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Co-imagining future scenarios can enhance environmental actors' empathy toward future generations and non-human lifeforms

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ABSTRACT

There is a growing call in sustainability science and practice to build empathy, especially among actors involved in environmental management. We explored how Participatory Scenario Planning (PSP), a popular collaborative environmental planning tool and an emerging transdisciplinary research approach in sustainability science, can influence empathy. We used as our central case a PSP we conducted to co-explore the future scenarios of the tidal wetland-dykeland ecosystem in the Bay of Fundy, Nova Scotia, Canada. Implementing a one-group pre/post-test study design, we measured immediate and longer-term (3 months after) changes in empathy targeted for present non-human lifeforms, present people, and future people among participating environmental actors (n=18). We applied the Empathic Concern Index Tool which measures emotions towards the welfare of the empathy target. Our paired t-tests showed that our central PSP case had large increases in empathy for present non-human lifeforms and future people, with the observed increase in empathy for future people lasting at least three months. We found no significant change in empathy for present people. We also tested the applicability (i.e., whether our findings are also observable to participants in a different treatment setting) using a case of a PSP (n = 9) that we conducted to co-explore the futures of agriculture, wetlands, and urban greenspaces in Quebec, Canada. We found that in our complementary case, empathy for future people was also significantly increased and the changes persisted at three months post-test. However, the Quebec case did not see significant increase in empathy for non-human lifeforms and present people. Our results contribute empirical evidence on the value of PSP as an approach to building and sustaining empathy, especially for non-human lifeforms and future people.

KEYWORDS:

Scenarios, empathy, participatory, future generations, non-humans

INTRODUCTION

Empathy has been considered critical in shaping and allowing pro-social behaviors or actions that benefit others (e.g., helping, sharing, cooperating) (Decety et al., 2016; Eisenberg et al., 2010; Pang et al., 2022). A range of conceptual and operational definitions exist for empathy. Some use empathy interchangeably with emotions such as sympathy and pity while others use it to describe cognitive–behavioral processes such as *perspective-taking* and *decentering* (Batson 2009; Håkansson Eklund and Summer Meranius 2021; Hall and Schwartz 2019). A widely accepted definition, which we will use in our study, is the "other-oriented emotion (i.e., empathic emotions) produced by taking the perspective of a person (or a target of that emotion) perceived to be in need" (Batson 1991, p.89). It is a person's emotional response of altruistic sensitivity and care to the perceived state of the other (Batson 2009, 2011), also referred to as 'empathic concern'.

Empathy is rooted in understanding and adopting the perspectives of another person or a specific target of empathy (e.g., groups, nonhumans) (Batson et al., 2002). Such alteration of perspectives increases emotional responses for that person/target, leading to improved valuing of the welfare of and positive attitude for that person/target. This enhanced value judgment and positive attitude turns to increased likelihood and motivation for pro-social behaviors and actions (e.g., helping that person/group) (Batson et al., 2002; Glen et al., 2020; Stocks et al., 2009; Taylor et al., 2020). In the context of sustainability sciences, empathy has been shown to associate or contribute to pro-environmental attitudes and behavior (e.g., Berenguer, 2007; Ienna et al., 2022; Schultz, 2000; Walker & Chapman, 2003) and sustainability-oriented decisions that consider those who have long been marginalized in decision-making (e.g., non-human lifeforms, future generations) (Brown et al., 2019; Di Fabio & Kenny, 2021) (Figure 1). Other emerging evidence also shows that such emotions affect our thinking, behavior, and actions toward sustainability issues (Nabi et al. 2018; Pihkala 2022) as they guide what kind and how we interpret information; trigger our action tendencies; and leave memory traces for future behaviors (Brosch and Steg 2021).

<Insert Figure 1>

Empath holds potential to play an important role in more sustainable and equitable environmental management, especially if environmental actors can extend empathy beyond the (present) human community (Brown et al., 2019; Gould et al., 2023). That is because empathy can help environmental actors be more sensitive and caring when considering sustainability solutions to account for the welfare and needs of those affected by environmental issues (Berenguer 2010; Gould et al. 2023; Sherren et al. 2022; Tam 2013). Environmental actors who empathize with non-human lifeforms and/or future people can profoundly shape our commitment to interspecies and intergenerational justice (Colombo et al., 2017; Lambert et al., 2024; Rockström et al., 2023; Syropoulos et al., 2020).

Building Empathy with Participatory Scenario Planning

Such a growing body of literature highlighting empathy's potential for sustainable and equitable environmental management has led to increased calls to explore interventions designed to build empathy (Brown et al., 2019), particularly towards non-humans and future generations (Lambert et al., 2024; McKnight, 2010; Rock & Gilchrist, 2021; Talgorn & Ullerup, 2023). Batson (1991, 2009, 2011) and Batson et al. (1995) explain that the primary mechanism of building empathy depends on how an individual understands and adopts perspectives of "others" or the target of empathy (Figure 1). Therefore, it can be dependent on a person's knowledge of the target, especially on their perception of the target's state of welfare and needs. Batson further explains that this knowledge/perception can be shaped by one's memory or prior knowledge about the target of empathy, communication with the target, communication with those who have immediate knowledge/experiences with the target, and/or observing physical and verbal cues of the target.

Another mechanism to build empathy is to imagine oneself in realities beyond one's lived experience (Herrera et al., 2018), especially if the target's state is unfamiliar (Weisz and Zaki 2017). This mechanism is particularly important for targets of empathy that are perceived to be more distant and different from oneself, such as plants, animals, or future people (Wade-Benzoni and Tost 2009). Imagining allows the individual to experience "oneness", or a sense of merged and interconnected identities with the target (Cialdini et al., 1997). It also affects how the individual sees the perceived probability to experience an event or a condition

happening even if this is more likely to happen to the target (Gaesser, 2013). Several empathy-building interventions rely on this mechanism, ranging from pedagogical techniques such as imaginative theatre-based instruction (Grove O'Grady 2020) to immersing oneself in virtual realities (Louie et al. 2018; Mado et al. 2021).

These mechanisms of building empathy can be operationalized by Participatory Scenario Planning (PSP); one of the emerging popular approaches for imagining alternative realities in sustainability science. PSP brings together multiple knowledge and perspectives in a series of collaborative activities to co-imagine alternative realities of plausible futures or "scenarios" of a system of interest (Bennett et al. 2003; Freeth and Drimie, 2016; Notten 2005). Currently, PSP is primarily valued as a planning tool to engage environmental actors in creating more holistic and legitimate strategies, agenda, and policy options for environmental management (Bennett and Zurek 2006; McBride et al. 2017). Its participatory nature has also made PSP a popular transdisciplinary approach to inspire more adaptive and resilient environmental management by understanding future uncertainties and opportunities from a more holistic perspective (Kishita et al. 2016; Schneider and Rist 2014).

<Insert Figure 2>

There is limited research available that explores the effects of scenarios on empathy. A very few (e.g., Blythe et al. 2021) has shown that being exposed to future scenarios can immediately increase empathy but not in the longer term. However, it should be noted that a PSP is not merely an exposure but an active immersion in the very creation of these alternative realities. PSP centers on active participation and communication throughout the process of developing the scenarios, making it an effective space for social learning with other participants (Poskitt et al. 2021). Such social learning can be an opportunity for one to gain information or reignite prior knowledge/memory about the targets of empathy, given that some of the participating individuals can have direct/immediate knowledge about the targets or maybe one of the targets themselves. In turn, such a social learning can (re)shape their existing perception of the target's welfare and needs, eventually evoking empathic emotions. PSP can also facilitate priming, such that the prolonged immersion in alternative realities in PSP serves as a strong stimulus/event that has effect on a subsequent stimulus/events without

conscious guidance or intention (Janiszewski and Wyer 2014; Molden 2014). PSP emphasizes the futures of the environment under discussion, which in turn can be a strong stimulus for future-oriented (e.g., empathize with future people/ future non-humans) or environment-oriented (e.g., empathize with non-human lifeforms) actions or decisions. Our current study, therefore, considers these relevant characteristics of PSP (i.e., space to imagine alternative realities, venue for social learning, and potential for priming) to posit that it can build empathy for participating individuals (Figure 2).

