

2022

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Recommended Citation

Snyder, Hunter T.; Oyanedel, Rodrigo; Sneddon, Christopher S.; and Scheld, Andrew M., Attitudes and behaviors for understanding compliance in Greenland's Atlantic salmon (*Salmo salar*) fishery (2022). *Conservation Science and Practice*.
doi: 10.1111/csp2.12775

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Attitudes and behaviors for understanding compliance in Greenland's Atlantic salmon (*Salmo salar*) fishery

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Funding information

Association of Hunters and Fishers in Greenland, Grant/Award Number: Lakse Fond; National Geographic Society, Grant/Award Number: EC-53874C-18; National Science Foundation, Grant/Award Number: NNA Track 1; Innovations in Energy Technologies an

Abstract

Noncompliance is a central challenge for conservation, but in settings with limited access to behavioral data, it can be difficult to evaluate what drives compliance. Conservationists can measure and evaluate resource users' attitudes, and in so doing, leverage a complementary, nonbehavioral measure for evaluating compliance. In Greenland, wild Atlantic salmon (*Salmo salar*) fishers are under increasing regulatory pressure to report salmon catch because the majority of North Atlantic salmon stocks are classified as suffering. The objective of this study is to measure salmon catch reporting compliance, reporting behavior, and attitudes toward Greenland's salmon management. We surveyed Greenland's licensed salmon fishers, used an unmatched count technique to estimate the incidence of underreporting salmon catch, and linked salmon fishers' actual catch reports to their survey responses. In 2019, more than 84% of salmon fishers reported their catch and demonstrating high levels of compliance. We also found that salmon fishers did not indicate strong instrumental motivations for reporting, but exhibited moral obligations and normative, legitimacy-based motivations to report catch. Salmon fishers found regulations to be fair, and that regulatory authorities were professional and acted honestly. Catch *underreporting* was also remarkably low, with 90–94% of respondents stating that they report all their catch. Joining together individuals' attitudinal and behavioral responses to conservation rules illustrates the benefits and limitations of expanding actor-based theories of compliance. This case of already high levels of compliance offers empirical evidence for further improving fisheries compliance, and it also illustrates the limitations that fishery managers face when conserving a highly migratory species.

KEYWORDS

arctic, compliance, endangered species, fisheries

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1 | INTRODUCTION

Noncompliance is a central challenge for sustainable fisheries (Fulton et al., 2011; Raakjær Nielsen, 2003) and effective conservation interventions among local communities more broadly (Agrawal, 2014; Erbaugh et al., 2020; Nolte et al., 2013). How to assess noncompliance information requires specific conceptual approaches from diverse literatures and disciplines (Oyanedel et al., 2020b). Fortunately, compliance is a core tenet of fisher behavior, and actor-based approaches, for instance, include models that attempt to explain an individual's behavioral motivations for complying or not with conservation rules (Oyanedel et al., 2020a). Actor-based approaches include instrumental, normative, and legitimacy-based factors for compliance (Ramcilovic-Suominen & Epstein, 2012). Measuring motivations for behavior is key for evaluating compliance in conservation settings and fisher behavior (Andrews et al. 2021; Fulton et al., 2011). Expanding this work in settings of small-scale fisheries and for reporting compliance is needed in values-oriented settings where motivations extend beyond instrumental factors for compliance (Andrews et al. 2021; van Putten et al. 2012).

In conservation settings where behavioral data cannot be easily collected, it would be valuable to know what resource users think about the regulations that govern their activities. To use motivations to explain behaviors may be possible because theory in social psychology and behavioral economics have been advanced in part by demonstrating empirically that there are strong relationships between peoples' motivations, or attitudes, and their behaviors (Ajzen, 1991; Ajzen & Fishbein, 1980; Andreoni et al., 1998; Kosinski et al., 2013; Kraus, 1995). Building upon theoretical and methodological developments from the behavioral sciences would advance the science and practice of conservation, and in particular, theoretical advancements for the study of compliance in small-scale fisheries (Cinner, 2018). If both measures of motivations and behavior could be collected, it may be possible to predict certain kinds of compliance in other conservation settings where behavioral measures are not available (Arias & Sutton, 2013; Bergseth et al., 2018). This predictive power would be especially valuable in data-poor, natural resource management settings (Ban et al., 2009; Honey, 2010; Kelleher et al., 2012). One such area with incomplete, missing, hidden, or poor quality data (Kelleher et al., 2012) is among small-scale fisheries, where communities' livelihoods depend upon sustainable fisheries and where there is limited capacity for monitoring and enforcement (Allison & Ellis, 2001; Béné et al., 2016; Smith & Basurto, 2019). Collecting both measures of motivations and behavior within the same small-

scale fishery would help close this knowledge gap and create generalizable lessons about the usefulness of motivations as predictors for compliance.

