



Changes in Sharing and Participation are Important Predictors of the Health of Traditional Harvest Practices in Indigenous Communities in Alaska

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Abstract

The well-being of Indigenous communities in Alaska is inextricably linked to traditional harvest practices (THPs) such as hunting, fishing, and gathering local wild foods. Regional trends in the health of THPs have not been quantitatively evaluated in Alaska. Therefore, we surveyed Indigenous residents in the Western Coastal (n = 623) and Interior (n = 437) Regions of Alaska to estimate perceptions of the extent and cause of change in the health of THPs over the last ten years. We found that THPs improved in Western Coastal and declined in Interior Alaska. The best predictors of improvement or decline in the health of THPs were 1) change in the ability to share the harvest, 2) change in participation in hunting and fishing activities, and 3) extent of challenges caused by climate change. The odds of a decline in the health of THPs were 8 to 13 times higher for households that reported a decrease in sharing of traditional foods.

Keywords Alaska · Arctic · Climate Change · Fishing · Food security · Hunting · Subsistence · Survey

Introduction

The Indigenous peoples of Alaska and the circumpolar North have maintained strong connections to the traditional ways of life that have sustained people and communities in the Arctic and Subarctic for generations (Carothers et al., 2021). Foundational to ancestral ways of living and social-ecological systems that support Indigenous peoples and contribute to intergenerational resilience are traditional harvest practices (hereafter THPs). THPs include hunting, fishing, trapping, and gathering local wild foods and resources. These practices are embedded in the culture, identity, economies, food

security, and overall physical and mental health of Indigenous communities in Alaska (McGrath-Hanna et al., 2003; Kruse et al., 2008; Gerlach & Loring, 2013; Heeringa et al., 2019). Also referred to as living a 'subsistence way of life,' THPs connect Indigenous people tangibly to the lands, waters, and animals and intangibly to nature's nonphysical and healing aspects (Breslow et al., 2016; Thornton, 2001; Wolsko et al., 2006). THPs are interwoven with most Indigenous ceremonies (potlatches, memorials, celebrations) in Alaska, highlighting the critical role that THPs play in spirituality and the continuance of cultures (ADFG, 2010; Carothers et al., 2021; Fienup-Riordan, 1995; Nelson, 1983). Participation in THPs supports cultural values that include psychological, social, and spiritual dimensions of well-being (Kuhnlein et al., 2006; Milburn, 2004). For example, THP's provide opportunities to support protective factors (e.g., prevention of chronic disease; Mohatt et al., 2007) through intergenerational activities. Young people gain knowledge, practical skills, and understanding of identity from older people as they make tools, prepare gear, learn safety protocols, and develop an awareness of one's spiritual preparation before going out on the land (Rasmus et al., 2014a). The benefits of these teachings provided through the process of THP's contributes to the long-term well-being of the individual

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and the community, even after wild foods have been distributed and consumed. Additionally, youth who engage in THP-related activities have higher levels of protection from substance abuse and suicide risk than peers who engage in fewer activities (Philip et al., 2016; Rasmus et al., 2014b, 2019; Wexler et al., 2020). Reciprocal relationships between humans and the nonhuman world, including taking care of the land, coasts, waterways, treating animals with respect, and encouraging others to do the same, are all ways that the Indigenous people of Alaska collectively care for themselves and their communities (Fienup-Riordan, 2000). In this way, THPs are essential for the health and sustainability of cultures and communities in Alaska and their interdependent balance with nature.

Participating in THPs and the subsequent distribution of harvested resources shapes cooperative social organization and nurtures kinship relationships (Berman, 2009; Magdanz et al., 2002). Households in Indigenous communities of Alaska share expenses, supplies, labor, and products related to THPs (Brown et al., 2017). These acts of reciprocity reinforce an ecologically-managed, kinship-based socioeconomic system in Alaska Native communities that creates and maintains connections within extensive social networks that add security and stability to rural Indigenous communities (BurnSilver et al., 2016; Ready, 2019; Walch et al., 2018). For Indigenous communities of Alaska, having a generous spirit is often linked to living a good and long life, including giving away and sharing with those who have less (Rearden, 2009). For example, the tradition of passing out a person's first wild-food catch to the community shows how reciprocity is embedded and continued through current THPs in Alaska Native communities (Rearden, 2009). By emphasizing the values of generosity and sharing, these traditions contribute to community well-being and resilience by strengthening social networks that individuals rely upon during times of need. This is reflected in potlatches in which communities plan and save for months to give away food and other gifts to guests from neighboring villages who attend the celebration. Gifts to others are said to return in other ways and in greater numbers. This cycling of traditional foods and other material and non-material resources through social networks is the basis for the continuity of cultures and livelihoods in communities (Elder & Kamerling, 1988; Simeone, 2002). The network takes care of households that may not have the means to conduct THPs for themselves (Harder & Wenzel, 2012).

Given the importance to Indigenous communities in Alaska, the health of THPs needs to be monitored and protected. Assessments of the health THPs are especially justified during rapid change when access to local resources is less predictable (Brinkman et al., 2016; Cold et al., 2020). Currently, northern regions reliant on THPs are undergoing amplified climate change, expanded natural resource

development, shifting regulations and land management plans, dynamic fluctuations in fish and game populations, rising fuel costs, demographic reorganization, and enhanced exposure to globalized social media and economic markets (Berman, 2009; Box et al., 2019; Brinkman et al., 2014; Melia et al., 2016). All these factors can affect THPs in complicated and interconnected ways that are not fully understood (Loring & Gerlach, 2015).

Monitoring the health of THPs necessarily involves the engagement of THP practitioners in the research process. Assessments of THPs in Alaska must include input from those who are impacted most by a multifaceted change to identify where research, management, and policy attention should be allocated (Duhaime et al., 2004). The continuance and preservation of ancestral ways of living is a critically important part of self-governance in Indigenous communities and a priority focus of Alaska Native leadership at the regional, state, and federal levels. The collective perceptions of Indigenous residents need to be systematically explored and carefully documented to inform decisions that promote self-determined environmental management, the preservation of traditions, and the continuance of healthy THPs in Alaska Native communities. To address this need, we surveyed residents in two regions in Alaska to 1) estimate perceptions of the current conditions and trajectory of change in the health of THPs and 2) advance knowledge on the effects of a holistic set of factors on the health of THPs. More specifically, we were interested in determining if and why the health of THPs has improved or declined over the last ten years.

State agencies have conducted intensive household surveys within individual communities every couple of decades to collect information on patterns of a harvest of subsistence resources (ADFG, 2020). During those surveys, quantitative estimates are generated on participation in THPs, along with the harvest numbers and use of wild foods. Qualitative ethnographic information is collected to provide context that supports quantitative estimates. Few studies have quantitatively estimated Alaska Native residents' perceptions (e.g., attitudes) of trends in the health of THPs at regional scales (Wu, 2020). In addition, few studies have accounted for the diverse interdisciplinary factors that impact THPs (Kruse et al., 2008).

