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Catching versus Counting: Comparing the Pro-Environmental Attitudes, Behaviors, and Climate Concerns of Recreational Fishers and Citizen Scientists

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Abstract: The ongoing and interactive effects of climate change, overharvesting, and habitat loss on fish and fisheries impacts a wide array of stakeholders who rely on access to sustainable fish populations for their health, recreation, well-being, and income. Successful responses to these threats will require the involvement of stakeholders in co-developing solutions. Understanding the socio-psychological characteristics of these diverse stakeholders, including their environmental attitudes and behaviors, can potentially improve management support and effectiveness across and within these groups. Past research has focused on climate impacts and adaptation efforts in commercial fisheries, but less is known about climate-related perceptions and attitudes of recreational fishers and other stakeholders such as citizen scientists. This study investigated how pro-environmental attitudes (PEAs), pro-environmental behaviors (PEBs), and climate change concerns vary among fisheries-based recreationists based on activity type (recreational fishing, fish monitoring for citizen science) and specialization level. Among stakeholders, citizen scientists (fish counters) exhibited the strongest PEBs, followed by more specialized recreational fishers. Citizen scientists also had stronger PEAs than recreational fishers and non-fisher/non-citizen scientists, but there were no significant differences in PEAs across specialization levels. Citizen scientists showed greater concern for climate change than recreational fishers and non-fisher/non-citizen scientists. However, respondents overall showed greater concern for "the environment" than for climate change. Our results suggest that both activity type and specialization level are important considerations when developing strategies to promote pro-environmental behaviors and climate concerns and that communication frames centered on healthy ecosystems may be more effective with some stakeholders than those focused solely on climate change. We discuss implications for building public support of climate engagement efforts and sustainable, climate-resilient fisheries.

Keywords: sustainable fisheries; climate change; fishing; nature-based activities; pro-environmental attitudes; pro-environmental behaviors; citizen science

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1. Introduction

Many fish populations are under threat from the interactive impacts of climate change [1–3], habitat loss [4], overfishing, and ineffective management [5], often with many cascading socioeconomic impacts on people and communities [6–8]. It is increasingly important to co-develop and implement adaptation strategies [9] that reduce harm to at-risk species and to the people who rely on them for their physical, economic, and psychological well-being [6,10,11]. Public awareness, understanding, and support for sustainable fish and fisheries impacted by climate change is a vital component of these strategies (e.g., [12]), which requires understanding the socio-psychological implications of climate change and subsequent adaptation efforts on relevant stakeholders. While much research has focused

on climate implications and adaptations within the commercial fishing industry [13–16], recreational fishers and other fish-based recreationists must also cope with the impacts of climate change [3,17], making them important stakeholders to consider in the development of climate-resilient, sustainable fisheries. Here, we explore the relationship between participation and specialization in these activities and pro-environmental attitudes (PEAs) and pro-environmental behaviors (PEBs), to help shed light on the human dimensions of fisheries-based recreation and citizen science. In doing so we seek to better understand how these relationships may influence stakeholder engagement and climate adaptation efforts.

The effects of climate change and habitat degradation on fish populations can affect outdoor nature-based recreation in a number of ways, including the timing (season), location, financial commitment, and even types of activities in which outdoor recreationists are able to participate. For example, recreationists may cope with extreme weather events by planning their activities during lower risk seasons, moving their activities to a safer location, investing more money in equipment that allows them to continue their activity despite climate risks, or even finding a new activity that is more resistant to the impacts of climate change [18]. McCreary et al. [18] found that recreationists with greater climate concerns exhibited more of these coping behaviors related to climate risks when planning their activities. Specifically with regard to fish-based recreation, climate change is likely to make certain offshore species more difficult, expensive, and dangerous to catch [3,17]. Numerous studies have shown that many marine fish species are undergoing changes in spatial distribution, often moving poleward, farther offshore and/or deeper [19–22], which can mean that accessing target species will require more time, effort, and resources. New species are also appearing in locations where they previously have not been common, in some cases opening up new opportunities for fishing, for example black sea bass in the Gulf of Maine [23,24].

In the present study, we assess how participation type and specialization level in fish-based recreation in a coastal American state (Massachusetts) are related to environmental attitudes, self-reported behaviors, and climate change perceptions. Fisheries have played a vital role in the culture and subsistence of coastal indigenous communities in the region for millennia [25]. The arrival of Europeans in New England signaled a major emphasis on the commercial value of species such as cod [26] and, more recently, American lobster [27], as well as the destruction of riverine fish habitat due to damming [28,29]. Declines in fish stocks and especially the virtual collapse of the cod fishing industry in recent decades has prompted numerous studies of the role that climate change has played in these events [30], including studies of the perceptions of climate change among commercial fishermen [7,8]. Among New England commercial fisheries, climate change has been linked to changes in species abundance [30,31] and distribution [32] and declines in fishing opportunities and employment within the industry [33,34].

PEAs, PEBs, and climate concern among individuals connected to New England fisheries are of particular importance due to the accelerated rate at which marine waters in this region are experiencing climate-driven change [35]. Less is known of the attitudes of recreational fishers, despite the fact that they target many of the same species as commercial fishers, including striped bass, black seas bass, various ground fish (including cod and haddock), and American lobster [36]. This is especially true when compared to other non-extractive activities such as annual citizen science fish counts of herring in this region. River herring is an anadromous fish that has suffered population declines as a result of anthropogenic activities [37], but is beginning to return in greater numbers to coastal waterways where fish habitat has been restored by the removal of dams [29]. Fish counting has become a popular springtime activity for citizen scientists that provides important population data for fisheries managers [38].

Input from these additional stakeholders in environmental management and adaptation planning is important but often lacking [39,40]. We sought to better understand how both activity type and level of specialization in each activity influences environmental

attitudes, behaviors, and climate perceptions among members of these two stakeholder groups with different relationships to fisheries.

