Tourism as a Tool for Polar Bear Conservation: Promoting Climate Advocacy in the Arctic

By Kamryn Dehn

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Introduction

Polar Bears and Climate Change

Polar bears (*Ursus maritimus*) are increasingly threatened by the impacts of climate change in the Arctic. Apex predators, the species is highly dependent and intricately tied to the sea ice ecosystem in the Arctic region, an ecosystem that is undergoing rapid change as a result of increasing temperatures. Polar bears are hypercarnivorous predators, utilizing the sea ice to hunt for their primary prey, ringed seals (*Pusa hispida*) and bearded seals (*Erignathus barbatus*). The thick blubber of these two seal species satisfies the high caloric need of polar bears to meet energy demands and survive in the Arctic. Because these seals are mostly found in sea ice habitat, the ice provides bears with access to prey. Polar bears are highly adapted to this lifestyle and use the ice as a platform to hunt seals surfacing at breathing holes. However, there are regional ice differences across the Arctic. The Arctic is divided into four main ice ecoregions and polar bear subpopulations residing in each ecoregion may experience the impact of climate change differently. Each ecoregion surrounds the Arctic basin and differs in seasonality, ice formation patterns, and degree of sea ice loss.

1. Divergent Ice Ecogregion: Here, ice forms continuously along shore and is pushed outwards towards the Convergent Ice Ecoregion due to ocean currents. Historically, this region experienced year-round ice cover but increasing annual temperatures have led to ice-free periods in the summer. Polar bears are not adapted to this and must decide to stay on land or drift out with the ice to deeper waters that lack the productivity needed to support seal populations (Amstrup, 2021). According to Bromaghin et al., 2015, the Southern Beaufort Sea subpopulation, located in this ecoregion, saw a decline of about

25-50% between 2001 and 2010. The bears in this ecoregion are considered some of the most vulnerable because they are not accustomed to ice-free fasting periods.

2. Convergent Ice Ecoregion: The convergent ice ecoregion is characterized by larger, multiyear ice sheets that form when ice along the shore combines with ice coming from the Divergent Ice Ecoregion. Because the ice conditions here are currently more stable, the bears here are considered less vulnerable to warming temperatures (Amstrup, 2021).
3. Seasonal Ice Ecoregion: In this ecoregion, the ice melts each year during the warmer months and refreezes in the fall, creating an annual ice-free period (Amstrup, 2021). Polar bears here have adapted to this seasonal change in ice cover, relying on built-up fat reserves until the ice reforms. However, the duration of the ice-free period has lengthened by about 13 days per decade since 1979, forcing the bears to fast longer each year (Stroeve et al., 2014; Pagano et al., 2024).
4. Archipelago Ice Ecoregion: This ecoregion once had year-round ice, but this has started to change in recent years. Since 2006, ice-free periods have occurred during the warmer months. While the populations here are considered to be the last to be impacted by climate change, this onset of annual ice-free periods is alarming (Amstrup, 2021).

According to Stroeve and Notz, 2018, sea ice loss during the winter months has accelerated from 2.4% to 3.4% per decade since 2000 due to increasing carbon emissions. Rantanen et al., 2022 found that the Arctic is currently warming almost four times the average global rate, resulting in sea ice loss. However, this impacts not only the extent of sea ice but also its thickness. Comiso, 2012 discovered that the summer sea ice extent has declined about 14% per decade and the sea ice volume has declined 28% per decade since 1979. This is all further

exacerbated by the process of "Atlantification" in which the warmer, saltier Atlantic ocean currents extend into the Arctic, transforming the Arctic waters into those more like the Atlantic (Ingvaldsen et al., 2021).

The loss of ice restricts polar bear access to seal hunting grounds. Consumption of high-value prey like seals is significant, especially for female bears, who experience delayed implantation of fertilized eggs (Friebe et al., 2014). If she lacks adequate fat reserves, implantation will not occur and she will not become pregnant. If a female is pregnant, she must then rely on built-up fat reserves to survive through her long winter denning and subsequent cub-rearing period. Cubs are born in the den, weighing just 600-700 grams (Bear Biology, 2023); however, they will gain up to 25 times their birth mass before exiting the den (Churchill Polar Bears, 2023). A female must have enough fat to sustain not only herself but cub growth.

While considered hypercarnivores, polar bears do not generate as high a bite force relative to body mass compared to other more specialized carnivores such as felids or mustelids (Christiansen, 2007). Because of this, polar bears must compensate by utilizing brute strength to assist in taking down prey and usually target small, subadult seals higher in nutritional value and easier to catch (Christiansen, 2007; Stirling and McEwan, 1975). However, if sea ice and subsequent seal access becomes more restricted due to increasing Arctic temperatures, polar bears may have to seek out other prey that may be harder to take down (Amstrup, 2003). Retreating ice displaces the polar bears, forcing them to remain on land, fasting, for longer periods leading to a variety of health impacts including nutritional stress, muscle atrophy, difficulty with thermoregulation, and even reproductive failure (Durner et al., 2009; Petherick et al., 2021). Some polar bears have attempted to adapt by pursuing alternative food sources such as

whale remains from indigenous hunting. However, such sources may require a higher processing cost for a lower energetic return compared to seal blubber (Christiansen, 2007).

This extended fasting period and reliance on alternative foods can influence reproduction. Nutritional stress in females can increase difficulty in becoming pregnant and providing adequate nutrition to cubs (Noyce and Garshelis, 1994). Females are less likely to complete successful reproduction and cub-rearing, as the mass and survival of cubs are tied to the nutritional status of the mother (Derocher and Stirling, 1996). Specifically, Rode et al., 2010 found that between 1982 and 2006, the mass of cubs declined as sea ice declined. However, the number of older cubs (i.e., yearlings) observed with mom was higher during years of increased sea ice. This indicates that ice is tied to cub mass and mortality, likely due to the pressure of nutritional stress on the mother. As sea ice declines and seal hunting grounds become more restricted, it will be harder for polar bears to maintain a stable, healthy population.

Overall sea ice reduction also opens up the region further to anthropogenic activities such as commercial fisheries, drilling, shipping, and tourism. This may exacerbate existing stresses placed on the polar bears, contribute to habitat disruption, and influence overall population growth (Comiso, 2012; Petherick et al., 2021).

Understanding Wildlife Disturbance

Disturbance refers to anything that may disrupt the daily lives of wildlife. For polar bears, disturbance can be caused by anthropogenic activities such as hiking, hunting, and snowmobiles, amongst others. According to Coetzee and Chown, 2015, disturbance “comprises anthropogenic activities that are typically non-lethal but may cause short-and/or longer-term stress and fitness responses in wildlife.” These disturbances may lead to physiological stress, behavioral change,

and overall fitness declines, which may have longer-term implications for individual health and survival.

Disturbance implies that when a bear comes in contact with a disturbance source, its health and safety may be compromised. The impact of a disturbance may change depending on the proximity of the source to the bear, as negative impacts typically increase as the distance decreases. It has been observed that bears maintain “buffer zones” or “personal space bubbles” between themselves and other wildlife, and move away when the zone is breached (Sommer, 1959; Dixon, 1998). When a bear’s buffer zone is crossed, a variety of responses may occur. Bears may exhibit a variety of behavioral responses and/or experience internal, physiological responses. Behavioral responses may range from subtle such as lip popping or staring to more overt like fleeing (Herrero et al., 2005). These observable behaviors indicate a stress response is occurring and the bear has identified a perceived threat. Behavioral responses may be acute or chronic depending on the nature of the disturbance and lead to avoidance of important habitat, disrupt hunting times, and interrupt resting periods (Costello et al., 2013; Smith and Johnson, 2004; Smultea et al., 2016).

However, behavioral responses are just one aspect of reactions to disturbance. Polar bears may also undergo internal, physiological responses when a disturbance source is detected. These can also be acute or chronic and may include alterations in hormone levels, most notably increased cortisol levels, elevated heart rate and blood pressure, and heightened alertness (Ditmer et al., 2015). Prolonged responses such as chronic stress can impact the overall health of a bear including energy usage and reproductive ability.

These health impacts are particularly concerning in light of the nutritional stress brought on by increasing temperatures and sea ice loss. As the Arctic warms, polar bears are forced to

stay on land in closer proximity to humans. Due to elevated anthropogenic activities combined with the closer proximity to humans, polar bears may encounter more disturbances that further impact their health and reproductive ability, and lead to food conditioning. Food-conditioned bears are those who have learned to associate humans with food and are more likely to venture towards human areas, attracted by food, garbage, and pets. This can lead to more conflict with humans and increased bear mortality as food-deprived bears are more likely to take risks to access food (Atwood et al., 2017). Between 1970 and 2000, 618 polar bears were killed in defense of life or property in Nunavut, Canada and 74% of the killings occurred during the ice-free period (Dyck, 2006).

Studying the impact of disturbance on wildlife can be difficult and there are a variety of approaches utilized during research. Disturbance can be considered from multiple perspectives, specifically behavioral, physiological, and at the population level. For example, Wieglus et al., 2002 analyzed brown bear telemetry collar data to determine if the bears selected against certain types of roads. Le Grand et al., 2019 monitored heart rate responses to simulated bear hunts with dogs. Population-level responses to disturbance focus less on individual responses and more so on the implications of responses regarding population growth. Shimozuro et al., 2020 utilized this approach and found that over 70% of male brown bears with highly habituated mothers were eventually killed by humans. This approach highlights how certain responses to disturbance have long-term conservation implications, and emphasizes the importance of understanding the effects of increased human-bear contact.

However, it is important to recognize responses to disturbance can also vary based on environmental conditions. Wind speed, time of day, and the demographics of a bear (i.e., sex, age, reproductive status, etc.) can also lead to high variation in responses (Andersen and Aars,

2008). For example, Ditmer et al., 2015 determined that strong winds amplified bear responses to drones. This is likely because the increased wind speed masked the sound of the drone until it was in very close proximity to the individual bear. Due to the high variation of responses and multiple approaches to defining disturbance, researchers need to develop a standardized method of determining if disturbance is occurring that considers all angles. This will help better inform policy and create clear legislation and guidelines to protect bears.