With social, economic, ecological, and cultural factors shaping THPs, an interdisciplinary assessment of many factors and their interactions is needed to facilitate a comprehensive understanding of the current status and trends in THPs, and what may be driving changes. This approach aligns with holistic and One Health frameworks held by many Indigenous cultures (Cochran et al., 2013; Hueffer et al., 2019). Research designs adopting a similar worldview may foster acceptance and application of findings by communities. Including multiple communities in the same

survey can overcome inference problems associated with assessments of individual communities that used different study designs at different times. Localized circumstances lead to unique conditions, attitudes, and behaviors that may not be generalizable to other communities in the region. For example, harvest regulations, transportation costs, resource availability, sharing networks, the extent of knowledge transfer across generations, and wage-economy responsibilities vary among communities. They may impact the timing, intensity, and productivity of THPs. Also, multi-community assessments within regions and comparisons between regions may help to inform government agency efforts that tend to implement comprehensive policies that can be applied across large scales (Nilsson & Larsen, 2020). Differences in the collective voice between regions may suggest caution before applying policies across regions. Our study synthesized the collective voice of many communities in two regions of Alaska to achieve reasonable representation and broadly applicable solutions relevant to diverse communities.

Methods

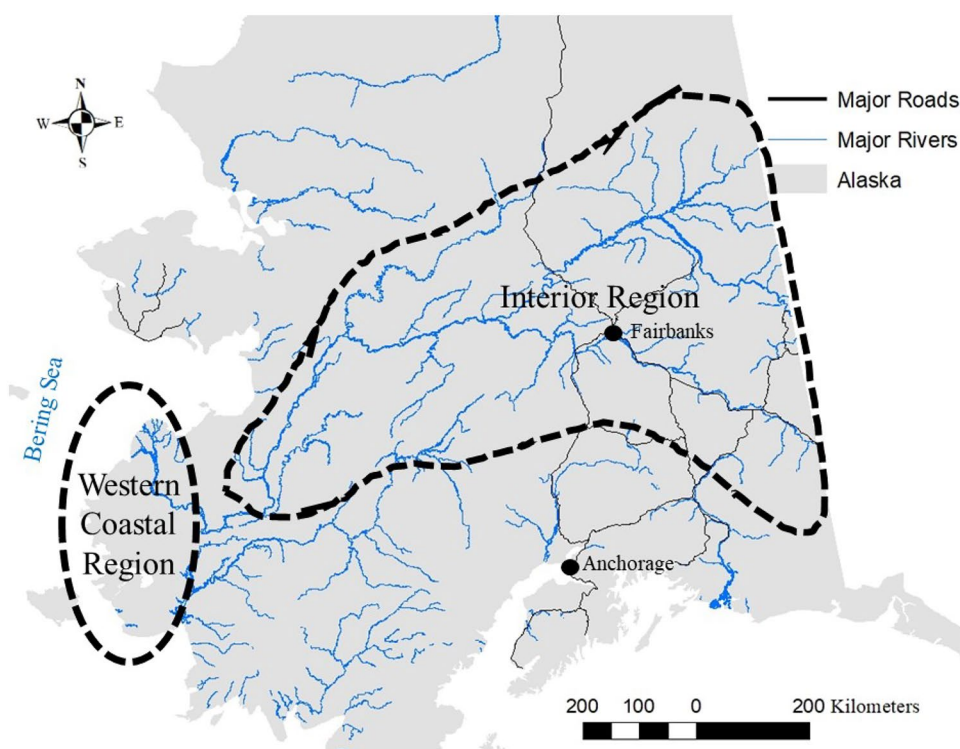
Study Areas

The target population for our survey was Indigenous residents in the Interior and Western Coastal regions of Alaska (Fig. 1). Although the Interior region contains the city of

Fairbanks and other communities on the road network with large proportions of non-Indigenous residents, our surveys focused on Indigenous residents. In these two regions combined, approximately 75% of Indigenous households harvest wild foods, and nearly all consume wild foods (Fall, 2018). Fall (2018) estimated wild food harvest to be 133 and 172 kg/person per year in Interior and Western Coastal rural communities. The resources acquired through THPs are supported and supplemented by wage employment resulting in a mixed cash-subsistence economy (Burnsilver et al., 2016). Because of high transportation costs and limited storage capacity, commercial goods and fuel are expensive in rural communities off the road network compared to urban areas of Alaska. Employment in Indigenous communities is primarily in the public sector (education, health, and social services), with median household income averaging around \$40,000 across the Interior and Western Coastal region census areas (U.S. Census Bureau, 2021). THPs in both regions are vulnerable to climate-related changes in the environment, such as increased flooding, erosion, thawing permafrost, and shifts in the seasonal weather (Brinkman et al., 2016; Herman-Mercer et al., 2019).

The Interior Region we studied included a broad representation of Indigenous communities within the Tanana Chiefs Conference (TCC) region of Interior Alaska. TCC is an Alaska Native Tribal Consortium formed in 1971 with the passage of the Alaska Native Claims Settlement Act (ANCSA) to support the health and social services of the 38 villages and 42 federally recognized tribes within the

Fig. 1 Interior and Western Coastal Region study areas of Alaska. Indigenous residents of communities within those regions participated in a survey on the health of traditional harvest practices (THPs). Except for urban centers (Fairbanks, Anchorage), community locations were not provided to protect the anonymity of participants



region. Twelve of these communities are located on the road system. In contrast, the remaining 26 communities occur near navigable rivers and are only accessible by small plane, boat, or long overland travel (snowmobiles in the winter) on unmaintained trails. This region covers approximately 609,000 km², an area nearly the size of the state of Texas. Residents of rural communities off the road system are mainly Alaska Natives. The region includes eleven distinct Athabascan or Dene language and cultural groups (Krauss, 1982). Interior Alaska is located within the continental climatic zone of Alaska, which experiences the greatest annual temperature variability within the state. The Boreal forest is the primary ecosystem type in Interior Alaska and is characterized by mixed coniferous-deciduous forest with extensive wetlands comprised of low scrub bogs, meadows, and marshes. Communities within Interior Alaska have a heavy reliance on moose (*Alces alces*) and salmon, including Chinook (*Oncorhynchus tshawytscha*) and summer and fall chum (*O. keta*). Non-salmon fish species, trapping of small fur-bearers, birds, and gathered foods such as berries are also widely utilized but in lower quantities by weight (kg/person) (Brown et al., 2015).

The Western Coastal Region included four communities (population 2,974) near the Yukon-Kuskokwim Delta of Southwest Alaska (U.S. Census Bureau, 2021). The communities' anonymity was protected following research best practices in rural areas with small populations. Community residents are primarily (> 90%) Yup'ik. The region borders the Bering Sea and has a subarctic maritime climate. The environment is mainly a flat wetland/tundra complex with lakes, rivers, and a small amount of mixed-forested habitat in riparian areas. The Western Coastal Region communities are not connected by maintained roads and are considered more remote and less accessible by non-locals than the Interior Region. Travel in and out is by small plane. Western Coastal Region communities harvest a mix of the terrestrial game (moose, waterfowl), fish (salmon, herring [*Clupea harengus*], halibut [*Hippoglossus stenolepis*]), and marine mammals (seals [*Erignathus barbatus*, *Pusa hispida*], beluga whale [*Delphinapterus leucas*], walrus [*Odobenus rosmarus*]). Most THPs occur by boat and an all-terrain vehicle in the summer and by snowmobile in the winter.

