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Research article

Examining public preferences for wood smoke mitigation policies in the sub-Arctic

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A B S T R A C T

Outdoor air pollution is a significant problem worldwide. Policies developed to mitigate air pollution require support from local residents to be successful. While some research has examined various social and psychological metrics associated with support for some types of pollution mitigation, less is known about what variables are critical in resident support for different types of policies that help mitigate air pollution associated with woodsmoke. This research examined the extent that perceived health and economic risks, perceived uncertainties in measuring air quality and estimating risks, trust in government, and affect relate to support for three different types of outdoor wood smoke mitigation policies in Alaska. Using a multiple regression analysis of data obtained from a mail-based survey (n = 442), we characterized local affective associations with wood burning, economic concerns and health risks around heat options, perceived uncertainties, and levels of trust in government. The research identified several social and psychological variables that were important in understanding support for air pollution policies associated with wood smoke. Significantly, we found that perceived economic risk of not taking actions to mitigate outdoor air pollution from wood smoke was related to support for all three policy options. Trust in local government was positively correlated to support for education and regulatory policies, and perceived uncertainty was inversely related to support for regulations. The research also confirmed other known findings with respect to variables associated with support for air pollution regulation policies including perceived health risks and affect.

1. Introduction

Outdoor air pollution is a significant global environmental health risk [1]. Effective responses to addressing air pollution often require attention to the broader socio-economic context, including the linked issues of affordable energy and energy security, resource use, and wood burning, especially in regions with high heating costs [2]. Wood burning is of particular consequence in northern regions, as it represents a common means of heating, but can also contribute significantly to fine particulate pollution [3]. Consideration of the views of residents is key in policy development in shaping policy responses in the governance of environmental risks [4]. Three categories of mitigation policies are generally used: 1) education about the problem, which presumes that residents will act in ways that mitigate pollution if they learn about mitigation strategies; 2) financial incentives, which reward residents for acting in ways that mitigate pollution; and 3) regulatory, in which residents receive penalties for non-adherence to mitigation strategies [5]. However, we currently have an incomplete picture of the factors that lead to resident support for these various categories of mitigation policies to address air pollution.

A few studies have pointed to the idea that certain social and psychological factors, such as perceived health risks of pollution, affective associations towards heating sources, and sociodemographic variables, including age, gender, and education, might be

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important in determining resident's differential support for air pollution mitigation policies [6–8]. However, the role of perceived economic risks and uncertainties about the accuracy of air quality measurements have not been studied in the context of air pollution. There is reason to believe that these variables might be important, as they have come to the fore in studies of other types of policies, such as climate change mitigation [9–11]. Because there are temporal differences in how people experience climate change vs. air pollution (long-term vs. immediate), these factors may play out in different ways for the topic of air pollution. Further, the level of trust in government entities is likely an important driver of resident views and support for different kinds of policies [12], yet it has been understudied with respect to air pollution. Finally, the literature is lacking comprehensive studies that consider all of these factors in tandem with respect to levels of support across all three categories of mitigation policies [7,8]. Such a study has the potential to uncover important patterns in resident views and associations between variables that have previously been missed.

The work presented here undertook a study that takes all of these factors into consideration, asking how and to what extent perceived health and economic risks, perceived uncertainties about the reliability of outdoor air quality measurements, trust in government, and affect, are related to three policy options to address winter air pollution (education, financial incentives, and regulatory). Our study site, a sub-Arctic community, is an ideal backdrop in which to ask these questions, as it experiences extreme wintertime conditions. Wood burning is a common heating strategy in this setting, and residents may have affective associations towards this heating source [13]. The extreme conditions also mean that the cost of home heating is high, which may result in residents experiencing perceived tradeoffs between health and economic risks. Trust in government, or lack thereof, may also influence support for different policy options, and this may be in part linked to perceived uncertainties about accuracy of measurements and other areas [14,15]. The findings of this study have implications not only for the focal community, but for other northern communities that experience similar challenges with wintertime air pollution.

This research is grounded in theoretical approaches that have been used previously in investigations of public support for policies aimed at addressing air pollution. The investigation of risk and uncertainty draw on consequentialist approaches, such as theories of planned behavior or norm-activation models, whereby individuals make decisions based on assessments of the consequences of possible choices [16,17]. There are several potential risks to and impacts from elevated levels of $PM_{2.5}$, including health concerns, especially among sensitive populations, and economic concerns associated with declines in property value, increased health and medical expenditures, and the loss of federal highway transportation funds [1,18]. There are also economic considerations related to costs associated with addressing wood smoke mitigation, such as increased heating costs [19].

In addition to consequentialist approaches, other research emphasizes the emotional element of human behavior. This includes judgement, decisions, and behavior that are guided in part by experiential systems, which rely on associations that are linked to emotion and affect, or the positive and negative feelings about ideas, objects, or images [20,21]. Additionally, the level of perceived uncertainty can affect public confidence in policy decisions, encourage disparate risk assessments, and justify discounting threats [22]. There are multiple types of compounding uncertainties relevant to public understanding of air pollution, including monitoring and prediction, assessing potential risks, and estimating the impacts of policy interventions [23,24]. This is especially the case in the sub-Arctic where there is uncertainty in measuring and monitoring $PM_{2.5}$ due to operational and calibration challenges with instrumentation at extremely cold temperatures and uncertainty in quantifying the contributing sources to $PM_{2.5}$ [25]. Finally,

trust in government serves a central role in reducing the complexity of risk, facilitating cooperation, and supporting compliance [14,15]. There is emerging consensus that trust consists of two dimensions: confidence in abilities and trust in intent [26]. For potentially contested issues such as air pollution, trust includes individuals processing the information and institutions implementing policy changes at multiple levels of governance.

2. Methods

A mail-based questionnaire was used to understand support for three types of policies designed to address air pollution in the Fairbanks North Star Borough (FNSB), Alaska and their relationship to several social and psychological factors. Below we review the study area and methods used to understand these relationships. [See Supporting Information for the mail-based questionnaire (S1).]