Arctic Tourism and Mitigating Disturbance

Arctic tourism has seen large increases in recent years, particularly due to the impact of climate change driving individuals to see polar bears and the landscape before they're potentially gone (D'Souza et al., 2021; Runge et al., 2020). This form of tourism is called "last chance tourism," and refers to tourism focusing on visiting endangered wildlife before they are irreversibly impacted by anthropogenic activity. (Wilson, 2019). This concept may also be referred to as "climate tourism", "doom tourism", or "fear of missing out tourism," (Lemelin et al., 2010). Increased accessibility in the region has made more human activities possible like transportation and infrastructure, which support a growing tourism sector.

Arctic tourism includes a range of activities such as tundra buggy tours, kayaking, cruises, and snowmobiling. Hiking, camping, and "eco-adventures" are all seen in the Arctic tourism space too. In 2012, Alaska alone brought in roughly $3.2 billion in revenue from nature-based tourism. That same year, those activities brought Canada about $40.4 billion (United States Department of the Interior et al., 2012). However, while tourism represents an important sector of the economy for many states and countries, it also brings an anthropogenic "footprint" that can lead to disturbances within the ecosystem. For polar bears, this means increased contact with humans, potential habituation, and the possibility of food-conditioning, all

of which can lead to conflict, mortality, and greater nutritional stress (Bath and Enck, 2003; Burson III et al., 2000). As tourism increases in the face of climate change, it will be more important to understand how to balance this growing demand with the need to minimize wildlife disturbance.

However, tourism can also contribute positively to conservation efforts. Allowing the public to view polar bears in their natural habitat can foster increased appreciation for the Arctic ecosystem and encourage individuals to get involved. Wildlife viewing programs can also increase motivation to support polar bear conservation as witnessing the species could improve attitudes and perceptions of the species (Pegas et al., 2013; Stem et al., 2003). According to Tkacynski et al., 2022, participants may also be encouraged to become environmental advocates and start discussions regarding climate change.

These positive outcomes have been seen in a variety of wildlife tourism studies. Filby et al., 2015 interviewed participants before and after a dolphin swim program in Port Phillip Bay and found a significant increase in biocentric values and intent to integrate pro-environmental behaviors into their daily lives. Ziegler et al., 2021 observed residents participating in whale-watching programs in the Philippines and discovered improved personal perceptions about the sharks and increased integration of more pro-environmental behavior in their own lives. Furthermore, Jacobs and Harms, 2014 found that interpretation-based programming on whale-watching boats proved more significant for long-term whale conservation relative to government regulations.

Programs that also integrate opportunities for engagement allow their participants to connect with the focal species and deepen their understanding of the ecological role a species plays. According to Tkaczynski et al., 2022, viewing wildlife opportunities allows members of

the public to educate themselves regarding the impact of human activity on the species. Viewing programs can result in improved attitudes toward conservation. Christensen et al., 2007 and Orams, 2000 suggest that these programs can even lead to behavior modification that supports conservation goals. These pro-environmental behaviors may include reducing water usage, limiting plastic consumption, and recycling (Tkaczynski et al., 2020; Tkaczynski et al., 2021). Overall, this suggests that engaging wildlife viewing programs with education opportunities are a powerful tool to bolster conservation efforts for polar bears.

However, the effectiveness of polar bear viewing programs must be balanced with the need to minimize disturbance. Viewing distance guidelines provide an alternative to limiting polar bear viewing altogether. A viewing distance refers to the distance kept between a human, or group, witnessing the wildlife, in this case, a polar bear. These distances can be applied in a variety of settings such as tundra buggy tours, snowmobiling, and water-based programs, and have applications for human development in polar bear ranges too. Viewing distances allow people to witness polar bears from a distance that is safe for both the bear and the viewer, and may help minimize the possibility of food conditioning and habituation. Official distance guidelines should be based on current research findings and represent a conservative estimate of the closest distance one can get to a bear without causing a disturbance response (behavioral, physiological, or population-level).

There is currently a wide variety of distances represented in the literature as the number of studies are limited and each study has utilized unique approaches and methodology. For example, Burson III et al. 2000 conducted a study of wildlife in Denali National Park to determine responses to vehicle traffic driving along a road. When bears were a minimum of 100m from the road, the number of bears seen did not significantly change. However, this did not

take into consideration the number of bears actively avoiding the area or the degree of habituation in the bears seen. In all species studied, the researchers found no adverse responses when animals were more than 100m from the road. This was based on human observation, thus internal physiological stress responses may not have been detected. Smith and Johnson, 2004 had similar results when studying brown bears along a river in a popular fishing spot. They discovered that there was not a significant difference in the time a bear spent on the river when comparing areas with no humans and areas with humans about 200m away. Again though, this was an observation-based study and did not account for bears actively avoiding the river, habituation, or undetected internal stress responses.

While these viewing distance guidelines are significant in reducing potential disturbance, it is important to also consider what distances result in quality programs that participants enjoy. For example, strict viewing guidelines could reduce overall participant satisfaction and the power of these programs to bolster conservation efforts. Very little research has been done regarding the relationship between viewing distance guidelines and the outcomes of wildlife viewing programs. However, Dybsand, 2020 analyzed TripAdvisor reviews of multiple polar bear viewing programs and discovered that tourists were more likely to leave a negative review if they saw fewer polar bears than anticipated from program marketing. This suggests that program success and effectiveness could be tied to participant satisfaction with how many polar bears are seen, and from what distance. Too restrictive guidelines could also reduce opportunities for participant engagement and undermine conservation goals, limiting the educational value of these polar bear viewing programs.

To best implement viewing distance guidelines into polar bear viewing programs, the current effectiveness of these programs needs to be assessed as well as what aspects of these

programs are impacted by viewing distance satisfaction. This study aimed to answer four questions:

1. What program-related factors contribute to satisfaction?
2. Do viewing distances contribute to satisfaction?
3. Do current programs contribute to increased intent to participate in pro-environmental behaviors?
4. Does the information presented during programming contribute to increased intent to participate in pro-environmental behaviors? If yes, which lines of information?

Study Methods

A survey was designed and distributed in Churchill, Manitoba, Canada between October 9th and October 20th, 2023. Churchill is a wildlife tourism destination as it is considered the "polar bear capital of the world" and a popular spot to observe polar bears in their natural habitat. This is because Churchill is located in the Seasonal Ice Ecoregion and the polar bears congregate near the town each fall, by Hudson Bay, waiting for the ice to re-freeze. The survey aimed to assess factors influencing program satisfaction, such as viewing distances, if intent to participate in pro-environmental behaviors increased, and what aspects of the educational programming influenced increases in intent to participate in pro-environmental behaviors.

The survey consisted of 20 questions, comprising a mix of open-answer, multiple-choice, and Likert-scale questions. The questions were grouped into four main categories:

1. Demographics: This section gathered basic information about the respondent to better understand the individual's background. Questions included:
    a. Age
    b. Highest level of education
    c. Country of residence
    d. Income range
2. Program Indicators: This section focused on what aspects of the viewing program impacted the respondents' overall satisfaction with the program, which were measured on a 5-point Likert scale ranging from strongly agree to strongly disagree. Questions gauged information about:
    a. Satisfaction with cost and group size
    b. Satisfaction with tour guide quality

    c. Satisfaction with distance to polar bears
    d. Satisfaction with time spent with the bears and the number of polar bears seen
3. Pro-Environmental Behaviors: The third section aimed to assess changes in intent to participate in pro-environmental behaviors before and after program participation. Respondents were asked to rate their likelihood of participating in a list of behaviors before and after participation in their polar bear viewing program. Responses were also measured on a 5-point Likert scale ranging from extremely likely to extremely unlikely. Behaviors included, but were not limited to:
    a. Seek out information about climate policies.
    b. Share information about the Arctic on social media.
    c. Advocate for renewable energy.
    d. Vote in support of policies aimed at mitigating or reducing climate change.
4. Statement Agreement: This final section included a set of statements regarding climate change, its causes, and its impact on the Arctic region. Participants were asked to rank their agreement with the statements according to a 5-point Likert scale ranging from strongly agree to strongly disagree. These statements were designed to assess knowledge gained from the viewing program and the effectiveness of the program's educational content. A few statements included:
    a. Temperatures in the Arctic are increasing due to climate change.
    b. Melting sea ice is currently a threat to polar bears.
    c. Climate change is altering the Arctic landscape.

However, to prevent leading participants to answer in a specific way, several question structures were inverted. For example, in the program indicators section, respondents were asked

the degree to which they agreed with the statement, “This was not a valuable experience.” Similarly in the climate change statement agreement section, respondents were asked to rate how much they agreed with the statement, “carbon emissions are not contributing to climate change.” Inverting several statements throughout the Likert-scale questions ensured that participant answers were not skewed positively due to survey design bias.

Surveys were distributed opportunistically to visitors of the Polar Bears International house, most of which had participated in a local polar bear viewing program. Three different survey formats were utilized to maximize participation and accommodate individual preferences. The formats included paper, iPad-based, and survey links that could be scanned with an individual’s cell phone.

Once the data collection period ended, all responses were coded and subsequently entered into the IBM SPSS software for data analysis. This software was selected due to the wide range of analytical tests available for ordinal data sets.

Results

What program-related factors contribute to satisfaction? Do viewing distances contribute to satisfaction?

To determine what factors, including viewing distances, contribute to satisfaction, two statistical tests were utilized. Ordinal regression models were run to determine how well the program indicators predicted select program indicators. Mantel-Haenszel tests of trend were then run to assess relationships between those selected program indicators.

The first ordinal regression model was run to determine the effect of nine program indicators on overall program satisfaction. The nine program indicators included satisfaction with group size, cost, time spent with polar bears, number of polar bears seen, and distance to polar bears. The other indicators included perceived program value, if the program started time, and how knowledgeable and interactive the tour guide leading the program was. A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(18) = 7.967$, $p = 0.979$. Both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(87) = 15.144$, $p = 1.000$ and $X^2(87) = 16.500$, $p = 1.000$, respectively. However, 75% of cells contained zero frequencies, so these two results were treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model though, $X^2(9) = 24.712$, $p = 0.003$. However, no statistical significance was determined for any individual indicator on overall program satisfaction.