Questionnaire Development

University and Tribal Organization researchers partnered to develop survey questionnaires for each region. The Interior survey was a collaboration between the University of Alaska Fairbanks (UAF) Community Partnerships for Self-Reliance Program and TCC's Hunting and Fishing Task Force. The Western Coastal Region was a collaboration among UAF's Community Partnership for Self-Reliance Program, UAF's Center for Alaska Native

Health Research, and project coordinators from participating communities. We conducted a series of focus-group discussions with collaborators to inform questionnaire development. Focus groups were intended to expand the researcher's knowledge and awareness of the topic, learn about the breadth of community perceptions, help structure the survey design, test potential survey questions, and concentrate questions on salient and vital topics. Essentially, focus groups helped us ask the right questions the right way to meet study objectives and generate results that can inform effective and timely decisions. The UAF's Institutional Review Board approved all research involving human research subjects (IRB# 5426513–13).

We designed questionnaires to explore participant perceptions of the health of THPs over the last ten years. We focused on the last ten years to capture variation and change in THPs across years while minimizing potential recall bias. Each region independently defined THPs. The Interior Region partners defined THPs as the "traditional hunting and fishing practices of our people, including the harvesting and sharing of fish, game, and other resources and the ceremonies which accompany these practices that provide for the social, cultural, spiritual, and economic well-being and survival of our people and communities" (TCC, 2021). The Western Coastal Region partners defined THPs as the ability of households and families to harvest and put away Yup'ik foods for winter. Both regions consider THPs healthy if fish, wildlife, and plants are abundant and accessible, culture and knowledge to live off the land are passed down to future generations, and Alaska Native communities are empowered to influence decisions that affect harvest practices.

The structure and intent of the survey questionnaires in each region were similar (Appendices 1 and 2). Both surveys used fixed-scaled or close-ended questions to assess perceptions on whether the health of THPs has improved or declined; the extent of agreement or disagreement that THPs are being challenged by climate change, fuel costs, and harvest regulations; the extent of increase or decrease in sharing of harvest; participation in THPs; and months required to use (consume, share) annual harvest of key wild foods (e.g., moose, fish). The wording of some individual questions differed slightly between regions, reflecting input provided from a series of focus-group discussions among collaborators from each region on how to optimize the interpretation and relevance to the region's communities and THPs. Also, collaborators in the Western Coastal Region chose to collect age and gender information of participants, but the Interior Region collaborators chose not to. Both regions chose not to collect income information of participants. Marine mammals are only harvested in the Western Coastal Region, so these practices could not be compared between regions.

Sampling Design

The sampling approach differed between regions. Collaborators on the Interior Region survey sought to include representation of as many communities as possible (TCC contains 38 communities), acknowledging that this may result in lower response rates within individual communities. Collaborators on the Western Coastal Region survey sought to include fewer communities ($N = 4$) and maximize each community's response rates.

We distributed surveys in the Interior Region using three methods to ensure a broad representation of communities across the Interior Region. The Interior Region survey was initially distributed at the 2017 annual TCC Convention, which draws representation from all federally recognized tribes within the region. We also mailed packets of surveys to all tribal councils within each region community with pre-paid return envelopes. Tribal councils encouraged community residents to pick up surveys at tribal council offices, which often serve as a central meeting location. Lastly, an online version of the survey was created and posted on the TCC Facebook page. Facebook is heavily used for communicating and sharing information among rural communities.

During 2019, we mailed packages of the Western Coastal Region surveys to project coordinators responsible for disseminating and collecting surveys in each participating community. A research associate also traveled to each community to assist with in-person distribution of surveys. Due to the timing of the surveys, survey participants consisted of community members who were in the community and heard announcements via VHF radio, word of mouth, and Facebook announcements on community pages.

Data Analysis

We performed all statistical analyses using SPSS software. We provided descriptive statistics (frequencies) for responses to questions in each region to characterize overall perceptions of the health of THPs. For further analysis, we grouped participants based on whether they reported that the health of THPs has *improved*, *neither improved nor declined* or *declined* over the last ten years. We tested for differences between groups based on how they responded to questions related to the following: change in the ability to share harvest; challenges to THPs from climate change, fuel-energy costs, and harvest regulations; time required to deplete harvest of key traditional foods (moose, fish), and change in time spent participating in THP activities. We used a cross-tabs analysis in SPSS to identify proportional differences (Z-tests) in responses between groups.

We considered the main effects of independent variables. We used a multinomial logistic regression model to estimate the association between change in the health of

THPs (dependent variable: improved, neither improved nor declined, and declined groups) and different responses to survey questions (independent variables). Using the likelihood ratio test, we determined if our fitted model outperformed the Null model (intercept-only model with unbiased random structure). We estimated if our models reasonably approximated the behavior of the data using Pearson chi-square and deviance chi-square tests. We used the odds ratios (i.e., exponentiated beta coefficients) of variables that contributed significantly to the model to estimate how differences in responses to survey questions influenced the odds that the health of a household's THPs have *improved* or *declined* over the last ten years. An odds ratio represents the odds of a particular outcome (*improved* or *declined*) because of the presence of a factor (responding one way to a survey question) compared to the presence of a different factor (responding a different way to the same survey question).