Atlantic salmon (*Salmo salar*) stocks occupy a large range in the North Atlantic. As an anadromous finfish, they inhabit freshwater riverine systems early in their life history, enter the marine environment primarily to feed, and ultimately return to their rivers of origin to spawn (Fleming, 1996). Atlantic salmon are one of the most widely sold farmed finfishes (Cai et al., 2017), but their wild counterparts in the North Atlantic are approaching collapse (Dadswell et al., 2021; Parrish et al., 1998). There is consensus that drivers of declines are challenging to identify, but that fishing mortality, spawning habitat, dams, and other coastal development may play a role (Dadswell et al., 2021; Sheehan, 2019). Salmon conservationists and biologists alike agree that understanding human dimensions of salmon is key to mitigating the threats that salmon face (Dadswell et al., 2021; Thorstad et al., 2021). In Greenland, Atlantic salmon serve a documented role in household subsistence and are culturally significant (Poppel & Kruse, 2009; Inger Katrine Dahl-Petersen et al., 2014; Hickey et al., 2021). As a result, a subsistence fishery continues with private and professional fishers. Fishing-based mortality of salmon is especially concerning to Atlantic salmon conservationists (Dadswell et al., 2021; Sheehan, 2019). Compounding the uncertainty of stock declines, little is known about the drivers of compliance nor of the attitudes toward salmon fishery regulations. This knowledge deficit is especially relevant and addressable in Greenland's Atlantic salmon fishery, one of the few remaining Atlantic salmon fisheries.

Since the 1950s, Greenlanders' fishing for wild Atlantic salmon (*Salmo salar*) has been internationally controversial. Discrete salmon stocks throughout the North Atlantic are connected by both their life history and through political and management institutions because salmon travel through several territorial waters throughout their life history (Bubier, 1988). Within the territorial waters of North Atlantic coastal states in North America and Europe, conservationists, fishers, and fishery managers have held diverse and at times conflicting priorities for how salmon stocks should be used, protected, or improved (Editorial, 1981). While consensus on management areas has been reached, and resource user compliance has improved, the population outlook for wild Atlantic salmon remains discouraging. Drivers of compliance and the specific features of the governance system, then, are central to sustainably and justly managing Greenland's Atlantic salmon fishery, and in so doing mitigating Atlantic salmon collapse (Dadswell et al., 2021; Thorstad et al., 2021).

Data on catch reporting in Greenland's salmon fishery suggests that levels of compliance have increased in the last 3 years, and catch data has been available for several decades (Government of Greenland, 2020). However, no replicable estimate of salmon catch *underreporting* among salmon fishing license holders has been conducted. Recent literature suggests that many environmental compliance issues are because of omission, such as failing to report catch (Huisman & van Erp, 2013). In addition, we know little about the drivers and which specific management features of the governance system may be facilitating high levels of compliance.

There are several relevant actor-based theories that may help us understand compliance in Greenland's Atlantic salmon fishery. Ramcilovic-Suominen and Epstein propose a compliance framework, which delineates instrumental, normative, and legitimacy-based motivations for compliance (Ramcilovic-Suominen & Epstein, 2012). Instrumental motivations may manifest in a salmon fishers' calculation of the costs and benefits of complying with salmon conservation rules (Becker & Landes, 1974; Sutinen & Andersen, 1985). Normative motivations, such as a fishers' sense of morality and how resource users perceive each other, are known to exist among small-scale fishers, because they are often interdependent and share other key group characteristics (Arias & Sutton, 2013; Bergseth & Roscher, 2018; Nelson, 1982; Ostrom et al., 2002; Thomas et al., 2016), so there is reason to believe that Greenland's salmon fishers are also motivated by normative factors. Legitimacy-based motivations may be at play in Greenland, as they are known to be key across fisheries (Karper & Lopes, 2014; Kuperan & Sutinen, 1998; Sandström et al., 2014) and in particular among small-scale fisheries (Oyanedel et al., 2020a; Snyder et al., 2020). Measuring fishers' attitudes toward these regulatory changes and their behavioral responses may allow us to explain compliance in Greenland's salmon fishery. Here, we use actor-based approaches to interpret and explain compliance with measures of attitudes and behavior. Our hypothesis is that individuals' attitudes provide key insights on how they behave in the immediate regulatory environment in which their resource use occurs. In addition, we hypothesize that nonreporters have systematically different attitudes or perspectives to those who do report salmon catch.

Theories of compliance in conservation guide our understanding of salmon fishers' compliance, and they help to clarify the role that attitudes or motivations could play in this understanding. Elements of actor-based theories of compliance can illuminate how and why fishers follow the rules in Greenland's salmon fishery, and which attitudes or behaviors are associated with crimes

of omission. This is necessary because in fisheries, we know little about crimes of omission when compared with a recent study of crimes of commission (Bergseth & Roscher, 2018). Addressing this knowledge deficit is especially relevant given the increasing reliance upon accurate catch reports for effective fisheries management (Food and Agriculture Organization of the United Nations, 2012).

Understanding the extent of compliance is the first measure to identify for understanding the drivers of compliance (Conteh et al., 2015; Snyder & Erbaugh, 2020). However, respondents may be reluctant to share why they choose not to comply with catch reporting or other salmon fishery regulations. We must ethically resolve these challenges because we wish to hear the most from people who exhibit noncompliant behavior. To ask resource users directly about sensitive matters, such as their willingness to report truthfully, can lead to doubt over the truthfulness of responses. To resolve this issue so we can understand the extent of noncompliance, we employ indirect questioning. Indirect questioning techniques as described below help resolve the challenge of asking sensitive questions (Hinsley et al., 2019). Indirect questioning makes it possible to estimate sensitive behaviors with a high level of accuracy while also respecting a persons' desire to share information in a manner that is not ostensibly revealing. Doing so also meets ethical criteria for protecting respondents' identities. Information on the specific indirect questioning techniques are set forth below.