2.1. Study area

The FNSB, with a population of just over 95,000 people, is located in a continental climate in the sub-Arctic where the summers may exceed 32 °C and winter temperatures may drop below −45 °C [27,28]. An extensive literature has documented wintertime air pollution in the FNSB [3]. Findings from these studies highlight high wintertime $PM_{2.5}$ concentrations across the region [29–31]. Cold winter temperatures, calm wind, low moisture, and temperature inversions are key geographic features contributing to high $PM_{2.5}$ concentrations within the FNSB [31]. Winter heating is a dominant factor affecting air pollution, and wood smoke from solid fuel heating devices is a major source of $PM_{2.5}$. One study indicated that in 2008–2011, woodsmoke contributed 60%–80 % of the measured PM2.5, varying at different sites [32], while a different method found woodsmoke was the largest single factor at 40 % in downtown Fairbanks [29]. More recent work analyzing data from 2009 to 2014 has identified 40 % of pollution from fresh woodsmoke and 12 % from aged smoke in downtown Fairbanks [33]. The most recent study, analyzing from 2013 to 2019 found woodsmoke was down to 19 % of pollution in downtown Fairbanks [34]. However, the FNSB violating monitor, located in North Pole, was not studied and prior work has shown that woodsmoke is a larger fraction of PM pollution at North Pole, so it is likely that FNSB air quality violations still have wood smoke as a major source. Improving source apportionment and understanding spatial distribution of pollution was a major focus of the ALPACA-2022 field study [35]. A 2010 survey of heating devices in the FNSB nonattainment area found that ∼23 % were wood-burning stoves or fireplaces [36]. Affordable energy is a major concern for residents and wood burning often increases as other fuel prices increase [13].

A portion of the FNSB was designated as a $PM_{2.5}$ nonattainment area by the Environmental Protection Agency (EPA) in 2009 for failing to meet the revised 24-h national ambient air quality standards [37], which is currently set at 35 μg/m^3 (Fig. 1). Violation is related to the annual 98th percentile of the 24-h $PM_{2.5}$ concentration averaged over three years. In the FNSB, violations are most likely to occur in December and January [38]. Summers can also have spikes of $PM_{2.5}$, but since wildfires are not considered controllable, these days are considered exempt from the FNSB regulatory issue. The nonattainment area was later partitioned into three zones (Table 1), which enabled the development of sub area-specific control measures [39]. Regional differences in population, households, wood burned annually, political ideologies, and experiences with air quality advisories that restrict the use of wood stoves suggest there may be differences in support of wood smoke mitigation policies, perceived health and economic risks, and trust in government within the FNSB nonattainment area.

In response to a nonattainment status designation, a Moderate State Implementation Plan (SIP) was submitted by the State of Alaska, Department of Environmental Conservation (DEC) to the EPA. The moderate SIP outlined plans and strategies to assess and characterize the problem, evaluate options to mitigate air pollution, and adopt a series of multiple regulatory, financial incentive, and education-based policies designed to attain compliance with the National Ambient Air Quality Standards [43]. Within the FNSB, an Air Pollution Control Commission (APCC) developed an air quality framework that outlined four goals to reduce $PM_{2.5}$: establish policies to address solid fuel fired devises contributing to $PM_{2.5}$ and energy efficiency; remove economic obstacles to address air pollution; ensure all members of the community understand responsibilities for achieving compliance; and develop technological solutions that address alternative sources of heating and energy efficiency [44]. Although $PM_{2.5}$ concentrations have declined since the implementation of the 2015 Moderate SIP [30], a Serious SIP was submitted to the EPA in 2019 as $PM_{2.5}$ concentrations still exceeded air quality standards [45].

Addressing air pollution and wood smoke in the FNSB is contested due to competing concerns about economic impacts, public health risks, and threats to self-determination [44]. These circumstances have contributed to several changes in mitigation policies to address $PM_{2.5}$. Although several FNSB Assembly and voter initiatives were passed since 2009 to regulate $PM_{2.5}$ and attain compliance with the Clean Air Act, FNSB voters also narrowly passed the Home Heating Reclamation Act in 2018, which removed the borough's authority to regulate home heating devices, enforce burn bans, and issue air quality alerts [44]. Air quality enforcement now falls under the Alaska DEC. Further there are issues of distrust. For example, by 2014 over 1400 wood stoves were replaced in the FNSB as part of a woodstove change out program that offered financial incentives for residents to replace or remove older and more polluting stoves [44]. However, more stringent EPA emission standards for wood stoves in 2015, known as the New Source Performance Standards, meant that some of the recently replaced stoves were in non-compliance.

Although significant research has investigated winter air pollution in the FNSB and wood stove use [29–32,36], there remains a more limited understanding of community preferences for different strategies to address winter air quality, their perceived heath and economic concerns, trust, and perceived uncertainties. Understanding these preferences and priorities, including how they vary across

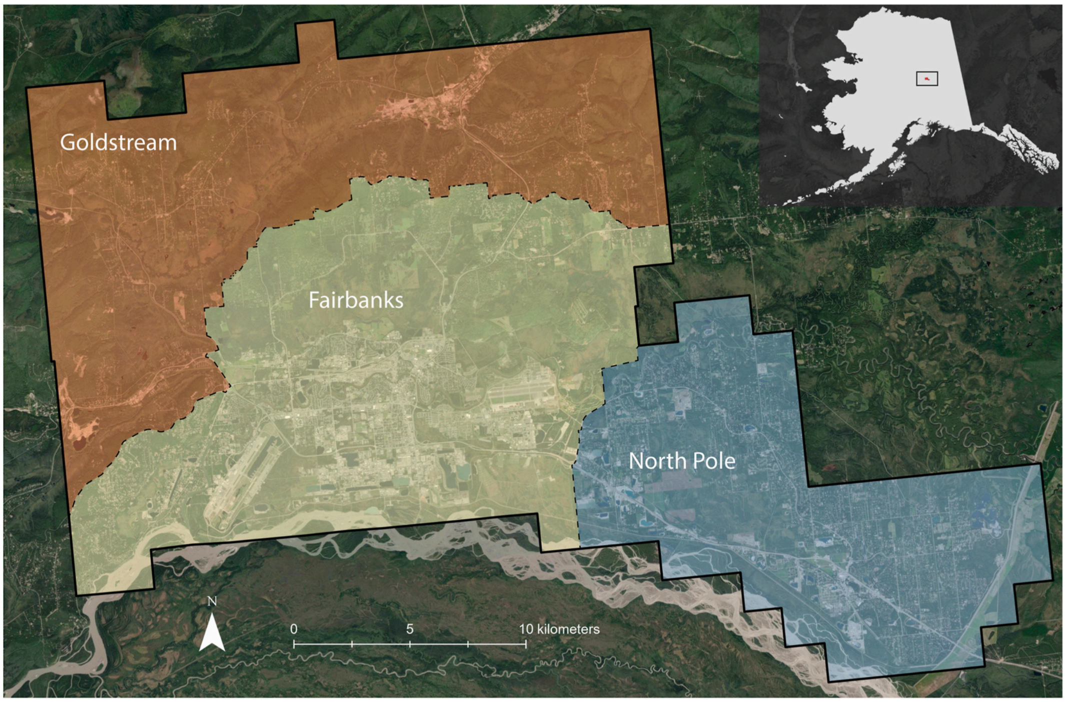

Fig. 1. $PM_{2.5}$ nonattainment area for the Fairbanks North Star Borough, Alaska. Data sources: [40,41].

