts of impact rely on hearsay and conjecture rather than scientific evidence for certain impacts.

At the level of the angler, our model found evidence of two main factors influencing angler perceptions: exposure to or experience with the species (days spent fishing in a year) and knowledge systems (education) (Shackleton et al. 2019b). Our model predicted increasingly negative perceptions of pink salmon among anglers who fished more frequently and had not pursued post-secondary education. As anglers spent more time fishing in the rivers, they likely gained increasing exposure to pink salmon and witnessed more consequences of their abundance on fishing experiences firsthand, such as pink salmon carcasses washing ashore (Bailey et al. 2018), or differences in species caught during trips. These experiences with pink salmon may thus influence their perceptions of the species, shaping more negative perceptions compared to anglers who have fewer experiences or encounters with pink salmon. These perceptions may further be amplified by an angler's desire to maintain their known environment, stemming from emotional factors and one's sense of place (Humair 2014; Shackleton et al. 2019b). Furthermore, our findings regarding differences based on education contrast results from other studies exploring this factor, which found that people with more advanced education were more likely to hold negative perceptions of invasive alien species or were more likely to support their management (Boshoff et al. 2008; Sharp et al. 2011; Potgieter et al. 2019). These findings may indicate an imbalance of knowledge among anglers about pink salmon and their effects on the environment, or they may suggest other factors associated with sociodemographic variables are coming into play such as media, social network, or

other influences. Moreover, there could have been a connection between fishing frequency and post-secondary education as anglers living closer to rivers or rural areas and with easier access to fishing may be less educated than the occasional anglers who may visit from city centres located closer to universities (e.g., Arlinghaus et al. 2008). Nevertheless, more data and research are needed to explore these ideas, and the difference in perceptions between levels of education may be negligible since most participants felt negatively towards pink salmon to begin with.

At the level of the effects imposed by the species, pink salmon holds the potential to seriously affect the state of freshwater environments and the return of ecosystem services provided by the Norwegian freshwater systems (Vaz et al. 2017). Concerns evident from the responses of recreational fishers probably correspond to concerns about biological impacts of pink salmon, which have not been well studied. Hypotheses about impact, for instance, include the potential that pink salmon may increase competition over spawning territory with early arrivals of native salmonids such as Atlantic salmon, brown trout, and Arctic char due to slight overlaps in early or late spawners (Sandlund et al. 2019; VKM 2020). Pink salmon are known to aggressively defend spawning habitat, potentially resulting in Atlantic salmon seeking suboptimal areas rivers for holding before spawning. Pink salmon may also increase competition over food with native salmonids in the fry and juvenile stages as a result of similar diets and increased time spent externally feeding in the rivers (Sandlund et al. 2019; VKM 2020). Conversely, pink salmon eggs may provide a food source for juvenile native fish (Dunlop et al. 2020), while adults can be suitable prey for aquatic and terrestrial predators such as river otters (*Lutra lutra*), grey heron (*Ardea cinerea*), and many more (VKM 2020). Furthermore, abundant

decomposing pink salmon carcasses may increase invertebrate production in the river, (Bailey et al. 2018), but it could also reduce the availability of local oxygen and harm the survival of incubating salmonid eggs (Sandlund et al. 2019). Additional concerns exist, such as the introduction of pathogens and parasites, but there is a lack of data on this matter (Mo et al. 2018; Sandlund et al. 2019). Overall, pink salmon presence may cause ecological, economic, and social implications that can affect anglers at varying degrees depending on their lifestyles and value orientations, thus influencing their perceptions of the species (Simberloff et al. 2013). For instance, over 80% of participants stated that they believed pink salmon threatened the viability of Atlantic salmon, sea trout and sea-run char. While these predictions remain untested, it highlights the challenge that managers will face in coming years without biological data but with social concerns about the ecosystem structure and function affected by increasing pink salmon abundance.

B) Implications of Pink Salmon Presence on Angler Behaviour

Our results indicated no substantial negative changes in reported angler behaviour from the presence of pink salmon, as over half of the participants stated they would not modify their habits in future years when pink salmon counts may be high. Unfortunately, we were unable to make assumptions about participants' interpretations (whether 'high counts' was interpreted as counts experienced thus far, higher than experienced thus far, or only during odd-numbered years when pink salmon are at their peak) due to limitations of the survey design. Ultimately, while the presence of pink salmon may decrease fishing satisfaction, it did not appear to negatively impact angler participation as a whole. Our

findings parallel those from a similar study in the Great Lakes, where no significant decrease in recreational angler participation was associated with the presence of invasive alien species (Lauber et al. 2020). Since the magnitude and rate of the spread of invasive alien species typically differ geographically, Lauber et al. (2020) found that while certain areas of the Great Lakes experienced declined angler participation, the total number of fishing trips across the Great Lakes did not significantly decrease. Additionally, they suggested that not all anglers depend on catch rates or specific species to fish, and thus may not have been bothered enough by the invasive alien species to change their behaviours (Lauber et al. 2020). Similar factors may explain our findings in Norway. For instance, up to 67% of our participants reported they would fish less often or stop fishing entirely in their main river should the fishing license price increase and the chances of catching pink salmon were equal to or greater than the chances of catching Atlantic salmon. Compared to the 15% of participants who reported they would fish less often or stop fishing entirely solely due to the increased fishing license cost, these results were illustrative of the impact of pink salmon on fishing experiences and participation. However, the same results were not reflected in the variables assessing changes to angler behaviours or habits, indicating that while participation may decrease in certain rivers, anglers may simply choose to fish in different rivers with lower pink salmon abundance. The potential for movement of anglers however should be further researched and considered in future management of this fishery.

We found that a relatively large proportion of anglers would modify their fishing behaviours to catch more pink salmon as means to remove them from the rivers. This statement was further supported by the large number of anglers who reported they would

volunteer in targeted efforts to remove pink salmon, highlighting stewardship among anglers towards maintaining the quality of freshwater salmon fisheries. Angler stewardship is closely linked to personal norms and the prevalence of fishing to one's identity, wherein anglers will be more likely to participate in pro-environmental behaviours should they align with their values and sense of self (Bruskotter & Fulton 2007; Landon et al. 2018; van Riper et al. 2019). While our questionnaire did not necessarily collect information on personal norms or values, the top motivator for participating in recreational fishing among our participants was to experience nature, which, coupled with the reported stewardship behaviours, suggests that most anglers hold biocentric values and wish to conserve the natural environment. These findings indicate community support for recreational harvest of pink salmon as a population-control measure and are not uncommon among similar studies aiming to reduce expansion of alien species, including trout hybrids in Yellowstone National Park or largemouth bass (*Micropterus salmoides*) in Wisconsin lakes (Pasko & Goldberg 2014; Heim et al. 2020; Sullivan et al. 2020).

Our model revealed that potential changes in angler behaviour were influenced by perceptions of pink salmon, main fishing area, and whether anglers were locals or visitors to their main rivers. Despite lacking a measure for subjective norms, the significant predictors found in our study sufficiently help us explain behavioural intent and thus supports that angler behaviour is relatively aligned with the theory of planned behaviour framework. To summarize, we found that local anglers who predominantly fished in Troms or Eastern Finnmark (northern counties that experienced heavy pink salmon abundance (Sandlund et al. 2019; VKM 2020)) and possessed stronger than average

negative perceptions of pink salmon were more likely to change their behaviours in future years when faced with abundant pink salmon. We were not surprised to see anglers' *main fishing area* as a predictor of behaviour change considering the development of pink salmon distribution across the Norwegian coastline. Prior to the population boom in 2017, pink salmon had been regularly caught in northern rivers (namely Finnmark county) and less regularly observed or caught in other regions of Norway (Sandlund et al. 2019). In 2017 and 2019, pink salmon abundance increased in scale and became more abundant in northern regions of Norway, with the highest numbers reported in eastern Finnmark (Sandlund et al. 2019; Berntsen et al. 2020). The degree to which the effects imposed by abundant alien species are felt by anglers largely depends on the magnitude and rate of the invasion (Shackleton et al. 2007). As such, we would not expect both angler perceptions and behaviour changes to be uniform across the country, as anglers who fished predominantly in northern regions, such as Troms or Finnmark counties, would have had more exposure to pink salmon and thus would have been more likely to change their behaviour or advocate for the species' management. This also supports our findings that greater negative perceptions of pink salmon relates to the frequency of fishing and potential higher exposure to pink salmon. Anglers' main fishing area, however, only had an effect when considering anglers' proximity to their main rivers (i.e., whether they were local or visitor) and perceptions of pink salmon and their management.

As the theory of planned behaviour states, attitudes towards the behaviour, along with perceived behavioural control and subjective norms, can in turn predict the behaviour (Ajzen 1991). Therefore, as our model predicted, anglers who possessed negative

perceptions of the species and advocated for their management would be more likely to modify their behaviours and participate in removal programs. Lastly, local anglers may have had stronger desires and perceived behavioural control than visiting anglers to maintain their known environment, stemming from emotional factors and one's sense of place (Stedman 2003; Shackleton et al. 2019b). With the increased abundance of pink salmon potentially resulting in changes to the fishing experience and conditions of many rivers, these feelings may have led to negative perceptions towards the species and thus stronger desires to modify their fishing habits or participate in removal programs (Humair 2014; Shackleton et al. 2019b).

C) Study Limitations

We acknowledge limitations within our study as our survey only captured a sample of the entire fishery but did access a major component of the overall fishing population. We aimed to reduce sampling bias by randomly distributing the survey to 50% of all anglers who purchased a fishing license in Norway to fish for salmon, sea trout or Arctic char. Non-response bias may be a result of invitation emails being missed or going to respondents' junk or spam folders, respondents opting out mid-way, forgetting to return to the survey, or being too busy to respond (Gigliotti & Henderson 2015). It is possible that individuals wishing to express their displeasure about pink salmon may have been more apt to respond to the survey than agnostic counterparts. Unfortunately, no data are available to provide further assessment of the non-response bias. Our response rate is lower than a similar study with the same license database in previous years, (e.g., 40% response rate in Stensland et al. 2017), however we only had access to 50% of the license

database which may explain our response rate in comparison. Nonetheless, our survey received a substantial number of responses with an average response rate for targeted online surveys (Sheehan 2001; Nulty 2008; Shih 2009). Although our response rate is lower than similar studies in Norway. As with many surveys, there is potential for self-reporting responses biases including recall bias that may lead to inaccurate catch data or fishing location, and social desirability bias resulting in potential overreporting of socially favourable behaviour in applicable questions by participants. Finally, it is important to note that our participants had experienced the drastic increase of pink salmon in Norway for only two years (2017, 2019) before taking our survey, and that we surveyed the anglers in an even-numbered year (2020) when pink salmon counts were low. As such, past recollection of their perceptions and attitudes during the 2017 and 2019 fishing seasons may have diminished and responses may differ during an odd-numbered year when pink are once again abundant.

2.6 Conclusions and Management Implications

Our study presents the first assessment of salmonid-targeting recreational anglers' perceptions of the presence of pink salmon, a potential invasive species, in Norwegian rivers, as well as the potential resulting changes in fishing experiences and angler behaviour. We discovered relatively widespread negative perceptions towards pink salmon in Norway and significant support for their management among our participants. In some cases, differing perspectives towards the management of abundant species converge, resulting in social conflicts that complicate management through the development of distrust and lack of community support (Estévez et al. 2014; Moon et al.

2015; Crowley et al. 2017, 2019; Shackleton et al. 2019b). Seeing as the perceptions among our participants were fairly congruent, social conflicts may not be such a concern but should still be considered due to the possibility of perceptions changing over time and the existence of a minority group of anglers with positive preceptions of pink salmon. As we learn more about the direct and indirect impacts of pink salmon on the native biodiversity and environment in Norway, managers may need to consider population-control measures.

Public support for management of invasive alien species has historically depended on the type of eradication strategy (e.g., De Ruyver et al. 2021; Sharp et al. 2011; Crowley et al. 2017). For example, European hedgehogs (*Erinaceus europaeus*) introduced to the South Uist island in Scotland were contributing to the decline of wading shorebirds and thus prompted the Scottish Natural Heritage to inititate lethal control of hedgehogs (Jackson & Green 2000). Since hedgehogs are viewed as a national symbol of wildlife in the United Kingdom, this strategy faced a great deal of criticism and lack of support from the public and media, many of whom favored and showed support for translocation of hedgehogs instead (Webb & Raffaelli 2008; Crowley et al. 2017). Considering pink salmon are a harvestable and seemingly valued game fish in other countries due to their introduction in Russian rivers and the Great Lakes, targeted recreational harvest appears to be a suitable strategy that was strongly supported among our participants (e.g., through tournaments or other major events, and stewardship programs).

While we recognize there may not yet be enough biological evidence to support decisions on pink salmon population control measures in Norway, our findings highlighted the declining quality in fishing experience and therefore decreased angler

satisfaction as a result of their presence. Since angler satisfaction can shape angler behaviour, we expected angler participation rates to decline alongside decreased fishing satisfaction. Instead, our results revealed increased participation to help remove pink salmon from the rivers among half of our sample, further emphasizing the support and desire for population control measures. Nevertheless, participation rates in certain rivers could still decline, particularly those in which pink salmon catches are more common than catching other salmonids (Figure 2-2). Future research should explore the reasons why anglers possess these perceptions to obtain a better understanding on how exactly pink salmon may be affecting fishing experiences and angler satisfaction as it would help inform the development of strategies to reduce impacts to fishing experiences. We also recommend re-assessing angler perceptions of pink salmon in future years to evaluate how perceptions might change over time and in response to the future patterns of the species' presence in Norway.