Once the extent of the noncompliant behavior is estimated, it becomes possible to explore how legitimacy-based motivations are associated with such behaviors. Catch reporting requirements can be understood as their input, throughput, and output legitimacy. Our study focuses on throughput legitimacy because how catch reporting requirements are carried out by resource users and processed by fishery managers is an area for which we know very little, especially when compared with the known input (Hickey et al., 2021) and output factors (Snyder et al., 2021) of legitimacy in Greenland's salmon fishery. A study that specifically identifies the extent to which people do not report salmon catch and their reasons why can help improve the processes that underpin the success of Greenland's management of Atlantic salmon fishing.

2 | METHODS

2.1 | Survey pool

Our research objective was to evaluate compliance in this fishery by understanding the relationships between

salmon fishers' reported fishing behavior and their attitudes. We use responses to a survey as a measure of attitudes, and salmon catch records as a measure of actual behavior. In 2019, we developed an anonymous, IRB-approved nationwide online survey instrument on salmon fishing in Greenland (STUDY00031018). We drew our survey pool from all 2019 salmon fishing license holders. Salmon fishing license holders were classified as either private or professional fishers (see Supplementary Materials for breakdown of license types and regulations). We queried their contact details with assistance from Greenland Fisheries License Control Authority (GFLK). GFLK sent us contact details including phone and email, with personal identifiers removed. License holders were assigned a unique but anonymous identifier code to access the survey. We later used this code to link survey responses with anonymized 2019 salmon catch records for each individual.

2.2 | Survey design

Survey questions were drafted in English, reviewed by two recreational fisheries survey experts and a member of staff from the Association of Hunters and Fishers in Greenland (KNAPK). The survey was reviewed by Greenland Fisheries License Control Authority (GFLK) and the Government of Greenland Fisheries Department (APNN). Survey questions were broken into sections and were formatted to include Likert, number entry, multiple choice, and open text questions. The survey sections included introductory questions, asking fishers about how much experience they have had harvesting from the sea and land, familiarity with current salmon regulations, and how they utilize their salmon catch. We also asked fishers to identify how they report, how difficult each reporting option (e.g., by phone, by mail, by fax) is for them, and their reasons for not reporting, if any. We conclude the survey by asking fishers about their attitudes toward the regulations, the enforcement authorities, and the survey instrument (to view the full survey, see Supplementary Materials).

Survey questions were translated into Danish and Greenlandic by a native Greenlandic speaker. The survey questions, including the UCT, were trialed for quality assurance of translations, user experience, and content, on nine persons familiar with salmon fishing but who did not have a 2019 salmon fishing license and therefore were not part of the sample. The survey was drafted and distributed in March 2020 using Qualtrics and was available in Greenlandic, Danish, and English. The online survey was distributed via email and SMS message to 500 of the 719 salmon fishing license holders. 219 salmon