A second ordinal regression model was run to determine the effect of nine program indicators on satisfaction with distance to polar bears. The nine program indicators included overall program satisfaction and satisfaction with group size, cost, time spent with polar bears, and number of polar bears seen. The other indicators included perceived program value, if the program started on time, and how knowledgeable and interactive the tour guide leading the program was. A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(27) = 11.446$, $p = 0.996$. Both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data $X^2(119) = 55.396$, $p = 1.000$ and $X^2(119) = 90.346$, $p = 0.977$, respectively. However, 80% of cells contained zero frequencies, so these two results were treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model though, $X^2(9) = 32.607$, $p < 0.001$. An increase in satisfaction with the number of polar bears seen was associated with an increase in the odds of satisfaction with distance to polar bears, with an odds ratio of 4.668 (95% CI, 1.456 to 14.965), Wald $X^2(1) = 6.720$, $p = 0.010$.

		Satisfied with Number of Polar Bears Seen					
		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Total
Satisfied with Distance to Polar Bears	Strongly disagree	1	0	2	0	0	3
	Somewhat disagree	0	1	1	0	0	2
	Neither agree nor disagree	0	1	0	0	2	3
	Somewhat agree	0	0	1	4	2	7
	Strongly agree	0	0	1	7	17	25
Total		1	2	5	11	21	40

Fig 1. The cross-tabulation produced by IBM SPSS showing the counts of scores from the program indicators, satisfaction with distance to polar bears and satisfaction with number of polar bears seen. A heatmap color scale was applied to showcase patterns in frequency.

The third ordinal regression test was run to determine the effect of nine program indicators on satisfaction of the number of polar bears seen. The nine program indicators included overall program satisfaction and satisfaction with group size, cost, time spent with polar bears, and distance to polar bears. The other indicators included perceived program value, if the program started on time, and how knowledgeable and interactive the tour guide leading the program was. A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(27) = 23.080$, $p = 0.681$. Both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data $X^2(119) = 56.321$, $p = 1.000$ and $X^2(119) = 68.878$, $p = 1.000$, respectively. However, 80% of cells contained zero frequencies, so these two results were treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model though, $X^2(9) = 32.382$, $p < 0.001$. An increase in satisfaction with distance to polar bears was associated with an increase in the odds of satisfaction with the number of polar bears seen, with an odds ratio of 3.069 (95% CI, 1.275 to 7.388), Wald $X^2(1) = 6.257$, $p = 0.012$.

The fourth ordinal regression test was run to determine the effect of nine program indicators on satisfaction with program cost. The nine program indicators included overall program satisfaction and satisfaction with group size, time spent with polar bears, number of polar bears seen, and distance to polar bears. The other indicators included perceived program value, if the program started on time, and how knowledgeable and interactive the tour guide leading the program was. A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared

the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(27) = 24.222$, $p = 0.618$. Both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data $X^2(107) = 74.954$, $p = 0.992$ and $X^2(107) = 93.296$, $p = 0.825$, respectively. However, 78% of cells contained zero frequencies, so these two results were treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model at a significance level of 0.1, $X^2(9) = 15.921$, $p = 0.069$. However, no statistical significance was determined for any individual indicator on overall program satisfaction.

A final ordinal regression model was run to determine the effect of nine program indicators on perceived program value. The nine program indicators included overall program satisfaction and satisfaction with group size, cost, time spent with polar bears, number of polar bears seen, and distance to polar bears. The other indicators included if the program started time, and how knowledgeable and interactive the tour guide leading the program was. A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(18) = 16.880$, $p = 0.531$. Only the Deviance Goodness-of-Fit test indicated the model was a good fit to the observed data $X^2(87) = 32.719$, $p = 1.000$. However, 75% of cells contained zero frequencies, so this result was treated as suspect. The final model also did not statistically significantly predict the dependent variable over and above the intercept-only model $X^2(9) = 14.323$, $p = 0.111$. An increase in satisfaction with time spent with polar bears was associated with an increase in the odds of higher perceived program value, with an odds ratio of 3.304 (95% CI, 1.099 to 9.938), Wald $X^2(1) = 4.525$, $p = 0.033$.

		Program was Valuable				
		Strongly disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Total
Satisfied with Time Spent with Polar Bears	Strongly disagree	2	0	0	2	4
	Somewhat disagree	0	1	0	3	4
	Neither agree nor disagree	2	0	0	5	7
	Somewhat agree	1	0	1	11	13
	Strongly agree	0	0	0	11	11
Total		5	1	1	32	39

Fig 2. The cross-tabulation produced by IBM SPSS showing the counts of scores from the program indicators, satisfaction with time spent with polar bears and perceived program value. A heatmap color scale was applied to showcase patterns in frequency.

The first Mantel-Haenszel test of trend was utilized to determine the presence of a linear association between overall program satisfaction and satisfaction with distance to polar bears. The test revealed a statistically significant linear association between the two $X^2(1) = 17.755$, $p < 0.001$, $r = 0.684$. Higher overall program satisfaction was positively associated with greater satisfaction with distance to polar bears, and vice versa.

The next Mantel-Haenszel test of trend was utilized to determine the presence of a linear association between overall program satisfaction and satisfaction with the number of polar bears seen. The test revealed a statistically significant linear association between the two $X^2(1) = 5.997$, $p = 0.014$, $r = 0.392$. Higher overall program satisfaction was positively associated with greater satisfaction with the number of polar bears seen, and vice versa.

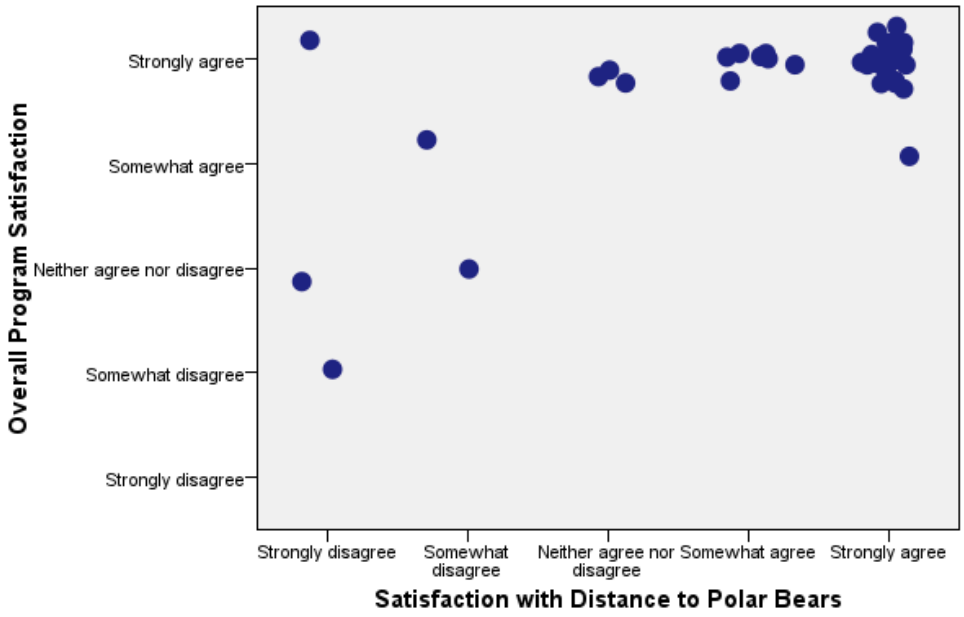

Fig 3. A scatter plot produced by IBM SPSS showing demonstrating the positive relationship between overall program satisfaction and satisfaction with distance to bears. Jitter was added to the plot to better outline the relationship.

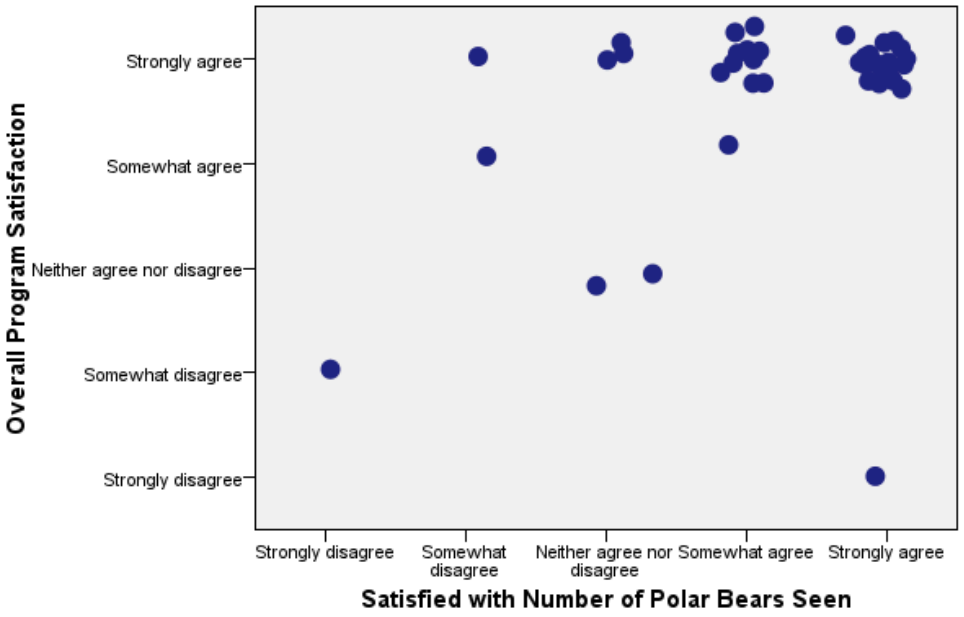

Fig 4. A scatter plot produced by IBM SPSS showing demonstrating the positive relationship between overall program satisfaction and satisfaction with number of polar bears seen. Jitter was added to the plot to better outline the relationship.

A third Mantel-Haenszel test of trend was utilized to determine the presence of a linear association between distance to polar bear satisfaction and satisfaction with the number of polar bears seen. The test revealed a statistically significant linear association between the two $X^2(1) = 19.095$, $p < 0.001$, $r = 0.700$. Higher satisfaction with distance to polar bears was positively associated with greater satisfaction with the number of polar bears seen, and vice versa.