2.7 Acknowledgements

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2.8 Tables

Table 2-1: Summary of sociodemographic variables of anglers who have fished for salmonids in Norwegian freshwaters

Sociodemographic variables	N	Percentage
Gender (N = 1175)		
Man	1132	96.3%
Woman	41	3.5%
Other	0	0.0%
Prefer not to say	2	0.2%
Residency (N = 1178)		
Permanent Resident	1150	97.6%
Foreign Visitor	28	2.4%
Education (N = 1174)		
Primary and Lower secondary school	50	4.3%
High school degree or equivalent	251	21.4%
Trade or Apprenticeship	275	23.4%
Bachelor's or College degree	327	27.9%
Post-graduate degree	271	23.1%
Employment (N = 1176)		
Full time	787	66.9%
Part time	30	2.6%
Casual or Contract	6	0.5%
Student	21	1.8%
On benefits	42	3.6%
Retired	250	21.3%
Unemployed	7	0.6%
Other	33	2.8%

Sociodemographic variables	N	Percentage
Income (N = 1176)		
Less than EUR 20,000	21	1.8%
EUR 20,000 – 40,000	107	9.1%
EUR 40,001 – 60,000	227	19.3%
EUR 60,001 – 80,000	236	20.1%
EUR 80,001 – 100,000	167	14.2%
EUR 100,001 – 120,000	126	10.7%
EUR 120,001 – 140,000	66	5.6%
EUR 140,001 – 160,000	58	4.9%
EUR 160,001 – 180,000	29	2.5%
EUR 180,001 – 200,000	23	2.0%
More than EUR 200,000	35	3.0%
Will not / Cannot answer	81	6.9%
Persons in Household (N = 1174)		
I live by myself	176	15.0%
2 persons	597	50.9%
3 persons	153	13.0%
4 persons	178	15.2%
5 persons	60	5.1%
6 persons	6	0.5%
7 or more persons	4	0.3%
Birth Year (N=1171)	**Value**	
Mean	1966	
Median	1965	

Table 2-2: Summary of all variables assessing angler perceptions of pink salmon in Norway.

Variables	**x̄**	***s***	**Median**	**Total N**
Perceptions of pink salmon in Norway *(1=Strongly disagree, 7=Strongly agree)*				
I have always disliked pink salmon	5.4	1.87	6	1150
My opinion of pink salmon has changed unfavourably	5.35	1.84	6	1152
Pink salmon should not get established in Norwegian nature	6.51	1.3	7	1171
I would eat pink salmon if I caught one	4.19	2.35	4	1110
Opinions on pink salmon management *(1=Strongly disagree, 7=Strongly agree)*				
I think pink salmon should be removed from the river	6.36	1.49	7	1166
The implementation of efficient pink salmon removal programs would increase my desire to fish in a river with high pink salmon counts	5	1.77	5	1119
I believe Pink salmon threaten the viability of Atlantic salmon, Sea trout, and Sea char	6.10	1.45	7	1130
I would volunteer in targeted efforts to remove pink salmon by angling or netting	6	1.48	7	1158
I would pay an extra fee to support pink salmon removal	4.91	1.92	5	1165
Species Preference *(1=Most preferred, 4=Least preferred)*				
Atlantic salmon	1.24	0.51	1	1130
Sea trout	2.02	0.55	2	1130
Arctic char	2.78	0.59	3	1130
Pink salmon	3.96	0.24	4	1130
Satisfactory pink:other salmon catch ratio *(0/10 to 10/10 pink salmon)*				
What would you consider an acceptable amount of Pink salmon caught for you to be satisfied with your fishing trip (assuming that salmon catches are held constant)?	1.50	3.04	0	1173

Table 2-3: Description of predictor variables included in both regression models, where model 1 is the multiple linear regression modelling the relationships between perceptions of pink salmon and sociodemographic and fishing habit variables, and model 2 is the binary logistic regression modelling the relationships between changes in behaviour and perceptions, sociodemographic variables, and fishing habits.

Predictor Variables	**Type**	**Description**	***p* (model 1)**	***p* (model 2)**
Perception Scale	Continuous	Composite scale with values between 8 and 56	N/A	0.003*
Education	Binary	Categories include: Primary and Secondary Education / Post-Secondary Education	0.015*	0.865
Local/Visitor	Binary	Categories include: Local / Visitor	0.098	0.001*
Income	Continuous	Lowest to highest income value	0.076	0.288
Years Spent Fishing	Continuous	As described	0.585	0.361
Days Spent Fishing	Continuous	Ordered categories based on increasing number of days spent fishing in a year (1 = 1 – 5 days fishing, 5 = More than 101 days fishing)	<0.001*	0.338
Main Fishing Area	Categorical	*7 Categories include:* (1) Southern Norway: Østfold, Akershus, Oslo, Buskerud, Vestfold, Telemark, Agder, Rogaland, and Hordaland	-	-
		(2) Southwest Norway: Sogn & Fjordane and Møre & Romsdal counties	0.143	0.097
		(3) Central Norway: Trondheim Region: in Sør-Trøndelag county and inner parts of Trondheim fjord in Nord-Trøndelag county, Namdal and Fosen / Northern Trondheim Region: in Nord-Trøndelag county north of Trondheim fjord and Fosen Peninsula	0.512	0.253
		(4) Northern Norway: Nordland county	0.394	0.475
		(5) Northern Norway: Troms county	0.358	0.028*
		(6) Northern Norway: West part of Finnmark County	0.331	0.868
		(7) Northern Norway: East part of Finnmark County	0.085	0.008*

Table 2-4: Descriptions of the questions referred to in Figure 2-2, assessing angler participation as a result of pink salmon abundance. Q55 serves as a control for effects of increased permit costs on fishing frequency.

Question Number	*Question Description*
Q55	If the cost of a fishing permit increased by 10% in your main Norwegian river, would you go fishing there…
Q19	If the cost of a fishing permit increased by 10% in your main Norwegian river, and the probability of catching Pink Salmon were **equal** to the probability of catching other salmon, would you go fishing there...
Q20	If the cost of a fishing permit increased by 10% in your main Norwegian river, and the probability of catching Pink Salmon was **higher** than the probability of catching other salmon, would you go fishing there...
Q21	If the cost of a fishing permit increased by 10% in your main Norwegian river, and the probability of catching Pink Salmon was **lower** than the probability of catching other salmon, would you go fishing there...
Q22	If the cost of a fishing permit increased by 10% in your main Norwegian river, and there were **no Pink Salmon at all**, would you go fishing there...

2.9 Figures

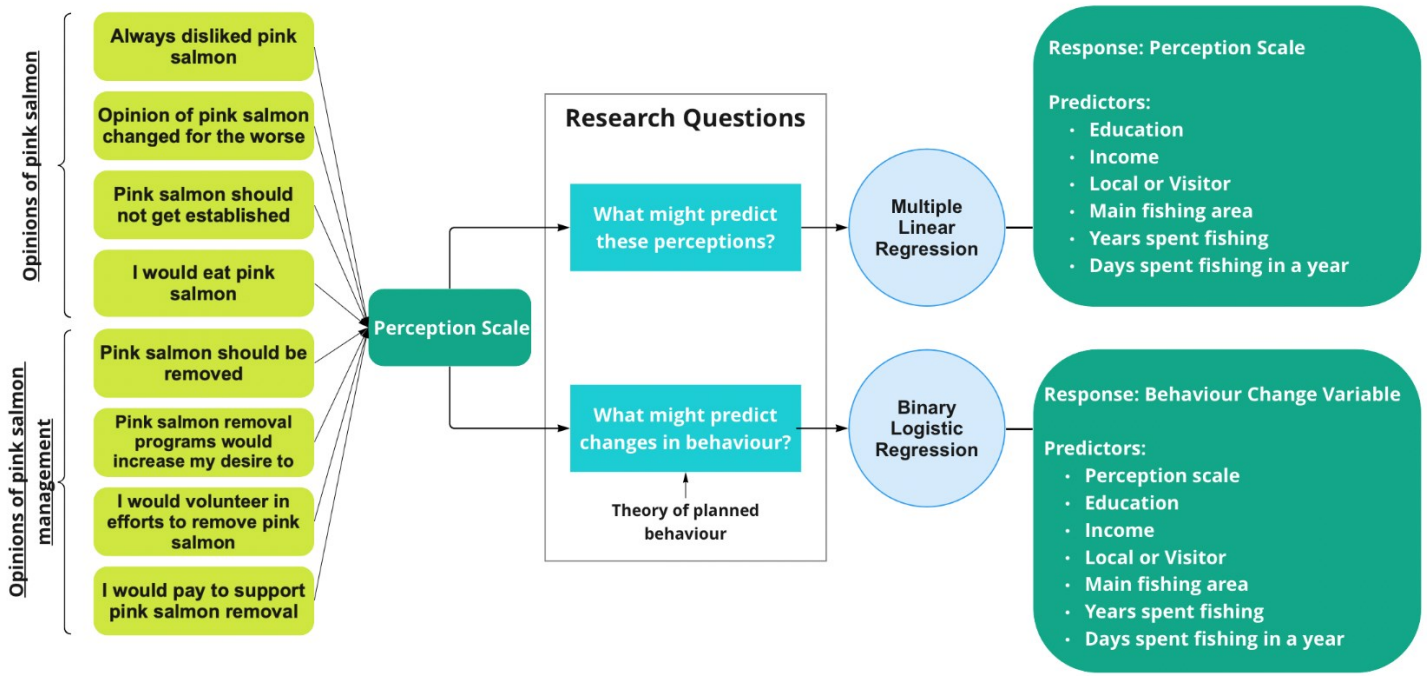

Figure 2-1: Flowchart of statistical analyses. The eight items in the left-most boxes are the eight variables used to create the perception scale, which was in turn used as the dependent variable in the first question "What might predict these perceptions?" and as an independent variable in the second question "What might predict changes in behaviour?". The predictor variables used in the binary logistic regression to predict changes in behaviour fit within the theory of planned behaviour framework as follows: Perception scale and education represent "attitudes towards the behaviour"; income, local or visitor, years spent fishing and days spent fishing in a year represent "perceived behavioural control"; while we have no measure for "subjective norms", main fishing area may loosely represent subjective norms by potentially revealing localized social norms.

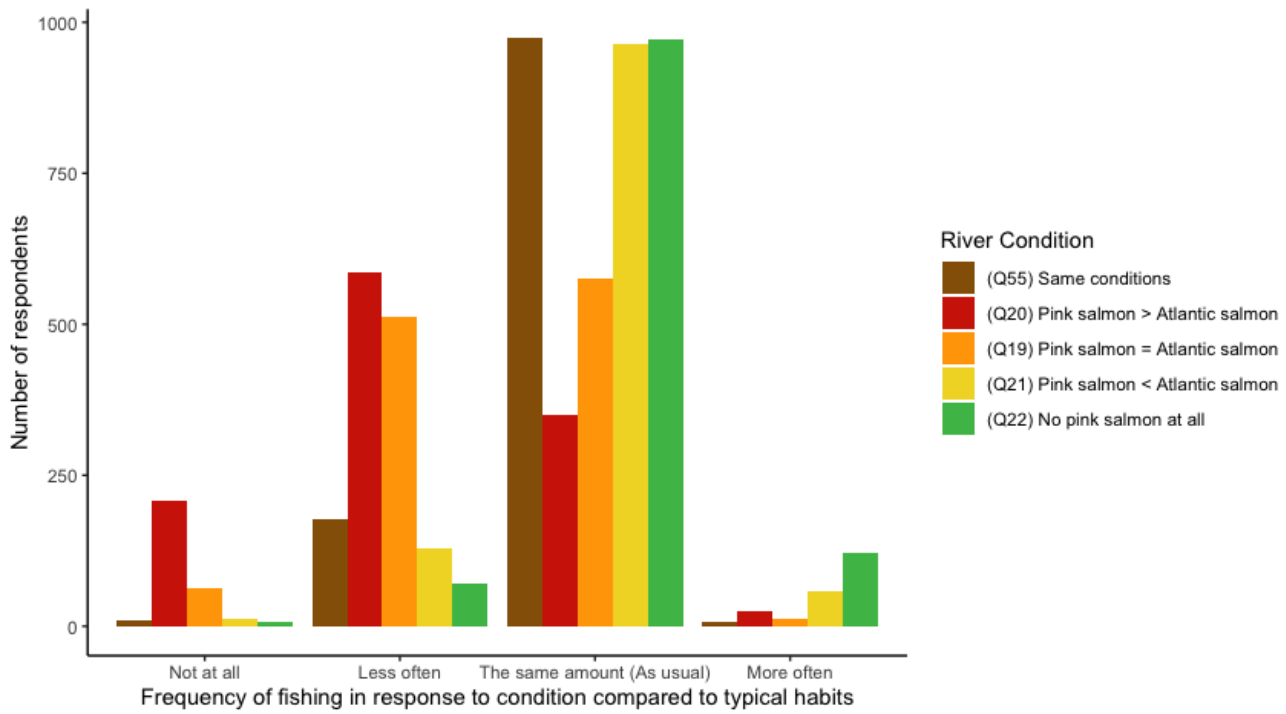

Figure 2-2: Distribution of responses to the questions described in Table 2-4, assessing impacts to angler participation via changes in fishing frequency in response to pink salmon abundance levels in the anglers' main rivers.