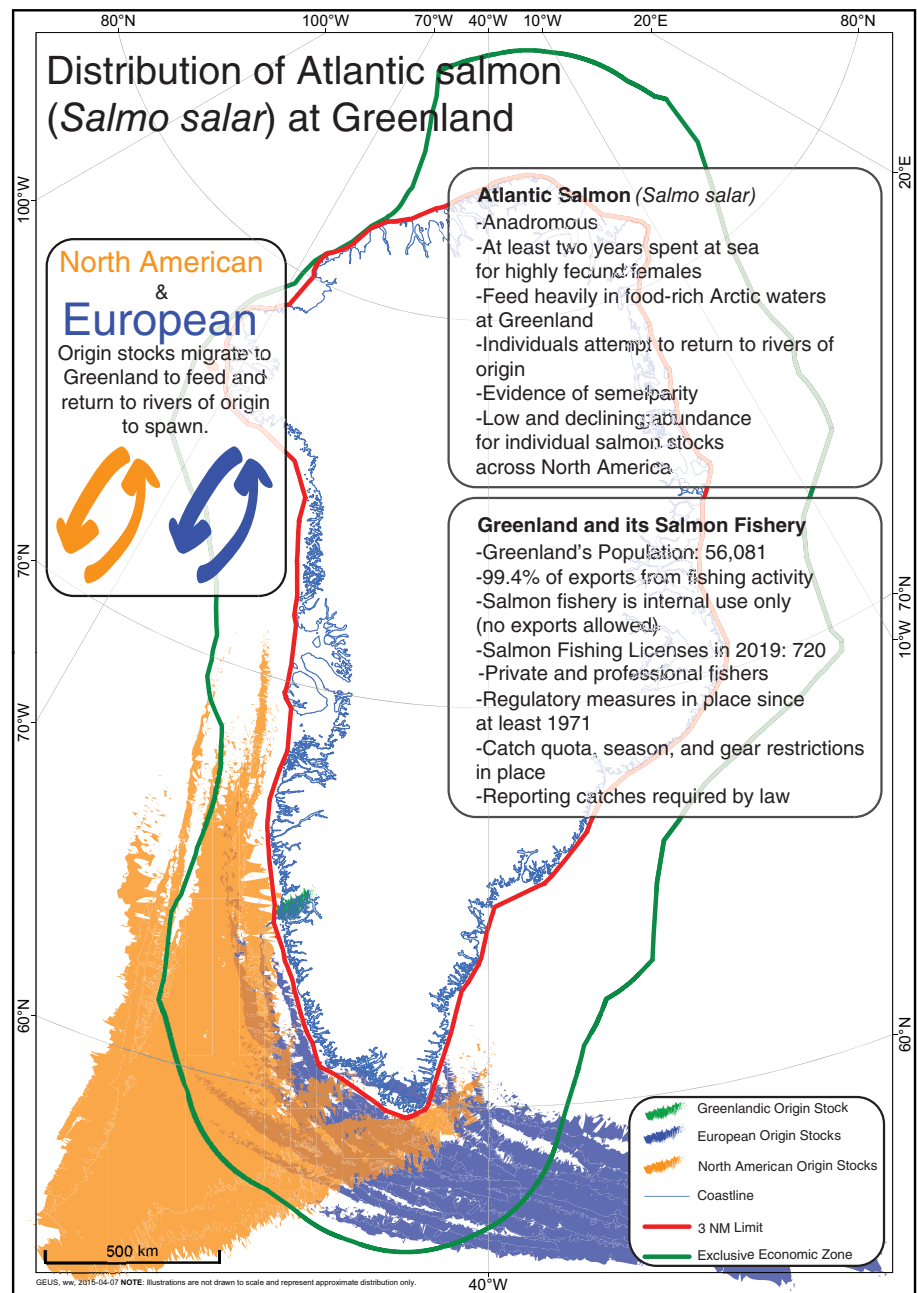
fishing license holders did not have contact information and could not be enrolled. The UCT groups were randomly assigned in R, and a group code (Group 1 or 2) assigned to each individual. Qualtrics read in this value and displayed the correct UCT statements for the group for which the individual was assigned. After the invitations were sent to the effective sample of 500, three reminder messages were sent by SMS and email to encourage participation. Five prizes of DKK 2000 or approximately USD 330 to a general store in Greenland were pledged. After the survey was completed, we randomly drew five respondents, each of whom were awarded a raffle prize. The survey closed 29 May 2020 (Figure 1).

2.3 | Unmatched count technique

Calculating the incidence of catch *underreporting* is not possible with salmon catch records alone, but it can be estimated with Unmatched Count Technique (UCT) as a component of the survey. UCT is a popular, quasi-experimental technique for indirectly asking sensitive questions (Hinsley et al., 2019), which can reveal illegal behaviors, such as underreporting. With UCT, respondents are broken into a treatment and control group. Both groups are asked to indicate how many statements from a list of statements are true for them, but not which exact statements. For the treatment group, a sensitive statement is also added. If the treatment and control groups are randomly assigned, the difference in the means between the groups can reveal the prevalence of the sensitive statement among the overall population (Coutts & Jann, 2011).

The use of UCT in fisheries cases has been limited to date (Bergseth et al., 2017), but is a simpler alternative to other methods, such as random response techniques (RRT) (Oyanedel et al., 2020a; Thomas et al., 2015). With UCT, we can ask respondents to indicate how many but not which behaviors they have engaged in from a list of other plausible behaviors, thus allowing underreporting behavior to be indicated indirectly (Droitcour et al., 2004). Using double-list UCT, we are able to evaluate underreporting of catch in a smaller study population (Glynn, 2013), because with double-list UCT, both the treatment and the control groups are given a sensitive statement, but with two separate UCT exercises, which improves UCT method efficiency. UCT's are also prone to floor and ceiling effects depending upon the content of the statements. Floor effects can occur if the nonsensitive statements provided are all so rare that the sensitive statement is the only plausible statement, and respondents over-report their true answer to conceal the

FIGURE 1 Map of the distribution of Atlantic salmon (*Salmo salar*) at Greenland. Map by author.



sensitive statement. Conversely, ceiling effects can occur if the nonsensitive statements provided are all too common, which can cause respondents to under-report to avoid admitting directly to the sensitive statement. To avoid these potential issues, the selected UCT statements were also reviewed during the initial survey review process (Hinsley et al., 2017). During the survey review, we included at least one nonsensitive item that was deemed to be rare so as to avoid the possibility of a ceiling effect. We also included a warm-up question so respondents were less likely to answer the UCT question improperly.

We were further able to ensure participant privacy and encourage participation because the survey could be

taken online in a place of the informant's choosing. We estimated how often salmon fishers' did not report their salmon catch using both direct and indirect questioning, anticipating that fishers would be reluctant to honestly answer a direct question about reporting salmon catch (Coutts & Jann, 2011).

2.4 | Analytical techniques

We analyzed 2019 salmon catch records, and responses to the salmon fishing survey, including the UCT experiment responses. Survey responses served as a measure of

individual salmon fishers' attitudes, and their individual catch records from 2019 served as a measure of their actual fishing behavior. We used RStudio version 1.2.5042 (R version 3.6.3) to summarize catch records for each license holder, and then joined them to the 186 salmon fishing survey responses.