Anecdotal evidence has already documented how PSP participants better reflect on their emotional connections with nature (Pereira et al. 2018). Whether participation in co-creating these alternative realities not only improves but also sustains empathy in the longer-term is a knowledge gap that requires further empirical testing. Here, we engaged PSP participants to determine the influence of participation on participants' empathy for non-human lifeforms, present people, and future people, immediately after, and three months after participation.

METHODOLOGY

Study Design and Study Participants

We implemented a one-group pre/post-test research design, with a 3-month follow-up to assess changes in empathy among actors who participated in scenarios development (Figure 3). As our central case, we used a PSP workshop held in November 2022 in Halifax, Nova Scotia, Canada. This workshop aimed to explore plausible futures of the tidal wetland-agricultural dykeland ecosystems of the Bay of Fundy to understand the social-ecological implications of different plausible futures on the Bay's ecosystem services (Sherren et al. 2021). The workshop was organized by NSERC ResNet (https://www.nsercresnet.ca/), a pan-Canada project that conducts research on six working landscapes, including the Bay of Fundy coast, to provide insights on how to sustainably manage, model, and monitor ecosystem services in these landscape (Bennett et al. 2021) .

<Insert Figure 3>

Workshop participants were part of various organizations across Nova Scotia, including research and academic organizations, governmental agencies from local and provincial to federal levels, native council, non-governmental organizations, and sectoral representatives (e.g., farmers) who are directly working on a diverse range of Bay of Fundy activities (e.g., research, conservation programs, public policy). They were selected and invited through a pre-determined list to encompass a diverse set of environmental actors who can influence, to varying degrees, the future of the ecosystems' delivery of goods and services. Specifically, creating the list was a collaboration between the NSERC ResNet researchers (incl. E.I.N.E.G and K.S.) and partners in the Bay of Fundy coast. We carefully focused on diverse organizational representations and diverse potential knowledge/expertise of different dimensions of the Bay of Fundy Coast (e.g., tidal wetlands, agriculture, heritage). We sent invitations to those we originally identified in this initial list, during which some declined for various reasons (e.g., unavailability) and some referred to alternative names. A total of 18 participants then participated in our 2-day workshop. All had some form of decision-making responsibility, ranging from project and team managers to organizational heads. There were 5 female and 13 male participants. All 18 workshop participants gave free and informed consent to be part of our study. We received an Ethics Review Board approval from McGill University (REB# 22-04-126) to conduct this study.

Our workshop engaged participants to collaborate in four main sessions, as summarized below.

- Remembering the Past (90 min): Participants viewed an excerpt from a documentary showing the landscape's changes over millennia. Afterward, participants individually shared their favorite memory of the Bay of Fundy.
- Understanding the Present (90 min): Participants listened to a series of presentations that showcased the findings of researchers who studied the social-ecological dimensions of the Bay of Fundy's tidal wetland-dykeland ecosystem. Participants then discussed what findings were surprising and conflicting with their own knowledge and experiences working with the ecosystem.
- Identifying the Drivers of the Futures (180 min): Participants were divided into three subgroups (i.e., six members each) to discuss the various social and ecological drivers that they believed could shape the ecosystem's future. They also discussed the relevant

environmental shocks for the ecosystem. After discussions and presentations by each subgroup, NSERC ResNet researchers (incl. E.I.N.E.G., E.B., K.S.) chose the two most common drivers that were prominently present or discussed across the three subgroups: (1) climate change and (2) values influencing decision-making. This was then presented to the group to discuss the most uncertain future directions for these drivers. Together, the whole group deliberated and agreed that the key uncertainty about climate change is whether action to address its impacts is taken proactively or reactively. The key uncertainty about values that influence decision-making is whether we prioritize public goods or private interests.

- Storytelling of the Futures (240 min)**:** Participants were divided into four subgroups, with each group tasked to imagine a storyline of the plausible future of the ecosystem under each unique combination of the drivers. They were asked to imagine the ecosystem's social and ecological aspects by 2072, using whatever means appealed to them. Brief descriptions of these storylines are presented in Table 1.

Measuring Empathy

We adopted the Empathic Concern Index Tool (ECIT) used by Batson et al. (1987a) to measure empathy; specifically state empathy or the empathic feelings that the individual feels at-the-moment for a particular empathy target (see Supplementary Material 1). The ECIT solicits self-reported ratings on the participants' empathic emotions as they feel towards a specific target. We selected this tool because it has been previously used and validated in multiple studies that measure the before-and-after effects of diverse interventions designed to increase empathy among individuals (e.g., Ji et al. 2016; Mado et al. 2021; Moss-Racusin et al. 2018). In addition, the tool can be rapidly implemented; an important consideration given that our study participants are also our workshop participants, and we did not want to detract from the PSP process.

We focused on three targets at which these empathic emotions can be directed: (1) present non-human lifeforms (e.g., plants and animals), (2) present people, and (3) future people who depend on ecosystem services provided in the Bay of Fundy tidal wetlands-dykelands ecosystems. For each target of empathy, we asked the participants to self-report, on a unidirectional 7-point scale (1= not at all; 7= extremely), how they feel at the moment on each

of each of the six vicarious emotions that Batson et al. identified to reflect empathy: "sympathetic", "moved", "compassionate", "warm", "tender", and "soft-hearted" (Batson 1987a,b). The tool therefore consisted of three sets of these emotions, one each for the three targets of empathy. Emotions within each set were randomized to reduce order bias. We calculated an Empathy Index for each target by taking the mean of all self-reported scores in all emotions.

We administered Batson's ECIT at the start of the workshop (Time 1 [T1]) and immediately at the end of the workshop (Time 2 [T2]) by pen and paper. We then conducted a follow-up three months after the workshop ((Time 3 [T3]) i.e., February 2023) via an online questionnaire. We determined that ECIT had high reliability in our case via the Cronbach's alpha coefficients for our current sample, recording a mean coefficient of 0.921 for all targets in T1, 0.916 in T2, and 0.920 in T3.

Analytical Approach

We conducted two sets of analyses to determine differences in participants' *Empathic Index* scores across time for each target of empathy: (1) T1 vs. T2 with n=18 and (2) T2 vs. T3 with n=16 (two T3 questionnaires were not returned). We used paired sample t-tests only after testing for the normality of all data sets using Shapiro-Wilk Normality Test. We looked for significant differences using a 95% confidence interval and used IBM® SPSS Statistics V.21 for our statistical analysis (see Supplementary Material 2 for SPSS results).

We also calculated effect sizes for those targets of empathy that are significantly different in T1 vs T2 comparison. We adopted the method of Morris and DeShon (2002) to estimate the effect size for single-group pre-test–post-test design (d_{RM}) and interpreted using Cohen (1988).

We also examined whether EI scores shifted from the empathic zone (EI>4.00), neutral zone (=4.00), and non-empathic zone (<4.00) from T1 and T2 and from T2 to T3. This method further allowed us to see the transformative potential of participation in a PSP on empathy.

Testing for applicability with an additional PSP case

Testing for applicability looks at whether results are generalizable for participants who are in a modified or slightly different treatment setting (i.e., PSP workshop) than those experienced by the original study population. We used another PSP Workshop as a case to test for applicability or to find similar patterns of empathy changes in another PSP. Testing for applicability differs from external validation, which aims to test whether results are valid in a treatment setting that is entirely equal to the treatment setting of the original study (Dekkers et al. 2010; Murad et al. 2018). External validation for a participatory process such as PSP can be difficult, if not impossible, given the challenge of entirely replicating the full details of the process.

We use as our case for applicability test another PSP workshop that NSERC ResNet organized in April 2023 to co-explore the environmental futures of three ecosystems in the Province of Quebec: wetlands, agricultural landscapes, and urban greenspaces. As in our central case or the PSP in Nova Scotia, we invited environmental actors (n=21) from diverse organizations across Quebec to participate. Our workshop closely followed the same overarching four sessions in our central case (see "Study Design and Participants"); however, there were some differences between the PSP workshop in Quebec and that in Nova Scotia (Table 2).