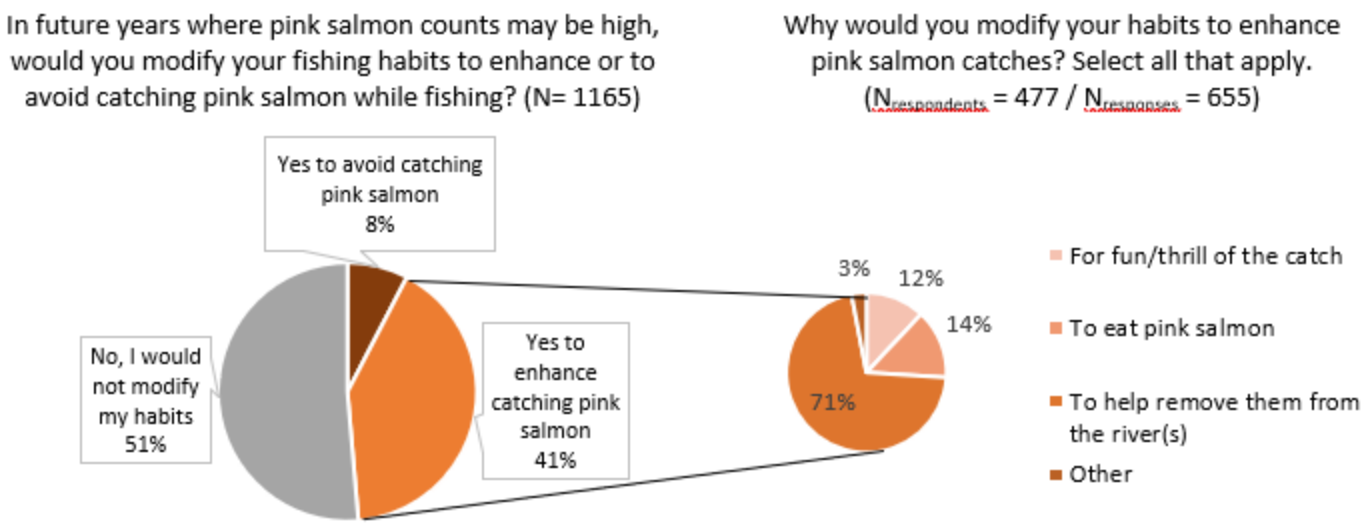

Figure 2-3: Percentage of participants who would modify their behaviour in future years when pink salmon counts may be higher than present levels (left), and the reasons why they would modify their behaviours to catch more pink salmon (right).

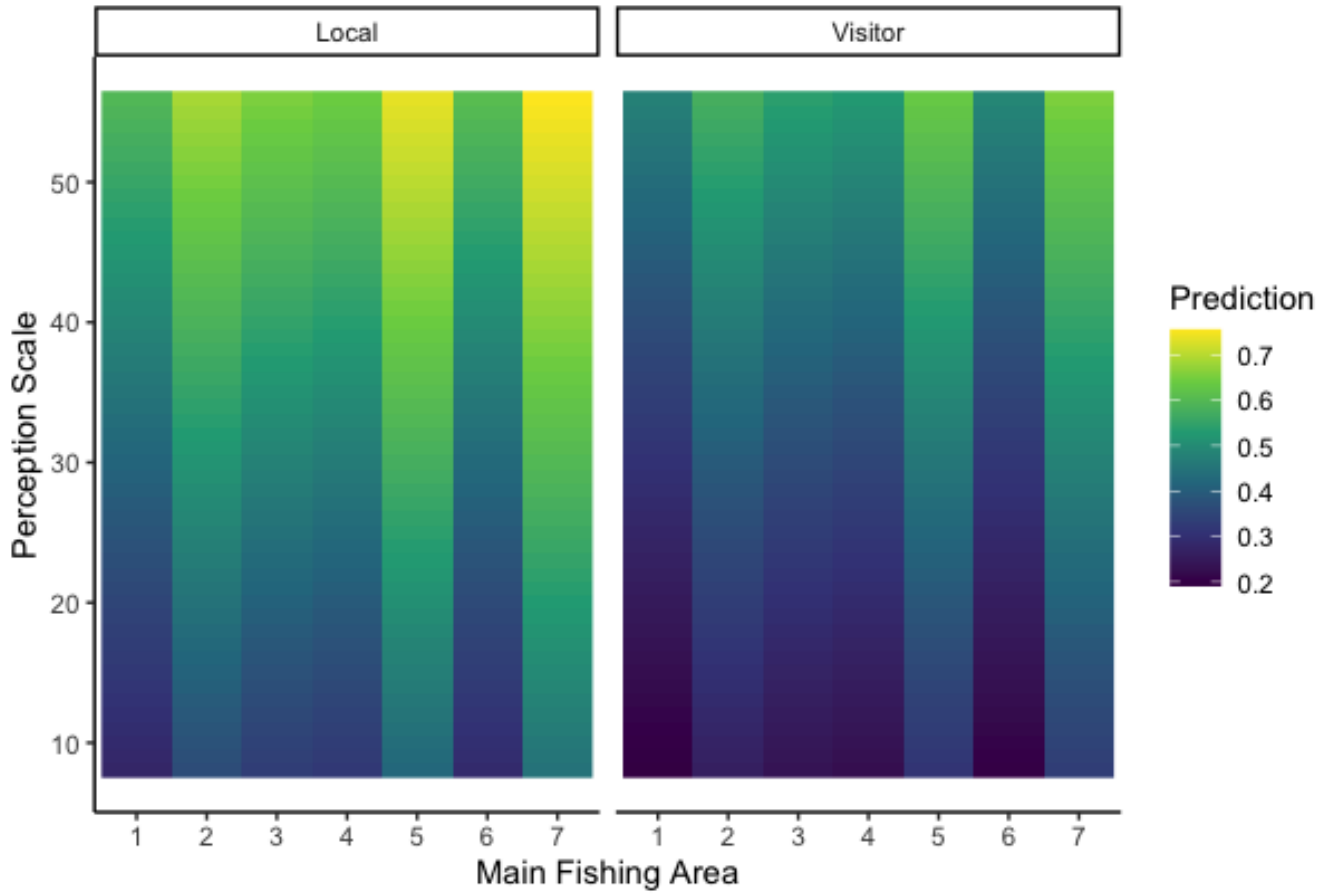

Figure 2-4: Colour-coded binary logistic regression model predictions considering all significant predictor variables (Graph on the left = Local anglers and graph on the right = Visiting anglers. Main Fishing Area along the x-axis by category. Perception scale along the y-axis as count data (8 to 56). Model prediction values < 0.5 = No change in behaviour, >0.5 = Change in behaviour).

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Chapter 3: Understanding the hidden connections between information channel use and proconservation behaviour among recreational anglers of the shore-based shark fishery in Florida, U.S.

3.1 Abstract

Shore-based shark fishing in Florida is a relatively low-cost and accessible fishery attracting a wide variety of experienced and inexperienced anglers which can lead to concerns about proper fish handling methods. Proper fish handling methods can help reduce post-release mortality among sharks, many of which are threatened with extinction. Therefore, we considered proper handling methods as a proconservation behaviour, which has been linked with information channel use to increase conservation knowledge. We use data from an online questionnaire to understand where anglers of this fishery obtain information about general fishing skills (e.g., capture and handling techniques). Next, we include their main information channels in a series of hierarchical regression models with perceived conservation knowledge and support for fishery management to explain proconservation behaviour regarding shark conservation. We found that most anglers learned about shore-based shark fishing through interpersonal communications with friends and family, but typically use the internet to learn more about fishing skills. While information channel use did not significantly predict proconservation behaviour, it did significantly predict management support for fishery management, which in turn significantly predicted proconservation behaviour among respondents. These findings can inform public educational outreach efforts to spread awareness of proper handling techniques and reduce instances of post-release mortality in sharks.

3.2 Introduction

A quarter of all sharks and rays are threatened with extinction, mainly due to overfishing and bycatch, but also due to habitat loss, and climate change (Dulvy et al. 2014). Of the threats to sharks, commercial fisheries are large contributors to shark population declines worldwide; however, little is known about the impacts of recreational shark fishing, a niche fishery that is largely under-represented in the literature (Gallagher et al. 2017; Roff et al. 2018; MacNeil et al. 2020). While it is assumed that recreational shark fishing does not significantly impact shark populations, this activity often involves angling sharks (using rod and reel) to exhaustion until it is safe to dehook and occasionally pulling the shark out of water for angler safety. Such practices can cause physiological stress to sharks, leaving them vulnerable to predation or death from injuries or depleted energy (Gallagher et al. 2014; Danylchuk et al. 2014; Weber et al. 2020). Consequently, improper handling practices or use of unsuitable gear could be harmful to both the shark and angler (Brownscombe et al. 2017). Proper management of recreational shark fisheries and promoting best handling practices is thus critical to maximize the protection of sharks, especially for vulnerable species that may be more sensitive to stress.

Management strategies may only be effective if anglers participate or comply with the best practices and regulations. Unfortunately, this is not always the case, especially if anglers disagree with the regulations, regulations are not enforced, or anglers are not aware of the regulations (Page & Radomski 2011; Cardona & Morales-Nin 2013). A recent publication revealed that non-compliance may be prevalent in a shore-based

shark fishery in Florida after highlighting illegal activities posted on an online public forum, such as landing prohibited species of sharks and delaying their release (Shiffman, et al. 2017). Shore-based shark fishing (SBSF) is a relatively low-cost mode of shark fishing where the ocean can be accessed by beaches, piers, and bridges, which could attract anglers with minimal experience to participate. Improper handling practices could thus be common, putting both the shark and angler at risk of harm. Moreover, Shiffman et al. (2017) highlights skepticism among anglers from this fishery towards researchers and the science behind regulations, which may impede communication between managers, researchers, and anglers (Dedual et al. 2013). Further impediments to communication within the Florida SBSF fishery may include fear that management actions will limit fishing opportunities, or animosity towards the impacts of commercial fishing on shark populations due to the potential ripple effects on recreational fishing (Dedual et al. 2013; Guay et al. 2021).

A major component of effective fisheries management is successful communication with anglers, which can inform them of current and new regulations, safe and best handling techniques, and potential opportunities that call for angler engagement and participation (Arlinghaus et al. 2013; Hunt et al. 2013). Effective communication between anglers, managers, and researchers may foster better relationships and trust which could increase involvement of anglers in fisheries management (Arlinghaus 2006). Since successful communication involves reaching the greatest number of anglers in the fishery and connecting with their values and beliefs, understanding angler values and where anglers acquire fishing-related information is crucial (Dedual et al. 2013). With these data, managers could target their outreach efforts through the most used channels to

reach the most anglers, while shaping the content to align with angler values and increase support for fishery management. Presently, there are few studies that investigate anglers' primary information channels (Hunt et al. 2013). Moreover, previous studies have found great diversity in information channels and sources used by individual anglers, which may hinder outreach efforts from managers if they are using a single or few output channels (Gray & Jordan 2010; Nguyen et al. 2012). Therefore, the first objective of this study is to identify the main channels through which anglers of the Florida SBSF fishery acquire information about fishing skills to help inform and target educational outreach efforts.

Engagement and collaboration with an informed angler community should improve support towards fishery management and conservation goals (Li et al. 2010). Studies have found that anglers who are more knowledgeable on shark-related conservation matters tend to have more positive attitudes towards researchers and management and be more likely to comply with regulations and participate in proconservation behaviours (e.g., O'Bryhim and Parsons 2015; Gallagher et al. 2017).

Exposure to information through different channels has been found to shape perceived knowledge, and therefore influence proconservation behaviours. For instance, Corbett (2002) found that intention to participate in a conservation program differed based on information exposure from different channels. Furthermore, information channel use has been linked to attitudes about conservation challenges and their management, which in turn may influence proconservation behaviour (Witzling et al. 2015). Therefore, there is evidence that suggests anglers' interactions with various

information channels may influence their knowledge, attitudes, and behaviours towards conservation and fisheries management (Corbett 2002; Witzling et al. 2015).

The Florida SBSF fishery presents a unique case to study these relationships, particularly because the relatively low-cost and easy-access features of this fishery can attract a wide variety of experienced and inexperienced anglers. This can lead to concerns about proper handling methods which can help reduce post-release mortality among sharks, many of which are threatened with extinction (Dulvy et al. 2014). As such, our second objective is to evaluate how these channels might ultimately influence angler support towards fishery management and willingness to participate in proconservation behaviour (i.e., proper handling methods). We pose three hypotheses: 1) Information channel use will influence angler perceived conservation knowledge, 2) Information channel use and perceived conservation knowledge will influence support for fishery management strategies, and 3) Information channel use, perceived conservation knowledge, and management support will influence proconservation behaviour regarding shark conservation.

3.3 Methods

Data Collection: Questionnaire

We distributed an online questionnaire (see Appendix B for the full questionnaire) via email to 11,277 recreational anglers who obtained a shore-based shark fishing permit from the Florida Fish and Wildlife Conservation Commission (FWC) in 2019. The questionnaire was designed for a larger study (see Guay et al. 2021) and included 40 questions assessing angler specialization, motivation, preferences, behaviour, perceptions

of shark conservation and fishery management, sociodemographic variables and more (see Appendix B and Guay et al. 2021 for additional information). Our questionnaire was designed based on similar studies surveying recreational shark anglers in other regions, and included a combination of multiple choice, 4-point Likert scales, and open-ended response questions (e.g., NMFS 2014; Gallagher et al. 2015; McClellan Press et al. 2016; Lovell et al. 2016; Drymon and Scyphers 2017; Johnson 2018; French et al. 2019). We included three filter questions to obtain our target participants (i.e., anglers with an FWC SBSF permit, who target sharks, and fish from shore), and sociodemographic variables included angler gender, age, education, employment, and residency. The remaining relevant questions will be described in the sections below. Prior to distribution, we sent the questionnaire to members of the FWC and of the National Oceanic and Atmospheric Administration National Marine Fisheries Service Highly Migratory Species (NOAA-NMFS-HMS) for review. We also piloted the questionnaire with shark anglers in Florida to reduce personal bias and ensure relevant questions (Moon et al. 2019). We initially sent the questionnaire via Qualtrics XM (2020) on March 13, 2020, followed by a prompting email on April 2, 2020, before terminating the questionnaire on April 17, 2020. From our list of 11,277 SBSF permit holders (in December 2019), 271 emails returned due to deactivated accounts and 16 emails were returned as duplicates, resulting in 10,990 permit holders receiving the questionnaire. Our questionnaire and research methods adhered the Carleton University Research Ethics Board requirements (CUREB-B Clearance #112118).