Table 1
Characteristics of the three control zones within the FNSB nonattainment area.

	Population	Households	Burn advisory cumulative days 2018/19–2021/22 (x; Range)	Cords of wood burned annually by houses with a wood stove
Fairbanks	57,746	25,013	34.8; 20.5–50.7	3.5
Goldstream	5783	2871	0; 0	3.5
North Pole	19,910	8259	41.9; 35.9–48.8	5.2

Data for population and households, burn advisory cumulative days, and chords of wood burned annually were obtained or generated from the following sources, respectively [28,36,42]. The Goldstream zone has no active regulatory grade monitoring stations, so there no basis to call advisories.

the nonattainment zones, serve an important role in achieving EPA compliance in ways that address economic considerations, individual choices, and a healthy environment [44].

2.2. Questionnaire design

Residents (n = 3000) within the FNSB nonattainment area were randomly selected to participate based on a mailing list purchased from a national marketing organization. The only sample frame criterion was that individuals must be the age of 21 years or older. This included individuals within each of the three control zones in the FNSB nonattainment area, including Fairbanks (n = 1895), Goldstream (n = 371), and North Pole (n = 734). A detailed discussion of questionnaire design and the linear regression modeling methods are discussed below. The research protocol for this project was approved by the University of Alaska Fairbanks, Institutional Review Board (IRB: #1455084). Participants were provided an information sheet that outlined informed consent. IRB waived signed consent as there was minimal risk of harm to participants and the project involved no procedures where written consent is normally required outside the research context.

Questionnaire design began with a literature search to identify the major sources of perceived economic and health risks, perceived uncertainties, and key policies related to winter air and wood burning. Seven interviews (58 % response rate) with representatives from the Fairbanks Air Quality Stakeholders Group were then conducted to verify key themes identified in the literature review [46]. Interviewees were selected based on a maximum variation purposeful sampling technique, which included staff from local and state government and individuals with interests and experience in public health and wood burning.

Support for regulatory, financial incentive, and education-based wood smoke mitigation policies were measured with several six-point Likert-type item questions (Table 2). Perceived economic and health risks, perceived uncertainty, and trust were assessed with 39 Likert-type items (Table 3). Affect was assessed by participants providing three words or phrases relating to using wood to heat homes and rating their feelings towards them (Table 3). These items reflected the key themes that emerged in the literature and previous semi-structured interviews.

Participants then evaluated their response quantitively based on a six-point bi-polar affect ranking (very negative to very positive), an approach frequently used to measure affect [6,8,47]. Using an inductive content analysis approach, participant affective responses were thematically coded. Themes with less than 10 affective associations were coded as other. Questions about use of wood stoves were not asked to reduce public burden and confusion, as there were other surveys about heating practices in Fairbanks and North Pole occurring at the time of this survey and the State of Alaska was planning an additional survey specifically targeting wood stove use the following year [48]. Additionally, asking personal questions about personal use of wood stoves, which may be perceived as threatening, sensitive, or intrusive, may lower responses from wood burning community, thus introducing bias into the results [49]. For

Table 2
Likert-type item and bi-polar questions used to create scales for the mitigation policies. Survey questions: Please rate your level of support or opposition for the following [regulations, financial incentives, or education programs] designed to address winter air quality in the Fairbanks North Star Borough nonattainment zones.

Scale	α	Likert items and bi-polar question(s)
Woodstove regulations	0.93	(a) ban wood burning when air pollution is high, except when no other adequate source of heat (NOASH) is available; (b) restrict the installation of wood burning stoves in new homes; (c) require non-certified wood heating devices to be replaced when a property sells; (d) Impose stricter emission standards for wood burning stoves installed in FNSB; (e) fine households that emit excessive smoke repeatedly; (g) require users of wood burning stoves to use different heating fuels when air pollution levels are high; (h) ban outdoor wood-fired boilers and stoves (hydronic heaters) – these stoves often have higher levels of wood smoke pollution than indoor heaters
Financial incentives	0.86	(a) provide free moisture meters to help determine if wood is dry; (b) provide financial incentives to replace old wood stoves with stoves that have stricter emission standards; (c) provide financial incentive for installing alternative heating systems if wood heaters are removed; (d) provide financial incentives for bringing in wood burning stoves and heaters, no strings attached; (e) provide fuel allowances/assistance to help offset costs of non-wood sources of heat during poor air quality days
Education programs	0.93	(a) how to properly use wood burning stoves; (b) how to properly store and dry firewood; (c) allowable fuels for wood burning stoves; (d) the current air quality and how conditions may change; (e) current regulations on wood burning; (f) the current financial incentives available to address winter air quality; (g) the public health risks of poor winter air quality

Note: Likert item response formats for each of the scales were as follows: strongly support, somewhat support, slightly support, slightly oppose, somewhat oppose, strongly oppose, I don't know.

Table 3
Likert items used to create perceived health and economic risk, perceived uncertainty, trust, and affective association scales. See (S1) for the exact question wording.