We administered a French-translated Batson's Empathic Concern Index Tool in the same manner as in our central PSP case (see "Measuring Empathy") (see Supplementary Material 1, Part B). We also obtained fewer valid complete pairs of responses for this applicability case, in which we only have nine pairs of responses for a T1-T2 comparison and seven for a T2-T3 comparison. Several participants did not participate in T2 as they needed to leave earlier due to a severe snowstorm in Quebec. This smaller sample size limits our ability to replicate the same analytical approach we implemented for our main case. Specifically, we used a Wilcoxon Signed Rank Test instead of a paired t-test. For comparisons that tested significantly different, we analyzed for Wilcoxon Effect Size.

RESULTS

Immediate Effects on Empathy

Our paired t-tests showed that Nova Scotia's PSP participants' empathic index for non-human lifeforms differed significantly between T1 (M=6.20, SD=0.69) and T2 (M=5.24, SD=0.92),

showing a significant increase (t=6.65, df=17, p<0.001) with a large effect size (d_{RM}=1.46, 95% CI [1.45-2.92]) (Figure 1). We saw the same positive change for the empathic index for future people, with a significant increase (t=4.80, df=17, p<0.001) with a large effect size (d_{RM}=0.99, 95% CI [0.45-1.84]) from the EI at T1 (M=5.33, SD=.96) to T2 (M=6.28, SD=0.61). Thus, the workshop had significant positive immediate effects on the actors' empathy for both non-human lifeforms and future people. We found no significant difference (t=1.92, df=17, p=0.072) for the empathic index for present people, suggesting that the Nova Scotia PSP workshop had no significant immediate effect on empathy for present people.

Analysis of our individual data showed that most participants were in the empathic zone for both time periods. However, three participants shifted from neutral in T1 to being empathic for non-human lifeforms in T2. One participant's EI shifted from non-empathic in T1 to empathic for future people in T2, and another one shifted from neutral to empathic for future people. However, three participants shifted from empathic in T1 to non-empathic for present people in T2.

Longer-term (3 months after) Effects on Empathy

Our paired t-tests on those who completed the survey three months after (n=16) showed that there was no significant difference (t=0.907, df=15, p=0.379) on the empathic index for future people between T2 (M=6.23, SD=0.62) and T3 (M=5.96, SD=0.92), indicating that the gains on empathy lasted three months after the workshop (Figure 2). We saw, however, a significant decrease (t=3.24, df=15, p=0.05) in the EI for non-human lifeforms from T2 to T3 (M=6.21, SD=0.67) to T3 (M=5.51, SD=1.19). Our paired t-test for this sample (n=16) also shows that there are no significant differences for the baseline and follow-up for empathy for non-human lifeforms (t=0.80, df=15, p=0.437). This suggests that the gains on empathy for non-human lifeforms did not last three months and returned to baseline. The empathic index for present people also shows a significant decrease (t=0.91, df=15, p=0.379) from T2 (M=5.81, SD=1.12) to T3 (M=5.10, SD=1.02).

Our analysis of individual data showed that the majority (>89%) of the participants were still empathic for all targets in T3 despite the tested significant decreases. Each target had only one participant shifting from being empathic in T2 to neutral in T3. One participant shifted

from being empathic at T2 to non-empathic for non-human lifeforms in T3, while one participant maintained being non-empathic for present people in both T2 and T3.

Changes of Empathy in the Applicability PSP Case

Our Wilcoxon Signed Rank Test for immediate effects (n=9) shows that, at a 95% confidence interval, empathy for future people received a significant positive change (p=0.018) with a large effect size ($d_{wilcoxon}$=0.79) (Figure 3). This finding mirrors our positive finding in our central case in Nova Scotia in which there was significant immediate increase for empathy for future people. Both empathy for non-human lifeforms (p=0.089) and present people (p=.481) had no significant change immediately after the PSP workshop in Quebec.

Analysis of our individual data showed that most participants were in the empathic zone for all time periods. One participant shifted from being neutral in T1 to being empathic for non-human lifeforms in T2. For empathy for present people, one participant shifted from being non-empathic in T1 to empathic in T2 while two participants shifted from being empathic in T1 to being neutral in T2.

For the longer-term (3 months after) effects (n=7), our Wilcoxon Signed Rank Test showed no significant differences in all targets of empathy at a 95% confidence interval (Figure 4). This means that the gains in empathy for future people were sustained three months after the PSP workshop in Quebec. This also mirrors our finding in our main case in Nova Scotia in which empathy for future people also lasted for three months. Comparing T1 and T3 (n=7) also yielded no significant differences in empathy for non-human lifeforms and present people, meaning there are no further increases or declines from the baseline empathy.

Our individual data analysis showed that one participant shifted from neutral from T2 to being empathic for non-human lifeforms in T3. One participant also shifted from being non-empathic in T2 to being empathic to present people in T3.

DISCUSSION

Our study posits that Participatory Scenario Planning or PSP's inherent characteristics of being a space to imagine alternative realities, social learning about the target of empathy, and

priming to empathize (Figure 2) can build empathy in the participating individuals. Indeed, our results provide empirical evidence that participation in such workshops to co-imagine future scenarios can have immediate and sustained effects on empathy. Such results show that PSP can indeed be a useful way to influence participants' empathic emotions. While this has been an assumed normative outcome of collaborative visioning processes (e.g., Pereira et al. 2018), our results provide empirical evidence to support this assumption. Our study demonstrates the power of PSP to make neutral or non-empathic individuals to be empathic, while further increasing empathy for those who are already considered empathic. Our results allow us to reframe PSP as an empathy-building intervention, heeding the call of sustainability scholars to find approaches to tap the overlooked potential of human emotions, especially empathic emotions, in our quest for sustainability (Brown et al. 2019; Gould et al. 2023; Nabi et al. 2018; Pihkala 2022). Moreover, we show that active participation to create the scenarios—and not just exposure to these alternative realities as in the case of Blythe et al. (2021)—can sustain the build-up in empathy at least after three months, highlighting how participatory processes can result in longer-term outcomes.

Such results also open new opportunities to rethink our goals in organizing participatory approaches, such as PSPs, for sustainability science research and practice. Our results imply that the growing scholarship of PSP, especially its popularity as a transdisciplinary approach to engage diverse actors, should not only look at developing novel methods for PSP (e.g., Seeds of Good Anthropocenes Approach, (Falardeau et al. 2019)) but also how these processes are designed and facilitated to consider its lasting cognitive and behavioral effects to its participants (i.e., as in the case of empathy). This echoes what Pereira et al. (2020) emphasized in a synthesis of participatory visioning processes: "conveners (of such research) must attempt to understand the human dimensions of social–ecological experimentations and recognise the emotions, perceptions and conflicts that are often ignored or understudied" (p.165).

Our study addresses a critical lack of research on interventions that can enhance empathy for future people and nature (Hara et al. 2023; Tam 2013). Our results show that PSP can be an intervention that can enhance empathy for both. Our central case in Nova Scotia and applicability case in Quebec both showed immediate positive changes with large effect for empathy for future people, with the central case also recording immediate positive changes

with large effects on empathy towards non-human lifeforms. These positive findings highlight the potential of PSP as an approach to develop sensitivity to the welfare of these neglected, if not completely ignored, parts of a system that can be affected by environmental issues. It thus allows for mindful consideration of the intergenerational and interspecies outcomes of sustainability solutions for these issues. In our main case study in Nova Scotia, for example, positive reinforcement on empathy could help the participating environmental actors to carefully negotiate multiple human and non-human values, which is important for environmental management of the tidal wetland-agricultural dykeland ecosystem of the Bay of Fundy under climate change (Sherren et al. 2016, 2021).

Increasing empathy for non-human lifeforms can also have positive implications to understanding and engaging with Indigenous worldviews– an essential consideration for Canada's environmental management of its landscapes. For example, the Mi'kmaq or the Indigenous communities in the Bay of Fundy centers "all my relations" (p. 846)– not only with fellow humans but including all non-human things around– when it comes to stewarding the environment (M'sɨt No'kmaq et al. 2021). However, this also calls for deeper critical reflection on whether enhancing empathy for a specific target might actually be counterproductive, particularly in light of the interconnectedness and oneness of human-nature (or more-than-human) relationships emphasized in Indigenous worldviews and ontologies (Reed et al., 2024). In several, if not all, Indigenous cultures, empathy for one transcends for all including community, nature, and even future generations (Niigaaniin & MacNeill, 2022). We also acknowledge the limitations of our conceptualization of empathy, including the instruments we used, in their implications and applications for Indigenous contexts.