Because we did not receive survey responses from 533 salmon fishers, there was a risk of nonresponse bias. Using Stata version 15 and R version 3.6.3, we evaluated the possibility of nonresponse bias by comparing the survey population ($n = 186$) to the entire sample ($N = 736$), according to four key variables: *fishcount* (how many salmon each fisher caught), *catchkg* (how much fish each fisher caught), *locality* (the municipality where a fisher resides), and *licensetype* (either a recreational or professional fisher). A Pearson's Chi-squared test was performed on *locality* and *licensetype* and a Two-sample Wilcoxon rank-sum (Mann–Whitney) test was performed on *fishcount* and *catch*, in light of a right skew distribution.

To evaluate whether fishers who report have similar or different attitudes to those who do not report, we conduct a Light Cohen's Kappa test on Likert scale questions to measure levels of agreement between questions and to potentially combine variables. We also create box and whiskers plots to depict the distribution of responses between fishers who did and did not report their salmon catch, for selected predictor variables. For questions where mean responses vary, we fit binomial general linear models (GLM) to detect significant differences between fishers who did and did not report their salmon catch. We fit the GLM to test the question of whether nonreporters have similar or different attitudes than reporters. We are motivated to test this because we could not anticipate whether the survey pool would consist of a balanced sample of fishers who reported and fishers who did not report salmon catch. To know these differences is also valuable to the targeted design of fisheries management, so as to avoid any change that would attempt to correct behavior among a small group while disproportionately affecting an otherwise compliant population of salmon fishing license holders.

The anonymous identifier code created by GFLK made it possible to anonymously compare individual fishers' behaviors, in terms of their reported salmon catch records with attitudinal responses from survey questions. UCT responses cannot be linked to individual attitudinal responses because UCT estimates use the treatment and control groups—and not individual responses—as the unit of analysis.

To analyze results, we created frequency statistics for the direct question (*Did you report all of your catch in 2019?*). To estimate the prevalence of catch

underreporting with the double-list UCT, we used *rgr* and *list* packages in the R programming environment (R Version 3.6.3). We calculated the means for both the control question and sensitive question, calculated the overall estimate by average difference of means (see Equation 1). The equation, following Coutts & Jann (2011) and Hinsley et al. (2019), is as follows (Equation 1—Formula for double-list unmatched count [UCT]):

$$p = \frac{p^1 + p^2}{2} \quad (1)$$

where $p_x = \text{mean}(\text{treatment group}_x) - \text{mean}(\text{control group}_x)$, where p^1 and p^2 are the proportion of participants engaged in sensitive behavior from list 1 and 2, respectively.

3 | RESULTS

In 2019, 84% of all salmon fishing license holders reported at least some of their salmon catch, up from 33% in 2017. From the effective sample of 500 salmon fishing license holders, 186 or 37% participated in the survey. A Pearson's chi-squared test showed that there were no significant differences between the effective sample and the survey pool, according to where fishers reside (*locality*, $p = .1364$). A Pearson's Chi-squared test with Yates' continuity correction suggests that there were no significant differences between license types (*licensetype*, $p = .522$). A two-sample Wilcoxon rank-sum (Mann–Whitney) test suggests that how many salmon they caught (*fishcount*, $p = 0.07$) and how much fish they caught (*catchkg*, $p = 0.06$) are also not significantly different.

Greenland's salmon fishers exhibit a diverse range of fishing experience, many with no experience to some with over 50 years of experience (\bar{x} 33.6 years). From within this pool of seasoned salmon fishers, it is perhaps unsurprising that <5% of respondents did not know about the salmon fishing regulations set forth in the 2018 Executive Order on the Fishing for Salmon. The survey pool also had an overwhelming familiarity with reporting animal harvests from the land and the sea, with <9% having no previous experience doing so. Among these 14 fishers with no previous experience, only one did not report their salmon catch. Asking for their perspective on the ecology of salmon, most respondents (83.7%) thought that salmon stocks at Greenland were healthy, and disagreed that the arrival and location of salmon had changed in 2019. Given that the survey was issued to salmon fishers, it also comes as no surprise that the majority of salmon fishing license holders find salmon to be important or