Both citizen science and recreational fisheries have increasingly attracted attention for their potential to increase PEAs and PEBs [41]. For example, catch data reported by recreational fishers using smartphone applications is a form of citizen science [42]. They differ in that citizen science protocols are usually more structured, determining when, how and what observations are recorded [43]. Specifically in regard to fishing and citizen science-based fish monitoring, participants of both activities typically share a common goal of maintaining healthy fish populations; however we lack a complete understanding of their level of concern over issues that can negatively affect fisheries (i.e., climate change and other environmental problems). Further research is also needed to understand the degree to which specialization level influences attitudes, behaviors, and climate concerns, rather than just activity type.

We hypothesized that PEAs would be associated with PEBs and climate concerns, and that these relationships will vary amongst the different groups. In doing so, our goal was to provide insights into effective strategies for engaging various fisheries stakeholders in climate adaptation efforts. We use the term "citizen science" in its broadest possible, most inclusive sense, i.e., that it does not imply any citizenship status amongst participants [44,45]. Similarly, we use the term "fisheries" to encompass all activities where humans interact directly with wild fish populations, whether these interactions involve consumption or not.

1.1. Literature Review

1.1.1. Outdoor Recreation and Pro-Environmental Attitudes and Behaviors

Previous research on outdoor recreation has shed light on the complexities that exist between human–nature interactions, PEAs, and PEBs. For instance, there is evidence that attitudes and behaviors vary by both activity type [46–48] and specialization level (i.e., the degree to which participants dedicate time and resources towards a defined activity) [49–51]. However, these studies have yielded inconsistent findings. In some cases, environmental concerns and behaviors were stronger among those who engage in appreciative activities (e.g., hiking, wildlife watching) than those participating in extractive activities (e.g., hunting, fishing) [46,47]. Other studies have shown very little difference between these two classifications [48], and some have suggested that specialization level has stronger ties to environmental attitudes and behaviors than to activity type [52]; but see [51]. These inconsistencies suggest that categorizing nature-based activities and their participants into broad groups may mask the intricacies associated with specific activity types or participant expertise [49]. Examining activities and participant specialization on an individual basis may provide better insight into how these factors relate to environmental attitudes and behaviors.

Outdoor, nature-based recreation has long been viewed as a potential vehicle for promoting environmentally responsible behavior. Dunlap and Heffernan [46] were among the first to show a positive association between participation in outdoor recreation and environmental concern. They also found that environmental concern was greater among appreciative recreationists (hikers, bird watchers) than among extractive recreationists (hunters, fishers). However, after that initial study, further investigations into these connections have yielded inconsistent results. Teisl and O'Brien [47] generally supported Dunlap and Heffernan's [46] hypothesis, showing that PEBs were stronger among appreciative recreational activities. On the contrary, a number of other studies found no differences in PEBs between appreciative and extractive activities, but instead revealed that participation in any type of outdoor recreation was associated with more environmentally friendly behaviors [48,53]. In some cases, demographic factors were stronger predictors of environmental concern than participation in outdoor recreation [54,55]. Moreover, specific behaviors can also differ within the larger categorizations of "appreciative" and "consumptive" or "extractive" (We use the term extractive instead of consumptive due to the high prevalence

and importance of catch-and-release and other non-consumptive types and motivations for fishing) activities. For instance, Teisl and O'Brien [47] found that hunters had stronger behaviors associated with monetary donations and participation in wildlife organizations, but fishers were more likely than hunters to purchase environmentally labeled products.

Van Liere and Noe [52] found no significant correlation between outdoor recreation and environmental behaviors, and instead suggested that PEBs were better explained by recreation specialization. Recreation specialization was first investigated by Bryan [56], who demonstrated that recreationists fall on a continuum of skill and commitment level and that they progress along this continuum as they become more specialized in their respective activity. Specifically, Bryan [56] found that more specialized trout fishers showed greater support for catch-and-release practices and habitat management than more generalist fishers. In this way, fishing could be both extractive and appreciative depending on the fisher's level of specialization. Further research has generally supported a positive correlation between PEAs and PEBs and specialization level albeit with some variability among different types of activities. Raynal et al. [40] explored the positive association between habitat-dependent outdoor recreation and specialization, arguing that specialized recreationists dependent on specific outdoor settings are more prone to act in ways that will conserve those settings. Thapa et al. [57] found a positive correlation between specialization level among self-contained underwater breathing apparatus (SCUBA) divers and pro-environmental behaviors, while Anderson and Loomis [58] found that highly specialized SCUBA divers performed only certain PEBs more frequently than less specialized divers. Alternatively, in their study of pro-environmental attitudes and behaviors among birdwatchers, Cheung et al. [59] found a positive correlation between specialization level and PEAs, but not PEBs.

1.1.2. Citizen Science and Pro-Environmental Attitudes and Behaviors

Citizen science is playing an increasingly important role in overcoming the logistical obstacles of large-scale research projects by enlisting the help of the public in data collection [41,60], and also serves to democratize science [61]. With help from a widespread pool of participants, researchers can better understand and address a number of environmental issues, such as the spread of invasive species [62], threats to air and water quality [43,63], and population estimates of vulnerable species [41]. Aside from making projects more feasible, citizen science has also been recognized for the potential benefits it may provide participants, such as increased scientific knowledge and environmental literacy [64,65].

Far less is known of how participation in citizen science activities may promote individual behavioral change [51,66]. Citizen science has only recently been included in attitudinal and behavioral comparisons among different types of nature-based recreation [48,67,68]. Citizen science often involves direct interaction with nature and is receiving more attention for its potential to foster stronger PEAs and PEBs among participants [41,64,69]. Among projects with an environmental or nature-based component, citizen science may also provide an avenue for increasing awareness of, and concern for, climate-related issues. However, we still lack a full understanding of how citizen science fits into the overall framework of nature-based activities, environmental attitudes, and behaviors, particularly in the context of awareness of climate change impacts [41,70].