Scale	α	Likert items and bi-polar question(s)
Perceived outside health risks (Heath risks)	0.93	How concerned are you about the following potential health risks related to wood smoke in Fairbanks and North Pole during the winter when you are outside? (a) my immediate health, such as eye irritation, coughing, difficulty breathing, or aggravated asthma, and other short-term effects; (b) my long-term health, such as impacts to my heart and lungs; (c) the health of my family; (d) the health of children, elderly, or other sensitive populations
Perceived economic risks of programs designed to reduce wood smoke (Econ risks – action)	0.86	Please rate your level of concern about the potential economic impacts of programs designed to reduce wood smoke in Fairbanks and North Pole. (a) reduced property value due to restrictions on wood stoves that provide a primary or secondary source of heat; (b) increased energy costs of using non-wood sources of heat; (c) disproportionate impacts to low-income households; (d) loss of local jobs and economies
Perceived economic risks of not addressing wood smoke (Econ risks – inaction)	0.93:	Please rate your level of concern about the potential economic impacts of not addressing wood smoke in Fairbanks and North Pole. (a) increased medical costs; lost wages and productivity; (b) loss of federal highway transportation funds; (c) reduced property values because of nearby heavy polluters; (d) loss of local jobs and economies
Trust in State of Alaska (Trust AK)	0.86	Please rate your level of agreement for the following statements related to trust in state-level government. (a) provides all of the available information when making decisions about air quality; (b) has similar opinions as I do about air quality; (c) has sufficient staff expertise to implement air quality policies; (d) Has sufficient financial resources to implement air quality policies; (e) considers many perspectives when making decisions about air quality; (f) has too many conflicts of interest to address winter air quality[a]; (g) enforces air quality alerts in a fair and reasonable manner; (h) has sufficient resources to forecast accurately poor air quality days used to issue advisories and alerts
Trust in FNSB (Trust FNSB)	0.83	Please rate your level of agreement for the following statements related to trust in the Fairbanks North Star Borough. (a) provides all of the available information when making decisions about air quality; (b) has similar opinions as I do about air quality; (c) has sufficient staff expertise to implement air quality policies; (d) Has sufficient financial resources to implement air quality policies; (e) considers many perspectives when making decisions about air quality; (f) has too many conflicts of interest to address winter air quality[a]
Perceived uncertainty (Uncertainty)	0.92	Please rate the level of uncertainty associated with the following aspects of winter air quality in Fairbanks and North Pole. (a) how accurately monitoring stations report air quality where I live; (b) measuring the amount of air pollution that is from wood smoke, compared to other sources; (c) the health impacts from breathing wood smoke; (d) estimating the economic impact of policies that regulate wood stoves; (e) the accuracy of certification tests for wood stoves provided by the Environmental Protection Agency; (f) estimating the average winter air quality 5 years into the future; (g) changes in state or local policies that regulate wood and wood stoves; (h) the accuracy of air quality forecasts that are used to issue advisories and alerts
Affective association (Affect)	0.75	Think about the phrase 'Using wood to heat home in Fairbanks and North Pole' for a moment. When you hear this phrase, what comes to your mind first? This could include sights, sounds, smells, ideas, or words. Please write these words or phrases down and rate your feelings about them.

Note: Likert item response formats for each of the scales were as follows: Health and economic risks (not, slight, somewhat, moderate, very, extreme); Trust (strongly disagree, somewhat disagree, slightly disagree, slightly agree, somewhat agree, strongly agree); Uncertainty (certain, slightly uncertain, somewhat uncertain, moderately uncertain, very uncertain, extremely uncertain). Participants were given the option of I don't know for each question.

[a] Inverse response values were used increasing the scale.

example, participants may feel that disclosing personal information about household wood burning devises and use may incur negative consequence, and thus be less likely to complete the survey.

The mail-based questionnaire was implemented between March and April 2022, which included several steps to increase the response rate [50]. A pre-notice letter was mailed to each participant to describe the purpose and voluntary nature of the project. A week later, the questionnaire was mailed to each participant, which included first-class postage with a business reply for return mailings. All participants received a combined thank you and reminder post card a week after the questionnaire was mailed. Only a single mailing and reminder letter were used, as opposed to a multiple wave survey, as there were other upcoming mail-based surveys in the FNSB regarding home heating, air quality, and fuel use. We coordinated our research with personnel from other survey projects to clarify messaging and differences between the questionnaires as well as ensure that methods used in one project would not adversely affect outcomes on other survey projects (e.g., multiple waves in one survey may reduce responses in different survey; reduce duplication of questions).

2.3. Sample description

The questionnaire response rate was 14.7 % (n = 442). Response rates were slightly higher in the Goldstream zone (22.6 %, n = 84) compared to Fairbanks (13.5 %; n = 257) and North Pole (13.7 %; n = 101). The margin of error (95 % confidence level) for these samples are as follows: FNSB nonattainment area (4.6 %), Fairbanks zone (6.1 %), North Pole zone (9.7 %), and Goldstream zone (10.7

%). Participants provided socio-economic data, including gender, income, age, and education (Table 4). Compared to the population of the FNSB nonattainment area, the sample overrepresented people identifying as white (87 % vs 80 %) and underrepresented people identifying as black (3 % vs. 5 %). Differences between the population and survey responses for Alaska Natives and Pacific Islanders were less than 1 %.

2.4. Data analysis

Three ordinary linear regression analysis models were used in the JMP statistical software package to test the relationships among support ($Support_i$) for three different mitigation policies and the role of perceived health and economic risks, perceived uncertainty, trust, and affect. The general model equation (Equation (1)) was:

$$\text{Support}_i = \text{HealthRisks}_i + \text{EconRisks inaction}_i + \text{EconRisks action}_i + \text{Trust AK}_i + \text{Trust FNSB}_i + \text{Uncertainty}_i + \text{Affect}_i + \varepsilon_i \quad (1)$$

Each of the three scales measuring support mitigation policies (Table 2) and seven scales assessing social and psychological factors (Table 3) were created by taking the mean of participant responses to several Likert-item and bi-polar questions. Summary statistics were calculated for the entire FNSB nonattainment area and each of the three zones (Fig. 1). These data, created by aggregating multiple items into a single scale, are treated as interval data in this research. Although individual Likert-type item responses produce ordinal data, aggregating multiple Likert-item questions with 5- to 7-point response formats produces data that are not significantly different than continuous data [51]. Each scale held a high level of internal reliability, as indicated by the interpretation of Cronbach's alpha (α). Interpretation of Spearman's ρ (Table 5) suggested that some scales were strongly correlated, including trust in the FNSB and trust in the State of Alaska ($\rho = 0.70$), perceived health risks and the economic impacts of not addressing wood smoke ($\rho = 0.69$); and uncertainty and trust in FNSB ($\rho = 0.60$). However, a review of factor loadings from a principal components analysis (with varimax rotation), revealed that the data may be treated as separate dimensions. Specifically, all measures of perceived uncertainty and trust in FNSB loaded on different factors, all measures of perceived economic risks of inaction and perceived health risks loaded on different factors, and four of the six trust FNSB measures loaded on Factor 1 and five of the eight uncertainty factors loaded on Factor 2.

3. Results

The following section summarizes the findings for each of the scales, support for each of the three types of wood smoke mitigation policies, and the regression analysis. The FNSB nonattainment area refers to the entire study region. Zones refer to the Fairbanks, Goldstream, and North Pole regions within the FNSB nonattainment area.