Current empirical evidence shows that exposure to scenarios is insufficient to sustain gains in empathy (e.g., Blythe et al. 2021). However, our study highlights the power of being engaged in co-creating alternative realities through participation in PSP for both building and sustaining empathy for future people. In both our central case in Nova Scotia and applicability case in Quebec, empathy built for future people was found to be durable for at least three months. This also supports PSP as a priming mechanism that serves as a strong stimulus/event to think or do future-oriented actions/decisions (i.e., empathize with future people). This aligns with Sherren et al. (2022) who found that coastal residents of Nova Scotia who they primed to think

about coastal futures using focus group treatments showed strong normative intent towards working towards solving climate change for the future generations and making changes so that future generations can live like the present generation does.

We acknowledge that our findings did not see sustained effects for empathy for nonhuman lifeforms. It is possible that the "future" focus or framing of a PSP is stronger than its "nonhuman lifeform" framing, making effects on empathy for nonhumans less durable (Blythe et al., 2021). For example, Young et al. (2018) explains that building long-term empathy for animals requires an intentional framing in which the animal should be given a sense of "individuality, motivations, and experiences while also choosing information that draws similarities between us and them" (p. 332). Sustaining empathy, especially targeted for non-human lifeforms, remains a challenge. Other scholars have successfully sustained empathy in their interventions through supplementary or follow-up reinforcements (e.g., Mehta et al., 2021; Pang et al., 2022). Thus, scholars and practitioners of PSPs can design supplementary and follow-up reinforcements to their PSPs, which can be designed with more intentional framing for nonhuman lifeforms.

We found no significant differences pre-/post- PSP on empathy for present people in both our cases, with further decrease from the pre-PSP empathy three months after in our main case in Nova Scotia. We believe that this is rooted to the mechanisms of empathy-building operationalized by PSP (Figure 2). Participants may be immersed in alternative realities in PSPs, but these are grounded in plausible realities of the futures rather than reimagining the present realities. Social learning is also centered on information exchange that shapes the future of the environment, while priming is heavier in empathizing for future and non-human components. This merits further thinking and reflection on when it is more suitable to use PSP, especially if the goal of the process is to build empathy for present people.

In complement, such observations require further exploration: what does this trade-off mean for environmental management and sustainability in general? Our empirical findings reminds of what Brown et al. (2019) cautioned, stating: "it may be possible to enhance absolute levels of empathy that are durable over time, but it is also possible that empathy is a relative emotion whereby enhancing empathy in one direction diminishes it in another or where enhancing

empathy in the short-term has implications for longer term emotions" (p.16). Our findings for three targets (or *direction* as in the language of Brown) of empathy show that we can simultaneously increase empathy for multiple targets in the short term. Thus, it is not necessarily true that one's empathy is zero-sum, at least with regard to the three targets we have explored. However, it is still unclear whether there was a trade-off in the longer-term given that not all targets that received increased empathy persisted. We recommend that interested researchers conduct experimental studies to see how changes in empathy for present people interact with empathy with non-human lifeforms and future people particularly in the context of behaviors and actions for sustainability.

Methodological and Analytical Limitations

Our study had a relatively small sample size and did not include a control group in both our main and applicability cases. Our small sample sizes, coupled with ethical requirements of avoiding identifiable characterization of individuals or groups, also limited our analytical capacity to comparison of empathy changes and effect sizes. We were not able to model, for example, how participants' traits (e.g., gender), inherent reflexivity, and positionality might influence such trends. Without a control group, which was unfeasible given the nature of our workshop, we were only able to test for relative change or within-group effect. Thus, our findings have not fully dissected the nuances of empathy-building through PSP. Future scholars who may have the resources could use multiple cases to achieve bigger sample size that may be subjected to a more aggregated statistical analysis. Small sample sizes also poses self-selection bias issues. We also recognize that PSP did not increase empathy for present people in both our cases. Future studies can modify the process to see if empathy for such a target can be influenced. An additional lingering question, however, is how much empathy is enough to motivate sustainable actions and decisions. While our study builds on the characteristics of PSPs to operationalize the mechanisms to build empathy, future studies can do more nuanced studies on how these characteristics– including their interplays– influence its empathic effects (e.g., what exactly is being learned that alters an individual's perception of the target's needs and welfare). Several of these limitations may also benefit from a more qualitative exploration of PSP's effect on its participants' empathy, especially since PSPs are commonly done in small sizes.

CONCLUSION

Participatory Scenarios Planning (PSP) is often touted as an approach to bring diverse perspectives together to co-explore environmental futures and to influence the thinking and feeling among participants. However, this claim has rarely been tested. Our current study posits that it can build empathy given how PSPs characteristics can operationalize mechanisms to empathy-building. We provide empirical evidence from two PSP cases showing that participating environmental actors improved their empathy. In particular, we found immediate improvements in empathy for future people and empathy for non-human lifeforms. Long term research can be important to follow through how such changes in empathy, especially the empathy for future people which was found to be durable even three months after each PSP cases, might influence actions and decisions for sustainability. Our study also encourages PSP practitioners and scholars to pay more attention to the design and implementation of collaborative processes, such as PSP, to carefully consider the long-term implications on their participants' empathy and emotions.

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AUTHOR CONTRIBUTIONS

This study was conceptualized by Elson Ian Nyl Ebreo Galang, Elena Bennett, and Gordon Hickey. Developing the measurement tool and analytical approach was by Elson Ian Nyl Ebreo Galang, Julia Baird, and Gilian Dale. Participant recruitment was performed by Elson Ian Nyl Ebreo Galang and Kate Sherren. Implementation of the workshop and data collection were done by Elson Ian Nyl Ebreo Galang, Elena Bennett, and Kate Sherren. All authors were

involved in the writing and reviewing of this manuscript. Elena Bennett and Gordon Hickey were responsible for overall supervision of the study.

ETHICS DECLARATIONS

Conflict of interest

The authors declare no conflicts of interest.

Ethical approval

We received an Ethics Review Board approval from McGill University (REB# 22-04-126) to conduct this study.

Informed consent

All subjects gave their informed consent for inclusion before they participated in the study.

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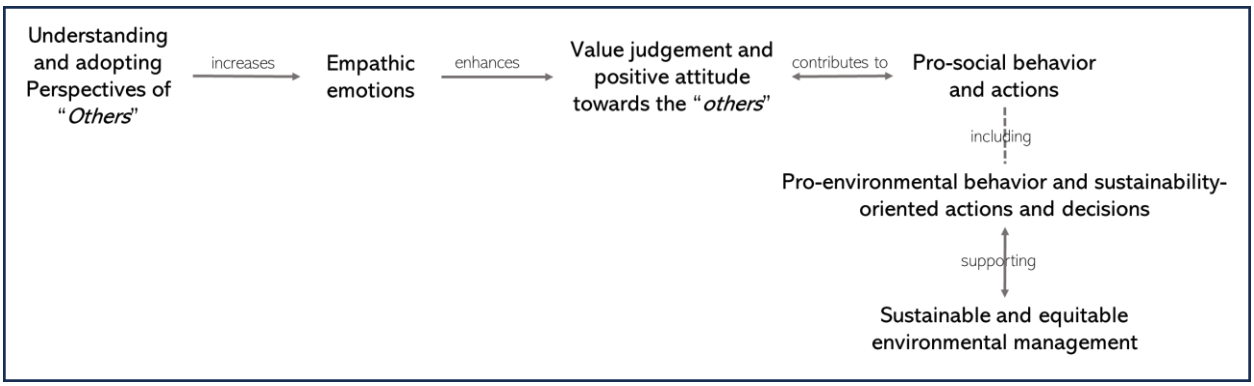

Figure 1. Summary of relationships between empathy processes and sustainable and equitable environmental management.