It is often assumed that the benefits of participation in citizen science activities extend to increases in PEAs and PEBs, but studies examining these relationships have yielded inconsistent results [65,69,71]. Lewandowski and Oberhauser [71] found that participants in butterfly monitoring projects across the U.S. were more likely to plant nectar or host plants, encourage others to plant more, involve others in monitoring or conservation, and talk informally with others about butterflies or conservation after completing their projects. Forrester et al. [65] comparably found that participants in a mammal conservation project were more likely to talk about mammal conservation with others after their citizen science project. Importantly, environmental attitudes were strong among participants prior to starting the project, and they did not change afterwards. In contrast, Toomey

and Domroese [69] found that environmental concern was strong amongst participants initially, and that their level of concern increased after completing their projects. They did not, however, document significant changes in conservation behavior. Here, we sought to better understand how participation in these more structured citizen science activities (specifically fish monitoring) compared to more leisurely activities (recreational fishing) in the context of PEAs, PEBs, and climate perceptions.

2. Materials and Methods

2.1. Participants

Online survey responses were collected from Massachusetts residents in November 2018. Participation in the survey was limited to Massachusetts residents because data were being collected as part of a larger study investigating ways to reduce psychological distance to environmental problems. Our sample of 383 respondents comprised 47 citizen scientists, 151 recreational fishers, 24 respondents who self-identified as both fishers and citizen scientists, and 161 people who identified as neither recreational fishers nor citizen scientists. We used a tiered recruitment strategy that involved invitations sent via email to a random sample of 1000 recreational fishers using addresses provided by the Massachusetts Division of Marine Fisheries; across four Massachusetts citizen science listservs; and via a Qualtrics Research Panel that yielded 208 responses. Qualtrics is an online survey platform for building and distributing surveys, and we used a fee-based distribution service offered by Qualtrics to collect a minimum of 200 survey responses from Massachusetts residents who would not necessarily participate in recreational fishing or citizen science. While Qualtrics Research Panels uses a non-probability sampling approach and critiques focus on their potential lack of representativeness [72], several recent studies have shown that effective panel design and sampling can lead to robust and representative samples [73–75].

Recreational fishers and citizen scientists were offered the chance to participate in a raffle for one of two USD 25 gift cards (Amazon or Bass Pro Shops) as an incentive. Survey development and data collection for both recreational fishers and citizen scientists were completed through Qualtrics Survey Research Suite. We deliberately used these various data collection approaches in order to maximize the diversity of respondents with respect to their interest and experience (i.e., specialization) in recreational fishing, citizen science, or neither.

The survey was set up to exclude any non-Massachusetts residents as well as anyone who did not commit to provide their best answers. Participants who self-identified as either fishers, citizen scientists, or both were shown additional questions to assess their level of specialization in these activities (see Figure S1 for full survey instrument). Participants who indicated that they belonged to neither category were not shown any questions regarding specialization. Participants were also asked to indicate their relationship (if any) to the state's natural resources. Possible choices included recreational fisher, commercial fisher, charter/for hire, fishing guide, citizen scientist, or none of these. Commercial fishers, charter/for hire and fishing guides were excluded from analysis (see below).

All participants then answered questions relating to their past pro-environmental behaviors, their perception of the importance of various political issues, environmental attitudes, and climate change perceptions. Lastly, participants were asked to provide demographic information, and the survey concluded by thanking participants and allowing them to enter a gift card raffle. The median time to complete the survey was roughly 16 min. The survey was approved by Northeastern University's Institutional Review Board (Approval #13-07-16).

2.2. Survey Instrument Development

The survey was developed using Qualtrics Survey Research Suite to measure the environmental attitudes, PEBs, and climate change perceptions of participants. The survey contained a total of 49 items as part of a larger study exploring the effects of nature-based videos on PEAs, PEBs, and perceptions of climate change in the context of psychological

distance. The survey instrument is available in Figure S1. Environmental attitudes were measured on a five-point Likert scale using the New Ecological Paradigm (NEP) scale developed by Dunlap et al. [76], which asks participants to indicate the extent to which they agree with a set of 15 statements expressing both positive and negative ecological worldviews. PEBs were measured using an adapted version of the scale developed by Dutcher et al. [77], which asks participants whether or not they have ever engaged in a series of six environmental behaviors. We added two questions that specifically addressed behaviors relating to climate change and sustainable seafood choices to better reflect the aims of our study. To assess the degree of specialization of participants who identified as fisher or citizen scientist we used a self-classification measure developed by Needham et al. [50]. This measurement includes statements that describe three levels of specialization, including generalist, intermediate, and specialist. The exact wording of the original statements was used to measure specialization in fishers, but we adapted these statements for citizen scientists to make them specific to this activity.

Two questions were used to assess participants' climate change perceptions. The first question asked whether or not participants believe climate change is happening, with possible answer choices including "yes," "no," and "don't know" [78]. The second question, from Roser-Renouf et al. [79], asked participants to select five issues from a list of 23 political issues that were most important to them, including climate change and the environment. It is important to note that the wording of this question was "Please select five issues from the list below that are most important to you" and did not contain the word "political" to avoid introducing any potential bias during the survey by suggesting that the survey was related to politics.

2.3. Statistical Analysis

Responses from the Qualtrics panel of Massachusetts residents were combined with responses from the survey administered to recreational fishers and citizen scientists. Respondents who self-identified as citizen scientists but did not participate in any fish-related projects were removed from the analysis. Respondents who self-identified as both fishers and citizen scientists were excluded from analysis in order to avoid violating assumptions of independent observations. Additionally, respondents from the fisher group who self-identified as anything other than "recreational fisher" (commercial fisher, charter/for hire, or fishing guide) were excluded from analysis since these subgroups have different motivations for fishing (i.e., leisure versus livelihood) [80–83]. Statistical analysis was done to compare environmental attitudes based on NEP scores, pro-environmental behaviors based on PEB scores, and climate change perceptions between stakeholder groups and between specialization levels. All negative statements in the NEP scale were reverse coded. NEP scores were calculated for each participant on a scale of 15–75, with a median score of 45 indicating neutral attitudes, a score higher than 45 indicating stronger PEAs, and a score lower than 45 indicating weaker PEAs (Figure S1). The PEB scale was re-coded so that a maximum score of eight indicated participation in all eight behaviors and a score of zero indicated participation in none of the behaviors. Participants' answers to questions about climate change concerns were sorted into four categories based on whether they selected both climate change and "the environment", climate change only, "the environment" only, or neither climate change nor "the environment "as their top five issues from the list of 23 concerns (see Table S1 for full list of issues from which respondents could select).