3.1. The scales: perceived economic and health risks, perceived uncertainty, trust, and affect

Analysis of the questionnaire findings revealed several insights into perceived health and economic risks, perceived uncertainties, trust in government, and affective associations relating to wood burning and air pollution among residents in the FNSB nonattainment area (Fig. 2). A total of 867 affective associations of wood burning and their corresponding ratings were elicited, with an average of 1.96 responses per participant. Twenty-one distinct categories of affective responses were identified with at least 10 similar responses, representing 60.44 % of the total responses. The economics of wood burning, including cost effectiveness and affordability was the most frequently mentioned association (11.07 %). Other frequently identified associations were general descriptions of air pollution, including the aesthetics, air quality, and smoke (7.84 %), warmth (6.57 %), coziness and comfort (6.34 %), bad smells (6.11 %), health concerns (4.73 %), sustainability and renewable (4.50 %), practices of wood burning (4.38 %), and good smells (4.38 %). Some affective associations of wood smoke were not consistently negative nor positive. Of the individuals providing at least two affective

Table 4
Sample description (%).

Gender		Education	
Female	33.5	High school diploma	31.7
Male	64.2	Bachelor's degree	37.6
Other	2.3	Master's degree or higher	30.7
Age		Race	
18–25	1.0	American Indian/Alaska Native	8.3
26–35	9.0	Asian	1.1
36–45	15.4	Black	3.2
46–55	16.2	Hawaiian/Pacific Islander	0.3
56–65	22.1	White	87.1
>65	36.8		
Income ($)			
<25,000	7.7		
25,000–49,999	16.0		
50,000–99,000	34.2		
100,000–149,999	24.8		
>150,000	17.4		

Table 5
Spearman's ρ correlation coefficients for perceived health and economic risk, perceived uncertainty, trust, and affect scales.

Scale	Heath risks	Econ risks - action	Econ risks - inaction	Uncertainty	Trust FNSB	Trust AK	Affect
Heath risks							
Econ risks - action	−0.18***						
Econ risks - inaction	0.69***	−0.10*					
Uncertainty	−0.37***	0.30***	−0.48***				
Trust FNSB	0.33***	−0.29***	0.46***	−0.60***			
Trust AK	0.26***	−0.23***	0.32***	−0.57***	0.70***		
Affect	−0.47***	0.40***	−0.39***	0.37***	−0.31***	−0.21***	

Note: *$p \leq .05$, two-tailed test. ***$p \leq .001$, two-tailed test.

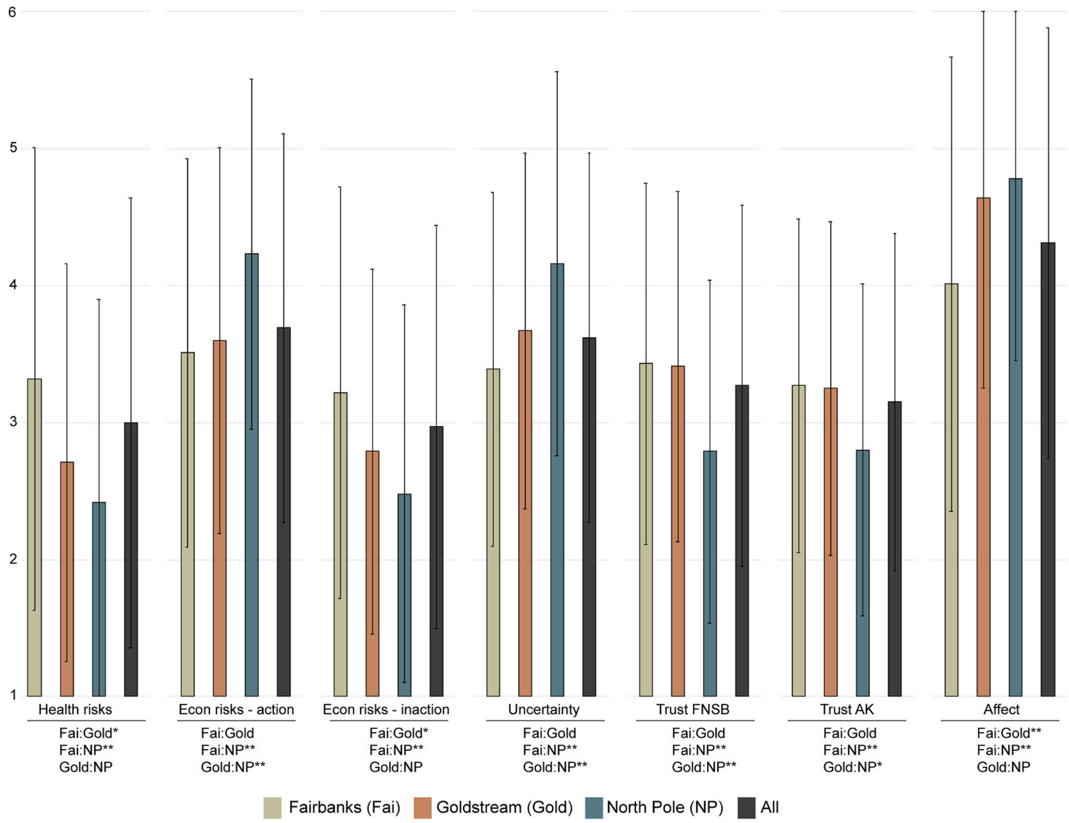

Fig. 2. Mean response values and standard deviations for dependent variables. Mean responses from 1 to 6, with high values representing higher perceived health and economic risks, perceived uncertainty, trust, and positive affective associations. Significant differences between the scales are represented by an asterisk (*$p \leq .05$; **$p \leq .01$). Kruskal-Wallis tests were used to assess the overall differences and Mann-Whitney U tests were used for pairwise comparisons. Sample sizes for the dependent variables are as follows: health risk (n = 437); econ risk – action (n = 433); econ risk – inaction (n = 436); affect (n = 320); trust FNSB (n = 415); trust AK (n = 408); uncertainty (n = 408).

associations and ratings, 19.01 % provided both very positive and very negative responses.

Overall, economic risks of efforts designed to address wood smoke were perceived to be greater than public health risks and economic risks of inaction. The high level of perceived economic risks of taking action to address air pollution may be related to the high heating costs and limited number of affordable alternative energy sources across the study area. Individuals held significantly higher trust in local FNSB government than the State of Alaska ($p \leq .01$). Several participants provided unsolicited feedback on various dimensions of trust in the FNSB adjacent to their closed ended Likert-type response options such as distrust in the FNSB due to financial conflicts of interests with regard to their support for natural gas. Participants perceived that there were *somewhat* to *moderate* levels of uncertainty associated with the measurement of wintertime air quality, assessment of impacts, and policy responses.

There were some differences within zones of the FNSB nonattainment area (Fig. 2). Perceived health and economic risks from not addressing wood smoke were significantly higher in Fairbanks compared to North Pole ($p \leq .01$) and Goldstream ($p \leq .01$ and $p \leq .05$, respectively). Similarly, residents of North Pole held significantly higher affective associations with wood burning and greater concern about the potential economic impacts of programs designed to reduce wood smoke compared to Fairbanks and Goldstream ($p \leq .01$).