Results

Sample Description

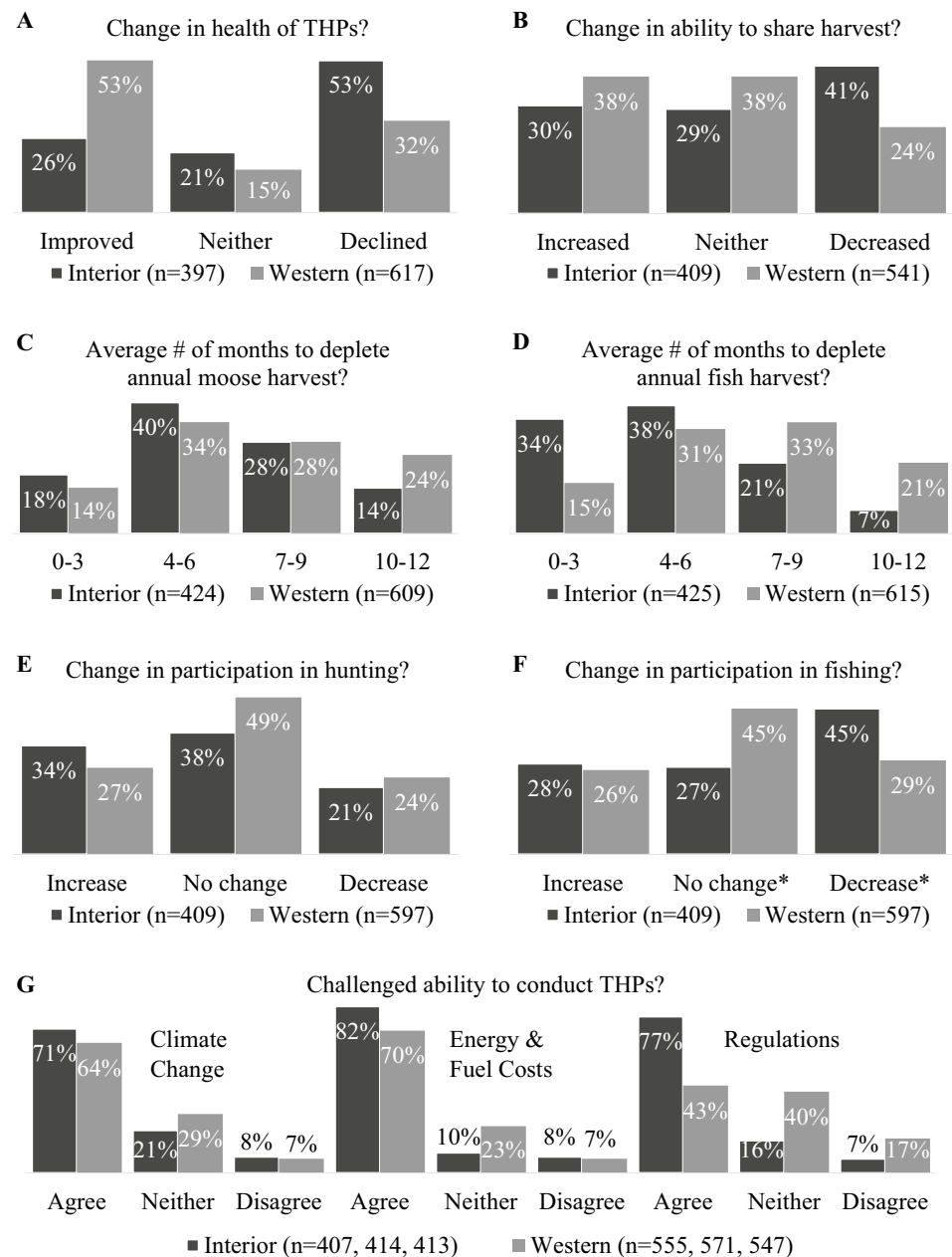
For the Interior Region, 437 people residing in 33 communities participated in the survey. All survey respondents lived, were from, or conducted THPs in the Interior Region. Our target population size was 9,266 (Alaska Native residents ≥ 18 years old), and our sample error was $\pm 4.6\%$ at the 95% confidence interval. For the Western Coastal Region, 623 people residing in four communities completed the survey. Our target population size was 1,703 (Alaska Native residents ≥ 18 years old), and our sample error was $\pm 3.1\%$ at the 95% confidence interval.

All Western Coastal Region respondents lived and conducted THPs in the remote communities included in the survey. In the Interior Region, most respondents lived in a rural community (71%) off the road system (57%). All rural residents conducted THPs near the rural community where they resided. Of the respondents residing in an urban area (29%; e.g., Fairbanks), most individuals (85%) were originally from a rural community. Most (83%) respondents residing in an urban area but from a rural community continued to conduct THPs near the rural community from which they originated.

Regional Comparison

We found regional differences in responses to most survey questions, with the Interior Region consistently more likely to report that conditions are changing in a direction that does not support the health of THPs (Fig. 2). The Western Coastal Region was more likely to report that the health of THPs has improved, and the Interior Region was

Fig. 2 Participant responses (%) to survey questions on the health of traditional harvest practices (THPs) in the Interior (black bars) and Western Coastal (grey bars) Regions of Alaska. All participants were asked to answer questions based on their experience over the last ten years. The asterisk (*) indicates that proportions for that response category were significantly different ($\alpha = 0.05$) between *improved* and *declined* groups based on Z-test



more likely to report that the health of THPs has declined (Fig. 2A). In the Western Coastal Region, 53% of participants reported that the health of THPs has improved or significantly improved, and 15% reported a decline or significant decline. In the Interior Region, we found the inverse, with 53% reporting that the health of THPs has declined or significantly declined, and 26% reporting improved or significantly improved (Fig. 2). Regions were also different in the extent of change in the ability to share the harvest of traditional foods, with 41% of participants in the Interior Region reporting a decrease, compared to 24% in Western Coastal (Fig. 2B). The amount of time (months) required to deplete the majority ($\approx 90\%$) of their annual harvest of important wild foods (moose and fish)

during a typical year over the last ten years was greater in Western Coastal than in the Interior Region (Fig. 2C, D). The Interior Region increased participation in hunting activities (Fig. 2E) and decreased participation in fishing activities (Fig. 2F) more than the Western Coastal Region. In the Interior Region, more participants reported that they agreed that their households' THPs were challenged by climate change, fuel, and energy costs, and hunting and fishing regulations, compared to the Western Coastal Region (Fig. 2G). We found the most considerable regional difference in challenges on the question of the regulation, with 77% of participants in the Interior Region agreeing that regulations have challenged their ability to conduct THPs, compared to 43% in the Western Coastal Region.

Differences between Groups Reporting that THPs had Improved or Declined

With Interior and Western Coastal Regions differing in their perceptions of change in the health of THPs over the last ten years, we analyzed regions separately. We grouped participants based on whether they reported that the health of their households' THPs has changed improved, neither improved nor declined or declined over the last ten years. We compared responses to other survey questions between groups (Figs. 3 and 4).

In the Interior Region, we found no differences between the improved and declined groups based on the extent that each agreed that climate change has challenged THPs, and

based on the amount of time required to deplete their annual harvest of fish (Fig. 3). For the Interior Region, more participants in the declined group agreed that fuel and energy costs and harvest regulations had challenged their ability to conduct THPs than in the improved group (Fig. 3). A greater proportion in the declined group reported a decrease in the ability to share the harvest and participate in hunting and fishing activities. A smaller proportion of participants in the declined group reported that 10–12 months was required to deplete 90% of their annual moose harvest (Fig. 3). A greater proportion of the declined group resided in an urban area than the improved group.