Participants were divided into one of three categories based on how they described their relationship to natural resources. These categories included fisher, citizen scientist, or non-fisher/non-citizen scientist. The fisher category included only recreational fishers (excluding any commercial fishers, charter/for hire, or fishing guides), the citizen scientist category included only citizen scientists who participate in river herring monitoring (see [38] for overview of activities), and the non-fisher/non-citizen scientist category included all other participants who indicated that they did not participate in either recreational fishing or citizen science fish counting. Since the data did not fit a normal

distribution, we used nonparametric statistical tests. Kruskal–Wallis tests were used to compare mean NEP scores and mean PEB scores between stakeholder groups, and chi square tests were used to compare climate change perceptions between stakeholder groups. Kruskal–Wallis tests were used for comparing NEP and PEB scores because these data were compared across three independent categories, and chi square tests were used for comparing climate perceptions because these data are categorical and were compared across categorical groups. Raw NEP and PEB values were used for analysis.

A second analysis was done to compare attitudes, behaviors, and climate change perceptions between participants based on their level of specialization in fishing or citizen science. Participants were divided into one of four categories (none, low, medium, or high) based on their level of engagement with fishing or citizen science activities. Specialization level was defined as "none" for participants who were non-fisher/non-citizen scientists, and specialization level for all other participants was based on self-categorization during the survey. Specific wording of response choices can be found in Figure S1. Kruskal–Wallis tests were used to compare mean NEP scores and mean PEB scores between specialization levels, and chi square tests were used to compare climate change perceptions between specialization levels. Again, Kruskal–Wallis tests were used for comparing NEP and PEB scores. We recognize that the unequal sample sizes between groups may increase the risk of Type II error; however, this does not affect the ability to calculate a test statistic through either the Kruskal–Wallis or chi-square tests. All data analysis was completed using SPSS software version 28. In order to compensate for multiple tests and reduce the risk of type I error, results were considered statistically significant at a level of $p \leq 0.001$.

3. Results

We received a total of 383 complete responses from survey participants; however, there were a total of 333 participants after removing respondents who self-identified as both fishers and citizen scientists, respondents who participated in non-fish-related citizen science projects, and respondents in the "fisher" category who were not recreational fishers. Overall participants were mostly white (87%), majority female (57%), and a plurality (20%) were between 45–54 years old. A majority had completed at least some college or a two-year degree (51%). A plurality of participants (15%) had an annual income between USD 100 001-USD 150 000 USD. The breakdown of the three stakeholder groups from all participant responses was: 43% fishers (n = 136), 11% citizen scientists (n = 36), and 48% non-fisher/non-citizen scientists (n = 161). The breakdown of the four specialization levels was: 48% none (n = 161), 19% low (n = 62), 24% medium (n = 81), and 12% high (n = 29). Demographic information broken down by stakeholder group and specialization level is displayed in Table S2.

The NEP scale showed a high level of internal consistency, with a Cronbach's [84] α of 0.796. The mean and median NEP scores among participants were both 56, indicating that participants overall tended to have stronger environmental attitudes. The pro-environmental behavior scale, including all eight statements, also showed a high level of internal consistency, with a Cronbach's [84] α of 0.82. Cronbach's α is a measure of the internal consistency of multi-item questionnaires and normally ranges between 0 and 1, with α values closer to 1 representing greater internal consistency. Generally, an α value greater than 0.7 is considered acceptable [85]. The mean and median PEB scores among participants were both 4, indicating that participants tended to partake in half of the possible pro-environmental behaviors.

3.1. Stakeholder Identity, Environmental Attitudes, and Pro-Environmental Behaviors

A comparison of mean NEP scores (a measure of PEA) and mean PEB scores across the three stakeholder groups revealed that citizen scientists had the strongest environmental attitudes (mean NEP score = 61.6) and partook in the most pro-environmental behaviors (mean PEB score = 6.6), followed by fishers (mean NEP score = 55.8; mean PEB score = 4.4), and non-fisher/non-citizen scientists (mean NEP score = 55.5; mean PEB score = 3.2). A

Kruskal-Wallis test showed significant differences in mean NEP scores across the stakeholder groups (H(2) = 16.910, $p < 0.001$; Figure 1). Specifically, significant differences existed between citizen scientists and non-fisher/non-citizen scientists and also between citizen scientists and fishers. Additionally, mean PEB scores differed significantly across all groups (H(2) = 59.293, $p < 0.001$; Figure 1).