Data Analysis

For this study, we focused on four constructs: I) angler's information channels, II) angler perceived conservation knowledge, III) management support, and IV) proconservation behaviour which we describe in the sections below.

Identifying Anglers' Main Information Channel

We included an open-ended question assessing anglers' main information channels to learn more about fishing skills and practices, as well as an open-ended question to understand where they specifically learned about shark fishing (Table 3-1). We manually coded both variables, initially into specific categories that emerged from the data, and then reduced to fewer broader themes based on characteristic similarities and categories used in similar studies assessing anglers' preferred information channels (Nguyen et al. 2012; Witzling et al. 2015). The variable assessing main information channel to learn more about fishing skills was then labelled as "information channel" and used in its reduced (e.g., 5 categories) form for further analyses.

Angler Perceived Conservation Knowledge

Perceived conservation knowledge was measured using a 4-point Likert item assessing level of agreement *(disagree, somewhat disagree, somewhat agree, agree*) on the following statement: "*I am knowledgeable about shark conservation related issues".* We reduced the 4-point item into a binary variable by collapsing "*agree*" and "*somewhat agree*" together, as well as "*disagree*" and "*somewhat disagree*" to be used in a binary logistic regression.

Angler Support for Fishery Management

Management support was measured by first creating a composite scale using five statements extracted from two 4-point Likert scale questions assessing anglers' level of agreement towards regulations and the state of the SBSF fishery management (described in Table 3-2). We assigned each angler a score measuring their support for fishery management by rating each response from one (*disagree*) to four (*agree*), except for one item which was reverse coded, and calculated the sum of the five variables resulting in a single composite variable with a minimum score of 5 and a maximum score of 20. We labelled the scale "*management support*", within which lower values (≤ 12) indicated lack of or low support for fishery management, and higher values (≥ 13) indicated sufficient or total support for fishery management. We then calculated Cronbach's alpha coefficient to measure the internal consistency reliability of the five variables used to create the scale (Eisinga et al. 2013). The Cronbach's alpha coefficient for the five variables used was 0.64, indicating relatively acceptable internal consistency among variables within the management support scale (Bonett & Wright 2014). When we included *management support* in a model as a predictor variable, we used it in this scale format as a numerical variable, however when we included it as a response variable, we collapsed the scale into a binary variable for use in a binary logistic regression. To do this, we categorized anglers such that respondents with a score of ≤ 12 were categorized as "*not supportive*", and respondents with a score of ≥ 13 were categorized as "*supportive*". We opted for this strategy to maintain consistency in model type for this series and for ease of model comparison.

Angler Proconservation Behaviour

Proconservation behaviour was measured using a 4-point Likert item assessing level of agreement *(disagree, somewhat disagree, somewhat agree, agree*) on the following statement: "*I would change how and where I fished if it helped shark survival".* We reduced the 4-point item into a binary variable by collapsing "*agree*" and "*somewhat agree*" together, as well as "*disagree*" and "*somewhat disagree*" to be used in a binary logistic regression. We used this variable to represent proconservation behaviour as it demonstrates willingness to modify current behaviours should it increase post-release survival of sharks, many of which are threatened with extinction (Dulvy et al. 2014).

Hierarchical Modelling of Proconservation Angler Behaviour

To understand how anglers' main information channels, perceived conservation knowledge, and management support might predict proconservation behaviour regarding shark conservation, we performed a series of three hierarchical binary logistic regressions (Table 3-3). We also included two sociodemographic variables in each model to measure potential external influences, and to improve the models' fit to the data (determined by comparing Akaike's Information Criterion with and without sociodemographic variables). The two sociodemographic variables we measured were education and age as studies have found links between both variables to higher perceived conservation knowledge, management support and proconservation behaviour (Sharp et al. 2011; Witzling et al. 2015; Potgieter et al. 2019). Education was modified to reflect as a binary variable with respondents categorized into "secondary education" and "post-secondary

education" as their highest level of education achieved. Age was modified into equally distanced groups (< 21 years; 21 – 30 years; 31 – 40 years; …; > 60 years) and included as a numerical variable. These modifications were helpful in simplifying the model for clearer interpretation of results.

Model A evaluated the influence of information channel (5 categories), age, and education (predictor variables) on perceived conservation knowledge (response variable). Model B evaluated the influence of the previous predictor variables in addition to perceived conservation knowledge (as a predictor) on management support (response variable). Finally, Model C measured the influence of all prior predictor variables in addition to the numerical management support scale (as a predictor) on proconservation behaviour (response variable) (Table 3-3).

3.4 Results

Our questionnaire received a response rate of 17.2% with 1895 of the 10,990 questionnaires completed. We removed duplicate, invalid, and incomplete questionnaires (<90% completion), and filtered respondents for recreational anglers who target sharks from shore, resulting in a total of 972 questionnaires included in the analysis.

Sociodemographic Description of Sample Population

The respondents were predominantly male (94%, N=964) residents of Florida (67%, N=964) distributed relatively equally between ages of 21 and over 60 with an underrepresentation of anglers aged 20 or younger (5%, N=961). When compared to the demographic variables of the entire SBSF permit list (14,809 anglers who held an FWC

SBSF permit in May 2020), our sample exhibited relatively similar patterns other than minor deviances in age distribution. Therefore, our sample respondents appeared to represent a sufficient approximation of the entire fishery. Most respondents were employed full time (60%, N= 959), retired (17%), or self-employed (10%), and most hold either an undergraduate or college degree (40%, N=955) or a secondary education diploma (26%).

Identifying Main Information Channels

After initial categorization based on common themes among responses, we identified 11 individual information channels from which anglers specifically learned about shark fishing (Table 3-1). In addition to the 11 channels, we formed two categories: *Combination* to distinguish anglers who use multiple channels, and *Other* to gather uncommon responses such as television series or movies, social media, or listing a specific location. The most common channels among our sample were through interpersonal communication/interactions with friends and family (32%, N=918) or other anglers (19%). The least common channels were prints (magazines, pamphlets, signs, etc.), fishing clubs, and tackle shops (2% combined). We further reduced these 11 channels into five broader categories, as outlined in Table 2-1.

As for information channels through which anglers seek to learn about general fishing skills, we identified 8 channels, in addition to the two formed categories: *Combination* and *Other*, which primarily included responses such as personal experience through fishing. The most common individual information channel used among our sample was the general internet (35%, N=883), however 18% of respondents also listed

YouTube on its own, making it the second most common individual channel. The least common channels were prints and fishing clubs (1% combined). We further reduced these eight channels into five broader categories as outlined in Table 2-1, which were used in further analyses outlined below.

Hierarchical Modelling of Proconservation Angler Behaviour

Prior to performing the series of hierarchical models, we tested all predictor variables to verify there was no multicollinearity. Most anglers (92%) perceived themselves to be knowledgeable of shark-related conservation matters, were supportive of management (Table 3-2) and were willing to modify their fishing habits to increase shark survival post-release (88.2%). Angler education and age were ultimately excluded from each regression model as they introduced increased standard errors, either increased or did not significantly reduce each model's AIC, and they were not significant predictors in any model. Model A revealed that information channel was not a significant predictor of perceived conservation knowledge. Model B revealed the information channels "*internet*" and "*combination*" to be significant predictors of management support. The log odds of an angler being supportive towards fishery management increased by a factor of 1.04 (95% CI [0.55, 1.53]) for anglers who used the internet as a channel to learn more about fishing skills and increased by a factor of 0.91 (95% CI [0.28, 1.58]) for anglers who used a combination of channels. We calculated McFadden's Pseudo R^2 ($R^2 = 0.03$, $p<0.001$) and the Hosmer and Lemeshow goodness of fit test ($X^2 = 0.4068$, df= 8, pvalue= 0.9999) and found no significant evidence of poor model fit. Model C revealed management support as a significant predictor of proconservation behaviour, in which the

log odds of an angler willing to modify their fishing habits to increase shark survival increased by a factor of 2.19 (95% CI [1.70, 2.70]) for every unit increase in management support score. Again, we calculated McFadden's Pseudo R^2 ($R^2 = 0.14$, $p<0.001$) and the Hosmer and Lemeshow goodness of fit test ($X^2 = 2.7154$, df= 8, pvalue= 0.9509) and found no significant evidence of poor model fit.

3.5 Discussion

Our study primarily identifies the main channels through which recreational shark anglers from the SBSF fishery in Florida obtain information on general fishing skills, filling an area of research in fisheries science which receives little attention. The desire to learn more about or gain expertise in an activity of interest is not exclusive to recreational shark angling, hence these findings may be applicable and comparable to broader recreational fisheries and other social-ecological systems such as hunting. We aimed to reduce sampling bias by distributing the questionnaire to the full FWC SBSF permit list, however our study presents limitations as we only captured a sample of the entire fishery. Non-response bias may have been due to skepticism towards researchers (Shiffman et al. 2017), missed emails or emails sent to junk or spam folders, respondents abandoning the questionnaire partway through, forgetting to complete the questionnaire, or being too busy to respond (Gigliotti & Henderson 2015). Nonetheless, our response rate (17.4%) remained fairly consistent with other targeted online questionnaires (Sheehan 2001; Nulty 2008; Shih & Fan 2009), and sociodemographic comparison of the entire FWC SBSF permit list suggested that our respondents were relatively representative of the fishery.

We found that while most anglers learned about shark fishing through interpersonal communications with friends, family, or other anglers, most tended to use the internet to learn more about general fishing skills. A study investigating use of information channels among recreational salmon anglers in British Columbia, Canada, found similar results, in which most anglers sought information about proper handling techniques on the internet (Nguyen et al. 2012). Moreover, over 25% of our respondents reported the use of YouTube to learn about fishing skills, a global free video-sharing website in which virtually anyone may upload public video content. While the use of the internet to learn physical skills is fairly common in developed countries, there may be caveats to the lack of direct observation and instruction one does not receive online. It could be possible that when fishing, fishing tips or tricks learned online may not translate as easily into practice and cause harm to the catch. Moreover, anglers primarily using YouTube could be watching videos from recreational anglers in other U.S. states or countries with different regulations and unknowingly participating in illegal shark fishing practices in the state of Florida. In addition, almost 60% of respondents agreed (or somewhat agreed) that most anglers knew what they were doing and would release sharks unharmed, and almost 75% agreed (or somewhat agreed) that more SBSF education and training is needed, suggesting probable malpractice or improper shark handling practices within this fishery, of which the amount is unknown (Table 3-2). While the internet is a great tool that facilitates ample learning opportunities and provides easier access to information and communication, the potential risks and caveats should not be ignored.

Our hierarchical models did not support any of our hypotheses in full but did support our second and third hypotheses in part. For our first hypothesis, no significant

relationship was found between information channel use and perceived conservation knowledge. Exposure to information through different channels has been found to be associated with perceived knowledge in the context of alien invasive species prevention compliance (Witzling et al. 2015). In that study, interpersonal communication, media (television, social media, the internet, etc.), and signs were positively associated with perceived knowledge of alien invasive species, but fishing clubs as a channel were not, suggesting that use of different channels can lead to different levels of perceived knowledge. We may not have seen similar results among our respondents due to questionnaire design restricting our measure of perceived knowledge to only a single variable addressing "*shark conservation related issues*" – a broad subject that can be interpreted in different ways. Anglers may have also answered this question dishonestly due to social desirability bias, or fear of not being taken seriously should they not be knowledgeable of such issues. Conversely, it is possible we sampled a highly knowledgeable population of anglers as those who participated in our questionnaire may already be receptive and knowledgeable of scientific findings on this topic, potentially resulting in no relationship found. Lastly, the open-ended nature of our variable measuring information channel allowed for both specific (e.g., "My friend Henry", "FWC website", or naming a specific online forum) and general (e.g., "Internet", "Researchers") responses, which may have led to generalization of coding and less nuances in categories, thus blurring any potential relationship with perceived conservation knowledge.

Our second hypothesis was partially supported. We found that angler support for fishery management was positively associated with the use of two information channels

(internet and combination), but not associated with perceived conservation knowledge. Previous studies found that anglers who were more knowledgeable of respective conservation issues were more likely to report positive attitudes towards conservation and management (Gallagher et al. 2015; O'Bryhim & Parsons 2015; Murphy et al. 2018). This was not the case for our study potentially because of biases from self-reported conservation knowledge. While perceived knowledge and actual knowledge do not always correlate, perceived knowledge may still influence beliefs and attitudes, and thus we expected to find similar results with those studies among our respondents. The use of the internet to learn more about fishing skills may result in increased support for management due to easier access to information. Ease of access to information may help build angler awareness of shark conservation and the importance of fishery management. However, we recognize that 'internet' is quite broad and the nuances may be overlooked, which does not tell the complete story. Similarly, the use of a combination of channels to learn more about fishing skills presumably exposes the angler to a wider variety of information sources, and consequently being more informed. Further, this may suggest that these anglers are seeking more information as they are exposed to and are gathering information from multiple places. Thus, it is possible that the relationship between conservation knowledge and support for fishery management revealed itself through the relationships found with information channel use, however more research on the use of these two channels would be needed to confirm the possible hidden relationship.

Our third hypothesis was also partially supported. We found that angler support for fishery management positively influences their proconservation behaviour toward shark conservation. However, we found no relationship between information channels

anglers used and their perceived conservation knowledge to proconservation behaviour. Our results align with many studies which reported that anglers who were more supportive of shark fishery management were more likely to adopt best handling practices which reduce shark mortality (Gallagher et al. 2015; French et al. 2019). O'Bryhim and Parsons (2015) also found that anglers who were knowledgeable on sharks were more likely to participate in behaviours supportive of shark conservation. The lack of association between perceived conservation knowledge and proconservation behaviour regarding shark conservation in our results may be a result of the limitations in how the constructs of conservation knowledge or proconservation behaviours were measured (as described above).