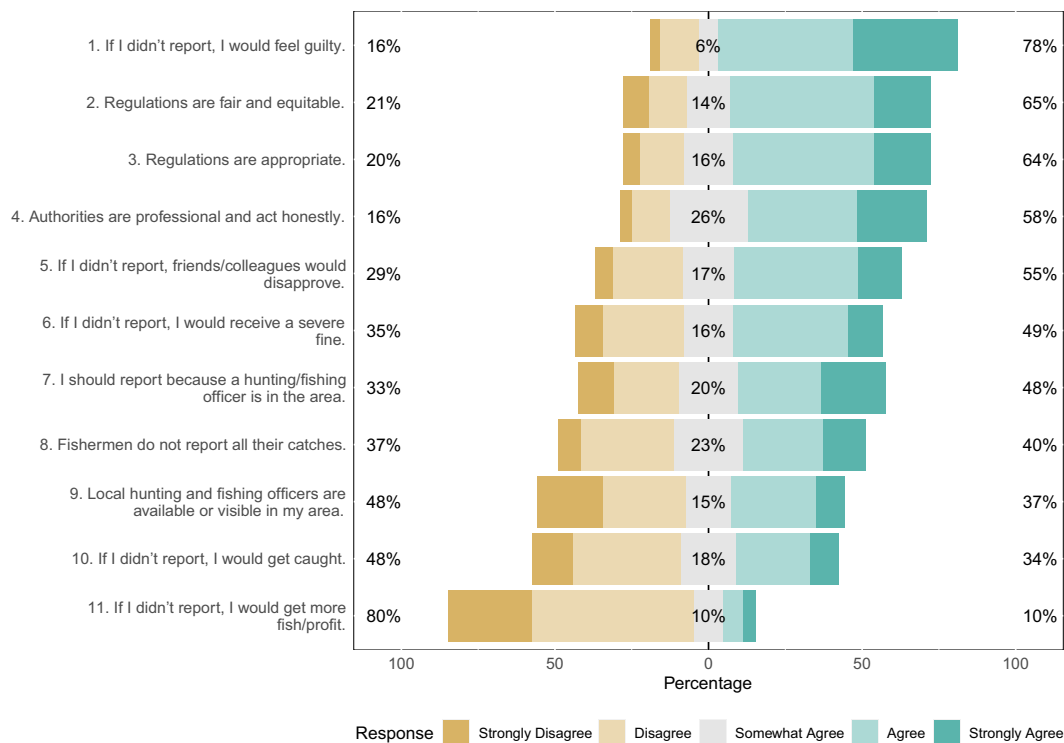


FIGURE 2 Responses to survey questions on instrumental (statements 6, 10, 11), normative (statements 1, 5, 7, 8, 9), and legitimacy-based (statements 2, 3, 4) factors. Data: 2019 Salmon fishing survey.

very important as a Greenlandic food source as well as a source of income, suggesting noninstrumental factors at play in this fishery system.

The main survey results are presented in Figure 2. The majority of respondents found salmon fishing regulations to be fair, equitable, and appropriate, with the authorities that enforce them to be professional and honest. Concerning fishers' normative attitudes, respondents indicated strong moral obligations to report. Their sense of guilt for not reporting had the highest frequency response of any question asked. Respondents either disagreed or had neutral positions on their salmon catch reporting being driven by instrumental motivations. 80% disagreed with reporting driven by profit possibilities, 48% disagreed with reporting driven by the likelihood of getting caught, and 35% disagreed with reporting driven by the likelihood of receiving a severe fine.

When we linked fishers' catch records to their survey responses, we observed that 91% of survey respondents were reporters. That is, the vast majority of survey respondents also reported their salmon catch in 2019. The imbalanced survey pool raises the question of whether *nonreporters*, who comprised 9% of the survey respondent pool, have similar or different attitudes than reporters. Results of the binomial GLMs suggest that most responses to survey questions do not differ significantly among reporters and nonreporters. However,

significant differences were observed for two questions about why fishers do not report. Nonreporters were more likely to agree that they did not know how to report, with a coefficient estimate of 1.39 ($p < .000$; CI .72–2.23) and that reporting is confusing, with a coefficient estimate of 0.88 ($p = .006$; CI .25–1.55). While less significant, nonreporters were also more likely to indicate that they see no benefit to reporting, that they do not have access to the internet or to a phone, that they have no time, and that they do not trust the government. The perception that salmon catch reports being used against fishers was not found to have a systematic relationship with a fishers' report status ($p = .06$; CI -1.13 –1.49).

While we focus primarily upon salmon catch reporting requirements, there are three major regulatory provisions: fishing within the season; gear limitations; and reporting salmon catch. In response to direct questions, 5.8% of fishers indicate using more nets that are allowed, 6.4% of fishers indicate fishing before or after the designated salmon season, and 5.9% of fishers said that they did not report all of their salmon catch. Of the 17 respondents who did not officially report salmon catch to the Government of Greenland, only two indicated in the survey that they did not report all of their salmon catch, nine choosing not to answer, and six said that they did, on the contrary, report all of their catch. 145 salmon fishers answered the UCT questions, which revealed that

TABLE 1 Results of direct and UCT question “Did you report all of your salmon catch in 2019?”

Question type	Estimated incidence (%)	<i>n</i>	SD (%)
Direct	5.92	152	2.4
UCT	9.99	145	8.3

Note: Data—2019 Salmon fishing survey.

10% of salmon fishers did not report all of their salmon catch ($n = 145$, estimate .099, SD .0828). The direct question and UCT results are drawn from different sample sizes and units of analysis. However, the standard deviations of each estimated incidence can be evaluated and suggest that they are not significantly different from each other (Table 1).

4 | DISCUSSION

We estimated that nearly all of Greenland's salmon fishers comply with salmon fishery regulations, especially salmon catch reporting. Specifically, the 2018 Executive Order on the Fishing of Salmon required salmon fishing license holders to report, or else lose their license renewal for the following year. The proportion of salmon fishers who reported their catch continued to increase from 2018 to 2019. This high level of compliance is perhaps unsurprising given the historic familiarity that Greenlanders have with reporting marine and terrestrial harvests (Dahl-Petersen et al., 2014). However, salmon catch reporting compliance levels have risen from 2017 to 2019, and is thought to be due in part to the implementation of new legislation (Government of Greenland, 2020). Using regulatory deterrents and nudges can help ensure high levels of compliance into the future (Snyder et al., 2021). In the face of changes to their routine, fishers do have the capacity to *further* comply. Even though fishers can earn an income from salmon catch, and enforcement is known to be lacking, few fishers indicated instrumental motivations to not report all their salmon catch.