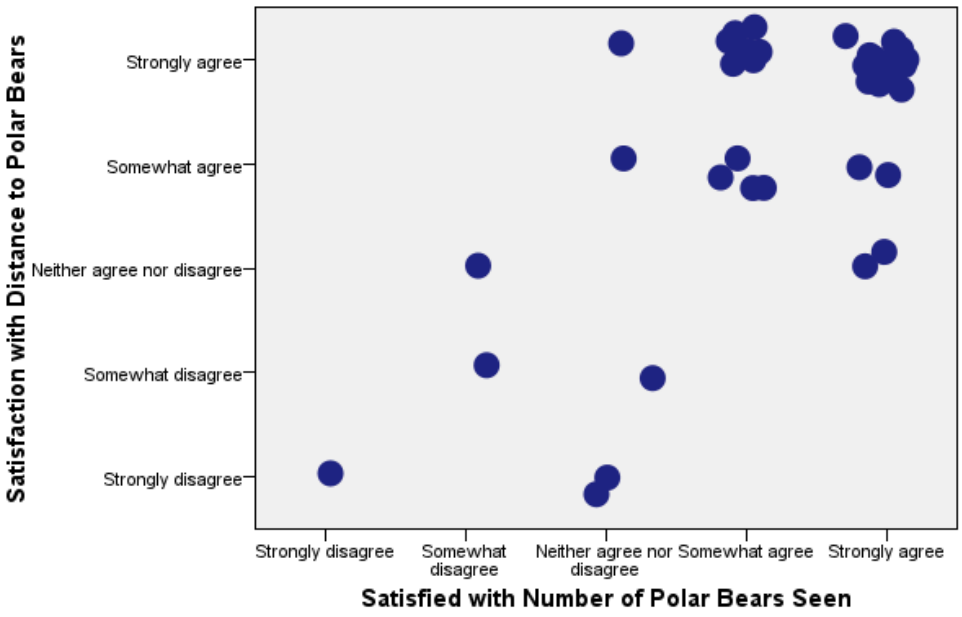

Fig 5. A scatter plot produced by IBM SPSS demonstrating the positive relationship between satisfaction with distance to polar bears and satisfaction with number of polar bears seen. Jitter was added to the plot to better outline the relationship.

The Mantel-Haenszel test of trend did not find any statistically significant linear relationship between overall program satisfaction and program cost satisfaction ($X^2(1) = 0.464$, $p = 0.496$), overall program satisfaction and perceived program value ($X^2(1) = 0.233$, $p = 0.629$), satisfaction with distance to polar bears and satisfaction with cost ($X^2(1) = 0.005$, $p = 0.946$), satisfaction with distance to polar bears and perceived program value ($X^2(1) = 1.386$, $p = 0.239$),

satisfaction with number of polar bears seen and satisfaction with cost ($X^2(1) = 0.034$, $p = 0.855$), satisfaction with number of polar bears seen and perceived program value ($X^2(1) = 0.069$, $p = 0.792$), and satisfaction with cost and perceived program value ($X^2(1) = 2.311$, $p = 0.128$).

Do current programs contribute to increased intent to participate in pro-environmental behaviors?

To determine if participating in a polar bear viewing program increased a respondent's intent to incorporate various pro-environmental behaviors into their daily life, the Wilcoxon signed-rank test was utilized.

Intent to seek out information about climate policies did show a statistically significant median increase in score, $z = 2.21$, $p = 0.021$. Of the 49 participants in the study, 39 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were not approximately symmetrically distributed, thus the sign test was instead utilized. Of the 39 responses analyzed, 9 showed an improvement in score, 1 did not score as high, and 29 demonstrated no improvement. However, the results should be considered with caution due to the large number of ties.

Intent to encourage others to participate in eco-friendly behaviors also showed a statistically significant median increase in score, $z = 3.09$, $p = 0.001$. Of the 49 participants in the study, 39 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were not approximately symmetrically distributed, thus the sign test was instead utilized. Of the 39 responses analyzed, 14 showed an

improvement in score, 1 did not score as high, and 24 demonstrated no improvement. However, the results should also be considered with caution due to the large number of ties.

Intent to donate to organizations dedicated to climate change mitigation did demonstrate a statistically significant median increase in score with a significance level of 0.1, $z = 1.81$, $p = 0.070$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 38 analyzed responses, 11 showed an improvement in score, 5 did not score as high, and 22 showed no improvement.

Intent to sign up for email communications from Polar Bears International or similar organizations also elicited a statistically significant median increase in scores, $z = 2.01$, $p = 0.041$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were not approximately symmetrically distributed, thus the sign test was instead utilized. Of the 38 responses analyzed, 15 showed an improvement in score, 5 did not score as high, and 18 demonstrated no improvement.

Intent to advocate for renewable energy did demonstrate a statistically significant median increase in score with a significance level of 0.1, $z = 1.79$, $p = 0.073$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 38 analyzed responses, 10 showed an improvement in score, 4 did not score as high, and 24 showed no improvement.

Intent to become a member of an organization focused on climate change mitigation did not show a statistically significant median increase in score, $z = 1.38$, $p = 0.167$. Of the 49 participants in the study, 39 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 39 analyzed responses, 11 showed an improvement in score, 7 did not score as high, and 21 demonstrated no improvement.

Intent to donate to conservation focused organizations did not show a statistically significant median increase in score, $z = 1.18$, $p = 0.235$. Of the 49 participants in the study, 39 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 39 analyzed responses, 9 showed an improvement in score, 7 did not score as high, and 23 showed no improvement.

Intent to discuss the concept of climate change with others did not show a statistically significant median increase in score, $z = 1.49$, $p = 0.135$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 38 analyzed responses, 12 showed an improvement in score, 5 did not score as high, and 21 showed no improvement.

Intent to share information about the Arctic on social media showed no statistically significant median increase in score, $z = 1.55$, $p = 0.120$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the

38 analyzed responses, 13 showed an improvement in score, 7 did not score as high, and 18 showed no improvement.

Intent to vote in support of policies aimed at mitigating or reducing climate change also did not show any statistically significant median increase in score, $z = 0.92$, $p = 0.358$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 38 analyzed responses, 11 showed an improvement in score, 8 did not score as high, and 19 showed no improvement.

Intent to volunteer for a conservation focused organization did not elicit a statistically significant median increase in score, $z = 1.38$, $p = 0.166$. Of the 49 participants in the study, 38 responses were analyzed for this specific question. A histogram with a superimposed normal curve demonstrated the difference scores were approximately symmetrically distributed. Of the 38 analyzed responses, 12 showed an improvement in score, 5 did not score as high, and 21 showed no improvement.

Does the information presented during programming contribute to increased intent to participate in pro-environmental behaviors? If yes, which lines of information?

Due to the large number of ties in the preceding section, ordinal regression tests were also utilized to determine which climate change statement agreements predicted higher pro-environmental behavior post-scores.

The first ordinal regression model looked at which statement agreements best predicted the post-score of, “Become a member of an organization focused on climate change mitigation.”

A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(30) = 23.806$, $p = 0.781$. Only the Deviance Goodness-of-Fit test indicated the model was a good fit to the observed data, $X^2(94) = 64.305$, $p = 0.992$. However, 78% of cells contained zero frequencies, so the result was treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model though, $X^2(10) = 28.315$, $p = 0.002$. The model also demonstrated that a higher score for the agreement statement, "Temperature in the Arctic is increasing due to climate change," was associated with an increase in the odds of a higher post-score for "Become a member of an organization focused on climate change mitigation", with an odds ratio of 13.937 (95% CI, 1.781 to 109.038), Wald $X^2(1) = 6.301$, $p = 0.012$.

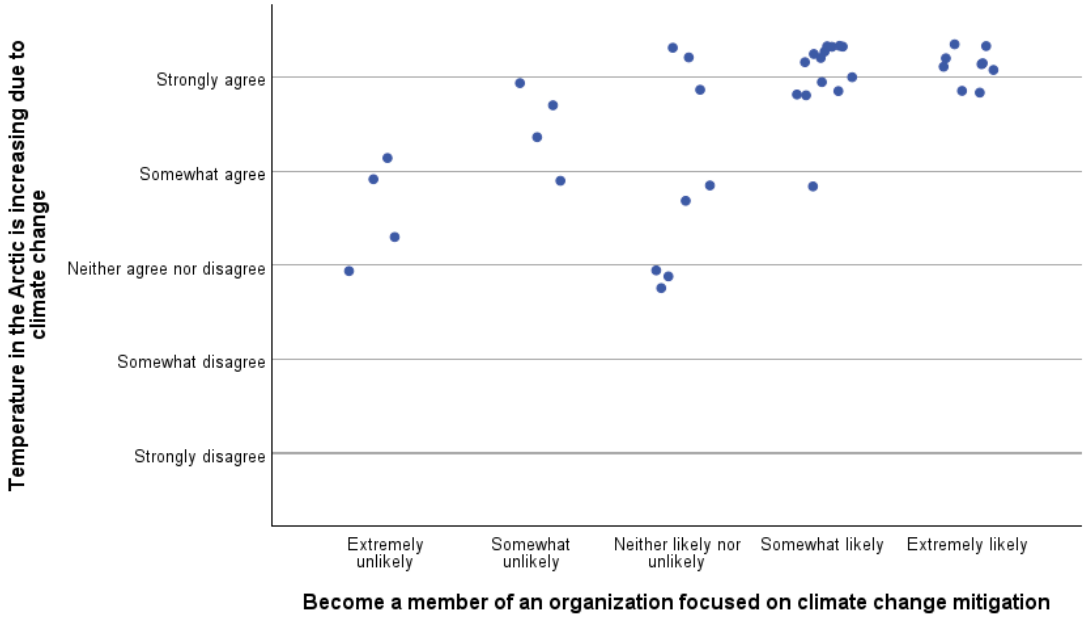

Fig 6. A scatter plot produced by IBM SPSS demonstrating the positive relationship between scores for, "Temperature in the Arctic is increasing due to climate change," and the post-scores for, "Become a member of an organization focused on climate change." Jitter was added to the plot to better outline the relationship.

The next ordinal regression model looked at which statement agreements best predicted the post-score of, “Seek out information about climate policies.” A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(30) = 10.467$, $p = 1.000$. Only the Deviance Goodness-of-Fit test indicated the model was a good fit to the observed data, $X^2(94) = 43.823$, $p = 1.000$. However, 78% of cells contained zero frequencies, so the result was treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model though, $X^2(10) = 33.596$, $p < 0.001$. One agreement statement was statistically significant and an increased score was associated with an increase in the odds of a higher post-score. The agreement statement, “Modern climate change is not a result of natural heating and cooling cycles”, had an odds ratio of 2.298 (95% CI, 1.014 to 5.208), Wald $X^2(1) = 3.974$, $p = 0.046$. With a significance level of 0.1, two agreement statements were statistically significant and increased scores were associated with an increase in the odds of a higher post-score for “Seek out information about climate policies.” These included, “Temperature in the Arctic is increasing due to climate change,” Wald $X^2(1) = 2.957$, $p = 0.086$ and, “The media does not display an appropriate amount of concern about climate change,” Wald $X^2(1) = 3.731$, $p = 0.053$.