Residents of North Pole also held significantly lower ($p \leq .05$) trust in the FNSB and State of Alaska and perceived greater uncertainty ($p \leq .01$) compared to Fairbanks and Goldstream.

3.2. Support for regulatory, financial incentives, and education programs

Within all zones of the FNSB nonattainment area, respondents held the lowest support for regulatory policies, moderate support for financial incentives, and the greatest support for education programs designed to address wood smoke pollution (Fig. 3). Support for each of the three policy options to address air pollution varied across zones within the FNSB nonattainment area. Overall support for regulatory, financial incentives, and education programs to address winter air pollution were significantly higher ($p \leq .05$) in Fairbanks compared to North Pole. Residents in Goldstream also held significantly higher support for regulation ($p \leq .01$) and education programs ($p \leq .05$) than in North Pole.

3.3. Predicting support for policies designed to address air pollution

Across the entire FNSB nonattainment area, interpretation of the adjusted R^2 values R^2_{adj}) suggests that the model for predicting support for regulation ($R^2_{adj} = 0.74$) was a better fit than the models for education programs ($R^2_{adj} = 0.32$) and financial incentives ($R^2_{adj} = 0.20$). All of the factors, except trust in the State of Alaska, were significant in support for regulatory policies ($p \leq .05$). Only two factors were significant in support for financial incentives and education programs (Table 6).

Greater perceived economic risks from inaction to address wood smoke pollution was associated with a significantly higher support for all three wood smoke mitigation policies. Other factors were significant for two of the three policy options. Perceived health risks were significant and positive in support for regulation ($p \leq .01$) and financial incentives ($p \leq .05$), but not significant for education programs. Additionally, greater trust in the FNSB was related to significantly higher support for regulation ($p \leq .01$) and education programs ($p \leq .05$), but not for financial incentives. Affect, perceived uncertainty, and the perceived economic risks of actions designed to address wood smoke pollution were only significant in support for regulation. Specifically, greater support for regulatory policies was significantly related to lower positive affective associations with wood burning ($p \leq .01$), lower perceived uncertainty ($p \leq .05$), and lower concerns about the economic risks of acting ($p \leq .01$). Trust in the State of Alaska was not significantly related to support for any of the three policy options.

4. Discussion

This research provided insights into several social and psychological variables not examined extensively in the literature with respect to support for various types of mitigation policies designed to address air pollution—educational, regulatory, and financial.

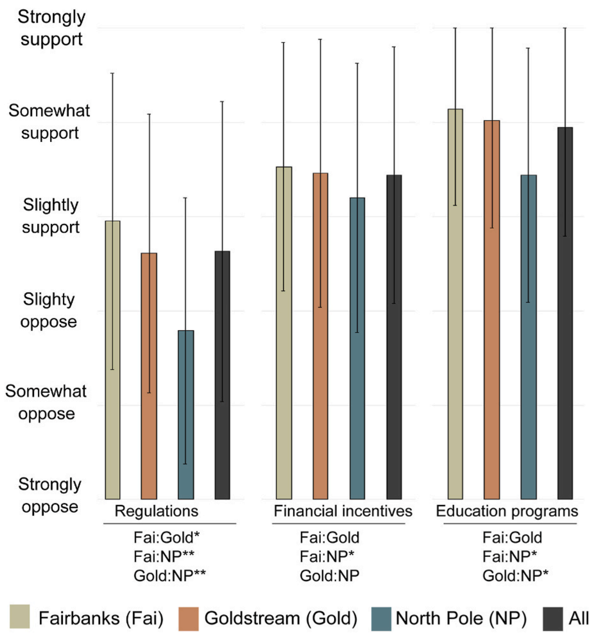

Fig. 3. Support for policies to address air pollution. Standard deviations are represented by whiskers. Significant differences between the scales, are represented by an asterisk (*$p \leq .05$; **$p \leq .01$). Kruskal-Wallis tests were used to assess the overall differences and Mann-Whitney U tests were used for pairwise comparisons. Sample sizes for the independent variables are as follows: regulation (n = 409); financial incentives (n = 433); education programs (n = 432).

Table 6
Parameter estimates, standard error, t-ratio, and significance for the relationship between perceived health and economic risks, perceived uncertainty, trust, and affect on support for three policies designed to address air pollution across the entire FNSB, Alaska nonattainment zone.

	Scale	Estimate	S.E.	t Ratio	Sig.
Regulations	**Health risk**	**0.270**	**0.052**	**5.13**	**<0.0001**
	Econ risk - action	**−0.289**	**0.042**	**−6.77**	**<0.0001**
	Econ risk - inaction	**0.249**	**0.058**	**4.23**	**<0.0001**
	Affect	**−0.209**	**0.039**	**−5.32**	**<0.0001**
	Trust FNSB	**0.215**	**0.062**	**3.46**	**0.0006**
	Trust AK	0.012	0.064	0.18	0.8573
	Uncertainty	−0.120	0.054	−2.21	0.0280
Financial incentives	**Health risk**	**0.156**	**0.078**	**2.00**	**0.0467**
	Econ risk - action	−0.013	0.063	−0.20	0.8398
	Econ risk - inaction	**0.170**	**0.087**	**1.94**	**0.053**
	Affect	−0.027	0.058	−0.46	0.6478
	Trust FNSB	0.136	0.092	1.47	0.1424
	Trust AK	0.015	0.096	0.16	0.8766
	Uncertainty	0.016	0.080	0.20	0.8448
Education programs	Health risk	0.078	0.061	1.27	0.2037
	Econ risk - action	−0.030	0.049	−0.61	0.5454
	Econ risk - inaction	**0.210**	**0.068**	**3.06**	**0.0024**
	Affect	0.004	0.045	0.09	0.9244
	Trust FNSB	**0.225**	**0.072**	**3.09**	**0.0022**
	Trust AK	0.012	0.075	0.16	0.8698
	Uncertainty	−0.050	0.063	−0.73	0.4639

Bold text refers to significant values. Standard Error (S.E.). Adjusted R-square values: Regulations (0.74); Financial incentives (0.20); Education programs (0.32). Parameter estimates represent the Beta values.

Below, we elucidate which variables were most important with respect to support for different policy types.