While it is not possible from our statistical analysis to conclusively infer what drives their compliance, fishers have generally positive perceptions of the regulations that govern their access and they look positively upon the authorities that enforce those regulations. In addition, high levels of compliance, high levels of agreement with normative attitudes, low levels of instrumental motivations, and high levels of perceived regulatory legitimacy is auspicious for a future where users, managers, and regulators work together to manage access to Atlantic salmon stocks. Voluntary compliance can persist if fishery managers are perceived to act professionally,

honestly, and fairly. We anticipate that if Atlantic salmon stocks continue to decline, what is deemed fair will become controversial among salmon fishers in Greenland.

These results also reaffirm the value of the compliance framework approach for understanding compliance in small-scale fisheries (Oyanedel et al., 2020b; Ramcilovic-Suominen & Epstein, 2012). Increasing collaboration between salmon fishers and managers is also likely feasible, given that nearly 60% of Greenland's salmon fishers said that they would provide more information by SMS message if the means to do so existed. Salmon fishers' willingness to share observations and ideas is substantial. The Association of Hunters and Fishers in Greenland (KNAPK) supports this level of communication during annual visits along the coast, and the sharing of ideas between and across individuals, local branch managers, and head office officials. Conservationists should continue to engage with local associations and participate in visits to maintain the common understanding that helps make compliance possible in this fishery.

We illustrate how measuring fishers' attitudes can identify opportunities that arise for compliance or non-compliance. Crime script analysis, which parses non-compliance into a series of discrete events, identifies the specific components of salmon fishery compliance with catch reporting requirements. We identified an individual process, in this case, how salmon catch reporting is conducted. This isolates the process-based factors that contribute to perceptions of legitimacy, such as the professional conduct of fishery officers or the ease of reporting salmon catch. Our survey instrument made it possible to measure how people report salmon catch, how they think catch reporting can be improved, and among which groups salmon catch reporting is most challenging.

Catch reporting is not mandatory in many recreational fisheries, and as a result, it is not normally possible to evaluate fisheries compliance by linking survey responses with official catch records (Midway et al., 2020). Because we were able to combine these data types, we can evaluate the possibility of respondent bias, given that achieving a census was unlikely and representative results are most valuable to fishery managers and intervention-oriented conservationists. Official catch records also shed light on the integrity of individual survey questions and associated responses. Salmon fishers more readily disclosed not reporting all of their catches when asked indirectly, and at the same time, we observed six cases where fishers said they reported all their catches, whereas the official records suggest that they did not. These six fishers who said that they reported all of their salmon catch to the Government of Greenland may

have in fact reported their catch, even though the official record shows that they did not. It is possible that their reports could have been submitted, but were either never received, were never filed, or were submitted incorrectly. It is also possible that the respondents did not understand the question, or that they inputted the incorrect response.

Responses to direct questions are doubted for their veracity, which further justifies the use of UCT for indirectly asking sensitive questions. UCT questions may increase the estimated incidence of salmon catch underreporting, but our results lack significance to confidently support this claim. Even though the UCT estimate is larger, salmon catch underreporting is small, with <10% of respondents indirectly indicating that they underreported their salmon catch. These results should be interpreted with the likelihood that both direct and indirect questions could be underestimated. Apart from the UCT exercise, all other survey questions were direct questions. Given that the UCT exercise revealed that direct catch reporting may be underestimated, it is possible that all direct questions may be systematically underestimated. However, the majority of survey questions posed were not about sensitive behavior, so it is not justifiable to doubt their accuracy. This specific use of UCT shows that it can be an easy-to-administer tool (Nuno et al., 2013) and that UCT can even be conducted via online survey instruments. Our study reinforces the necessity of carefully selecting both sensitive and nonsensitive items in the design phase (Hinsley et al., 2017). Though not commonly included, our study provides respondents with a warm-up, practice UCT question, which gave respondents familiarity with how to answer the question and provides further assurance that the UCT questions were answered correctly (Hinsley et al., 2017). However, the variability that can arise in a UCT must be lessened for the effect to be detected and interpreted as significant; in this case, that is not possible. Future studies that use UCT should take extra care to revise nonsensitive statements and sensitive statements to reduce the likelihood of variability in the estimate.