The third ordinal regression model was run to determine what agreement statements best predicted to post-score of, “Encourage others to participate in eco-friendly behaviors.” A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption

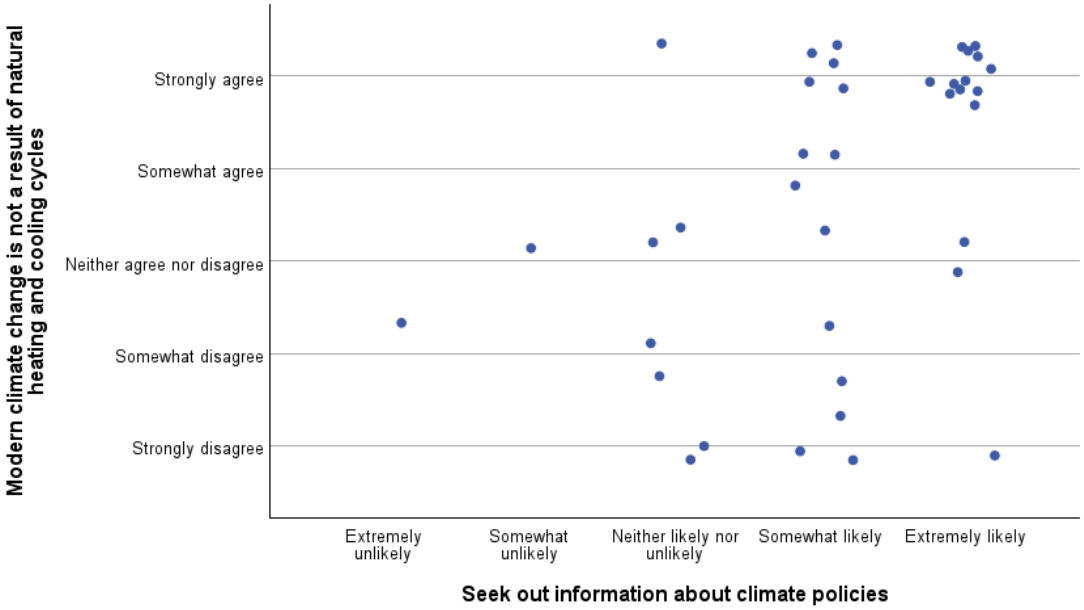

Fig 7. A scatter plot produced by IBM SPSS demonstrating the positive relationship between scores for, "Modern climate change is not a result of natural heating and cooling cycles," and the post-scores for, "Seek out information about climate policies." Jitter was added to the plot to better outline the relationship.

was met $X^2(20) = 15.507$, $p = 0.747$. Only the Deviance Goodness-of-Fit test indicated the model was a good fit to the observed data, $X^2(68) = 40.358$, $p = 0.997$. However, 72% of cells contained zero frequencies, so the result was treated as suspect. The final model did not statistically significantly predict the dependent variable over and above the intercept-only model, $X^2(10) = 13.593$, $p = 0.192$. No statistical significance was determined for any agreement statement.

Next, another ordinal regression model was run to see which agreement statements best predicted the post-score of, "Donate to conservation focused organizations." A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(30) =$

20.566, p = 0.901. Only the Deviance Goodness-of-Fit test indicated the model was a good fit to the observed data, $X^2(94) = 65.870$, p = 0.988. However, 78% of cells contained zero frequencies, so the result was treated as suspect. The final model also did not statistically significantly predict the dependent variable over and above the intercept-only model, $X^2(10) = 12.023$, p = 0.284. If using a significance level of 0.1, the agreement statement, "Temperature in the Arctic is increasing due to climate change," was statistically significant and an increased score was associated with an increase in the odds of a higher post-score for, "Donate to conservation focused organizations," Wald $X^2(1) = 3.108$, p = 0.078.

A fifth ordinal regression test was run to see which agreement statements were the best predictors of the post-scores for, "Discuss the concept of climate change with others." A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and determined the proportional odds assumption was not met $X^2(20) = 51.184$, $p < 0.001$. Due to this, a multinomial regression was run instead. Through this analysis, both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(48) = 28.196$, p = 0.990 and $X^2(48) = 25.846$, p = 0.996, respectively. However, 73% of cells contained zero frequencies, so the result was treated as suspect. The final model did not statistically significantly predict the dependent variable over and above the intercept-only model though, $X^2(30) = 40.609$, p = 0.094. The likelihood ratio tests of overall contribution of each independent variable to the model showed that the scores for the agreement statement, "Modern climate change is not a result of natural heating and cooling cycles," was a significant predictor in the model $X^2(3) = 9.346$, p = 0.025. However, if the significance level were at 0.1, the scores for the agreement statement, "Climate change is altering

the Arctic landscape," would also be a significant predictor in the model $X^2(3) = 7.418$, $p = 0.060$.

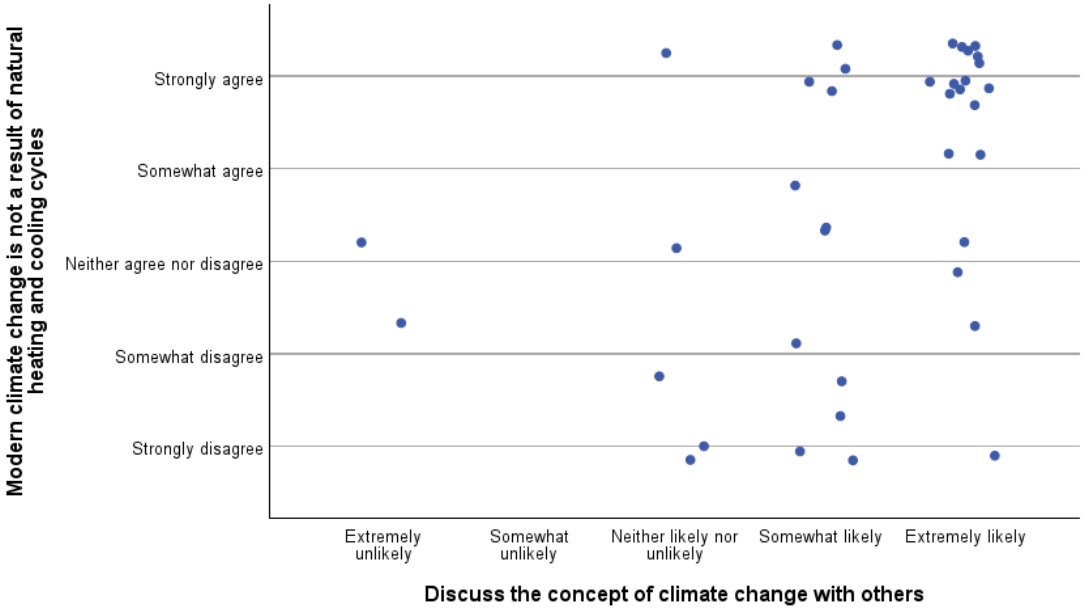

Fig 8. A scatter plot produced by IBM SPSS demonstrating the positive relationship between scores for, "Modern climate change is not a result of natural heating and cooling cycles," and the post-scores for, "Discuss the concept of climate change with others." Jitter was added to the plot to better outline the relationship.

Another ordinal regression analysis was utilized to test which agreement statements best predicted answers to, "Share information about the Arctic on social media." A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(30) = 22.163$, $p = 0.848$. Both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(94) = 66.291$, $p = 0.987$ and $X^2(94) = 77.709$, $p = 0.888$, respectively. However, 76% of cells contained zero frequencies, so the result was treated as

suspect. The final model also statistically significantly predicted the dependent variable over and above the intercept-only model, $X^2(10) = 21.842$, $p = 0.016$. Two agreement statements were statistically significant and increased scores were associated with an increase in the odds of a higher post-score for, "Share information about the Arctic on social media." The first agreement statement, "Temperature in the Arctic is increasing due to climate change," had an odds ratio of 13.287 (95% CI, 2.125 to 83.083), Wald $X^2(1) = 7.650$, $p = 0.006$. The second agreement statement, "The media does not display an appropriate amount of concern about climate change," had an odds ratio of 2.740 (95% CI, 1.394 to 5.382), Wald $X^2(1) = 8.554$, $p = 0.003$. If the significance level was raised to 0.1, the agreement statement, "Climate change is altering the Arctic landscape," would have been considered statistically significant, Wald $X^2(1) = 3.126$, $p = 0.077$.

The following ordinal regression test was run to see which agreement statements significantly predicted the post-score of, "Vote in support of policies aimed at mitigating or reducing climate change." A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and also determined the proportional odds assumption was met $X^2(30) = 24.415$, $p = 0.705$. Only the Deviance Goodness-of-Fit test indicated the model was a good fit to the observed data, $X^2(94) = 53.215$, $p = 1.000$. However, 79% of cells contained zero frequencies, so the result was treated as suspect. The final model also statistically significantly predicted the dependent variable over and above the intercept-only model, $X^2(10) = 29.179$, $p = 0.001$. Only one agreement statement was statistically significant and an increased score was associated with an increase in the odds of a higher post-score for, "Vote in support of policies aimed at mitigating or reducing climate