For the Western Coastal Region, a greater proportion of participants in the *declined* group agreed that climate

Fig. 3 Comparisons in proportions of responses (%) from participants in the Interior Region grouped based on whether they reported that the health of their household's traditional harvest practices (THPs) have improved, neither improved nor declined or declined over the last ten years. The asterisk (*) indicates that proportions for that response category were significantly different ($\alpha = 0.05$, Z-test) between improved and declined groups

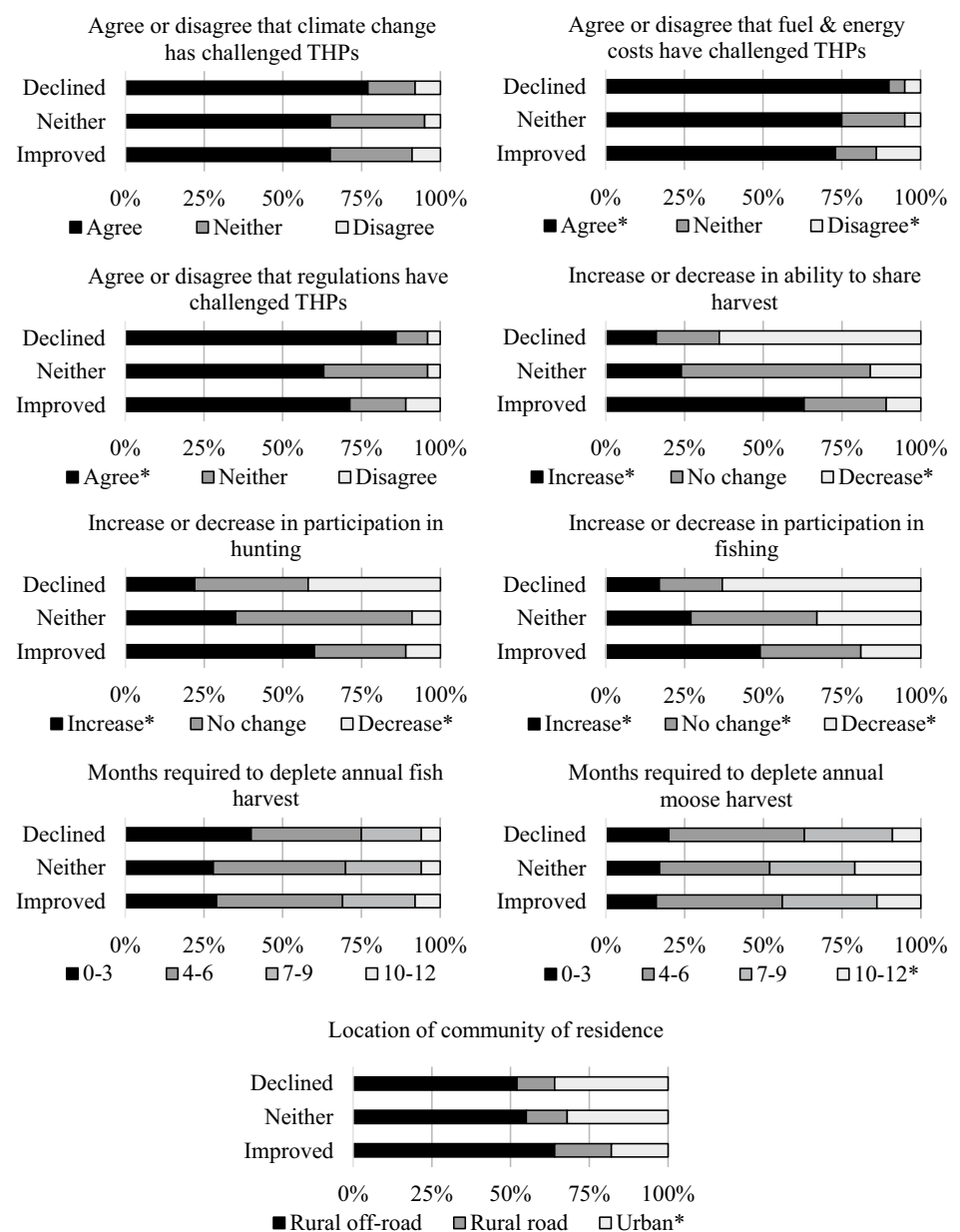
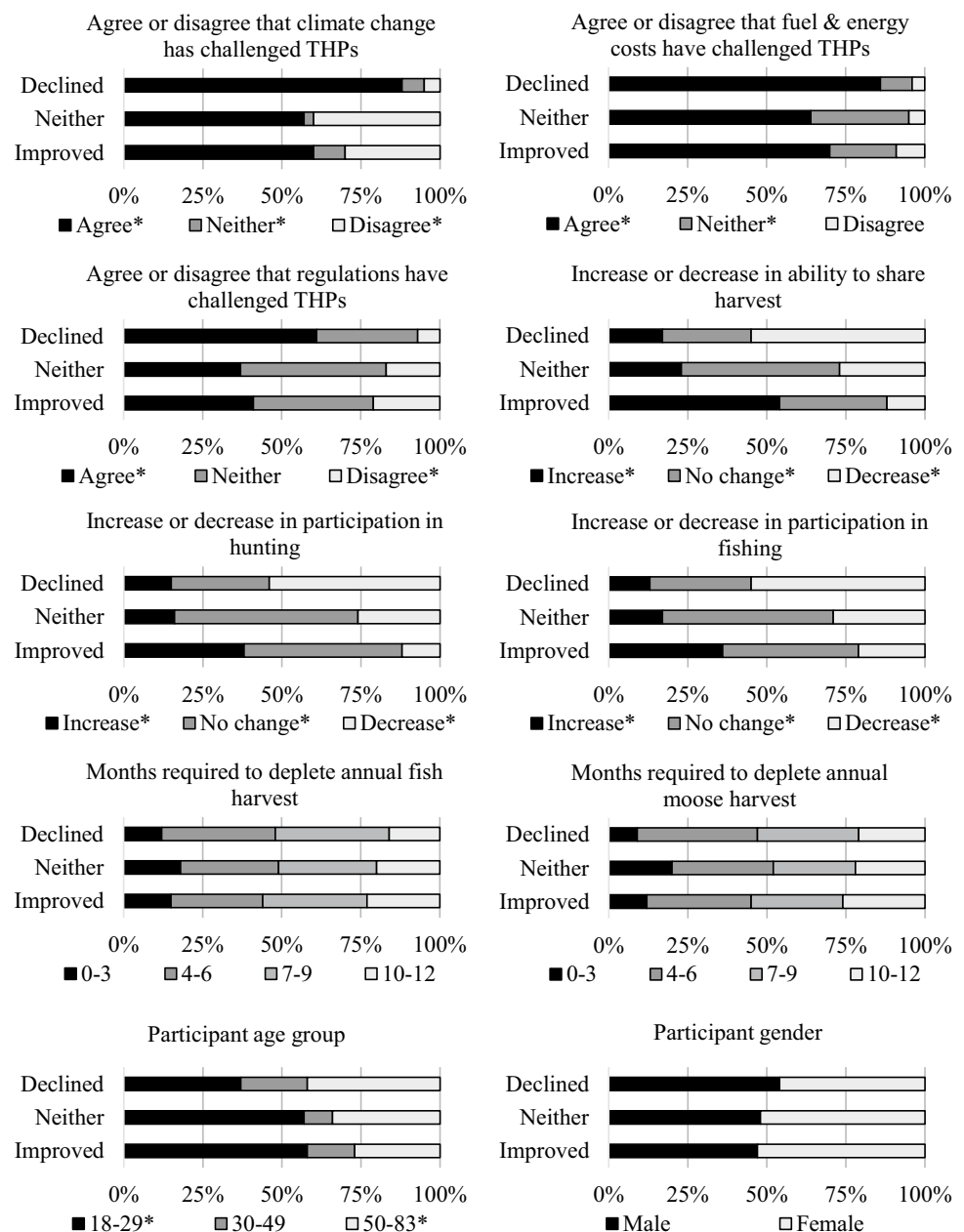