Most significantly, we found that perceived economic risk of inaction (that is, not responding to the threats of woodstove smoke) was the most important variable across the sample, and that such risks were positively related to greater support for all three types of mitigation policies (regulatory, educational, and financial). This is an important finding, as the role of economic risks of not taking action in the context of air pollution had not been examined previously. Perceived economic risk has previously been found to be an important factor in support for other environmental and public health protection efforts [52,53]. This, along with our results, suggests that perceived economic risks might be a central factor in public decision making about mitigation approaches more generally.

Looking into the variation across zones with respect to perceived levels of economic risk gives us insight into how these variables might be a function of personal experiences. For example, residents in Goldstream and Fairbanks were more concerned than North Pole residents about the economic risks of not taking action to mitigate woodsmoke. This might reflect the higher affective associations of North Pole residents towards woodburning, as well as the fact that North Pole residents burn more cords of wood annually. Individuals who cut their own wood might see a significant cost savings given the high costs of heating oil in the North; thus, the economic risks of not taking action to mitigate woodsmoke may not seem as significant as the economic risks of restricting wood burning. North Pole residents have also experienced more frequent wood burning bans relative to Goldstream and Fairbanks residents (Table 1), which might also play a role. Further research is needed to understand how previous experiences with specific environmental policies relate to public acceptance and support [54].

Trust was also an important crosscutting variable in our study—specifically, we found that trust in local government correlated positively to support for both educational and regulatory policies. This overarching positive association between trust in local government and support for regulation and educational programs suggests a willingness to cede power to local authorities to address air pollution when trust is high. However, we saw variations in levels of trust in government across the different study zones. Such variations are likely related to political ideology, previous experience with local and state government, and perceived conflicts of interest [55]. For example, participants who invested in new woodstoves through changeout programs to uncertified stoves may distrust state and local governments after learning that newly purchased stoves were not properly tested and certified before reaching consumers [56]. More stringent EPA emission standards for woodstoves in 2015 may have also contributed towards distrust in local and state government, as some previously replaced stoves were now in non-compliance.

This is the first study to our knowledge that demonstrates a significant relationship between trust in government and support for regulatory policies to address air pollution. Importantly, our approach disaggregated types of government. Our results suggest that trust can vary across levels of government—specifically, one might trust a local government body while distrusting government at the state level, and that this has implications for support of different kinds of mitigation policies. Differences in our research findings and other research are likely related to a limited number of Likert items used in trust scales in other studies that limit scope and not disaggregating trust in government across levels of jurisdiction [57].

Health risk was a variable that crosscut support for both regulatory and financial incentives. Specifically, we found that the greater the perceived health risk, the more residents were in support of these two types of policies. This result is consistent with previous research highlighting how greater perceived health risks are positive and significant in support for wood smoke mitigation policy [6,8].

No other variables predicted support for multiple types of mitigation policies. Instead, we found three additional variables that were negatively related to support for regulatory policies: perceived uncertainty, affect, and perceived economic risk of action. Our findings on the linkages between perceived uncertainty and support for wood smoke mitigation policies, which to our knowledge have not been investigated previously, suggest that perceived uncertainty is negatively related to support for regulatory policies, and that individuals appear to be willing to bear more such uncertainty in their support for financial incentives and education programs, but not regulatory approaches, designed to address air pollution [58]. Further disaggregating the role of different types of perceived uncertainty on support for wood smoke mitigation policy may reveal differences in effect, such as perceived uncertainties associated monitoring, assessing risks and impacts, and policy responses, as demonstrated by other literatures [9]. With respect to affect, we found that high levels of affect towards woodstoves were negatively correlated with support for regulatory policies. Given that affective associations are linked to emotions and experiential systems, this result is not surprising, as it suggests that individuals who are attached to their woodstoves are not in favor of regulations limiting woodburning. The specific affective associations that we found, as well as the relationship between affect and regulation, were similar to those identified in other research relating to air pollution and wood burning [59–61]. With respect to perceived economic risks of taking action, we found that greater concerns about the potential adverse economic outcomes associated with programs to reduce wood smoke were related to lower levels of support for regulation. These findings are consistent with other research suggesting that higher perceived benefits associated with woodburning are associated with lower support for regulations [7].

In sum, we have presented new findings around perceived economic risks, perceived uncertainty, and trust, while also bringing forth findings that are consistent with previous research on public support for policies to address air pollution [6–8,57,62]. The lower level of support for regulatory policies, relative to education and financial incentive approaches, provide additional evidence that individuals prefer non-coercive options over disincentives, especially when policies target behaviors that have high economic costs [7,63].

Taken together, these findings suggest that educational and/or financial incentive policies designed to mitigate woodsmoke-related air pollution might find the most resonance in communities that have similar characteristics to those in the study, and that policy makers might find that regulatory policies are less successful with such communities. Given that we looked at associations between variables, rather than causation, we suggest that more specific policy recommendations might be developed from further research that tests causal relationships between variables. For example, a pilot test could examine how negative affective imagery linking wood smoke exposure to public health concerns affects support for regulatory air quality policies. Likewise, other experimental approaches could examine the effect of public messaging around the economic impacts of not taking action on support for regulatory, education, or financial incentive policies. Such approaches require attention to several features to reduce erroneous conclusions, including sensitivity analyses to show effects of alternative variables and data, assessments of stationary and critical examination of the statistical techniques used [64].

There are some limitations to our study. Although multiple steps were taken to increase the survey response rate, including a monetary incentive, first-class mail and return postage, colored ink printing, a pre-notice letter, and a follow-up reminder [50], our questionnaire received a 14.7 % response rate. Low survey response rates have the potential to introduce measurement error and sampling bias if the sample is not representative of the population [65]. However, given our overall sample size (n = 442) and representativeness of our sample (Table 4), we feel reasonably confident that our results hold validity, especially given that members of our team engaged with large subsections of the population through community meetings in which some of the patterns here were anecdotally represented [66,67]. Future studies might focus on obtaining a larger sample size, which could support assessments of regional variation of how social and psychological factors are related to support for air pollution policies.

5. Conclusion

Our study captured several new and confirmed other known findings with respect to variables that predict support for three air quality policies designed to address outdoor wood smoke: regulatory approaches, financial incentives, and education. Perceived economic risks of inaction (not mitigating woodsmoke) was the only factor that predicted support for all three policy options, while perceived economic risks of action (taking steps to mitigate woodsmoke) were only related to support for regulations. The development of publicly-supported policies to address the linked issues of winter air pollution, affordable energy, and woodburning thus require considerations of the economic tradeoffs between action and inaction. We also found that trust in local government is critical in support for regulatory and educational programming controlled by local jurisdictions, a new finding. The level of perceived uncertainty is negatively related to support for regulatory approaches, providing new insights into its role in affecting public confidence and risk assessments for wood smoke mitigation policies. Affective associations and experiential systems are significant in lower support for regulatory approaches, but less relevant in support for financial incentives and educational programs.