According to the theory of planned behaviour, people's behaviours may be predicted or explained by a combination of their attitudes towards the behaviour, perceived behavioural control over the behaviour, and subjective norms related to the behaviour (Ajzen 1991). Therefore, considering perceived behavioural control and subjective norms align, our results would follow the theory's framework in that increased support for fishery management (e.g., positive attitudes towards regulations) should lead to increased participation in behaviours which meet management conservation goals (e.g., compliance with regulations, best handling practices). Witzling et al. (2015) investigated how exposure to information from different channels may act as background variables within the theory of planned behaviour framework. Our study found similar results to theirs, in which no associations were found between information channels and behaviours, but associations were found between specific information channels and attitudes (i.e. fishery management support). These findings suggest that information

channel use may indirectly influence proconservation behaviours among our respondents by acting as a background factor to beliefs (Ajzen 2011).

3.6 Conclusions and Management Implications

Our study identified where anglers from the SBSF fishery in Florida, U.S. obtain fishery-related information and discovered a wide range of channels used among the anglers. Anglers particularly learned about the fishery through interpersonal communications, and predominantly used the internet to learn new fishing skills. Evidence of increased participation rates in recreational shark fishing (Drymon & Scyphers 2017; Kilfoil et al. 2017; Guay et al. 2021) may result in novice anglers handling their catch improperly, resultign in growing concerns for increased injury and mortality rates in released sharks. The SBSF fishery in Florida has gear, harvest, and handling restrictions as well as a mandatory online educational course on safe handling practices to obtain a permit, however there are currently no restrictions on the number of sharks anglers may catch provided they are released (FWC 2022). While post-release shark mortality from recreational fishing is not yet quantified, extrapolated values in our previous study reveal potentially hundreds of thousands of sharks caught per year within this fishery, which, if coupled with improper handling practices, could result in significant impacts to coastal shark populations of Florida (Guay et al. 2021). Our respondents, however, expressed positive attitudes towards fishery management and desires for more education on best handling practices and ensuring shark survival post-release. Managers could thus use our findings to target educational outreach through the most-used channels (e.g., the internet, YouTube) to reach the most anglers.

We also found that anglers who use the internet or a combination of channels (e.g., both internet and interpersonal communications) to learn more about fishing skills might be more supportive of fishery management, and therefore more willing to modify their behaviour to ensure shark survival post-release. These findings may be used to improve outreach efforts through other channels which did not associate with management support (e.g., interpersonal connections, other/prints such as signs) in an effort to increase management support and therefore increase behaviours which favour shark survival. For instance, with evidence of skepticism towards managers and researchers among the SBSF angler community in Florida, improving outreach efforts through interpersonal connections may soften the divide and increase support. Careful design of such efforts should be taken however, as public trust in government sources remains questionable (May & Burger 1996; Brewer & Ley 2013). Additionally, the use of signs near fishing access points (e.g., bridges, piers, shorelines, boat launches) has been shown to influence behaviour by engaging a sense of social norms (Witzling et al. 2015). We recommend further comprehensive research into where recreational anglers obtain information, as well as how often they use such channels to obtain a better understanding of how each channel is used. We encourage fishery managers to use these data to inform outreach educational and training opportunities in an effort to improve shark survival post-release.

3.7 Acknowledgements

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3.8 Tables

Table 3-1: Categorization of main information channels used by respondents to learn about general fishing skills. Arrows indicate placement of specific channels into broader categories.

How did you learn about shark fishing?			
Channels	**N**	**Channels**	**N**
Friends and Family	291	*Interpersonal Communication*	477
Other Anglers	173	*Circumstantial*	205
Circumstantial	110	*Internet*	140
Accidental bycatch	95	*Other*	31
YouTube	59	*Combination*	65
Internet	45		
Governing Body (FWC)	26		
Fishing Forum/Page	10		
Tackle Shop	8		
Fishing Clubs	5		
Prints	5		
Other	26		
Combination	65		
NA	54		

Where would you go to learn more about fishing skills?			
Channels	**N**	**Channels**	**N**
Internet	313	Internet	416
YouTube	162	YouTube	162
Other Anglers	80	Interpersonal Communication	138
Governing Body (FWC)	52	Other	37
Fishing Forum/Page	51	Combination	130
Friends and Family	34		
Tackle Shop	20		
Prints	7		
Fishing Clubs	4		
Other	30		
Combination	130		
NA	89		

Table 3-2: Summary of responses to two questions assessing attitudes towards shore-based shark fishery management and shark conservation.

Statements on fishery management	***Disagree***	***Somewhat disagree***	***Somewhat agree***	***Agree***	***Don't know/Does not apply***	***N***
*Current management measures and restrictions help shark conservation**	2.8%	5.3%	34.0%	53.9%	4.0%	965
*More regulations are required for recreational shark fishing**	31.2%	29.5%	20.2%	12.3%	6.7%	965
*Current management restrictions are too strict or interfere with my fishing**	41.2%	28.2%	17.6%	8.8%	4.0%	964
Most shore-based shark anglers know what they are doing and will release sharks unharmed	15.8%	22.7%	35.3%	21.3%	4.9%	966
*There needs to be more education and training for shore-based shark fishing**	8.0%	15.5%	38.6%	35.0%	2.9%	967

Statements on shark conservation	***Disagree***	***Somewhat disagree***	***Somewhat agree***	***Agree***	***Don't know/Does not apply***	***N***
*Sharks need to be better protected**	3.4%	9.1%	29.3%	55.2%	3.0%	968
I am knowledgeable about shark conservation related issues	0.8%	5.9%	39.0%	53.1%	1.1%	968
When SBSF, GHHS always survive after being caught	50.1%	17.0%	9.4%	3.3%	20.2%	966
I would not fish for sharks if I thought it could kill them	11.3%	21.9%	27.1%	37.3%	2.4%	965
Recreational fishing has a negative impact on shark populations	40.3%	29.5%	20.3%	3.8%	6.0%	968
Commercial fishing has a negative impact on shark populations	4.6%	6.3%	21.9%	62.5%	4.7%	967
I want to learn more about how to make sure my shark survives after I release it	3.3%	4.7%	18.2%	70.0%	3.8%	966
Populations of great hammerhead sharks are not at risk of extinction	33.9%	22.7%	9.4%	4.7%	29.3%	967
I would change how and where I fish if it helped shark survival	4.5%	6.1%	28.9%	57.7%	2.8%	965

Notes:
Statements marked with an asterisk (*) were used to create our composite scale variable "Management support"
SBSF = Shore-based shark fishing
GHHS = Great hammerhead sharks

Table 3-3: Summary of results from the hierarchical binary logistic regression models

	Model A (DV = PCK)				Model B (DV = MS)				Model C (DV = PEB)			
Independent Variables	**Coef.**	**SE**	**z**	**p**	**Coef.**	**SE**	**z**	**p**	**Coef.**	**SE**	**z**	**p**
Block A												
IC – Int.Com.	-	-	-	-	-	-	-	-	-	-	-	-
IC – Internet	0.57	0.39	1.45	0.146	1.04	0.25	4.16	< 0.001*	-0.07	0.34	-0.22	0.827
IC – YouTube	-0.08	0.42	-0.18	0.854	0.23	0.27	0.82	0.412	-0.04	0.39	0.104	0.917
IC – Combination	0.44	0.5	0.89	0.376	0.91	0.33	2.79	0.005*	0.11	0.45	0.25	0.799
IC – Other	0.6	0.79	0.76	0.45	0.83	0.48	1.71	0.087	-0.35	0.59	-0.59	0.556
Block B												
PCK – Knowledgeable					-0.6	0.45	-1.33	0.182	-0.07	0.56	-0.12	0.9
Block C												
MS – Supportive									2.19	0.25	8.71	<0.001*

Notes:
DV = Dependent variable
IC = Information channel, PCK = Perceived conservation knowledge, MS = Management support, PEB = Pro-environmental behaviour
Coef. = Coefficient, SE = Standard error, z = z value, p = p value

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Chapter 4: General Discussion

This thesis investigates various factors influencing recreational angler behaviour in an effort to dissect how certain behaviours may be encouraged to support fishery management and conservation goals. Chapter 2 used the theory of planned behaviour as a guiding framework to investigate factors that may predict changes in self-reported angler behaviour as a response to pink salmon presence, a non-native and potentially invasive species in Norway. This Chapter served as a representation of the conservation challenge of managing potentially invasive or harmful species to protect the native biodiversity, local natural environment, and the economy. Chapter 3 investigated how self-reported proconservation behaviour (e.g., handling techniques that reduce post-release mortality) among recreational anglers of the shore-based shark fishery may be influenced by perceived conservation knowledge, level of support for fishery management, and information channel used for learning about fishing skills. While not all shark species are threatened with extinction, approximately one quarter of sharks and rays are (Dulvy et al. 2014), and as such this Chapter served as a representation of the conservation challenge of protecting threatened species and minimizing mortality rates caused by human activities. Both Chapters 2 and 3 aimed to inform fishery management on the levels of support for conservation goals and identify possible avenues to increase behaviours that support conservation priorities. By examining these two contrasting fisheries management conservation goals, I identify similarities and differences in voluntary adoption of behaviours based on the nature of the potential necessary management measures (e.g., eradication versus protection).

4.1 Main Findings on Self-Reported Angler Behaviours

Overall, Chapter 2 revealed a divide among respondents who would (~49%) and would not (~51%) modify their fishing behaviours and habits (e.g., fishing frequency) in future years of increased pink salmon abundance. Most who would modify their behaviours stated they would do so to increase pink salmon catches to remove them from the rivers, suggesting great potential for angler participation in stewardship programs such as targeted removal efforts of pink salmon. These findings suggested population control measures would likely be effective, as management strategies which align with angler values and maintain a high level of support and participation are more likely to succeed in their goals (Clay & McGoodwin 1995; Schroeder et al. 2018). Chapter 3 revealed that most anglers were willing to modify their fishing behaviours and habits to increase shark survival post-release, suggesting a high level of angler participation in proconservation behaviour through the adoption of proper handling techniques which reduce post-release mortality in threatened species. However, responses to other questionnaire variables suggested probable improper handling practices within this fishery, presenting a potential conservation challenge for managers. While specific fish handling techniques can be regulated by policy, such measures would be ineffective if not properly enforced and oftentimes largely depend on voluntary adoption of such techniques (Cooke et al. 2013). Therefore, findings suggested increasing educational outreach efforts may help improve voluntary engagement in proper handling techniques, thereby reducing chances of post-release mortalities. While Chapter 2 demonstrated behaviour changes that supported the removal and harvest of potentially invasive non-

native species, Chapter 3 demonstrated behaviour changes that supported the safe release and protection of vulnerable species. Both Chapters provided insights into changes in behaviour in response to contrasting management conservation challenges. In the following section, I discuss similarities and differences in the factors that influence such behaviour changes between both Chapters.

4.2 Similarities and Differences: Lessons Learned on Factors Influencing Behaviour

Both Chapters 2 and 3 revealed high levels of participation in voluntary behaviours that support respective management conservation challenges. Considering the contrasting nature of each fishery, these similarities highlight the level of conservation support and biocentric value orientations held by recreational anglers. These findings further provide insight into the potential feelings of accountability and responsibility anglers may have in ensuring the sustainability of their activity or sport, which, along with value orientations, may contribute to the stewardship observed (Bruskotter & Fulton 2007). Upon investigating the factors that influenced changes in behaviour, angler attitudes were found to be significant predictors of self-reported behaviour change in both Chapters. It is important to note that management support could be considered as a proconservation behaviour itself considering management goals of creating sustainable fisheries (Bennett et al. 1978; Arlinghaus & Cooke 2009; St John et al. 2018), potentially explaining these similar results. However, measurements of attitudes in each Chapter included additional variables assessing concepts outside of solely management support (e.g., opinions of pink salmon in Chapter 2, and opinions of regulations interfering with their fishing in Chapter 3), and as such I considered attitudes separate from

proconservation behaviours. Furthermore, the similarities between both Chapters regarding behaviour provides some support to an existing social theory explaining behaviour. While some components are certainly absent thus restricting the ability to fully evaluate this theory, the link between attitudes and behaviours supports the theory of planned behaviour which posits that behaviour can be explained by attitudes, subjective norms and perceived behavioural control (Ajzen 1991).

Most observed differences between Chapters 2 and 3 were due to differing study designs, though there was one notable difference in how institutional education might have indirectly influenced self-reported behaviour change via links with attitudes. In Chapter 2, angler education level significantly predicted angler perceptions or attitudes towards pink salmon in Norway, though did not significantly predict changes in behaviour. Conversely in Chapter 3, angler education level did not significantly predict both attitudes nor changes in behaviour. The difference observed here may be explained by the differing contexts of each conservation challenge. The challenge in Chapter 2 involves a greater understanding behind why the presence of new species can be harmful whereas Chapter 3 involves understanding that the survival of a released catch is beneficial, which should be implied considering it is the purpose of catch-and-release fishing. Thus, these findings suggest the effects of institutional education on angler attitudes (and therefore behaviour) might be context-dependent and require local and context-specific data to be of use to fishery managers in predicting attitudes or behaviours. Moreover, additional factors which might also act on education level may be at play, requiring a more comprehensive approach involving many factors and possibly causing more hassle than is worth.