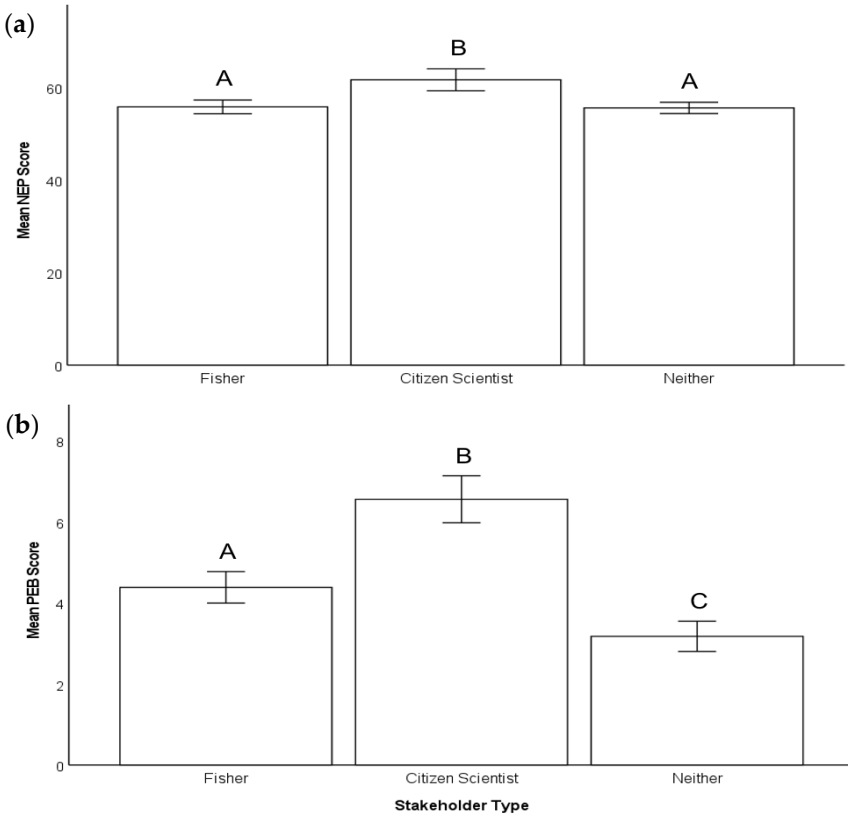

Figure 1. (**a**) Mean NEP (new ecological paradigm) scores across the four stakeholder groups. NEP scores range from 0–75, with higher scores reflecting stronger pro-environmental attitudes. (**b**) Mean PEB (pro-environmental behavior) scores across the four stakeholder groups. PEB scores range from 0–8, with higher scores reflecting participation in more pro-environmental behaviors. 95% confidence intervals are displayed. Different letters above each bar reflect statistically significant differences between stakeholder groups at $p < 0.001$.

3.2. Specialization, Environmental Attitudes, and Pro-Environmental Behaviors

There was no significant difference in pro-environmental attitudes among specialization levels (Figure 2); however pro-environmental behaviors did differ significantly across specialization levels (H(3) = 50.734, $p < 0.001$). Overall mean PEB scores increased with specialization level, ranging from 3.2 for non-specialized participants to 6.2 for highly-specialized participants. There was no significant difference between the non-specialized and low-specialization groups, but non-specialized participants differed significantly from the medium-specialization group and the highly specialized group. The low-specialization group did not differ from the medium-specialization group, but it was significantly different from the highly specialized group. There was no significant difference between the medium-specialization and highly specialized groups.

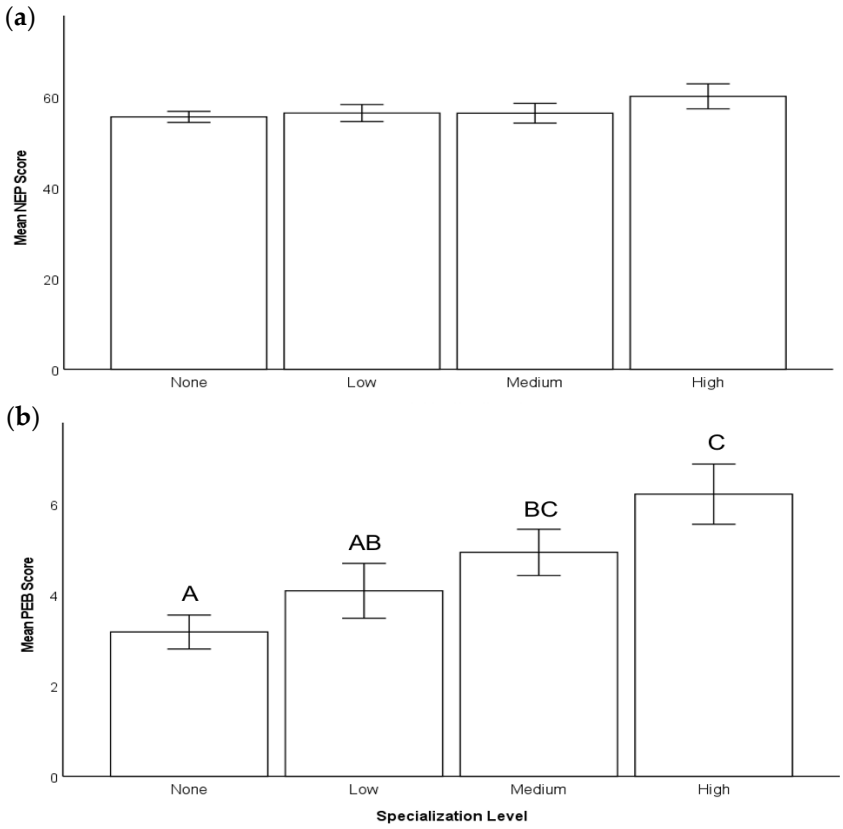

Figure 2. (**a**) Mean NEP (new ecological paradigm) scores across the four specialization levels. NEP scores range from 0–75, with higher scores reflecting stronger pro-environmental attitudes. (**b**) Mean pro-environmental behavior (PEB) scores across the four specialization levels. PEB scores range from 0–8, with higher scores reflecting participation in more pro-environmental behaviors. 95% confidence intervals are displayed. Different letters above each bar reflect statistically significant differences between specialization levels at $p \leq 0.001$.