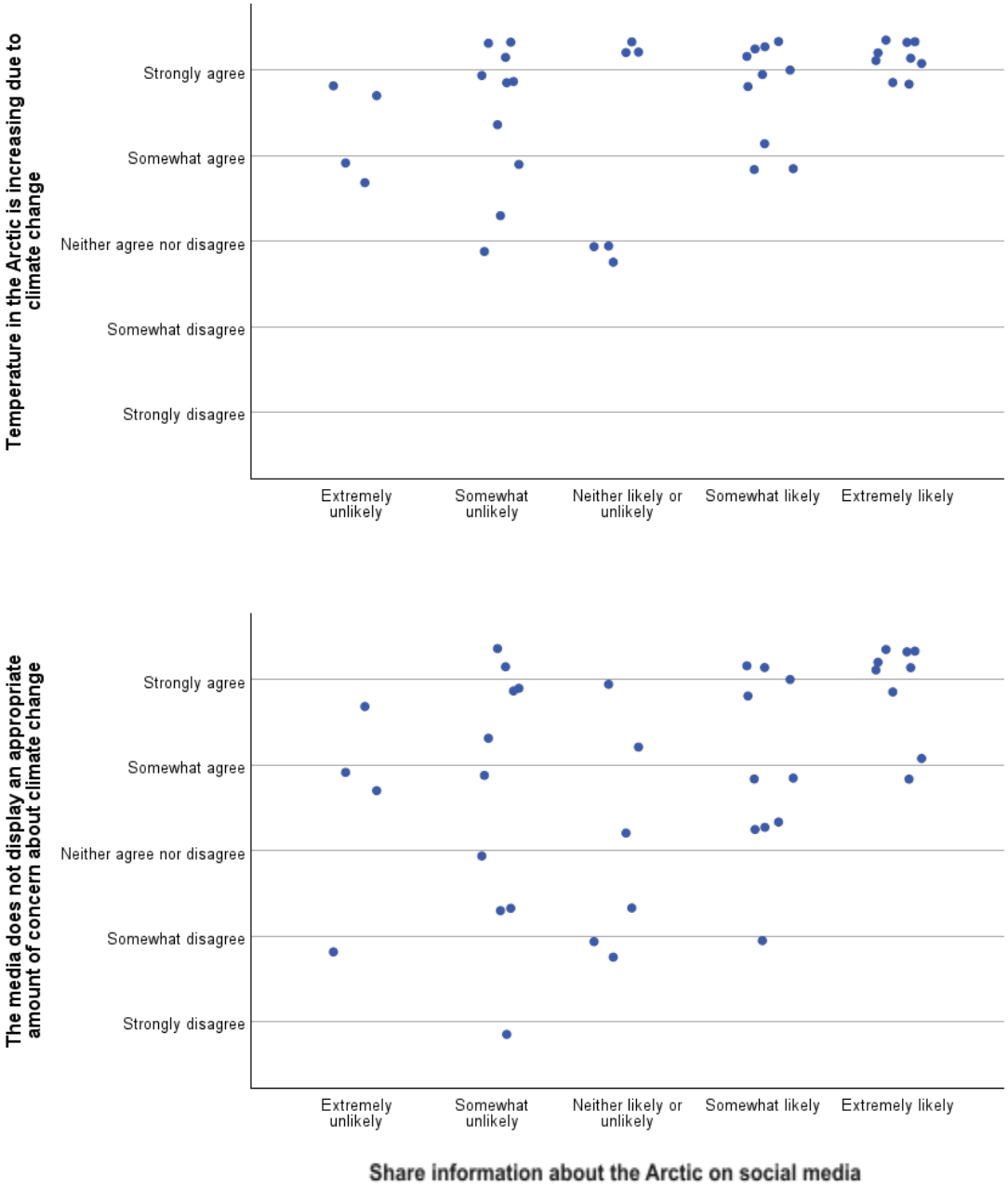

Fig 9. Two scatter plots produced by IBM SPSS demonstrating the positive relationship between scores for, "Temperature in the Arctic is increasing due to climate change," and the post-scores for, "Share information about the Arctic on social media," (top) and "The media does not display an appropriate amount of concern about climate change," and "Share information about the Arctic on social media," (bottom). Jitter was added to the plot to better outline the relationships.

change." The agreement statement, "vehicles emitting carbon are contributing to modern climate change," had an odds ratio of 9.849 (95% CI, 1.136 to 85.402), Wald $X^2(1) = 4.308$, $p = 0.038$.

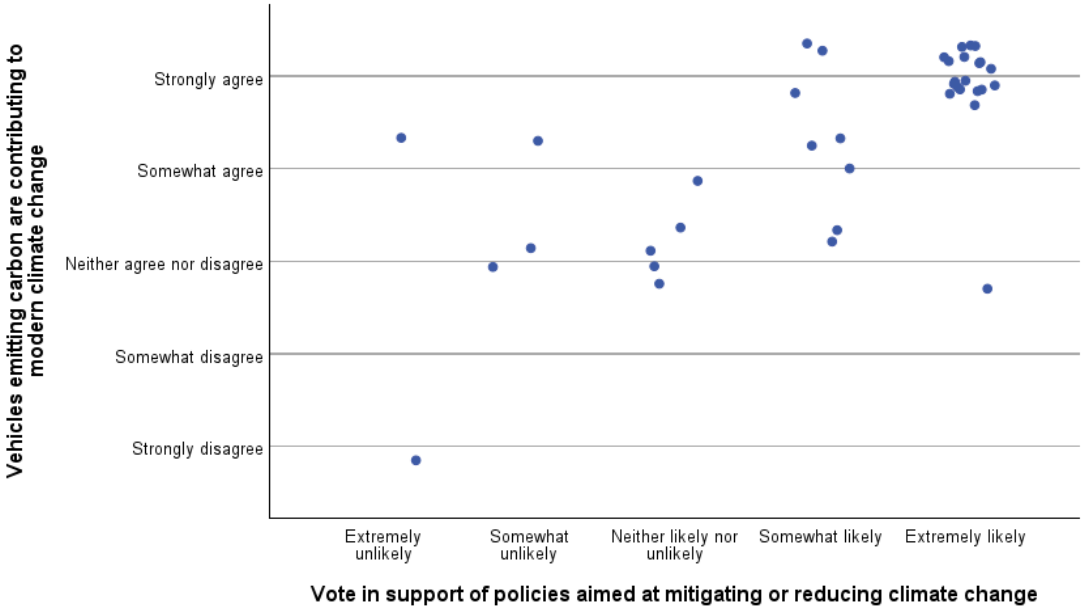

Fig 10. A scatter plot produced by IBM SPSS demonstrating the positive relationship between scores for, "Vehicles emitting carbon are contributing to modern climate change," and the post-scores for, "Vote in support of policies aimed at mitigating or reducing climate change." Jitter was added to the plot to better outline the relationship.

Then, a ordinal regression test was conducted to determine which agreement statements best predicted the post-score of, "Donate to organizations dedicated to climate change mitigation." A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and determined the proportional odds assumption was not met $X^2(30) = 64.181$, $p < 0.001$. Due to this, a multinomial regression was run instead. Through this analysis, both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(60) = 15.358$, $p = 1.000$ and $X^2(60) = 13.884$, $p = 1.000$, respectively. However, 77% of cells contained zero frequencies, so the

result was treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model, $X^2(40) = 65.162$, $p = 0.007$. The likelihood ratio tests of overall contribution of each independent variable to the model showed none were significant predictors in the model. However, if the significance level were raised to 0.1, the agreement statement, "Temperature in the Arctic is increasing due to climate change," would be a significant predictor in the model $X^2(4) = 8.167$, $p = 0.086$.

The next ordinal regression analysis looked at which agreement statements were the best predictors of the post-scores for, "Signup for email communications from Polar Bears International or similar organizations." A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and determined the proportional odds assumption was not met $X^2(20) = 62.231$, $p < 0.001$. Due to this, another multinomial regression was run instead. Through this analysis, both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(45) = 15.057$, $p = 1.000$ and $X^2(45) = 16.305$, $p = 1.000$, respectively. However, 70% of cells contained zero frequencies, so the result was treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model, $X^2(30) = 55.711$, $p = 0.003$. The likelihood ratio tests of overall contribution of each independent variable to the model showed the scores of four different agreement statements were significant predictors in the model. The statements included, "Temperature in the Arctic is increasing due to climate change," $X^2(3) = 10.918$, $p = 0.012$, "The Arctic is currently threatened by climate change," $X^2(3) = 12.884$, $p = 0.005$, "The media does not display an appropriate amount of concern about climate change," $X^2(3) = 9.981$, $p = 0.019$, and "Vehicles emitting carbon are contributing to modern

climate change," $X^2(3) = 14.273$, $p = 0.003$. All four statements are significant predictors in the model.