4.3 Conclusions and Management Implications

Since many of the negative impacts affecting fish populations and aquatic environments are caused in part by recreational fishing (Post et al. 2002; Lewin et al. 2006), a major management challenge involves promoting and encouraging widespread adoption of behaviours which support management conservation goals among anglers. I aimed to inform this challenge by exploring the prevalence of self-reported proconservation behaviours among fisheries with contrasting conservation priorities and the factors which predict such behaviours. With these findings, managers can get a more holistic view of various ways behaviour may be influenced and use this knowledge to improve the prevalence of the factors which promote the desired behaviour. For instance, since there is strong evidence that attitudes influence behaviour, managers may focus their outreach efforts in ways which promote the necessary attitudes (e.g., positive attitudes towards management) that predict the desired behaviour (e.g., voluntary adoption of proper handling techniques).

While it might also be important to thus identify the factors that influence the attitudes that in turn promote conservation-supporting behaviour, both Chapters found no significant evidence of factors that influenced *both* attitudes and self-reported behaviour change. The lack of interactions suggest a more complex relationship between factors that influence attitudes and factors that influence behaivours that might boil down to angler lifestyle or perceived (or actual) behavioural control (Ajzen 1991; St John 2018). For instance, Selinske et al.(2019) found that impediments to achieving land management goals of privately protected areas included time constraints, age, and financial reasons.

Instead, managers should focus on improving relationships and trust with the public and stakeholders through interpersonal interactions which many studies have shown can improve support in management goals (Cardona et al. 2103; Schroeder et al. 2018; St John et al 2018).

By exploring fisheries with contrasting conservation challenges, the applicability of my findings increased to a wider range of social-ecological systems facing similar challenges. As such, these findings may contribute to broader knowledge surrounding human behaviour, and inform the management of many more conservation challenges outside of fisheries science that would benefit from public or stakeholder participation in achieving conservation goals. I recommend future research should focus on comparing proconservation behaviours and the factors which influence them across various systems (e.g., hunting, agriculture, urban lifestyles) to obtain a better understanding of the driving forces behind proconservation behaviour and encourage such behaviours to sustain current natural resources enjoyed by many. To enable comparisons, future social-ecological research should focus on consistency in variables across studies and, as suggested by Partelow (2018), encourage transparency in research methodology. It is also important to re-assess proconservation behaviours and their influences both over time and alongside fundamental changes in the respective conservation challenges (e.g., if the problem is more severe or resolved). By doing so, researchers and managers can identify potential differences in behavioural responses to the challenge, which can lead to a more holistic understanding of the issue by providing insight into how the challenge may have affected social or cultural norms, values, or lifestyles.

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Appendices

Appendix A (associated with Chapter 2)

A.1 Questionnaire

Perceptions of Pink Salmon in Norwegian Rivers

Start of Block: Participant Rights and Consent

Q44
Welcome to the survey on recreational salmon fishing in Norway!
We are seeking your expert contribution to a research project about the state of recreational salmon angling in Norway and the impact of pink salmon to recreational fishing experiences. The project will run from September 2020 to September 2022.
The purpose of this survey is to gain a better understanding on how local and visiting fishers participate in recreational salmon fisheries in Norway. We need your answer to find out how different salmonid species captured by all kind of angler types contribute to satisfaction in fisheries and decisions about where and when to fish. The survey should take **about 15-25 minutes to complete** and will be available until **February 1st, 2021**. The project is funded by the Norwegian Environmental Directorate and is a collaboration among NORCE Laboratory for Freshwater Ecology and Inland Fisheries, the Norwegian Institute for Nature Research (NINA), Carleton University (Canada), the Norwegian University of Life Sciences (NMBU), and the Natural Resources Institute Finland (Luke). The results of the project will contribute directly to management decisions about the future of recreational fishing resources and your participation ensures that you have a voice in shaping the direction of future policies. As a survey participant, you are guaranteed rights by the EU General Data Protection Regulation (GDPR), which we outline below so that you can understand what your rights are should you opt to contribute to this survey.

You have been contacted because you indicated on your fishing license that you have consented to be contacted for the purpose of scientific research. You may be contacted again in 2021 for a second survey. **Participation is entirely voluntary**, and you have the

option to withdraw at any time. No identifying personal information is sought, meaning you will not be asked to provide name, place of work, telephone numbers, or addresses. Your email address is how we contact you but will not be published anywhere and all published and archived data will omit that information. Data will be shared between NORCE and Carleton University in Canada for analysis, and your responses will be anonymized and stored on a secure drive. The Norwegian Data Protection Agency ensures that you, as a survey participant, know what information is registered about you, can correct information about yourself, request deletion of any data you provide, and have access to a copy of your personal information. You may file a complaint to the Agency about the treatment of your information if you are dissatisfied.

We hope that you will be interested in the subject of this research and agree to provide your input for the survey. If you have questions about the survey you can contact the project proponents by emailing Jessika Guay at jessika.guay@carleton.ca or Robert Lennox at role@norceresearch.no or at +47 911 94 442. According to the EU General Data Protection Regulation, we must have your consent statement to participate as an expert source in this project. The project information has been emailed to you and is available online for your review. Please select the consent statement below to start the survey.

I voluntarily agree to participate in the study:

○ Yes (1)

○ No (2)

Skip To: End of Survey If Q44 = No

End of Block: Participant Rights and Consent

Start of Block: Block A: Fishing Profile / Specialization

Q46 **Part A: Fishing Profile.**

This section will ask you about your fishing experiences, motivations for fishing, and importance of fishing in your life.

Q1 Including this year, how many years have you been fishing for any species?

▼ Less than 1 year (1) ... 70+ (71)

Q2 Approximately how many days of the year do you spend fishing for any species?

- ○ 1 - 5 days (1)
- ○ 6 - 10 days (2)
- ○ 11 - 25 days (3)
- ○ 26 - 50 days (4)
- ○ 51 - 100 days (5)
- ○ More than 101 days (6)

Q3 Have you ever fished for Atlantic Salmon, Sea Trout, or Sea-run Char in freshwater?

	Yes (1)	No (2)
In Norway (1)	○	○
In other countries (2)	○	○

Display This Question:

If Q3 = In other countries [Yes]

Q52 If you selected "In other countries - Yes" in the question above, please specify which countries you have fished for Atlantic Salmon, Sea Trout, or Sea-run Char in the box below.

_____

Q53 *Please note: For the remainder of the survey, whenever we write "Salmon fishing" or "Other salmon", we mean fishing for Atlantic Salmon, Sea Trout, or Sea-run Char unless otherwise stated.*

Q4 When was the last year you fished for salmon in Norway?

- ○ 2020 (1)
- ○ 2019 (2)
- ○ 2018 (3)
- ○ 2017 (4)
- ○ Before 2016 (5)
- ○ I have never fished in Norway (6)

Skip To: End of Survey If Q4 = I have never fished in Norway

Q5 Are you a permanent resident or a foreign visitor to Norway?

- ○ Permanent resident (1)
- ○ Foreign visitor (2)

Display This Question:

If Q5 = Permanent resident

Q5_2 You have selected that you are a permanent resident. Which county do you reside in?

▼ Agder (1) ... Viken (11)

Display This Question:

If Q5 = Foreign visitor

Q5_3 You have selected that you are a foreign visitor. Which country do you reside in?

_____

Q6 How would you rate your fishing skills compared to other anglers?

	Much lower than average (6)	(7)	(8)	Average (9)	(10)	(11)	Much higher than average (12)
Fishing skills (1)	○	○	○	○	○	○	○

Q7 How would you rate your knowledge on fishing and fishing management compared to other anglers?

	Much lower than average (6)	(7)	(8)	Average (9)	(10)	(11)	Much higher than average (12)
Knowledge on fishing (1)	○	○	○	○	○	○	○
Knowledge on fishing management (6)	○	○	○	○	○	○	○

Q8 We would like to understand the reasons for why you fish for Atlantic Salmon, Sea Trout, or Sea-run Char. Please rate how important each statement listed below is for why you fish.

	Not at all important (1)	(2)	(3)	Neutral (4)	(5)	(6)	Very important (7)	**Don't know / Does not apply** (8)
To catch a big fish (1)	○	○	○	○	○	○	○	○
To catch as many fish as possible (2)	○	○	○	○	○	○	○	○
To master angling-related techniques and challenges (3)	○	○	○	○	○	○	○	○
To experience a challenging fight with the fish (4)	○	○	○	○	○	○	○	○
To catch fish for food to eat (5)	○	○	○	○	○	○	○	○
To experience nature (6)	○	○	○	○	○	○	○	○
To relax and get away from the regular routine (7)	○	○	○	○	○	○	○	○

To socialize or be with friends and family (8)	○	○	○	○	○	○	○	○

Q9 To what extent to you agree or disagree with the following statements about how important fishing is to you?

	Strongly disagree (13)	(14)	(15)	Neither agree nor disagree (16)	(17)	(18)	Strongly agree (19)	**Don't know / Does not apply** (20)
If I stopped fishing, I would probably lose touch with a lot of my friends (1)	○	○	○	○	○	○	○	○
Others would probably say I spend too much time fishing (3)	○	○	○	○	○	○	○	○
Others would probably say I spend too much money on fishing activities or gear (4)	○	○	○	○	○	○	○	○

Other leisure activities don't interest me as much as fishing (5)	○	○	○	○	○	○	○	○

End of Block: Block A: Fishing Profile / Specialization

Start of Block: Block B: Perceptions of Pink Salmon

Q47 **Part B: Perceptions of Pink Salmon**
This section will ask questions pertaining to your opinions and experiences with Pink Salmon in Norwegian rivers.

Q10 Have you ever encountered or caught Pink Salmon in Norway?

○ Yes (1)

○ No (2)

Skip To: End of Block If Q10 = No

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*

Q11 In the last 4 years (2017 - 2020), approximately how many Pink Salmon did you catch in Norway while recreational fishing? Please enter a numerical value.

_____

Q12 In the last 4 years (2017 - 2020), have you caught Pink Salmon in the same rivers you caught Atlantic Salmon?

- ○ Yes (1)
- ○ No (2)
- ○ I don't know (3)

Display This Question:

If Q12 = Yes

Q13 Which region in Norway have you caught Pink Salmon where you also caught Atlantic Salmon? (Note: You may select more than one option below.)

- [ ] Southeast Norway: In counties Østfold, Akershus, Oslo, Buskerud, Vestfold, Telemark (1)
- [ ] Southern Norway: in Agder counties (4)
- [ ] Southwest Norway: in Rogaland and Hordaland counties (6)
- [ ] Western Norway: in Sogn & Fjordane and Møre & Romsdal counties (8)
- [ ] Trondheimfjord Region: in Sør-Trøndelag county and inner parts of Trondheim fjord in Nord-Trøndelag county (10)
- [ ] Namdal and Fosen / Northern Trøndelag: in Nord-Trøndelag county north of Trondheim fjord and Fosen Peninsula (12)
- [ ] Northern Norway – Southern part: in Nordland county (14)
- [ ] Northern Norway – Middle part: in Troms county (16)
- [ ] Northern Norway – Western part of Finnmark County (18)
- [ ] Northern Norway – Eastern part of Finnmark County (20)
- [ ] I do not remember (21)

Page Break

Q14 Please rate your level of agreement with the following statements on Pink Salmon in Norway.

	Strongly disagree (1)	(2)	(3)	Neither agree nor disagree (4)	(5)	(6)	Strongly agree (7)	**Don't know / Does not apply** (8)
I have always disliked Pink Salmon (1)	○	○	○	○	○	○	○	○
My opinion of Pink Salmon has changed unfavourably (2)	○	○	○	○	○	○	○	○
Pink Salmon should not get established in Norwegian nature (3)	○	○	○	○	○	○	○	○
I would eat Pink Salmon if I catch one (5)	○	○	○	○	○	○	○	○

Q15 In future years where Pink Salmon counts may be high, would you modify your fishing habits to **enhance or to avoid** catching Pink Salmon while fishing?

- ○ Yes, to enhance catching Pink Salmon (1)
- ○ Yes, to avoid catching Pink Salmon (2)
- ○ No, I would not modify my fishing habits (3)

Skip To: Q18 If Q15 = No, I would not modify my fishing habits

Display This Question:

If Q15 = Yes, to enhance catching Pink Salmon

Q16_1 Please select all options below that apply for **why** you would modify your fishing habits to enhance catching Pink Salmon.

- ☐ I would like to help remove Pink Salmon from the river(s) (1)
- ☐ I would like to eat Pink Salmon (2)
- ☐ I enjoy catching Pink Salmon for the fun of it / thrill of a catch (3)
- ☐ Other, please specify (4) _____

Display This Question:

If Q15 = Yes, to avoid catching Pink Salmon

Q16_2 Please select all options below that apply for **why** you would modify your fishing habits to avoid catching Pink Salmon.

- ☐ I dislike Pink Salmon (1)
- ☐ Pink Salmon does not taste good (2)
- ☐ Pink Salmon is not fun to catch / does not put up a good fight (3)
- ☐ Other, please specify (4) _____

Q17_1 Please state **how** you would modify your fishing habits in future years when Pink Salmon counts may be high. Choose a score from 1 to 7 where 1= do much less, 4= about the same, 7= do much more for each statement below.

	Do much less (1)	(2)	(3)	About the same (4)	(5)	(6)	Do much more (7)	**Don't know / Does not apply** (8)
Time spent fishing overall (1)	○	○	○	○	○	○	○	○
Time spent fishing in a river that has Pink salmon (2)	○	○	○	○	○	○	○	○
Plan fishing trips to/in Norway in general (3)	○	○	○	○	○	○	○	○
Plan fishing trips to/in Norway specifically during even-numbered years when Pink salmon are less prevalent (5)	○	○	○	○	○	○	○	○
Use specific gear to avoid catching Pink salmon (6)	○	○	○	○	○	○	○	○

Q57 (Optional) If you wish, you may leave a comment or explanation to some of the statements from the previous question above.