3.3. Stakeholder Identity, Specialization, and Climate Change

Overall, a majority of participants (88%) indicated that they believe climate change is happening. There were not significant differences in climate change beliefs (based on a single question) between stakeholder groups, but a greater proportion of fishers (11%) indicated that they do not believe climate change is happening compared to the other stakeholders (Figure 3). One hundred percent of citizen scientists surveyed believed that climate change is happening. A chi square test showed a significant relationship between stakeholder type and the importance of climate change and the environment to participants (X^2 (6, N = 333) = 28.08, $p < 0.001$, Figure 4). A majority of citizen scientists (58%) selected both "climate change" and "the environment" among the top five issues they are most concerned with, while the plurality of fishers (34%) and non-fisher/non-citizen scientists (37%) selected neither "climate change" nor "the environment" among their top five most important issues. However, if these categories are broken down to look at overall selection for each issue individually (combining participants who selected only "the environment" or only "climate change" and those who selected both), "the environment" was the top selection for fishers (48%) and for non-fisher/non-citizen scientists (43%). For citizen scientists, climate change and the environment were roughly equivalent (75% and 78%, respectively). The complete breakdown of issue selection by stakeholder type can be found in Table S3.

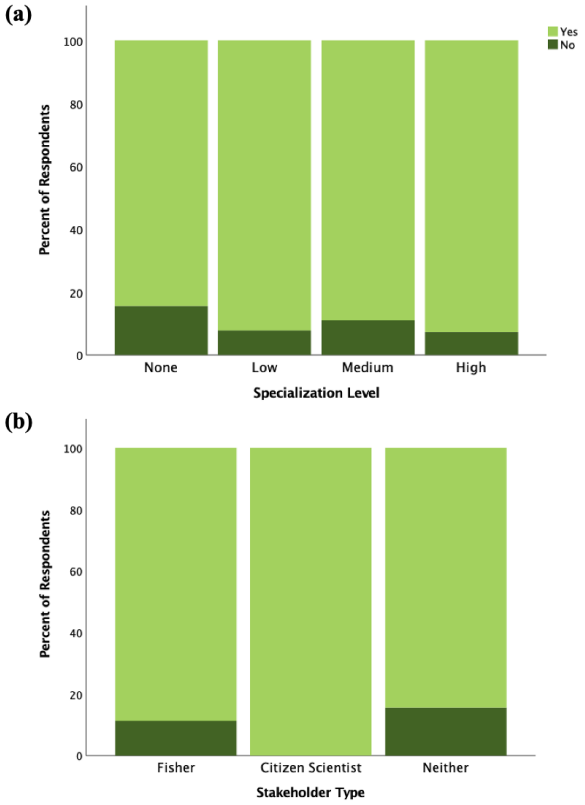

Figure 3. Proportion of participants' responses when asked if they believed climate change was happening broken down by (**a**) level of specialization and (**b**) stakeholder type.

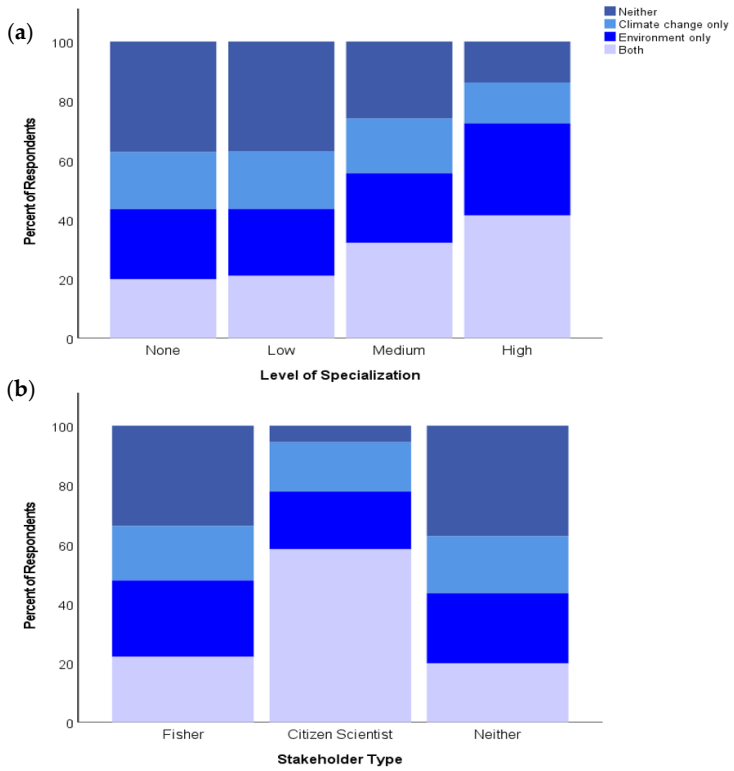

Figure 4. Proportion of participants who selected climate change and/or the environment when asked to select the five most important issues to them out of a list of 23 broken down by (**a**) level of specialization and (**b**) stakeholder type.

There were no significant differences in climate change beliefs or in the importance of "climate change" and "the environment" among specialization levels; however, the number of respondents who selected neither "climate change" nor "the environment" as a top five issue of concern generally decreased as specialization level increased (37%, 37%, 26%, and 14%, in increasing order of specialization), and the number of respondents who selected both "climate change" and "the environment" as a top five issue of concern likewise increased as specialization level increased (20%, 21%, 32%, 41%, in increasing order of specialization, Figure 4).

4. Discussion

The results of our study provide important insights into the interrelationships between environmental attitudes and behaviors, climate change perceptions, and participation in recreational fisheries and citizen science activities. While participation in either citizen science-based fish counting or recreational fishing was associated with stronger self-reported PEBs, our findings show that environmental behaviors varied both by activity type and by specialization level. In this case, citizen scientists had stronger PEBs than fishers, and more specialized participants had stronger PEBs than those with lower or no specialization in fish counting or fishing. With little variation in PEAs across activity type, and no variation across specialization level, our results also indicate that PEAs do not necessarily align with PEBs or prioritization of climate or environmental issues. Additionally, our results show that climate concerns also vary by activity type, but not necessarily by specialization level. Citizen scientists and fishers may share a common goal of maintaining healthy fish populations; however, they differ quite a bit in their prioritization of issues that affect fisheries' health. Overall, our findings shed light on the socio-psychological complexities that exist among fish-oriented recreationists and provide important insights into the challenges of encouraging climate mitigation efforts and in communicating risks associated with climate change to stakeholders. Importantly, we recognize the geographic limitations of our study location (Massachusetts) may limit the interpretation of our results to other regions with different demographics and ecosystems.