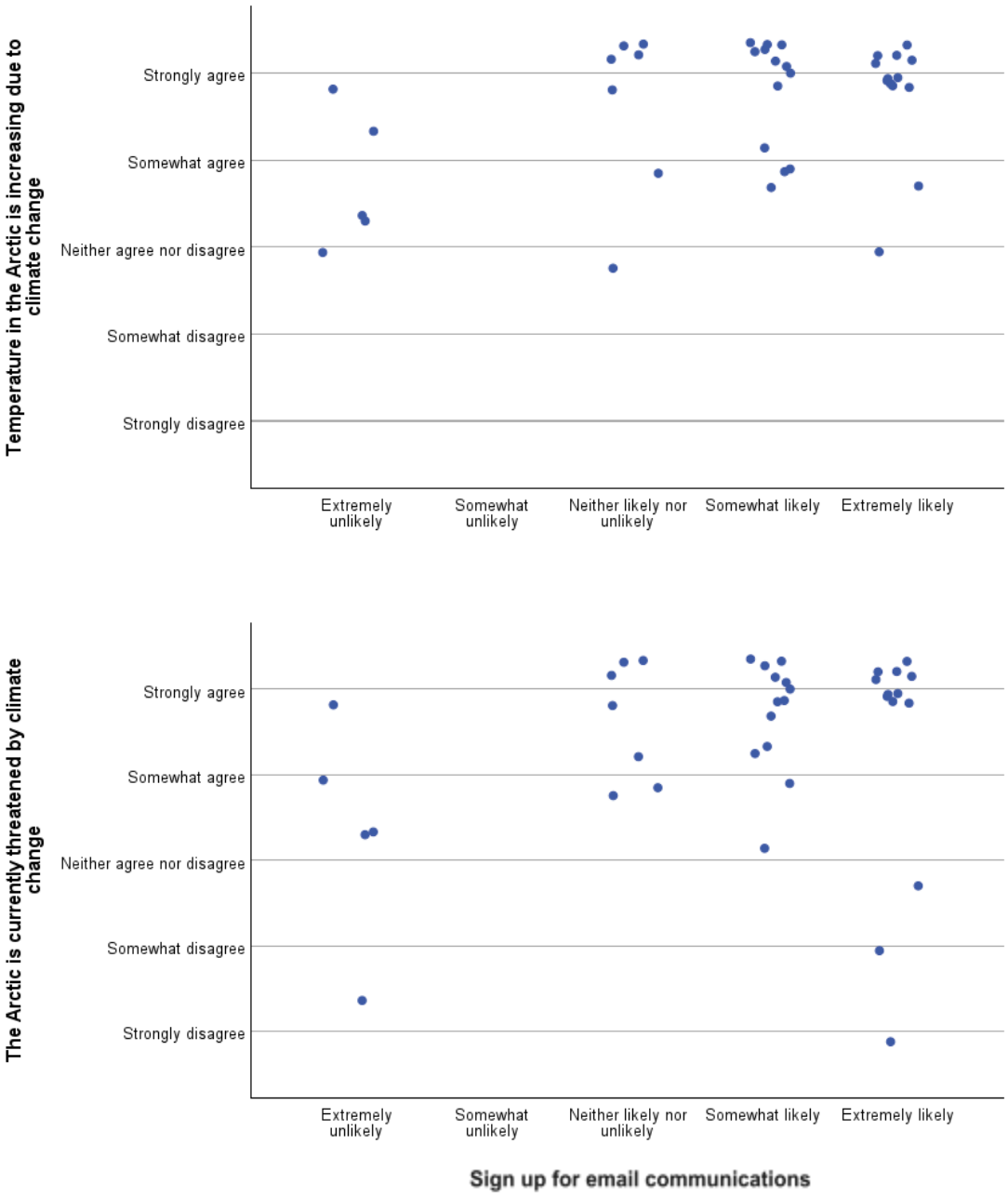

Fig 11. Two scatter plots produced by IBM SPSS demonstrating the positive relationship between scores for, "Temperature in the Arctic is increasing due to climate change," (top) and, "The Arctic is currently threatened by climate change," (bottom), and the post-scores for, "Sign up for email communications from Polar Bears International or similar organizations," respectively. Jitter was added to the plot to better outline the relationships.

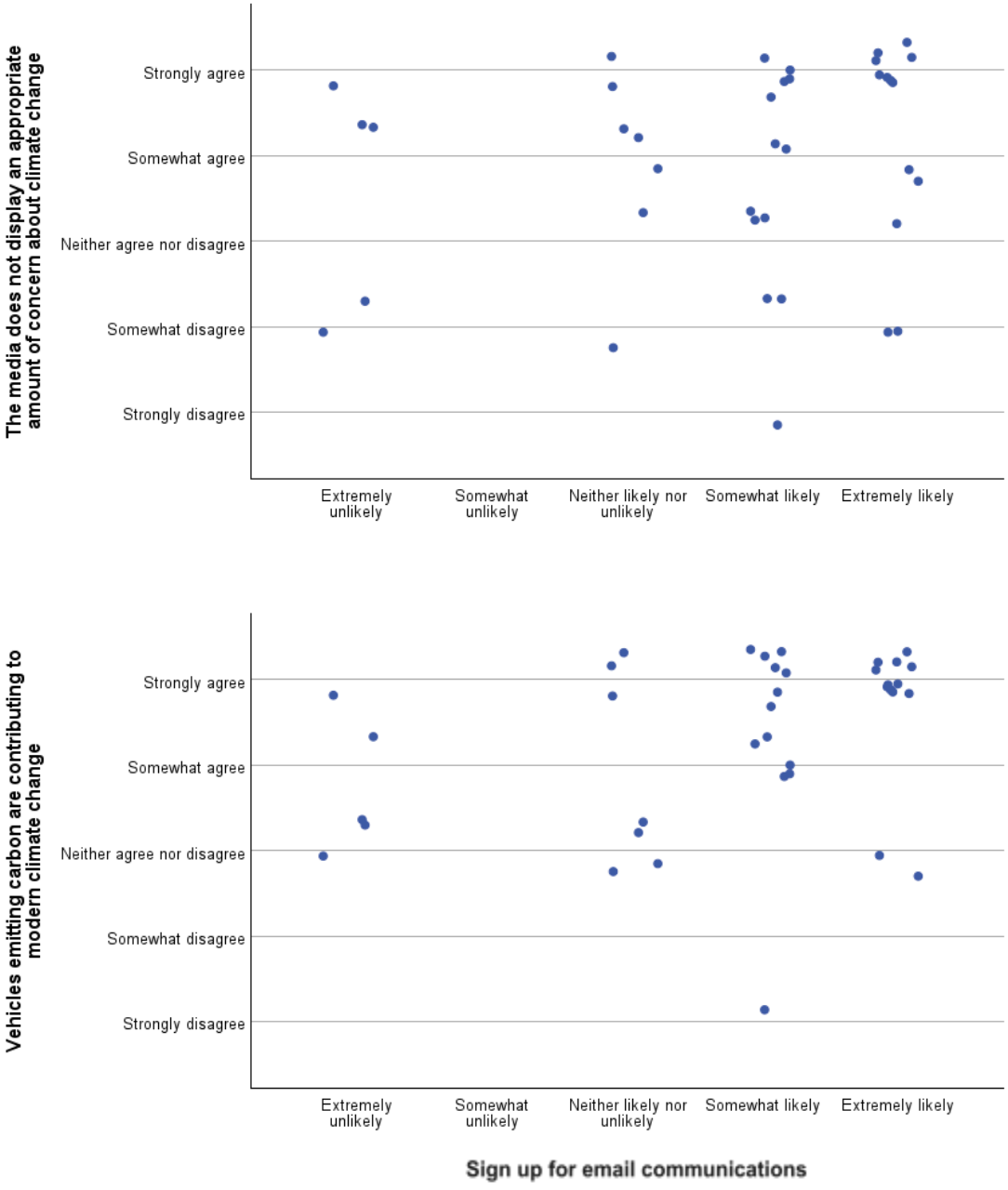

Fig 12. Two scatter plots produced by IBM SPSS demonstrating the positive relationship between scores for, "The media does not display an appropriate amount of concern about climate change," (top) and, "Vehicles emitting carbon are contributing to modern climate change," (bottom), and the post-scores for, "Sign up for email communications from Polar Bears International or similar organizations," respectively. Jitter was added to the plot to better outline the relationships.

Next, the ordinal regression test was chosen to see which agreement statements best predicted the post-score of, “Volunteer for a conservation focused organization.” A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and determined the proportional odds assumption was not met $X^2(30) = 55.273$, $p = 0.003$. Due to this, the multinomial regression was run instead. Through this analysis, both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(60) = 14.072$, $p = 1.000$ and $X^2(60) = 11.628$, $p = 1.000$, respectively. However, 77% of cells contained zero frequencies, so the result was treated as suspect. The final model did statistically significantly predict the dependent variable over and above the intercept-only model, $X^2(40) = 73.457$, $p < 0.001$. The likelihood ratio tests of overall contribution of each independent variable to the model showed the scores of two different agreement statements were significant predictors in the model. The statements include, “The Arctic is currently threatened by climate change,” $X^2(4) = 14.870$, $p = 0.005$, and, “The media does not display an appropriate amount of concern about climate change,” $X^2(4) = 13.571$, $p = 0.009$. However, if the significance level were raised to 0.1, the scores for the agreement statement, “Temperature in the Arctic is increasing due to climate change,” would also be a significant predictor in the model $X^2(4) = 9.340$, $p = 0.053$.

The last ordinal regression test was performed to determine which agreement statements best predicted the post-score for, “advocate for renewable energy.” A multicollinearity assumption test was run and resulted in tolerance values all above 0.1, confirming a lack of multicollinearity. A full likelihood ratio test compared the fitted model to a model with varying location parameters and determined the proportional odds assumption was not met $X^2(30) =$

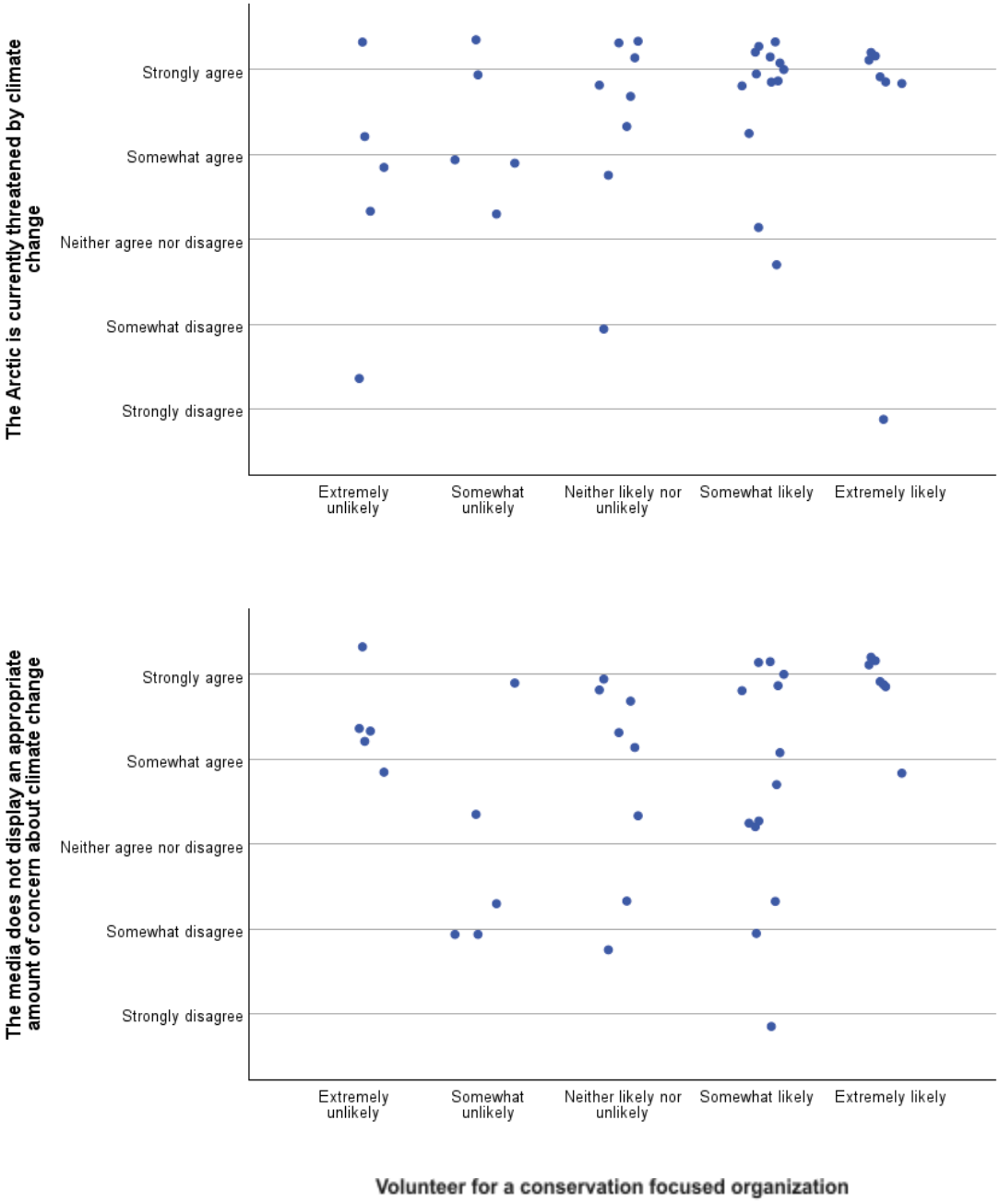

Fig 13. Two scatter plots produced by IBM SPSS demonstrating the positive relationship between scores for, "The Arctic is currently threatened by climate change," (top) and, "The media does not display an appropriate amount of concern about climate change," (bottom), and the post-scores for, "Volunteer for a conservation focused organization," respectively. Jitter was added to the plot to better outline the relationships.