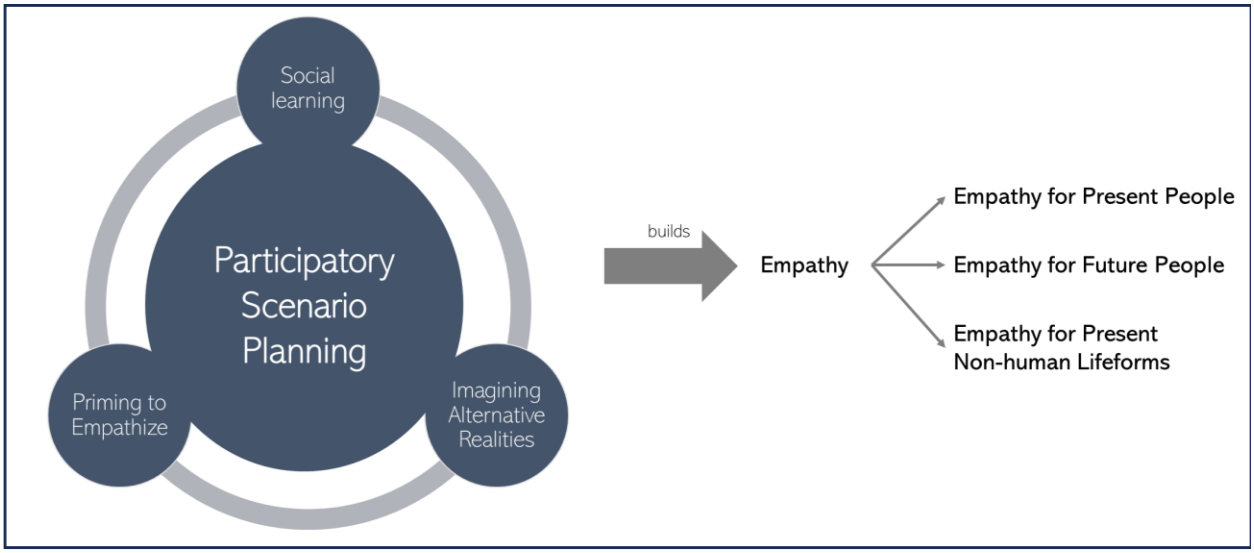

Figure 2. Conceptual framework representing how Participatory Scenario Planning (PSP) can build empathy. PSPs allow participants to imagine alternative realities, particularly imagining alternative plausible realities of futures. PSPs provides an opportunity for participants for social learning, allowing them to learn more about the needs and welfare of present people, future people, and non-human lifeforms. PSPs can also serve as a priming stimulus for future-oriented (i.e., empathize for future people) and environment-oriented (i.e., empathize for non-human lifeforms).

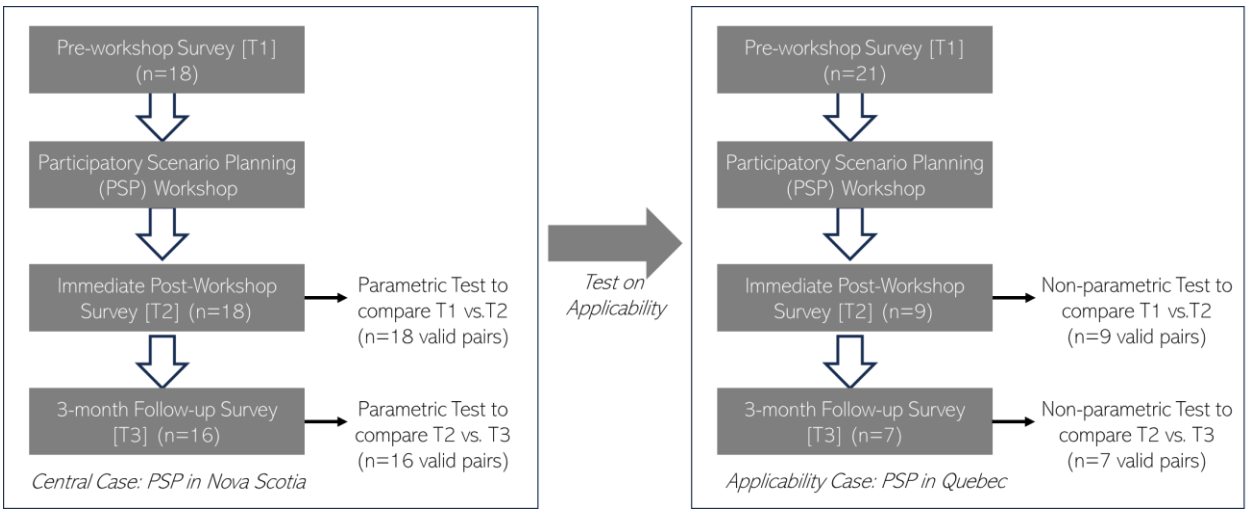

Figure 3. Overview of the research design, exploring pre-, post-, and follow-up changes in empathy of participants in two cases of Participatory Scenario Planning workshops in Nova Scotia and Quebec.

Table 1. Summary of storylines of plausible futures imagined during the participatory scenarios planning workshop for the tidal wetlands-dykelands ecosystem of the Bay of Fundy.

Driver: Approach to Climate Change	Driver: Values Influencing Decision-Making	Storyline of Plausible Future based on the Combination the Assigned Driver
Proactive	Public goods	In 2072, all interest groups in the Bay of Fundy receive equitable access to ecosystem services due to successfully coordinated and implemented nature-based solutions. This success continues until succeeding future generations despite the challenges brought by climate change, all of which are either mitigated by and/or adapted with nature-based solutions.
Proactive	Private interests	In 2072, entrepreneurs drive innovations for nature-based solutions to manage ecosystem services of the Bay of Fundy sustainably. In particular, tidal wetlands are conserved by crediting several ecosystem services such as carbon storage, wave attenuation, and biodiversity potential. Success in climate change adaptation and mitigation is achieved through these novel schemes.
Reactive	Public goods	In 2072, all interest groups in the Bay temporarily benefit from equitable access to ecosystem services. However, this is only short-term as the capacity of the ecosystem to provide these services eventually declines due to poorly addressed impacts of climate change. Succeeding future interest groups can face conflict as they aim to achieve the same equitable access despite a significant decline in ecosystem services.

Reactive	Private interests	In 2072, climate change exacerbates the impacts of corporate exploitation of ecosystem services, resulting in the eventual decline of the Bay of Fundy's ecological conditions. Only those with huge financial capital can mitigate and adapt to these changes. In the long run, the usual overtopping of dykes to keep sea level out of the communities along the dykelands will eventually become insufficient, eventually leaving majority with no choice but to move away.

Table 2. Key differences between the PSPs in Nova Socia and Quebec.

	Central Case (Nova Scotia)	Applicability Case (Quebec)
Scenario focus	Future of tidal wetland-dykeland landscape of the Bay of Fundy	Future of Quebec's wetlands, agricultural landscapes, and urban greenspaces
Workshop Language	English	French
Session 2: Understanding the Present	Presentations were delivered only by academic researchers	Presentations were delivered by academic researchers, governmental agency representatives, and non-governmental organization researchers
Session 3: Identifying the Drivers	Discussions were centered on climate action approaches and values that influence decision-making	Discussions were centered on development pathways and knowledge synthesis of varied knowledge types
Session 4: Storytelling the Futures	Four storylines were co-created for the tidal-wetland-dykeland ecosystem	Twelve storylines were co-created, four each for wetlands, agricultural landscape, and urban greenspaces