Fig. 4 Comparisons in proportions of responses (%) from participants in the Western Coastal Region grouped based on whether they reported that the health of their household's traditional harvest practices (THPs) have improved, neither improved nor declined, or declined overtime over the last ten years. The asterisk (*) indicates that proportions were significantly different ($\alpha = 0.05$, Z-test) between *improved* and *declined* groups for that response category



change, fuel, and energy costs, and harvest regulations had challenged their ability to conduct THPs compared to the proportion in the *improved* group (Fig. 4). A greater proportion in the *declined* group reported a decrease in the ability to share the harvest and participate in hunting and fishing activities. A greater proportion in the *declined* group was in the older age cohort (50–83) than in the *improved* group. In the Western Coastal Region, we found no differences between the *improved* and *declined* groups based on gender and the amount of time required to deplete their annual harvest of fish and moose (Fig. 4).

Predictors of Improvement or Decline in the Health of THPs

We modelled the predictive power and influence of significantly different variables between *improved* and *declined* groups. Our models' exponentiated beta coefficients provided odds that the health of THPs has *improved*, *neither improved nor declined* or *declined* based on their response to other questions that significantly contributed to the model (Table 1). We used the normative category (i.e., a category with the greatest proportion of responses)

Table 1 Model estimates of significance (Sig.) and strength of influence (exponentiated beta coefficient, Exp(B)) of predictor variables on whether a survey participant reported that the health of their household's traditional harvest practices (THPs) have *improved*, *neither improved nor declined* or *declined* over the last ten years in Inte-

rior and Western Coastal regions of Alaska. We used the normative categories (the highest proportion of responses) as the reference categories for the dependent variable (Change in health of THPs) and each predictor variable

Region	Change in health of THPs	Predictor variables	Participant response	Sig	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower CI	Upper CI
Western Coastal	Neither improved nor declined ^a	Change in ability to share harvest	Intercept	0.000			
			Decrease	0.000	3.576	1.876	6.816
			No change	0.000	2.918	1.735	4.908
			Increase	0 ^c			
		Change in participation hunting	Decrease	0.000	3.653	1.842	7.244
			No change	0.013	2.038	1.162	3.574
			Increase	0 ^c			
		THPs challenged by climate change	Disagree or Neither	0.735	0.925	0.589	1.453
			Agree	0 ^c			
			Intercept	0.000			
	Declined ^a	Change in ability to share harvest	Decrease	0.000	7.988	3.654	17.465
			No change	0.007	2.811	1.320	5.987
			Increase	0 ^c			
		Change in participation hunting	Decrease	0.000	5.109	2.271	11.492
			No change	0.722	1.153	0.526	2.529
			Increase	0 ^c			
		THPs challenged by climate change	Disagree or Neither	0.000	0.237	0.113	0.497
			Agree	0 ^c			
			Intercept	0.000			
Interior	Improved ^b	Change in ability to share harvest	Increased	0.000	12.829	5.975	27.545
			No change	0.000	5.305	2.354	11.959
			Decrease	0 ^c			
		Change in participation fishing	Increase	0.000	5.796	2.785	12.061
			No change	0.001	3.490	1.658	7.347
			Decrease	0 ^c			
	Neither improved nor declined ^b	Changing in ability to share harvest	Intercept	0.000			
			Increase	0.005	3.529	1.463	8.514
			No change	0.000	7.533	3.504	16.195
			Decrease	0 ^c			
		Change in participation fishing	Increase	0.035	2.411	1.063	5.470
			No change	0.005	2.871	1.383	5.956
			Decrease	0 ^c			

^aReference category for change in THPs for Western Coastal Region is 'Improved'

^bReference category for change in THPs for Interior Region is 'Declined'

^cReference category for each predictor variable

as the reference category for each variable in the model (Table 1).

For the Interior Region, two variables (ability to share harvest and participation in fishing activities) contributed significantly to our model of the change in the health of THPs over the last ten years (Table 1). Change in the amount of time spent participating in hunting activities was also a significant contributor to the model but was highly

correlated with responses to questions on participation in fishing activities. Therefore, we used fishing activities in the model because the contribution was more significant. According to our likelihood ratio test, our model outperformed the Null model (chi-square = 144.85, df = 8, $p < 0.001$). Our Goodness-of-Fit test also indicated that our data adequately fit the model (Pearson chi-square = 10.35, $p = 0.24$; Deviance chi-square = 11.23, $p = 0.19$).

In the Interior Region, a household's ability to share harvest had a very strong influence on the change in the health of that household's THPs over the last ten years (Fig. 5). The odds that THPs had *improved* were 12.8 times greater if the participant reported an increase (rather than decrease) in their ability to share harvest over the last ten years (Table 1, Fig. 5). The odds that THPs had *improved* were 5.8 times greater if a participant reported increasing (rather than decreasing) participation in fishing activities over the last ten years (Table 1, Fig. 5). Inversely, the odds that the health of a household's THPs had *declined* were 12.8 and 5.8 times greater if the participant reported a decrease in the ability to share and participation in fishing, respectively (Fig. 5).

For the Western Coastal Region, three variables (ability to share harvest, participation in hunting, and challenges from climate change) contributed significantly to our model of the change in the health of THPs over the last ten years. According to our likelihood ratio test, our model outperformed the Null model (chi-square = 138.258, df = 10, $p < 0.001$). Our Goodness-of-Fit test also indicated that our data adequately fit the model (Pearson chi-square = 19.53, $p = 0.73$; Deviance chi-square = 21.24, $p = 0.62$).

In the Western Coastal Region, a household's ability to share harvest also strongly influenced the change in the health of that household's THPs over the last ten years. The odds that THPs had *declined* was 8.0 times greater if the participant reported a decrease (rather than increase) in their ability to share harvest over the last ten years (Table 1, Fig. 5). The odds that THPs had *declined* was 5.1 times greater if a participant reported decreasing (rather than increasing) in hunting activities over the last ten years (Table 1, Fig. 5). THPs had declined by 4.2 times greater if a participant agreed (rather than neither agreed nor disagree or disagreed) that climate change has challenged

their household's ability to conduct THPs over the last ten years (Table 1, Fig. 5). Inversely, the odds that THPs had *improved* for the Western Coastal Region were 8.0, 5.1, and 4.2 times greater if the participant reported an increase in the ability to share and participate in fishing and disagreed or neither agreed nor disagreed that climate change has challenged THPs (Fig. 5).