56.946, p = 0.002. Due to this, another multinomial regression was run instead. Through this analysis, both the Deviance and Pearson Goodness-of-Fit tests indicated the model was a good fit to the observed data, $X^2(60) = 17.345$, p = 1.000 and $X^2(60) = 31.688$, p = 0.999, respectively. However, 78% of cells contained zero frequencies, so the result was treated as suspect. The final model did not statistically significantly predict the dependent variable over and above the intercept-only model, $X^2(40) = 54.861$, p = 0.059. However, the likelihood ratio tests of overall contribution of each independent variable to the model showed the scores of the agreement statement, "governments should take action to minimize or stop industries from emitting carbon," were a significant predictor in the model, $X^2(4) = 11.033$, p = 0.026. However, if the significance level were at 0.1, the scores for the agreement statements, "modern climate change is not a result of natural heating and cooling cycles," $X^2(4) = 8.383$, p = 0.079, and, "climate change is altering the Arctic landscape," $X^2(4) = 9.183$, p = 0.057, would also be significant predictors in the model.

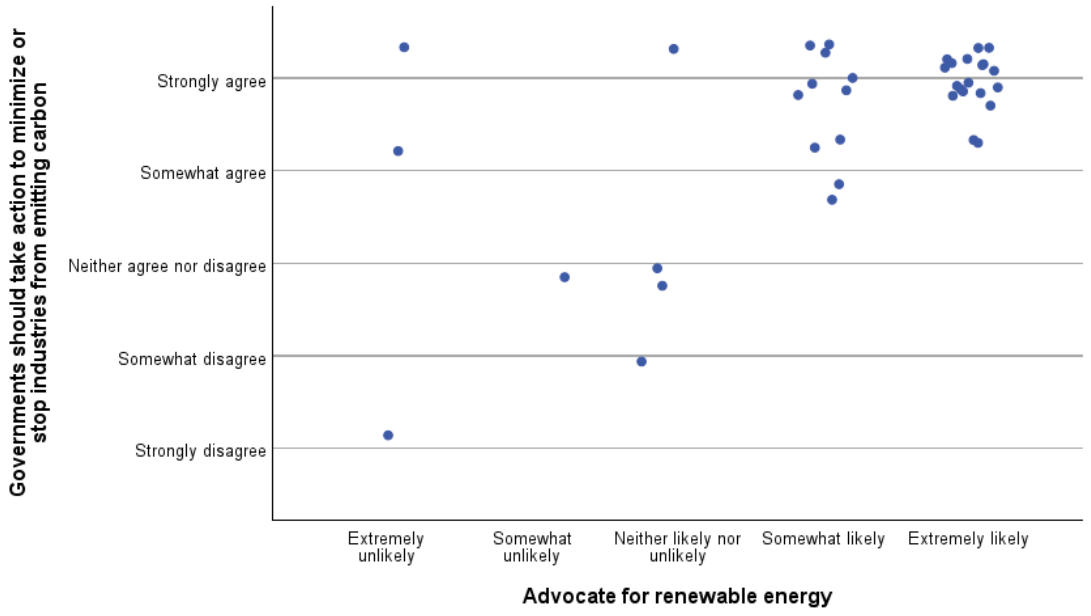

Fig 14. A scatter plot produced by IBM SPSS demonstrating the positive relationship between scores for, "Governments should take action to minimize or stop industries from emitting carbon," and the post-scores for, "Advocate for renewable energy." Jitter was added to the plot to better outline the relationship.

Discussion

These findings highlight several important insights into what elements influence satisfaction with polar bear viewing programs and the relationships between pro-environmental behaviors. A significant positive relationship was found between satisfaction with distance to polar bears and satisfaction with the number of polar bears seen. Additionally, there was a significant positive relationship discovered between the satisfaction with distance to polar bears and number of bears seen, and overall program satisfaction. These findings reveal that participants in these programs are not only concerned with the opportunity to observe a polar bear, but also how close they manage to get to one.

A significant positive relationship between overall program satisfaction and perceived program value was also discovered; as well as one between satisfaction with time spent with polar bears and perceived program value. This emphasizes that extended interactions with the polars can elevate participant satisfaction. All of these findings suggest that while implementing viewing distance guidelines could potentially hinder overall program satisfaction, this drop could be offset by increasing the number of polar bears seen and spending more time viewing polar bears.

However, it is important to note that while attempting to see more bears and/or spend more time with the bears may help maintain or enhance participant satisfaction, program operators need to consider how else they can preserve animal welfare. Smultea et al., 2016 conducted research on the responses of polar bears to ice-breaker operations and found that individuals displayed fleeing behavior during active ice-breaking. Active ice-breaking is louder and may have disrupted normal behaviors. However, the polar bears resumed normal behaviors

when the ice-breaking activity ceased. Amstrup et al., 1993 also observed the impact of noise on polar bears, specifically from aircraft and vehicles. This research found that distances of the noise source approximately 250-500 meters from den sites could lead to den abandonment. Together, these pieces of evidence suggest that programs should not occur in sensitive areas such as well-known denning zones and take precautions to minimize noise levels. Further mitigating disturbances such as decreasing associated noise will likely enhance the effectiveness of viewing distance guidelines and preserve animal welfare.

This study also looked at if participation in a polar bear viewing program contributed to increases in intent to participate in pro-environmental behaviors. Survey respondents expressed a significantly greater intent to seek out information about climate policies, encourage others to participate in eco-friendly behaviors, donate to organizations dedicated to climate change mitigation, sign up for email communications from Polar Bears International or similar organizations, and advocate for renewable energy. However, Lange, 2023 noted that self-reported pro-environmental behavior participation can create validity issues due to reporting biases and poor memory (Gifford, 2014; Kormos and Gifford, 2014). This represents a limitation in this analysis as all behaviors were self-reported.

Future research could benefit from longitudinal studies tracking behavioral changes, as well as utilizing behavioral paradigms to more accurately measure impact on behavior (Lange, 2023). While this analysis demonstrates a significant increase in intent to participate in a variety of pro-environmental behaviors, these results should be used cautiously. Multiple factors can contribute to increases, not just the participation in a polar bear viewing program, and the higher

baseline scores for the pro-environmental behavior suggest the respondents were already inclined to participate in the behaviors, limiting observable increases.

Because many of the scores for the pro-environmental behaviors indicated no change, additional analyses were conducted to determine which agreement statements were the greatest predictors for high pro-environmental behavior post-scores. Increased agreement with the statement, "Temperature in the Arctic is increasing due to climate change," was a significant predictor of greater intent to become involved with climate change mitigation organizations and share information about climate change on social media. More agreement with the statement, "Modern climate change is not a result of natural cycles," was a significant predictor of greater intent to seek out information about climate policies and discuss the concept of climate change with others. Similarly, greater agreement on, "The media does not display an appropriate amount of concern about climate change," significantly predicted increased intent to share information about the Arctic on social media and volunteer for a conservation focused organization. Overall, this demonstrates that by emphasizing these three specific areas of knowledge during programs, participants may be more inclined to seek out information about climate change, start discussions on social media, and volunteer for related organizations. All of these pro-environmental behaviors can contribute to long-term polar bear conservation efforts.

Three other statements were discovered to be significant predictors of several pro-environmental behaviors. Greater agreement with the statements, "The Arctic is currently threatened by climate change," "Vehicles emitting carbon are contributing to modern climate change," and, "Governments should take action to minimize or stop industries from emitting carbon," significantly predicted increased intent to volunteer for a conservation focused

organization, vote in support of policies aimed at mitigating or reducing climate change, and advocate for renewable energy, respectively. Arguably, these three behaviors contribute a more direct impact to climate change mitigation. Thus, this information should also be highlighted during programming to motivate participants to take concrete action and increase individual contribution to mitigation efforts.

Additionally, increased agreement with four different statements were also significant predictors of increased intent to sign up for communications from Polar Bears International or similar organizations These statements included, “The Arctic is currently threatened by climate change,” “Temperature in the Arctic is increasing due to climate change,” “The media does not display an appropriate amount of concern about climate change,” and, “Vehicles emitting carbon are contributing to modern climate change.” From a marketing and communications perspective, this result suggests that reinforcing these four lines of information could enhance individual program outreach efforts and elicit increased involvement in climate-friendly organizations. Overall, this could lead to elevated advocacy for polar bear conservation and climate action.

Conclusion

While polar bear viewing programs provide a valuable opportunity to elicit conservation engagement, it is also important to ensure balance between animal welfare and participant satisfaction. The results of this study suggest overall program satisfaction is positively associated with a variety of program indicators including the number of polar bears seen, distance to polar bears, and time spent observing the polar bears. Implementing viewing distance guidelines may influence this satisfaction but increasing the number of polar bears seen and the time spent with them could offset any losses. Viewing distance guidelines should be paired with exclusion of tours in sensitive areas, like denning habitat, and best practices to reduce tourism-associated noise. Additionally, this study determined that emphasizing various aspects of climate science and climate change awareness during programs can elevate educational takeaways and intent to participate in pro-environmental behaviors, supporting long-term polar bear conservation goals. A holistic integration of these recommendations will allow viewing programs to contribute to participant satisfaction, increased educational value, and climate change mitigation.

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