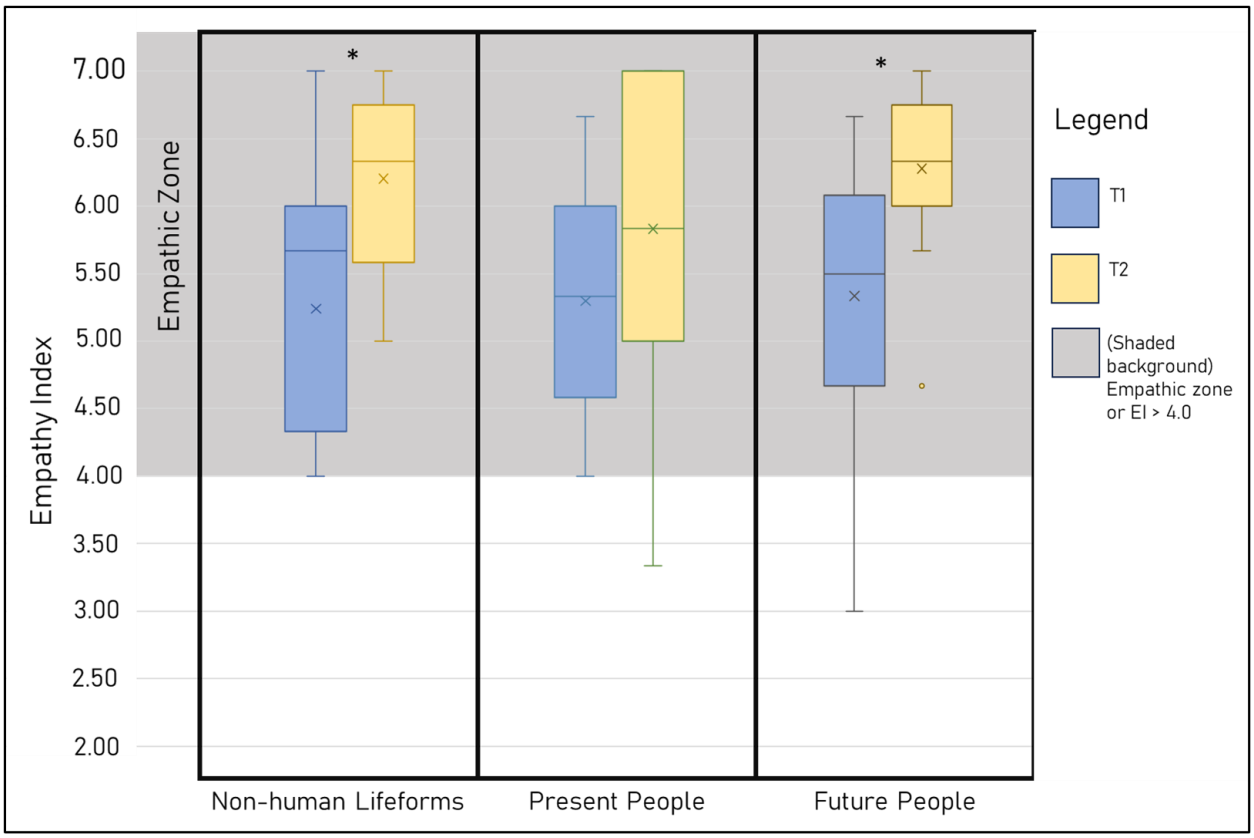

Figure 1. Box plots of empathy index (*n*=18) at the start (T1) and immediately at the end (T2) of our PSP in Nova Scotia across the three targets of empathy. Note: *=significant difference at 95% confidence interval, X= mean, box middle line= median, o= outlier.

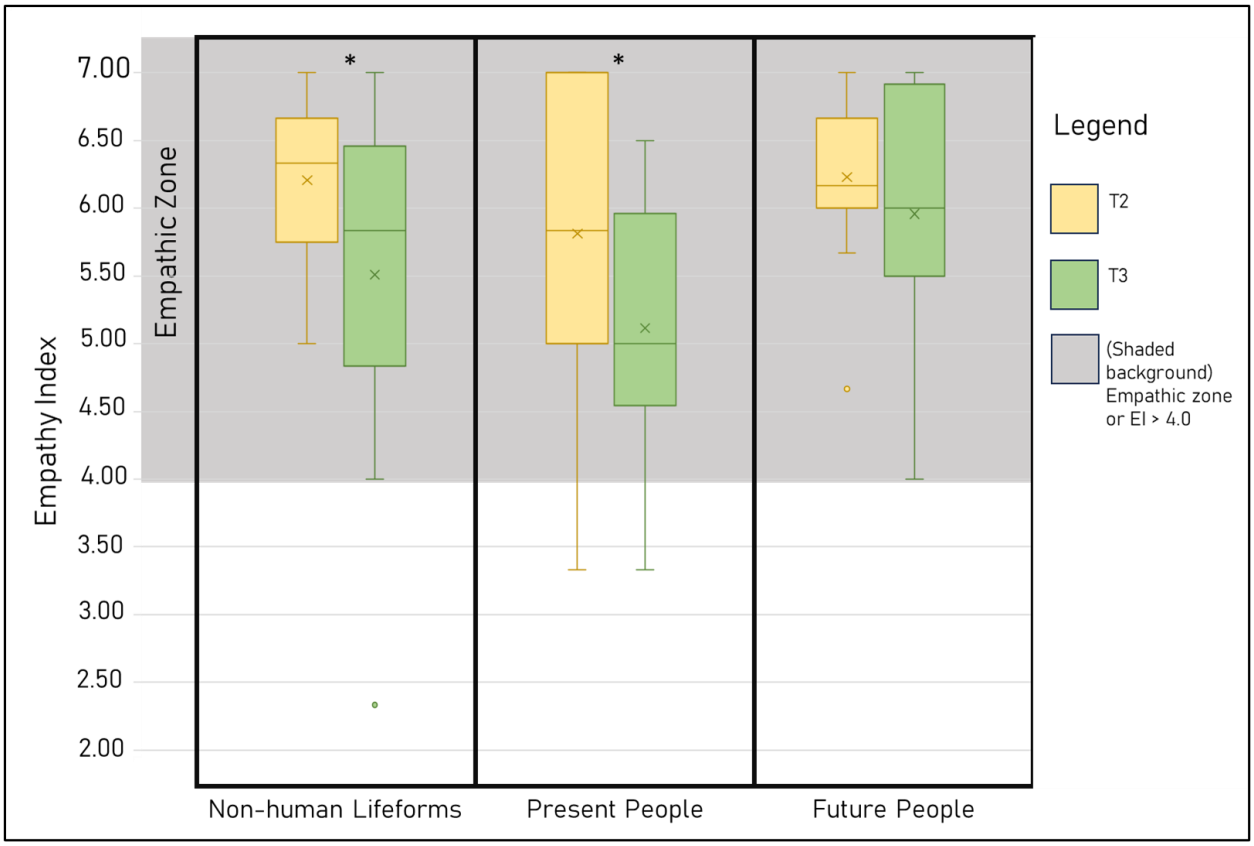

Figure 2. Box plots of empathy index (*n*=16) from immediately at the end (T2) and three months after (T3) of our PSP in Nova Scotia across the three targets of empathy. Note: *=significant difference at 95% confidence interval, X= mean, box middle line= median, o= outlier.