_____

_____

_____

_____

_____

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Q18 What would you consider an acceptable amount of Pink salmon caught for you to be satisfied with your fishing trip (assuming that salmon catches are held constant)?

- ○ No Pink Salmon at all (1)
- ○ 1 of 10 catches is Pink Salmon (2)
- ○ 2 of 10 catches are Pink Salmon (3)
- ○ 3 of 10 catches are Pink Salmon (4)
- ○ 4 of 10 catches are Pink Salmon (5)
- ○ 5 of 10 catches are Pink Salmon (6)
- ○ 6 of 10 catches are Pink Salmon (7)
- ○ 7 of 10 catches are Pink Salmon (8)
- ○ 8 of 10 catches are Pink Salmon (9)
- ○ 9 of 10 catches are Pink Salmon (10)
- ○ All of your catches are Pink Salmon (11)
- ○ Does not matter (12)

Page Break

Q55 If the cost of a fishing permit increased by 10% in your main Norwegian river, would you go fishing there...

- ○ More often (1)
- ○ The same amount (As usual) (2)
- ○ Less often (3)
- ○ Not at all (4)

Q19 If the cost of a fishing permit increased by 10% in your main Norwegian river, and the probability of catching Pink Salmon were **equal** to the probability of catching other salmon, would you go fishing there...

- ○ More often (1)
- ○ The same amount (As usual) (2)
- ○ Less often (3)
- ○ Not at all (4)

Q20 If the cost of a fishing permit increased by 10% in your main Norwegian river, and the probability of catching Pink Salmon was **higher** than the probability of catching other salmon, would you go fishing there...

- ○ More often (1)
- ○ The same amount (As usual) (2)
- ○ Less often (3)
- ○ Not at all (4)

Q21 If the cost of a fishing permit increased by 10% in your main Norwegian river, and the probability of catching Pink Salmon was **lower** than the probability of catching other salmon, would you go fishing there...

- ○ More often (1)
- ○ The same amount (As usual) (2)
- ○ Less often (3)
- ○ Not at all (4)

Q22 If the cost of a fishing permit increased by 10% in your main Norwegian river, and there were **no Pink Salmon at all**, would you go fishing there...

- ○ More often (1)
- ○ The same amount (As usual) (2)
- ○ Less often (3)
- ○ Not at all (4)

Q23 Please write your level of agreement with the following statements in regard to regulating Pink Salmon populations.

	Strongly disagree (1)	(2)	(3)	Neither agree nor disagree (4)	(5)	(6)	Strongly agree (7)	**Don't know / Does not apply** (8)
I think Pink Salmon should be removed from the river (1)	○	○	○	○	○	○	○	○
The implementation of efficient Pink salmon removal programs would increase my desire to fish in a river with high Pink salmon counts (2)	○	○	○	○	○	○	○	○
I believe Pink salmon threaten the viability of Atlantic salmon, Sea trout, and Sea char (3)	○	○	○	○	○	○	○	○
I **would** volunteer in targeted efforts to remove Pink Salmon by angling or netting (5)	○	○	○	○	○	○	○	○

I would pay an extra fee to support Pink Salmon removal (6)	○	○	○	○	○	○	○	○

End of Block: Block C: Fishery / Management Knowledge

Start of Block: Block D: Salmon Fishing

Q48 **Part C: Salmon Fishing Profile**
This section will ask questions specific to your salmon fishing experiences.

Q24 Please drag the options below to rank the following species in order of target preference when fishing. (Most preferred at the top, least preferred at the bottom)
_____ Atlantic Salmon (1)
_____ Sea Trout (2)
_____ Sea-run Char (3)
_____ Pink Salmon (4)

Page Break

Q25 Including your last year, how many years have you been fishing for salmon?

Number of years spent fishing in Norway (1)	▼ Less than 1 year (1) ... 70+ (71)
Number of years spent fishing in countries other than Norway (5)	▼ Less than 1 year (1) ... 70+ (71)

Q26 **The last year** you fished in Norway, how many days and number of Norwegian rivers did you go fishing for salmon?

Approximate number of days spent fishing for salmon in Norway (1)	▼ 1 - 5 days (1) ... More than 101 days (6)
Approximate number of rivers fished in Norway (2)	▼ 1 - 5 days (1) ... More than 101 days (6)

Q27 Approximately how many Atlantic Salmon, Sea Trout, or Sea-run Char did you keep or release during **your last year** in Norway? Please enter numerical values only.

○ Approximate number of Atlantic Salmon, Sea Trout, or Sea-run Char kept (1)

_____

○ Approximate number of Atlantic Salmon, Sea Trout, or Sea-run Char released (2)

_____

Page Break

Q28 Please rank your three main fishing areas from the list below by typing the ranked position (1, 2, 3) in the boxes below.

○ Southeast Norway: In counties Østfold, Akershus, Oslo, Buskerud, Vestfold, Telemark (2) _____

○ Southern Norway: in Agder counties (4)

_____

○ Southwest Norway: in Rogaland and Hordaland counties (6)

_____

○ Westcoast Norway: in Sogn & Fjordane and Møre & Romsdal counties (8)

_____

○ Trondheim Region: in Sør-Trøndelag county and inner parts of Trondheim fjord in Nord-Trøndelag county (10)

_____

○ Namdal and Fosen / Northern Trondheim Region: in Nord-Trøndelag county north of Trondheim fjord and Fosen Peninsula (12)

_____

○ Northern Norway – Southern part: in Nordland county (14)

_____

○ Northern Norway – Middle part: in Troms county (16)

_____

○ Northern Norway – Western part of Finnmark County (18)

_____

○ Northern Norway – Eastern part of Finnmark County (20)

_____

○ I do not remember (21)

_____

Q29 Are you a local or a visiting angler in your main fishing area? (A local has a short distance from home and usually lives at home while fishing the area. The visitor has a longer distance to travel and is staying overnight away from home during fishing)

- ○ Local (1)
- ○ Visitor (2)

Page Break

End of Block: Block D: Salmon Fishing

Start of Block: Block E: Demographics

Q50 **Part D: Tell us about yourself**
Although not about fishing, the next questions are standard in such surveys. All of this information remains confidential and anonymous.

Q30 What is your gender?

- ○ Man (1)
- ○ Woman (2)
- ○ Other (3)
- ○ Prefer not to say (4)

Q31 What year were you born?

▼ 2020 (36) ... 1916 (140)

Q32 What is your highest level of education?

- ○ Primary and lower secondary school (1)
- ○ High school degree or equivalent (2)
- ○ Trade or apprenticeship (3)
- ○ Bachelor's or college degree (4)
- ○ Post-graduate degree (Master's, PhD, Professional certifications) (5)

Q33 What is your employment status?

- ○ Unemployed (1)
- ○ Student (2)
- ○ Part-time (3)
- ○ Full-time (4)
- ○ Casual or Contract (5)
- ○ Retired (6)
- ○ On benefits (7)
- ○ Other (8)

Q34 What is your gross annual household income (before taxes)?

- ○ Less than EUR 20,000 / NOK (or SEK) 200,000 (1)
- ○ EUR 20,000-40,000 / NOK (or SEK) 200,000 – 400,000 (2)
- ○ EUR 40,001-60,000 / NOK (or SEK) 400,001 – 600,000 (3)
- ○ EUR 60,001-80,000 / NOK (or SEK) 600,001 – 800,000 (4)
- ○ EUR 80,001-100,000 / NOK (or SEK) 800,001 – 1,000,000 (5)
- ○ EUR 100,001-120,000 / NOK (or SEK) 1,000,001 – 1,200,000 (6)
- ○ EUR 120,001-140,000 / NOK (or SEK) 1,200,001 – 1,400,000 (7)
- ○ EUR 140,001-160,000 / NOK (or SEK) 1,400,001 – 1,600,000 (8)
- ○ EUR 160,001-180,000 / NOK (or SEK) 1,600,001 – 1,800,000 (9)
- ○ EUR 180,001-200,000 / NOK (or SEK) 1,800,001 – 2,00,000 (10)
- ○ More than EUR 200,000 / More than NOK (or SEK) 2,000,000 (11)
- ○ Will not / Cannot answer (12)

Q35 How many people live in your household, including yourself?

- ○ I live by myself (1)
- ○ 2 persons (2)
- ○ 3 persons (3)
- ○ 4 persons (4)
- ○ 5 persons (5)
- ○ 6 persons (6)

○ 7+ persons (7)

End of Block: Block E: Demographics

Start of Block: End of Survey

Q41 You are at the end of the survey! Please make sure to click on the "next" button below to submit your responses.

Thank you for your help! Your answers will be very helpful in understanding how Pink Salmon is perceived by salmon anglers, and how it may affect the fishing experience for local and tourist anglers. The findings obtained from your response could provide crucial insight for environmental management in monitoring Pink Salmon populations in Norway.

Please do not hesitate to contact Jessika Guay at jessika.guay@carleton.ca or Robert Lennox at role@norceresearch.no or at +47 911 9442 if you have any questions, or if you wish to withdraw your anonymized answers from the study.

Q42 Would you like to be contacted by the researchers if there are follow-up questions or to receive the findings?

○ Yes (1)

○ No (2)

Q43 If you have comments about the survey, Pink salmon, or salmon fishing and fishery management, we appreciate your comments. Please write them here:

_____

End of Block: End of Survey

Appendix B (Associated with Chapter 3)

B.2 Questionnaire

Florida Shore-Based Shark Fishing Survey

Start of Block: Consent Text

Q1
Welcome to the Florida Shore-Based Shark Fishing Survey Study!

As a thank you for your time, please make sure to enter your e-mail for a prize draw of one of five $50 amazon gift card.

This survey is being conducted by Jill Brooks, a PhD student, of the Carleton University Biology Department (jill.brooks@carleton.ca) working with Prof. Vivian Nguyen (Vivian.nguyen@carleton.ca). The survey was designed in collaboration with active shore-based anglers, researchers intimately familiar with the fishery, and feedback from relevant management agencies. Save Our Seas Foundation has funded the research. It is a collaboration between American Shark Conservancy and Carleton University.
The goal of the study is to understand activities associated with shore-based fisheries targeting large species, with a special focus on hammerhead sharks. We estimate that the survey will take about **10-15 minutes** to complete. **Your participation in this survey is voluntary**, and you may choose not to take part, or not to answer any of the questions. If you decide to withdraw after you submit the survey, we will remove your responses from survey data if you notify the researcher.
Our research aims to benefit stakeholders and managers by providing updated information about who uses the fishery and what do they think of current conservation and management practices. We do not anticipate any risks from taking the survey nor do we anticipate that you will derive any direct benefit. Your contributions, however, can support ongoing research on hammerhead tagging project with American Shark Conservancy (www.americansharkconservancy.org), a science-based and educational non-profit organization dedicated to conservation of sharks and the sustainability of fisheries.

Ethics Information:

All responses will be anonymized, encrypted and stored on a secure drive at Carleton University. Creel survey type information (Marine Recreational Information Program questions normally asked by State and Federal fishery officers) will also be shared with fishery managers in hopes to make both recreational and commercial shark fishing more sustainable for everyone.

If you would like to participate in this study, please follow the link above, for more information contact (jillbrooks@cmail.carleton.ca, 613-520-2600 x 4377) or Hannah Medd (hannah@americansharkconservancy.org, or on Instagram: @asc_sharkstudies)

You have the right to end your participation or withdraw your answers at any time, for any reason, up until May 31st. The ethics protocol of this project was reviewed by the Carleton University Research Ethics Board, which provided clearance (CUREB-B Clearance #112118) to carry out the research. If you have any ethical concerns with the study, please contact Carleton University Research Ethics Board-B (by phone at +1-613-520-2600 ext 4085 or via email at ethics@carleton.ca).

I voluntarily agree to participate in the study:

○ Yes (1)

○ No (2)

Skip To: End of Survey If Welcome to the Florida Shore-Based Shark Fishing Survey Study! As a thank you for your time, pl... = No

Page Break

End of Block: Consent Text

Start of Block: Part A: General Fishing Experiences and Lifestyle

Q3 **Part A: Your general fishing experiences and preferences** *This part will ask you questions about* ***your fishing experience and why you fish.***

Q4 How long have you been fishing for <u>any</u> species?

- ○ < 1 year (1)
- ○ 1 - 5 years (2)
- ○ 5 - 10 years (3)
- ○ 10 - 20 years (4)
- ○ > 20 years (5)

Q5 How *often* do you fish for <u>any</u> species?

- ○ Almost everyday (1)
- ○ Average of 2-3 times a week (2)
- ○ Average of once a week (3)
- ○ Average of once every two weeks (4)
- ○ Average of once a month (6)
- ○ Average of a few times per year (< 5 times per year) (5)

Q79 Do you hold a FWC shore-based shark fishing permit?

- ○ Yes (1)
- ○ No (2)

Q6 When you fish, do you ever target sharks?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If When you fish, do you ever target sharks? = No

Page Break

Q7 How long have you been fishing <u>for sharks</u>?

- ○ < 1 year (1)
- ○ 1 - 5 years (2)
- ○ 5 - 10 years (3)
- ○ 10 - 20 years (4)
- ○ > 20 years (5)

Q8 How often do you fish for sharks?

- ○ Almost everyday (1)
- ○ Average of once a week (2)
- ○ Average 2-3 times a week (7)
- ○ Average of once every 2 weeks (3)
- ○ Average of once a month (4)
- ○ Average of a few times per year (5)

Q15 Where do you rank yourself in terms of fishing skill level?