Discussion

Our survey results showed opposite trends in the direction of change in the health of THPs. However, our analyses of the effects of numerous variables on change in the health of THPs also revealed similar patterns across regions of Alaska about which factors are most influential. Our key findings indicated that change in sharing of traditional foods and participation in hunting and fishing activities were strong predictors of whether Indigenous residents reported that the health of THPs has improved or declined over the last ten years. Our research also highlighted the challenges of rapid climate change to harvest activities and traditional ways of life for Indigenous peoples and communities of Alaska.

Regional Comparison

Our results indicated that the health of THPs over the last ten years has declined in the Interior Region and improved in the Western Coastal Region (Fig. 2). The opposite trends in the health of THPs may be explained by interrelated social, ecological, economic, and geographic characteristics. Many communities in the Interior Region are either on the road system or in locations off the road system that are more accessible by non-local harvesters compared to the Western

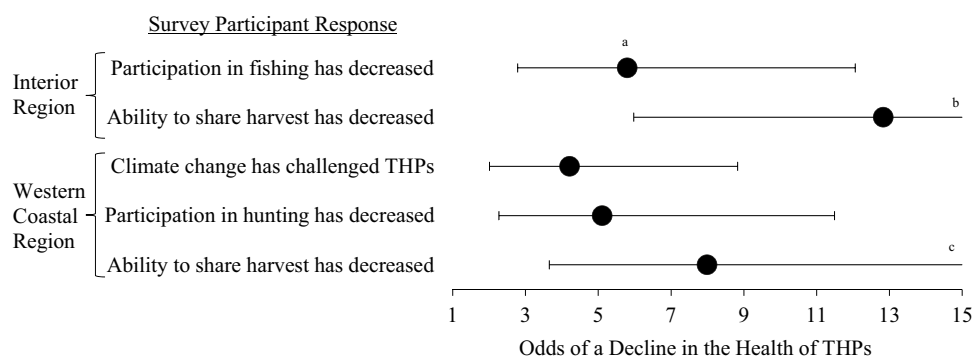


Fig. 5 The influence of essential survey variables (significant predictors in the model) on the odds (black circles) that the health of their household's traditional harvest practices (THPs) has *declined* over the last ten years. Error bars around the odds represent upper and lower confidence intervals. ^aInterpretation example: If a survey participant in the Interior Region reported their participation in fishing activities has decreased over the last 10 years, then the odds of a decline

in the health of their THPs was 5.8 times higher than the odds of an improvement in their THPs, compared to a survey participant that reported an increase in their household's ability to share harvest. ^bThe upper confidence interval of the odds for this response category extends to 27.5 ^cThe upper confidence interval of the odds for this response category extends to 17.5

Coastal Region. All Western Coastal Region communities are relatively remote and difficult and expensive to access for non-local hunters and fishers. More accessible areas generally have greater hunting and fishing pressure, leading to more competition, the potential for conflict among different user groups (local Alaska residents, non-local Alaska residents, and non-residents), and more restrictive harvest regulations (ADFG, 2020; Hasbrouck et al., 2020). This may explain why 34% more Interior Region participants agreed that harvest regulations had challenged their THPs than the relatively remote Western Coastal Region (Fig. 2). This also may explain why Interior Region participants residing in urban areas were the most likely to report a decline in the health of THPs (Fig. 3). In addition to increased competition for resources, Indigenous people residing in urban areas of Alaska are not Federally qualified subsistence users (ANILCA; Public Law 96–487, Title VIII), which means that they are unable to participate in federally regulated subsistence fisheries and hunts in rural areas of Alaska that have longer harvest seasons and larger quotas (Fall, 2016). Eighty-five percent of the urban residents that participated in our survey were originally from rural communities, and 83% of those continued to conduct THPs around rural communities that they came from. Therefore, based on our findings, roughly four in five Alaska Native residents in urban areas are under more restricted hunting and fishing regulations when they return to conduct THPs in the community they were from. The trend in outmigration of rural community residents to urban areas to boost wage-earning potential or seek education opportunities (Berman, 2009; Driscoll et al., 2010) may further reduce opportunities for Alaska Native people to participate in certain THPs within their usual and accustomed fishing and hunting grounds around their communities of origin.

The availability of wild foods also may be contributing to differences between regions in the health of THPs. Unlike the Interior Region, the Western Coastal Region has access to marine resources, and residents may have more opportunities to substitute one resource if another is scarce (Hansen et al., 2013a). Marine resources, such as pack-ice seals, represent a large proportion of the coastal community's annual harvest (Fall, 2018). Under the Marine Mammal Protection Act (MMPA), the harvest of marine mammals is limited to Alaska Native residents dwelling in coastal areas, so there is little competition with other user groups. Harvest regulations for marine mammals are relatively liberal (long seasons, large quotas). Section 119 of the MMPA (Public Law 103–238) allows federal agencies to establish cooperative agreements with Alaska Native Tribal organizations. Those co-management agreements provide Western Coastal communities with "full and equal" participation in the regulation and governance of marine mammal species (NOAA, 2020). The MMPA provides a rare opportunity for coastal Alaska

Native people to participate co-equally in managing food and harvest resources. Similar opportunities for managing species critical to THPs, such as moose or salmon, are unavailable to Alaska Native people in Interior Region communities. Restrictions on the harvesting of salmon impact both the Interior Region and Western Coastal Region. The limited opportunity for co-management of this most vital resource has created tension between state and federal agencies and Indigenous communities on Yukon River sections that travel from the Western Coastal Region through the middle of the Interior Region. Dwindling salmon runs have produced hardships for households, disaster declarations by the government, and elevated tension among stakeholders (Brown & Godduhn, 2015; Loring & Gerlach, 2010). Indigenous communities in both regions have expressed a deep concern that contemporary management structures have inhibited self-governance and stewardship opportunities in their traditional use areas. This has infringed on the cultural and spiritual rights intertwined with their THPs (Carothers et al., 2021).

Predictors of Improvement or Decline in the Health of THPs

The extreme importance of maintaining healthy sharing networks within and across Indigenous communities was highlighted by our findings. Participants that reported a decrease in sharing of traditional foods over the last ten years were 8–13 times more likely to report a decline in the health of THPs as compared to participants reporting an increase in sharing (Fig. 5). Sharing serves as a buffer against instability in annual harvest and a mechanism for supporting households with less capacity to conduct THPs (Magdanz et al., 2002). Disruptions or barriers to sharing have a more pronounced impact during times with reduced availability of resources and households more reliant (Elders, single mothers) on receiving harvest foods from others (Keating et al., 2020; Lewis, 2014). This may partially explain why a significantly greater proportion of older participants (ages 50–83) reported declining THPs in the Western Coastal Region (Fig. 4). Sharing is deeply tied to social cohesion, core community values, and the local economies that maintain many cultural practices and overall well-being (Duhaime et al., 2004). Steep declines in the salmon harvest in Interior Region communities on the Yukon River probably intensified the weakening of sharing networks (Brown & Godduhn, 2015). There have not been enough salmon to meet people's needs.