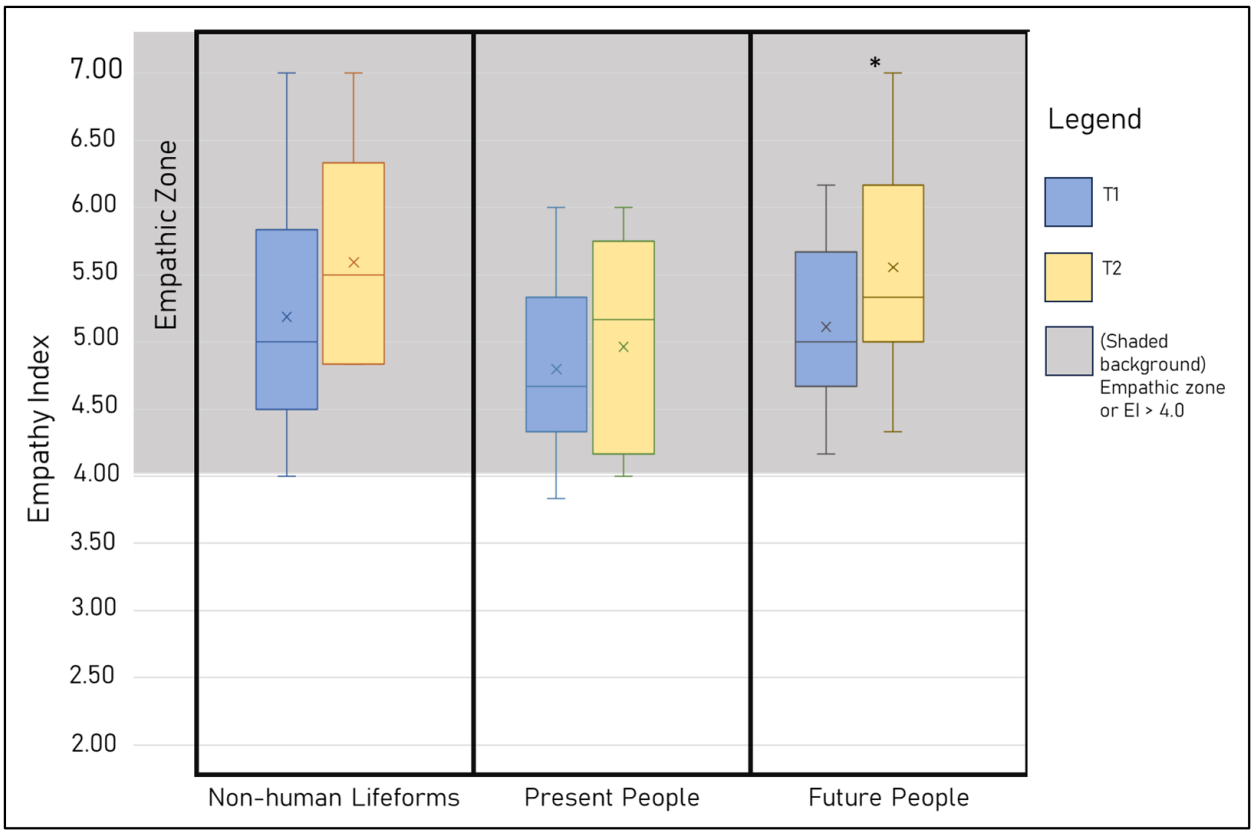

Figure 3. Box plots of empathy index (*n*=9) at the start (T1) and immediately at the end (T2) of our PSP in Quebec across the three targets of empathy. Note: *=significant difference at 95% confidence interval, X= mean, box middle line= median, o= outlier.

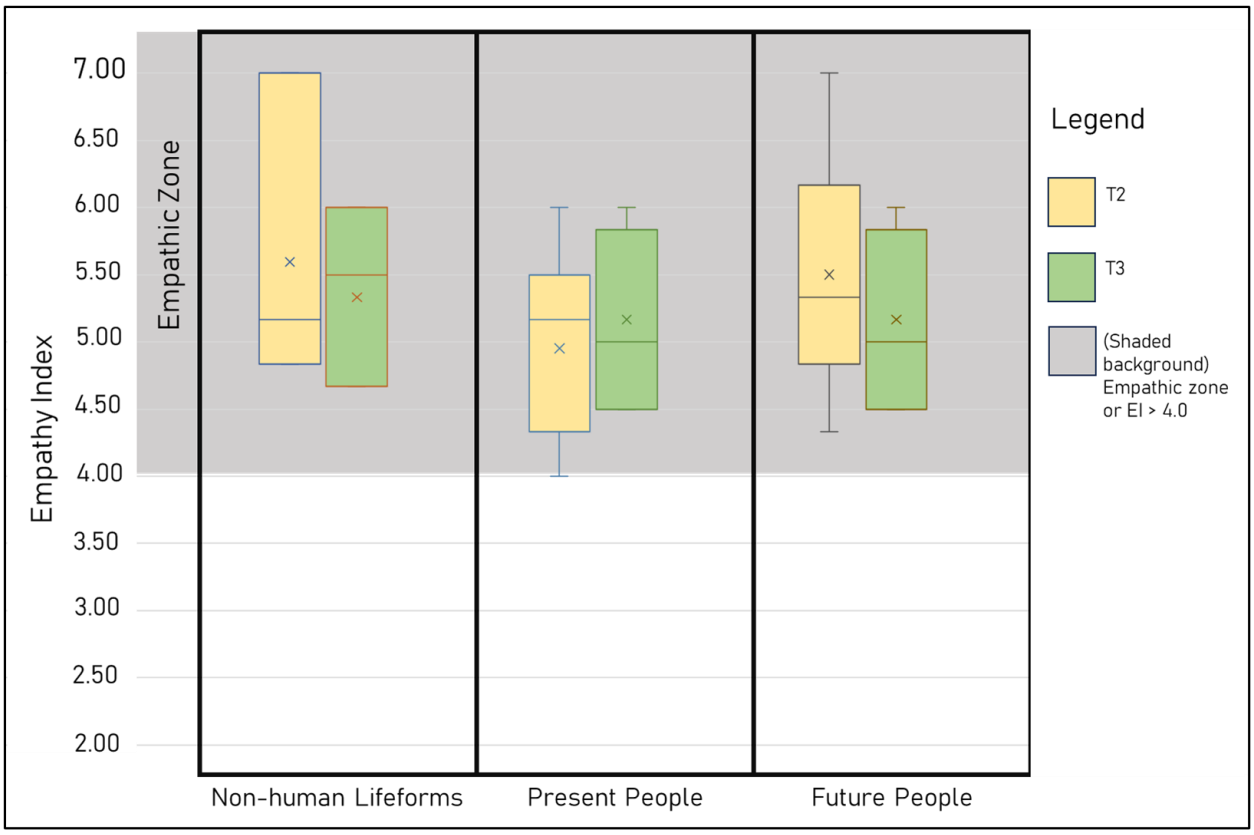

Figure 4. Box plots of empathy index (*n*=7) from immediately at the end and three months after of our PSP in Quebec across the three targets of empathy. Note: *=significant difference at 95% confidence interval, X= mean, box middle line= median, o= outlier.

SUPPLEMENTARY MATERIAL 1: Empathic Concern Index Tool

PART A: Administration for the Nova Scotia PSP Workshop

Note: All emotions must be randomized for each respondent.

How do you feel right now about the non-human lifeforms (e.g., plants, animals) in the Bay of Fundy tidal wetlands and dykelands? Please encircle.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree
I feel sympathetic	1	2	3	4	5	6	7
I feel soft-hearted	1	2	3	4	5	6	7
I feel warm	1	2	3	4	5	6	7
I feel compassionate	1	2	3	4	5	6	7
I feel moved	1	2	3	4	5	6	7
I feel tender	1	2	3	4	5	6	7

How do you feel right now for the present people who currently depend on ecosystem goods and services from the Bay of Fundy tidal wetlands and dykelands? Please encircle.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree
I feel sympathetic	1	2	3	4	5	6	7
I feel moved	1	2	3	4	5	6	7
I feel compassionate	1	2	3	4	5	6	7
I feel tender	1	2	3	4	5	6	7
I feel warm	1	2	3	4	5	6	7
I feel soft-hearted	1	2	3	4	5	6	7

How do you feel right now for the future people who will depend on ecosystem goods and services from the Bay of Fundy tidal wetlands and dykelands? Please encircle.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree
I feel tender	1	2	3	4	5	6	7
I feel warm	1	2	3	4	5	6	7
I feel compassionate	1	2	3	4	5	6	7
I feel moved	1	2	3	4	5	6	7
I feel soft-hearted	1	2	3	4	5	6	7
I feel sympathetic	1	2	3	4	5	6	7

Tool Reference:

Batson, C.D. (1987). Prosocial Motivation: Is it ever altruistic. Advances in Experimental Social Psychology, Vol. 20

PART 2: Administration for Quebec PSP Workshop

Note: All emotions must be randomized for each respondent.

Actuellement, que pensez-vous des formes de vie non humaines (par exemple, les plantes, les animaux) dans le paysage avec lequel vous travaillez principalement ? Veuillez encercler.

How do you feel right now about the non-human lifeforms (e.g., plants, animals) in the landscape that you primarily work with? Please encircle.