- ○ Beginner (1)
- ○ Intermediate (2)
- ○ Advanced (3)
- ○ Professional (i.e., you get paid for fishing) (4)

Q10 Please rank how important each statement is for **why you fish for sharks.**

	Not important (1)	Somewhat important (2)	Important (3)	Not sure (4)
To eat for food (1)	○	○	○	○
Fishing competitions (2)	○	○	○	○
Excitement/Thrill of the catch (3)	○	○	○	○
Satisfaction of catching the largest fish (4)	○	○	○	○
To develop and improve my skills (5)	○	○	○	○
To relax and get away from it all (8)	○	○	○	○
Opportunity to hang out with my friends and/or family (6)	○	○	○	○
To be outdoors and by water (7)	○	○	○	○
For physical exercise (9)	○	○	○	○

Q71 If you wish (optional), you may leave a comment or explanation to some of the statements from the previous question above.

_____

_____

_____

_____

_____

Q17 How many hours per week do you spend on social media (including Instagram, Facebook, and YouTube) watching fishing videos?

○ < 5 hours (1)

○ 5 - 10 hours (2)

○ 10 - 15 hours (3)

○ 15 - 20 hours (4)

○ > 20 hours (5)

Q16 Are you a member of a fishing forum, Facebook group, or club? (Choose all that apply)

☐ No (5)

☐ Fishing forum(s) (1)

☐ Facebook group(s) (2)

☐ Fishing Club(s) (3)

☐ Other (4)

End of Block: Part A: General Fishing Experiences and Lifestyle

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Start of Block: End of Survey & Draw

Q111 You are at the end of the survey, please make sure to click next to submit your responses. If you would like to be entered for a prize draw, please enter your name below.

Thank you for your help. Your answers will be very helpful in understanding the shore-based shark fishing community in order to improve the management of the shore-based shark fisheries for both the anglers and sharks.

Please do not hesitate to contact the researchers if you have any questions, or if you wish to withdraw your anonymized answers from the study: Jill Brooks 613-520-2600 x 4377 jill.brooks@carleton.ca

Please enter your e-mail here to be entered in a draw to win one of five $50 Amazon vouchers.

_____

Q112 Would you like to be contacted by the researchers if there are follow-up questions and to receive the findings?

○ Yes (1)

○ No (2)

Q113 OPTIONAL: Please leave any comments and other thoughts here.

_____

_____

_____

_____

_____

Q9 When fishing for sharks, what kind of fishing do you engage in?

- ○ Shore-based fishing only (1)
- ○ Mostly shore-based fishing (2)
- ○ Off-shore fishing only (3)
- ○ Mostly off-shore fishing (4)
- ○ Both equally (5)

Skip To: End of Block If When fishing for sharks, what kind of fishing do you engage in? = Off-shore fishing only

Q18 **PART B: Shore-Based Shark Fishery Questions** *Please answer the following questions with **shore-based shark fishing in mind.** These questions will help better understand the needs of the fishery.*

Q19 What year did you start fishing for sharks **from shore**?

▼ 2020 (9) ... Before 1965 (101)

Q20 How did you learn about shore-based shark fishing? Please type your answer in the box below.

_____

_____

_____

_____

_____

Q21 If you want to learn more about shore-based shark fishing skills, where would you go? Please type your answer in the box below.

_____

_____

_____

_____

_____

Q13 During your **busiest** shark fishing season , how many times per month do you fish for sharks from shore?

- ○ Almost everyday (1)
- ○ Average of 2-3 times a week (5)
- ○ Average of once a week (2)
- ○ Average of once every 2 weeks (3)
- ○ Average of once a month (4)

Q11 In what months of the year **do you normally go shark fishing** from shore? (Choose all that apply)

- ☐ All months (1)
- ☐ January (2)
- ☐ February (3)
- ☐ March (4)
- ☐ April (5)
- ☐ May (6)
- ☐ June (7)
- ☐ July (8)
- ☐ August (9)
- ☐ September (10)
- ☐ October (11)
- ☐ November (12)
- ☐ December (13)

Q12 What **time of day** do you **most often** fish for sharks from shore?

- ○ Early morning (2)
- ○ Midday (3)
- ○ Afternoon (4)
- ○ Evening (5)
- ○ After midnight (6)
- ○ Other, please specify (7) _____

Q14 Roughly how long are you actively shore-based fishing for sharks (duration of time the baits are in the water)? Please drag the slider.

	0 1 3 4 6 7 8 10 11 13 14
Less than 1 hour (1)	

Q22 Please drag the options below to rank in order of preference your target shark species when fishing from shore.

_____ Tiger (1)
_____ Blacktip (2)
_____ Bull (3)
_____ Lemon (4)
_____ Mako (5)
_____ Great hammerhead (6)
_____ Dusky (7)
_____ Other (8)

Q23 In the **past 12 months**, how many of each species below have you **personally** caught and reeled in to shore, regardless of whether it was harvested or released? Please leave it blank if you have caught none.

Tiger (1)	▼ 1 (19) ... 15+ (18)
Blacktip (2)	▼ 1 (19) ... 15+ (18)
Bull (3)	▼ 1 (19) ... 15+ (18)
Lemon (4)	▼ 1 (19) ... 15+ (18)
Great hammerhead (5)	▼ 1 (19) ... 15+ (18)
Nurse (6)	▼ 1 (19) ... 15+ (18)
Other (7)	▼ 1 (19) ... 15+ (18)

Q24 Please rate the level of agreement with the following statements about **how you prefer to fish for sharks <u>from shore</u>.**

	Disagree (1)	Somewhat disagree (2)	Somewhat agree (3)	Agree (4)	Does not apply/ Don't know (5)
I prefer a long fight time with the shark I catch (1)	○	○	○	○	○
Longer fight times increase the survival of sharks after release (2)	○	○	○	○	○
I will call out another angler if they are handling a shark poorly (3)	○	○	○	○	○
The chances of great hammerhead shark surviving depends on the number of experienced anglers present (5)	○	○	○	○	○
I often show others how to fish for sharks from shore (6)	○	○	○	○	○
I always cut the line when my catch is in poor condition (8)	○	○	○	○	○

Q72 OPTIONAL: If you wish, you may leave a comment or explanation to some of the statements from the previous question above.

_____

_____

_____

_____

_____

Q25 Can you give a rough estimate of **how much you <u>personally</u> spent on your last <u>shore-based</u> shark fishing trip**? (*Fishing trip is defined as hours or consecutive days planned and set aside for shark fishing*)

Please enter only numerical values (No text or symbols).

○ Number of days shark fishing (1)

_____

○ Total US$ for fuel (2)

_____

○ Total US$ for transport (e.g., flight, car rental, etc.) (3)

_____

○ Total US$ for accommodation (4)

_____

○ Total US$ for meals (5)

_____

○ Total US$ for fishing gear and bait (6)

_____

○ Total US$ on any other expenses related to the fishing trip (7)

_____

Q27 Can you give a rough estimate of your **total expenses for the last year** on **shore-based** shark specific fishing equipment? *Please enter only numerical values (No text or symbols).*

○ Total US$ for rod gear (Rods, poles, reels) (1) _____

○ Total US$ for tackle and gear (line, hooks, leader, knives) (2) _____

○ Total US$ for special marine fishing clothing (foul weather gear, waders, boots etc). (3) _____

○ Total US$ on any other shore-based shark specific fishing equipment not listed above. (4) _____

Q28 When was the **last time** you caught a **great hammerhead shark?** (you personally reeled it in, i.e. not your team)

○ Within the last 6 months (1)

○ Within the last 12 months (2)

○ Over 12 months ago (3)

○ I have never caught a hammerhead shark, and I am not interested in catching one (4)

○ I have never caught a hammerhead shark, but I would like to (5)

Skip To: End of Block If When was the last time you caught a great hammerhead shark? (you personally reeled it in, i.e. no... = I have never caught a hammerhead shark, and I am not interested in catching one

Skip To: End of Block If When was the last time you caught a great hammerhead shark? (you personally reeled it in, i.e. no... = I have never caught a hammerhead shark, but I would like to

Page Break

Q29 *This part of the survey will help researchers better understand* ***hammerhead shark ecology and improve our tagging studies*** *for great hammerhead sharks (e.g., using the most popular gear, etc).*

Q78 Were you targeting great hammerhead sharks when you caught this one?

- ○ Yes (1)
- ○ No (2)

Q30 For the **great hammerhead you caught from shore**, what type and size of gear did you use? Please choose the closest applicable categories OR if you would like to describe your gear in more detail, use the comments box at the end of the survey.

Reel Type and Size (1)	▼ Conventional 130# (1000yds of 130lb mono) (1) ... Not Applicable (11)
Rod Type (2)	▼ Conventional 130# (1000yds of 130lb mono) (1) ... Not Applicable (11)
Rod Length (3)	▼ Conventional 130# (1000yds of 130lb mono) (1) ... Not Applicable (11)
Hook Size (4)	▼ Conventional 130# (1000yds of 130lb mono) (1) ... Not Applicable (11)

Page Break

Q32 To help us better understand hammerhead shark ecology, could you tell us roughly **where you caught your last great hammerhead shark**? Click on the Florida map to pin location.

Q33 How did you deploy your bait?

▼ Casting (1) ... Other, please specify: (4)

Q34 Roughly, how long was the fight time? (i.e. time from hook strike to landing of the hammerhead)

- ○ < 10 mins (1)
- ○ 10 - 30 mins (2)
- ○ 31 - 45 mins (3)
- ○ 45 - 60 mins (4)
- ○ 60 - 90 mins (5)
- ○ Over 2 hours (6)
- ○ I don't remember (7)

Q35 Where was the hook located?

- ○ Jaw (1)
- ○ Throat (2)
- ○ Gut (3)
- ○ Fin (4)
- ○ Other, please specify (5) _____
- ○ I don't know (6)

Q36 How long did it take you to unhook and release the hammerhead shark back into the water?

- ○ < 1 min (1)
- ○ 2-5mins (2)
- ○ 5-10mins (3)
- ○ 10-15mins (4)
- ○ Over 15 mins (5)

Q37 How many people were you fishing with?

- ○ I was by myself (1)
- ○ I was with one other (2)
- ○ I was with two others (3)
- ○ I was with more than three other anglers (4)

Q31 For the **last great hammerhead shark you caught from shore**, roughly how long was it (in feet)? Please drag the slider on the bar below.

	6 7 8 9 10 11 12 13 14 15 16 17 18
Total length (feet) ()	

Q38 Did the shark survive after you released it?

- ○ Yes (1)
- ○ Yes, but it was injured (2)
- ○ No (3)
- ○ I am not sure (4)
- ○ I prefer not to say (5)

Q39 **Part C: Thoughts and perspectives on shark conservation and fishery management** *The next section allows you to voice your thoughts on the conservation of sharks and management of shore-based shark fisheries.*

Q40 Please rate your level of agreement with the following statements about **shark conservation and impacts.**

	Disagree (8)	Somewhat Disagree (6)	Somewhat Agree (2)	Agree (3)	Does not apply/ Don't know (9)
Shark populations need to be better protected (9)	○	○	○	○	○
I am knowledgeable about shark conservation related issues (1)	○	○	○	○	○
When shore-based fishing, great hammerhead sharks *always* survive after being caught (3)	○	○	○	○	○
I would not fish for sharks if I thought it could kill them (5)	○	○	○	○	○
Recreational fishing has a negative impact on shark populations (4)	○	○	○	○	○
Commercial fishing has a negative impact on shark populations (10)	○	○	○	○	○

I want to learn more about how to make sure my shark survives after I release it (6)	○	○	○	○	○
Populations of great hammerhead sharks are not at risk of extinction (7)	○	○	○	○	○
I would change how and where I fish if it helped shark survival (8)	○	○	○	○	○

Q70 If you wish (optional), you may leave a comment or explanation to some of the statements from the previous question above.

_____

_____

_____

_____

_____

Page Break

Q41 Please rate your level of agreement with the following statements about **shore-based shark fishery management.**

	Disagree (1)	Somewhat Disagree (2)	Somewhat Agree (3)	Agree (4)	Does not apply/ Don't know (5)
Current management measures and restrictions help shark conservation (1)	○	○	○	○	○
More regulations are required for recreational shark fishing (2)	○	○	○	○	○
Current management restrictions are too strict and/or interfere with my fishing (3)	○	○	○	○	○
Most shore-based shark anglers know what they are doing and will release sharks unharmed (4)	○	○	○	○	○
There needs to be more education and training for shore-based shark fishing (5)	○	○	○	○	○

Q42 If you wish (optional), you may leave a comment or explanation to some of the statements from the previous question above.

_____

_____

_____

_____

_____

Page Break

Q43 **Part D: Tell us about yourself** *This part captures some socio-demographic information for us to just look at trends and associations as part of our research. All information remains confidential and anonymous.*

Q44 What is your gender?

▼ Male (1) ... Prefer not to say (4)

Q45 How old are you?

▼ Less than 18 years (1) ... 60+ years (10)

Q46 Which state do you live in the US?

▼ Outside the U.S. (1) ... Wyoming (51)

Q47 What is your highest level of education?

▼ Less than high school (1) ... Post-graduate degree (Master's, PhD, Professional certifications) (5)

Q48 What is your employment status?

▼ Unemployed (1) ... Other (8)

Page Break

Q49 You are at the end of the survey, please make sure to click next to submit your responses. If you would like to be entered for a prize draw, please enter your email below.

Thank you for your help. Your answers will be very helpful in understanding the shore-based shark fishing community in order to improve the management of the shore-based shark fisheries for both the anglers and sharks.

Please do not hesitate to contact the researchers if you have any questions, or if you wish to withdraw your anonymized answers from the study: Jill Brooks 613-520-2600 x 4377 jill.brooks@carleton.ca

Please enter your e-mail here to be entered in a draw to win one of five $50 Amazon vouchers.

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Q73 Would you like to be contacted by the researchers if there are follow-up questions and to receive the findings?

- ○ Yes (1)
- ○ No (2)

Q50 OPTIONAL: Please leave any comments and other thoughts here.

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End of Block: End of Survey and Draw