The results of PEA and PEB comparisons across stakeholder types suggest that environmental attitudes do not necessarily translate into strong environmental behaviors are in line with previous research [86–91]. Some possible explanations for this disconnect include high costs associated with behavioral changes [90], situational reasoning that outweighs a person's environmental attitudes [89], cognitive control [91], and from an experimental design perspective, a mismatch in specificity between attitudinal and self-reported behavioral measurements [87]. In our study, certain items included in the PEB scale were purposefully made to be fish-specific and climate-specific, while the NEP scale includes more general environmental items. It is therefore possible that we created a mismatch between attitudinal and behavioral measurements by including more specific items in our PEB scale.

The stronger PEBs among fishers and citizen scientists compared to non-fisher/non-citizen scientists in our study supports previous findings that participation in nature-based recreational activities is positively correlated with PEBs [46,47,53]. Furthermore, reported PEBs also differed between recreational fishers and citizen scientists. It is important to note, however, that while the citizen science activity in our study was non-extractive, this is not always the case and that some citizen science activities are extractive in nature. Likewise, recreational fishing is not always an extractive activity, and we did not ask participants to disclose whether or not they kept the fish they caught. Dunlap & Heffernan [46] found environmental concerns to be stronger among people who participated in appreciative outdoor activities versus extractive outdoor activities, and Teisl and O'Brien [47] found that PEBs were stronger among appreciative recreationists than among extractive recreationists. However, it is important to not downplay the PEBs reported among recreational fishers, even if these were lower than those of citizen science fish counters. Recreational fishers still demonstrated a boost in PEBs compared to participants who did neither activity, suggesting

that recreational fishers could act as an important ally in promoting environmentally friendly behaviors and in enacting conservation measures, even if their motivations may vary from those of citizen scientists [92–94]; but see [95]. This is particularly true when we also consider how behaviors differed among specialization levels.

Reported PEBs increased with specialization level, with highly specialized participants showing significantly stronger PEBs than low- and non-specialized participants and medium-specialized participants showing significantly stronger PEBs than non-specialized participants. Our results correspond with previous findings that greater specialization in nature-based recreational activities is positively correlated with environmentally friendly behaviors [49,57,96]. This also aligns with Bryan's [56] findings that fishers tend to shift towards catch-and-release practices and become more supportive of habitat management as they become more specialized. The positive correlation between PEBs and specialization may be a function of both place attachment and perceived risk. For instance, more specialized recreationists tend to have stronger emotional attachment to specific recreational settings [97,98], and therefore may feel more protective of these resources. Additionally, more committed recreationists are likely to dedicate more resources to their activity, such as time, money, and energy, and therefore may incur greater penalties if they discontinue that activity [99]. According to Oh et al. [100], more specialized recreationists view their recreational experiences as more valuable than less-specialized recreationists, and they place greater value on ensuring the sustainable use of those recreational resources. Our findings provide further support that more specialized recreational fishers may serve as strong advocates for increasing PEBs within the recreational fishing community. Likewise, more specialized citizen scientists may help encourage stronger PEBs among their less-specialized peers. Furthermore, our results suggest that encouraging sustained participation in fisheries-based activities may serve to increase PEBs among these recreationists.

Comparing the breakdown of environmental behaviors by activity type and by specialization level in our study highlights the complex nature of socio-psychological characteristics among nature-based recreationists. Our results show that stakeholder groupings are not one-size-fits-all, and treating them as such may create misconceptions. In a review comparing hunters to environmental groups, Knezevic [101] points out that these two groups are often viewed as having opposing environmental ideologies due to the nature of their activities, when in reality they typically share the same goal of preserving wildlife habitat. Along the same lines, a study by Hermoso et al. [102] highlights the importance of understanding differences in SCUBA divers' characteristics for recruitment into SCUBA-based citizen science projects. They show that artisanal fishermen are generally more skilled divers with greater local ecological knowledge of their marine environment than recreational divers, however recreational divers generally have more time to participate in citizen science projects and own more technical resources, such as underwater cameras, to contribute to these projects.

Climate change beliefs did not differ significantly across stakeholder groups or specialization levels. Still, a majority of participants indicated that they believe climate change is happening. This was perhaps not surprising considering that our survey took place in Massachusetts, where climate opinion polls have shown widespread belief in the issue of climate change [103,104]. From a public outreach perspective, this may indicate that emphasis should be placed on promoting climate action rather than changing climate opinions in areas such as New England where climate beliefs tend to be high. However, while most participants accepted that climate change was happening, it was not a top issue for everyone. Citizen scientists selected "climate change" and "the environment" as top-five issues more often than recreational fishers or participants who did neither activity. Moreover, fishers' concerns for "climate change" and "the environment" closely mirrored those of non-fisher/non-citizen scientists, showing that participation in nature-based activities alone may not necessarily translate to prioritization of these over other political issues. The fact that there was no significant relationship between specialization level and climate and environmental concern further supports this idea. That said, it is worth

noting that while differences in the prioritization of climate change and the environment were not statistically significant among specialization levels, there was a positive trend in prioritization of these issues with increasing specialization level. While further research is needed to explore this potential relationship, it is possible that greater specialization in fishing and fisheries-related activities could support greater climate concerns.

The variation in climate concerns among participants is consistent with results from other studies. For instance, in their study among the Australian public ranking concern for various environmental issues, Dilkes-Hoffman et al. [105] found that climate change ranked lowest on a list of nine environmental problems. At an international scale, Smith et al. [106] found that climate change generally ranks high among environmental concerns across different countries, but not in the United States. They showed that in the U.S., climate change not only ranks lower than other environmental issues, but that it is also perceived as less dangerous than other environmental issues. While previous research shows that there is a high degree of variability in climate concerns among Americans [79], our study highlights the role that different fisheries-based activities and, more generally, interacting with nature may play in shaping concern for both the environment and climate change.