	Pas du tout d'accord Strongly disagree	Pas d'accord Disagree	Plutôt en désaccord Somewhat disagree	Neutre Neutral	Plutôt d'accord Somewhat agree	D'accord Agree	Tout à fait d'accord Strongly Agree
Je me sens sympathique I feel sympathetic	1	2	3	4	5	6	7
Je me sens sentimental I feel soft-hearted	1	2	3	4	5	6	7
Je me sens chaleureux I feel warm	1	2	3	4	5	6	7
Je me sens compatissant I feel compassionate	1	2	3	4	5	6	7
Je me sens ému I feel moved	1	2	3	4	5	6	7
Je me sens tendre I feel tender	1	2	3	4	5	6	7

Comment vous sentez-vous présentement concernant les personnes qui dépendent actuellement du paysage avec lequel vous travaillez principalement ? Veuillez encercler.

How do you feel right now for the present people who currently depend on the landscape you primarily work with?

	Pas du tout d'accord Strongly disagree	Pas d'accord Disagree	Plutôt en désaccord Somewhat disagree	Neutre Neutral	Plutôt d'accord Somewhat agree	D'accord Agree	Tout à fait d'accord Strongly Agree
Je me sens sympathique I feel sympathetic	1	2	3	4	5	6	7
Je me sens ému I feel moved	1	2	3	4	5	6	7
Je me sens compatissant I feel compassionate	1	2	3	4	5	6	7
Je me sens tendre I feel tender	1	2	3	4	5	6	7
Je me sens chaleureux I feel warm	1	2	3	4	5	6	7
Je me sens sentimental	1	2	3	4	5	6	7

I feel soft-hearted

Comment vous sentez-vous présentement concernant les personnes qui dans le futur dépendront du paysage avec lequel vous travaillez principalement ? Veuillez encercler.
How do you feel right now for the future people who will depend on the landscape you primarily work with?

	Pas du tout d'accord Strongly disagree	Pas d'accord Disagree	Plutôt en désaccord Somewhat disagree	Neutre Neutral	Plutôt d'accord Somewhat agree	D'accord Agree	Tout à fait d'accord Strongly Agree
Je me sens tendre I feel tender	1	2	3	4	5	6	7
Je me sens chaleureux I feel warm	1	2	3	4	5	6	7
Je me sens compatissant I feel compassionate	1	2	3	4	5	6	7
Je me sens ému I feel moved	1	2	3	4	5	6	7
Je me sens sentimental I feel soft-hearted	1	2	3	4	5	6	7
Je me sens sympathique I feel sympathetic	1	2	3	4	5	6	7

French translated from the original Tool Reference:

Batson, C.D. (1987). Prosocial Motivation: Is it ever altruistic. Advances in Experimental Social Psychology, Vol. 20

SUPPLEMENTARY MATERIAL 2: IBM® SPSS Results

Table S2.1 Mean of empathic index for each target for T1 (pre-workshop) and T2 (post-workshop) for the Nova Scotia PSP Workshop

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NHT1	5.24074	18	.92040	.21694
	NHT2	6.20370	18	.68732	.16200
Pair 2	PPT1	5.29630	18	.83930	.19783
	PPT2	5.83333	18	1.10406	.26023
Pair 3	FPT1	5.33333	18	.96338	.22707
	FPT2	6.27778	18	.60768	.14323

NH= Non-human lifeforms; PP= Present people; FP= Future People

T1= Time 1 or administration before workshop; T2= Time 2 or administration immediately after the workshop

Table S2.2 T-test comparison of the empathic index for each target for T1 (pre-workshop) and T2 (post-workshop) for the Nova Scotia PSP Workshop.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	NHT1 - NHT2	-.96296	.61452	.14484	-1.26856	-.65737	-6.64831	17.00000	.00000
Pair 2	PPT1 - PPT2	-.53704	1.18894	.28024	-1.12828	.05421	-1.91637	17.00000	.07229
Pair 3	FPT1 - FPT2	-.94444	.83431	.19665	-1.35934	-.52955	-4.80268	17.00000	.00017

NH= Non-human lifeforms; PP= Present people; FP= Future People

T1= Time 1 or administration before workshop; T2= Time 2 or administration immediately after the workshop

Table S2.3 Mean of empathic index for each target for T2 (post-workshop) and T3 (follow-up) for the Nova Scotia PSP Workshop.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NHT2	6.20833	16	0.66528	0.16632
	NHT3	5.51042	16	1.19485	0.29871
Pair 2	PPT2	5.81250	16	1.11534	0.27883
	PPT3	5.09375	16	1.02011	0.25503
Pair 3	FPT2	6.22917	16	0.61727	0.15432
	FPT3	5.95833	16	0.91793	0.22948

NH= Non-human lifeforms; PP= Present people; FP= Future People
T2= Time 2 or administration immediately after the workshop; T3= Time 3 or follow-up three months after

Table S2.4 T-test comparison of the empathic index for each target for T2 (post-workshop) and T3 (follow-up) for the Nova Scotia PSP Workshop.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	NHT2 - NHT3	.69792	.86113	.21528	.23905	1.15678	3.24185	15.00000	.00547
Pair 2	PPT2 - PPT3	.71875	1.12335	.28084	.12016	1.31734	2.55930	15.00000	.02179
Pair 3	FPT2 - FPT3	.27083	1.19393	.29848	-.36537	.90703	.90737	15.00000	.37856

NH= Non-human lifeforms; PP= Present people; FP= Future People
T2= Time 2 or administration immediately after the workshop; T3= Time 3 or follow-up three months after

Table S2.5 Wilcoxon Signed Rank Test comparison of the empathic index for each target for T1 (pre-workshop) and T2 (post-workshop) for the Quebec PSP Workshop.

Ranks

		N	Mean Rank	Sum of Ranks
LF2 - LF1	Negative Ranks	1[a]	4.00	4.00
	Positive Ranks	6[b]	4.00	24.00
	Ties	2[c]		
	Total	9		
P2 - P1	Negative Ranks	4[d]	3.25	13.00
	Positive Ranks	4[e]	5.75	23.00
	Ties	1[f]		
	Total	9		
F2 - F1	Negative Ranks	0[g]	.00	.00
	Positive Ranks	7[h]	4.00	28.00
	Ties	2[i]		
	Total	9		

a. LF2 < LF1; b. LF2 > LF1; c. LF2 = LF1; d. P2 < P1; e. P2 > P1; f. P2 = P1; g. F2 < F1; h. F2 > F1; i. F2 = F1

Test Statistics[a]

	LF2 - LF1	P2 - P1	F2 - F1
Z	-1.703[b]	-.704[b]	-2.375[b]
Asymp. Sig. (2-tailed)	.089	.481	.018

a. Wilcoxon Signed Ranks Test; b. Based on negative ranks.

NH= Non-human lifeforms; PP= Present people; FP= Future People

T1= Time 1 or administration before workshop; T2= Time 2 or administration immediately after the workshop

Table S2.6 Wilcoxon Signed Rank Test comparison of the empathic index target for T2 (post-workshop) and T3 (follow-up) for the Quebec PSP Workshop.

Ranks

		N	Mean Rank	Sum of Ranks
NH3 – NH22	Negative Ranks	5[a]	3.60	18.00
	Positive Ranks	2[b]	5.00	10.00
	Ties	0[c]		
	Total	7		
PP3 - PP2	Negative Ranks	2[d]	3.50	7.00
	Positive Ranks	4[e]	3.50	14.00
	Ties	1[f]		
	Total	7		
FP3 - FP2	Negative Ranks	4[g]	4.75	19.00
	Positive Ranks	3[h]	3.00	9.00
	Ties	0[i]		
	Total	7		

a. LF3 < LF2; b. LF3 > LF2; c. LF3 = LF2; d. P3 < P2; e. P3 > P2; f. P3 = P2; g. F3 < F2; h. F3 > F2; i. F3 = F2

Test Statistics[a]

	NH3 - NH2	PP3 - PP2	FP3 - FP2
Z	-.677[b]	-.742[c]	-.848[b]
Asymp. Sig. (2-tailed)	.498	.458	.396

a. Wilcoxon Signed Ranks Test; b. Based on positive ranks.; c. Based on negative ranks.

NH= Non-human lifeforms; PP= Present people; FP= Future People
T2= Time 2 or administration immediately after the workshop; T3= Time 3 or follow-up three months after

1118

1119

1120