Participants that reported a decrease in time spent hunting or fishing over the last ten years were 5–6 times more likely to report a decline in the health of THPs compared to those that had increased their participation in hunting or fishing activities (Fig. 5). Intuitively, less time spent conducting

THPs results in a reduced harvest (Schmidt et al., 2005). In addition, less time hunting and fishing has adverse effects on Indigenous communities' physical, emotional, and spiritual health (Carothers et al., 2021). The Alaska Education and Research Towards Health (EARTH) longitudinal study on cancer risk factors found a decline in traditional food harvesting activities in participants across the state. They recommended promoting traditional foods and harvesting activities for protection against chronic disease (Redwood et al., 2019).

Additionally, disruptions to Indigenous ways of life and THPs have been associated with the rise of suicide and mental health disparities in Alaska Native populations (Allen et al., 2011; Gone & Trimble, 2012). Efforts to reduce risk and promote well-being in young people and communities often indicate that active THPs are a primary prevention strategy (Rasmus et al., 2014a, 2019). There are multiple plausible causes for the decline in participation in THPs. Declining Chinook salmon returns to the Yukon River since 2000 have led to many commercial and subsistence fisheries closures, which resulted in economic disaster declarations (Brown et al., 2015). This may help to explain why the Interior Region had a more significant proportion of participants (45%) reporting a decrease in participation in fishing activities compared to the Western Coastal region (29%). The rising costs of equipment and fuel for travel to traditional harvest areas may also reduce participation (Brinkman et al., 2014), forcing a trade-off between working wage-employment jobs and having the time necessary to conduct THPs (Kofinas et al., 2010). Participants in the Interior Region more strongly agreed that fuel and energy costs had challenged THPs compared to the Western Coastal Region (Fig. 2).

Unlike the Interior Region, the extent of agreement that climate change has challenged harvest activities was a significant predictor of the change in health in THPs in the Western Coastal Region (Table 1, Fig. 5). The predictive importance in the Western Coastal Region may be related to coastal communities' distinct reliance on marine resources. In coastal communities, changes in the seasonality and extent of sea ice, coastal erosion, and stormwind and surge have major climate-induced effects on THPs and other aspects of rural life (Brubaker et al., 2011; Hansen et al., 2013b; Herman-Mercer et al., 2019; Huntington et al., 2016; Melvin et al., 2017). For example, Hauser et al. (2021) reported that the spring harvest of seals now ends ~26 days earlier than a decade ago because of earlier sea ice break up.

Despite the significant effects of climate change on change in health of THPs in the Western Coastal Region, both regions agreed that climate change had challenged THPs (Fig. 2). In Interior Alaska, climate change was identified as a challenge by participants reporting that THPs have improved and declined. Given the amplified warming across

the Arctic, it is expected that all regions will be experiencing an impact. Climate-related effects on THPs and rural communities' vulnerability to climate change have also been well documented in the Interior Region (Cold et al., 2020). In the Interior Region, climate impacts on THPs include the shifts in seasonality, unpredictable river ice, fluctuating water levels, erosion, and changing vegetation communities (Brown et al., 2018; Cold et al., 2020). Many of these factors have challenged safe and predictable access to traditional harvest areas at traditional times (Brinkman et al., 2016). Novel travel-safety concerns and increased uncertainty in environmental conditions have elevated stress within Indigenous households of both regions (Herman-Mercer et al., 2019).

Future Research

We recommend that future research address opportunities for bolstering and sustaining traditional food-sharing networks. This may include locally-supported and directed experimentation with different policies and actions that enhance the flow of foods to the most vulnerable households. Generational differences and factors such as household type, income, and educational level can influence sharing networks, social structure, and harvest productivity (BurnSilver et al., 2016; Keating et al., 2020; Ready & Power, 2018). Research on creative strategies for individual (e.g., household) and institutional (e.g., agency) adaption to climate change also is likely to be an increasingly pressing need (Brown et al., 2021). Incorporating flexibility (timing, duration) into fish and wildlife harvest regulations may help Indigenous communities cope with and overcome climate-related challenges (unpredictable, extreme, unseasonable environmental conditions) that can create barriers to participation in THPs when regulated harvest seasons are open (Brinkman et al., 2016). With the increased outmigration of rural community residents to urban areas, regulators may need to explore policy changes that help recent migrants maintain hunting and fishing opportunities as federally designated subsistence users in the rural areas they came from. This will improve food security while enhancing self-empowerment, a win-win scenario that cannot be achieved with government subsidies of non-local commercial goods. Linking research on nutrition and physical, psychological, emotional, and mental well-being with characteristics of THPs may create a more holistic understanding of Indigenous community resilience (Bersamin et al., 2019; Mohatt et al., 2007; O'Brien et al., 2017; Rasmus et al., 2014b). These issues can be sensitive topics and require extensive engagement and guidance by local communities to ensure that research adheres to appropriate and acceptable community protocols. Expanding monitoring of change in THPs in other regions of Alaska and the Arctic is warranted to

confirm the generalizability of our findings. Commonalities will inform the application of large-scale policies and recommendations for promoting well-being across Indigenous communities throughout the circumpolar North (Larsen & Fondahl, 2015).

Conclusion

The overall health of THPs during the last ten years has improved in the Western Coastal Region and declined in the Interior Region of Alaska. Our holistic investigation of multiple variables that affect or are affected by THPs highlighted key factors influencing trends in the health of THPs in Indigenous communities of Alaska during a time of rapid social, economic, and ecological change. Our study suggests that bolstering the flow of traditional foods among households, fostering participation in hunting and fishing activities, and supporting adaptation to climate-related stressors should be priorities for decision-makers (planning, regulation, policy) aiming to sustain healthy THPs. Policies that support and amplify opportunities for Alaska Native people to engage in their inherent rights to harvest traditional foods for community ceremonies, potlatches, funerals, and festivals are essential because social cohesion and sharing are fundamental components of these activities (Carothers et al., 2021; Fienup-Riordan, 2000). Region-wide assessments such as this one may provide meaningful, much-needed information that assists with prioritizing resources and research that support timely and adaptive decision-making and improve the effectiveness of sweeping policies. It is essential to recognize the value of THP's as the foundation for protective factors of well-being within Indigenous communities and ecological metrics that sustain the availability of traditional food resources.

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Data Availability The datasets generated from our surveys are not publicly available to ensure the privacy and confidentiality of the survey participants. However, they are available on reasonable requests from the corresponding author with approval from coauthors if requests do not compromise the confidentiality of survey participants.

Declarations

Informed Consent All research involving human subjects was reviewed and approved by the University of Alaska Fairbanks Institution Review Board (IRB# 5426513–13). All participants were informed about the project and asked to provide their informed consent prior to participating explicitly.

Conflict of Interest The authors have no financial or competing interests to declare that are relevant to the content of this article.

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