Still, this has major implications for building climate-ready fisheries because some fisheries stakeholders may oppose climate mitigation strategies if they conflict- or are perceived to conflict- with the other issues they prioritize. On the other hand, recreational fishers did tend to prioritize "the environment" over climate change. These findings shed light on which topics resonate most strongly with different stakeholders and have important implications for connecting with them on issues related to climate change and other environmental issues. For instance, climate change continues to be a polarizing topic in the United States [107,108], making it a challenge to connect with certain audiences on the issue. However, previous studies have shown that framing climate solutions in different contexts can harness support among groups who are otherwise less supportive of climate mitigation strategies [109]. Since "the environment" was a common issue of importance for all groups, framing certain climate-related impacts in an environmental context as opposed to a strictly climate-change context could provide an avenue for more meaningful conversations with groups who prioritize "the environment" over climate change. Specifically, using the term "environment" instead of "climate" in communications and public outreach strategies pertaining to developing sustainable fisheries may be more effective in gaining support from a more diverse group of stakeholders. These results further suggest that framing action around the multiple stressors that often interact with climate change–such as land use change and development [110–112]–rather than climate change, per se, may be more effective among some stakeholder groups such as recreational fishers.

Our results may also indicate a potential knowledge gap and/or psychological distance that exists between certain fisheries stakeholders and the damaging impacts of climate change. Psychological distance can develop in spatial, temporal, social, or hypothetical contexts [113]. For example, an event might feel psychologically distant if it takes place in another country, if it will not occur until the future, if it affects another group or person, or if there is uncertainty as to whether or not it will happen. Climate change impacts often fall into all of these categories, making psychological distance a difficult challenge to overcome. This has been demonstrated by research on climate change perceptions in the United States, which shows that many Americans believe climate change will cause more harm to people in developing countries, to future generations, and people living in poverty than it will to themselves, their families, or their communities [114]. It is possible that certain recreational fishers in our study have not personally felt the impacts of climate change on their activities and therefore do not prioritize climate change over issues that seem more tangible to them. From a fisheries management perspective, finding ways to reduce the psychological distance of climate change within the fishing community may serve to increase fishers' climate concerns and support for climate mitigation and adaptation strategies.

A possible limitation of our study includes the use of a single-item, self-classification measure to determine participants' specialization level. While this type of self-assessment

was generally found to accurately predict specialization levels among SCUBA divers in a study by Sorice et al. [115], they did find that casual divers were the least likely to be classified correctly. It is possible that asking participants to self-classify instead of using a multi-item classification scale could have led to some participants being classified incorrectly, particularly those with a low level of specialization in their respective activity. Additionally, given that our survey was distributed online only, this might have limited survey response, leading to potential coverage or non-response bias. For instance, fishers and citizen scientists tended to be older than participants who did neither activity, and low, medium, and highly specialized participants were generally older than non-specialized participants. Medium and highly specialized participants were mostly male, while low and non-specialized participants were mostly female. A greater proportion of citizen scientists were females, however previous studies have shown that more women than men tend to participate in wildlife-based citizen science projects [116]. Research from the Yale Program on Climate Change & George Mason University [117] shows that younger Americans tend to be more concerned with climate change than older Americans (60% 18–34, 58% 35–54, and 53% 55+) and women tend to be more concerned about climate change than men (60% to 52%, respectively). Additionally, women generally exhibit stronger environmentally friendly behaviors than men [118,119]. Yet, our results showed that despite age and gender, non-fisher/non-citizen scientists had less concern for climate change than citizen scientists and roughly the same concern as recreational fishers. They also engaged in fewer PEBs than any other group.

Overall, our study further supports previous research showing that participants of a single activity can display a variety of different characteristics based on their motivations for participation, local knowledge of their environment, and available resources [102]. Considering the multidimensional characteristics of fisheries-based recreationists may provide important insights into their motivations as recreationists, attitudes towards the natural resources they engage with, and their willingness to contribute their time, skills, and other resources towards addressing climate change and other environmental problems. Equally important to take into account is that these characteristics, especially climate opinions, are likely to evolve over time with shifts in the political climate and more people experiencing extreme weather events firsthand. Such considerations may help fisheries managers across the United States effectively address the need for building climate-resilient fisheries, particularly by helping to shape effective communications strategies that resonate with their target audience, reduce psychological distance between fisheries stakeholders and the impacts of climate change on their activities, and encourage greater participation in fisheries-based activities that may harness stronger pro-environmental behaviors among participants.

5. Conclusions

Our results showed that participation in nature-based activities is associated with stronger environmental behaviors. PEBs and climate concerns were stronger among appreciative recreationists, but also among more specialized recreationists regardless of activity type. These findings suggest that future comparisons among nature-based recreationists should consider both activity type and specialization level in order to provide a more comprehensive picture of their environmental habits and climate concerns. Additionally, encouraging long-term participation in fisheries-based recreation may help increase PEBs and climate concerns among participants. While prioritization of climate change increased with specialization level and was greater among appreciative recreationists, participants overall tended to prioritize "the environment" over climate change. These insights into the relationship between fisheries-based recreationists and their environment can help fisheries managers connect with key stakeholders as they form strategies to build fisheries that are sustainable and climate resilient.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15010307/s1, Figure S1: Full survey instrument; Table S1: A list of the 23 concerns participants could choose from when asked "Please select five issues from the list below that are most important to you." The order in which issues were presented in the list was randomized in every survey.; Table S2: Demographic information of participants broken down by stakeholder type and specialization level; Table S3: Percent of respondents who selected climate change and/or the environment when asked to select the five most important issues to them out of a list of 23. Selections are broken up by stakeholder type (a) and specialization level (b).

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The Human Subjects Data described in our study are available as a summary codebook in Northeastern University's Digital Repository Service (http://hdl.handle.net/2047/D20320123). Raw data are available upon request and approval from Northeastern University's Institutional Review Board (IRB) by contacting Scyphers (sscyphers@southalabama.edu).

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