The results of this study also reaffirm that illegal behavior does not always translate to an unwillingness to divulge information (Hinsley et al., 2019). Instead, this study shows that illegal behavior can be shared, and we argue that the triviality of sanctions for such behavior in this specific setting may explain why resource users are willing to divulge such information. Linking official salmon catch records with survey responses also allowed us to identify an overall lack of variance in responses between reporters and nonreporters. We hypothesized that nonreporters have systematically different attitudes or perspectives to those who do report salmon catch. With the exception of two questions, we were unable to

meaningfully show that a fishers' attitudes explain their actual salmon catch report status. However, results suggest that fishers who do not know how to report salmon catch or who find salmon catch reporting confusing are less likely to report salmon catch. There is a need to further simplify reporting to eliminate this confusion. Greenland's fishery managers also have the opportunity to familiarize license holders with how to report their catch when they are issued their licenses, especially among fishers with less experience in the fishery. As seen in this study and others, fishers with less experience are more likely to exhibit involuntary noncompliance, but experienced fishers can also find the rules confusing (Jentoft & Mikalsen 2004).

Imbalanced samples are a persistent challenge for studying noncompliance because we most wish to hear from people who are understandably reluctant to answer questions about their noncompliant behavior (Larkin et al., 2010; van der Hammen et al., 2016). We were therefore pleased that 9% of responses came from salmon fishing license holders who did not officially report salmon catch to the Government of Greenland. This percentage is high, given that only 14% of all salmon fishing license holders did not report salmon catch in 2019 (Government of Greenland, 2020). While we cannot be certain, our tests that evaluated differences between the survey pool and the overall population, as well as comparisons between reporters and nonreporters, give us confidence that the survey pool is otherwise representative of the salmon fishing license holder population, in terms of salmon counts, catch, license types, and participating localities. However, we recommend eliciting more perspectives from the professional salmon fishing population, recognizing that professional salmon fishers are slightly underrepresented in the survey response pool. They are also the individuals catching the greatest quantities and weights of salmon. It is possible that this professional segment did not respond to the survey because they were participating in spring fishing or were affected by the economic shocks of the COVID-19 pandemic, which began during the period when the survey was issued.

Future research could include follow-up surveys by phone or in person among salmon fishing license holders who did not submit their salmon catch reports during the 2019 season, or among those who chose not to participate in the salmon fishing survey. Having their responses included would capture a more complete picture of what drives salmon catch reporting. Scholars who are particularly interested in the attitudes of noncompliant resource users would especially benefit from a more complete survey of nonreporters. We saw a high response rate to the Salmon Fishing Survey of 37% despite the online format

and completion during the COVID-19 pandemic. This participation suggests that Greenlanders have something to say about salmon fishing and want to be involved in how Greenland's fisheries are governed. This participation and compliance is consistent with studies that show that positive perceptions of governance structures are key to participation and support (Bennett & Dearden, 2014; Bubier, 1988; Evans et al., 2011). High levels of participation are also an auspicious indicator of research that lives up to goals and objectives to conduct inclusive, respectful, and beneficial research in, for, and with Inuit communities (National Inuit Strategy on Research, 2018). These results have been distributed among Greenland's salmon fishery policymakers and all salmon fishers were given access to results in summer 2020. They have informed the dialogue between NASCO members and Greenland's efforts to manage its access to Atlantic salmon stocks within its exclusive economic zone. Importantly, they have clarified long-standing beliefs about underreported salmon catch.

While these results suggest that Greenland's salmon fishers have high moral standards and enforcement officials are professional role models, no fishery is flawless. First, it is not known how many Greenlanders fish for salmon without a license, and unreported salmon catch remains a possibility throughout their ranges (ICES, 2020). Second, salmon fishers endure structural challenges that limit salmon catch reporting, such as not having access to the internet or phone, or reside in localities where they are not as easily reached by the Association of Hunters and Fishers in Greenland. Lastly, Greenlanders failed to fish less than or equal to the quota in 2019 and 2020. As results from the survey reveal, some fishers take issue with current management plans. This discontent is not new; Greenlanders have indicated that they would like for managers to keep the season open longer (Nygaard, 2016), while at the same time, NASCO and other salmon stakeholders continue to encourage Greenland to fish no more than the annual quota.

Individuals' attitudes provide key insights on how they behave in the immediate regulatory environment in which their resource use occurs. Linking fishers' attitudes and their actual reporting behavior is beneficial because it tests the integrity of the questions that surveyors ask, the prevalence of nonresponse bias, and how much attitudes between reporters and nonreporters differ. Knowing both a person's attitudes and behaviors may also reveal structural inequalities that fishers face (Allison & Ellis, 2001; Fabinyi et al., 2014; Pinkerton, 2017), and as we show, this linking can even identify technical or clerical issues with reporting salmon catch, which create opportunities for noncompliance (Cohen & Felson, 1979). Improving compliance requires consideration for these structural barriers or situational factors that fishers face, and carrying them

through the design, implementation, and maintenance of their management systems. These process-based components of legitimacy are revealed by combining salmon fishers' attitudes and behaviors. The Government of Greenland has revised salmon reporting protocols based upon the results of this study (Government of Greenland, 2020) and there is also an opportunity to expand the thematic purview of the ICES Atlantic salmon working group (WGNAS). Including regulatory and human dimensions research in these fora would help guide specific policy design and implementation efforts, in both this and other highly migratory fisheries.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Snyder, H. T., Oyanedel, R., Sneddon, C. S., & Scheld, A. M. (2022). Attitudes and behaviors for understanding compliance in Greenland's Atlantic salmon (*Salmo salar*) fishery. *Conservation Science and Practice*, e12775. <https://doi.org/10.1111/csp2.12775>