Data Availability

Data supporting the research findings are not available due to privacy and ethical considerations. Participants of this research did not give content that their individual responses would be shared publicly. The data that have been used are confidential. Questions may be directed to the University of Alaska Fairbanks, Institutional Review Board, Office of Research Integrity at uaf-irb@alaska.edu.

CRediT authorship contribution statement

Nathan P. Kettle: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Laura D. Carsten Conner:** Writing – review & editing, Funding acquisition. **Krista Heeringa:** Writing – review & editing. **William R. Simpson:** Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e36171.

References

[1] I. Manisalidis, E. Stavropoulou, A. Stavropoulos, E. Bezirtzoglou, Environmental and health impacts of air pollution: a review, Front. Public Health 8 (2020) 1–13.
[2] R. Reyes, A. Schueftan, C. Ruiz, A. Gonzalez, Controlling air pollution in a context of high energy poverty levels in southern Chile: Clean air but colder houses? Energy Pol. 124 (2019) 301–311.
[3] W. Simpson, J. Mao, J. Fochesatto, K. Law, P. DeCarlo, J. Schmale, K.A. Pratt, S.R. Arnold, J. Stutz, J. Dibb, J. Creamean, R. Weber, et al., Overview of the alaskan layered pollution and chemical analysis (ALPACA) field experiment, ECS EST Air 1 (2024) 200–222.
[4] B. Anderson, T. Bohmelt, H. Ward, Public opinion and environmental policy output: a cross-national analysis of energy policies in Europe, Environ. Res. Lett. 12 (2017) 114011.
[5] EPA, Strategies for Reducing Residential Wood Smoke, vol. 45, Environmental Protection Agency, Washington DC, 2012.
[6] A. Boso, A. Hofflinger, C. Oltra, B. Alveraz, J. Garrido, Public support for wood smoke mitigation policies in south-central Chile, Air Quality, Atmosphere, & Health 11 (2018) 1109–1119.
[7] N. Bhullar, D. Hine, A. Marks, C. Davies, J. Scott, W. Phillips, The affect heuristic and public support for three types of wood smoke mitigation policies. Air Quality, Atmosphere, & Health 7 (2014) 347–356.
[8] D. Hine, A. Marks, M. Nachreiner, R. Gifford, Y. Heath, Keeping the home fires burning: the affect heuristic and wood smoke pollution, J. Environ. Psychol. 27 (2007) 26–32.
[9] N. Kettle, K. Dow, The role of perceived risk, uncertainty, and trust on coastal climate change adaptation planning, Environ. Behav. 48 (2016) 579–606.
[10] M. Aklin, J. Urpelainen, Perceptions of scientific dissent undermine public support for environmental policy, Environ. Sci. Pol. 38 (2014) 173–177.
[11] D. Gugushvili, A. Otto, Determinants of public support for eco-social policies: a comparative theoretical framework, Soc. Pol. Soc. 22 (2023) 1–15.
[12] B. Hoffmann, C. Scartascini, F. Cafferata, How can we improve air pollution? Try increasing trust first, Environ. Dev. Econ. 27 (2022) 393–413.
[13] D.L. Nicholls, A.M. Brackley, V. Barber, Wood energy for residential heating in Alaska: current conditions, in: Attitudes, and Expected Use, vol. 30, United States Department of Agriculture, Portland, Oregon, 2010.
[14] M. Siegrist, T.C. Earle, H. Gutscher, Trust in Cooperative Risk Management, Earthscan, London, 2007.
[15] M. Levi, L. Stoker, Political trust and trustworthiness, Annu. Rev. Polit. Sci. 3 (2000) 475–507.
[16] G. Loewenstein, E. Weber, C. Hsee, N. Welsh, Rick as feelings, Psychol. Bull. 17 (2001) 267–286.
[17] I. Ajzen, The theory of planned behavior, Organ. Behav. Hum. Decis. Process. 50 (1991) 179–211.
[18] B. Berezansky, B. Portnov, B. Barzilai, Objective vs. perceived air pollution as a factor of housing prices: a case study of the Greater Haifa Metropolitan Area, J. R. Estate Lit. 18 (2010) 99–122.
[19] A. DeGolia, E. Hiroyasu, S. Anderson, Economic losses or environmental gains? Framing effects on public support for environmental management, PLoS One 14 (2019) e0220320.
[20] P. Slovic, M.L. Finucane, E. Peters, D.G. MacGregor, Risk as analysis and risk as feelings: some thoughts about affect, reason, risk, and rationality, Risk Anal. 24 (2004) 311–322.
[21] M. Finucane, A. Alhakami, P. Slovic, S. Johnson, The affect heuristic in judgements of risks and benefits, J. Behav. Decis. Making 13 (2000) 1–17.
[22] K.M. Kuhn, Message format and audience values: interactive effects of uncertainty information and environmental attitudes on perceived risk, J. Environ. Psychol. 20 (2000) 41–51.
[23] F.J. Milliken, Three types of perceived uncertainty about the environment: state, effect, and response uncertainties, Acad. Manag. Rev. 12 (1987) 133–143.
[24] A. Gamarra, Y. Lechon, M. Vivanco, J. Garrido, F. Martin, E. Sanchez, M. Theobald, V. Gil, J. Santiago, Benefit analysis of the 1st Spanish air pollution control programme on health impacts and associated externalities, Atmosphere 12 (2020) 1–20.
[25] J. Schmale, S.R. Arnold, K.S. Law, T. Thorp, S. Anenberg, W.R. Simpson, J. Mao, K.A. Pratt, Local Arctic air pollution: a neglected but serious problem, Earth's Future 6 (2018) 1385–1412.
[26] T.C. Earle, Trust in risk management: a model-based review of empirical research, Risk Anal. 30 (2010) 541–574.
[27] M. Shulski, G. Wendler, The Climate of Alaska, University of Alaska Press, Fairbanks, Alaska, 2007.
[28] US Census Bureau, 2020 Census Data, U.S. Census Bureau, Washington, DC, 2020.
[29] Y. Wang, P.K. Hopke, Is Alaska truly the great escape from air pollution? - long term source apportionment of fine particulate matter in Fairbanks, AK, Aerosol Air Qual. Res. 14 (2014) 1875–1882.

[30] L. Ye, Y. Wang, Long-term air quality study in Fairbanks, Alaska: air pollutant temporal variations, correlations, and PM2.5 source apportionment, Atmosphere 11 (2020) 1–19.
[31] E. Robinson, M. Cesler-Maloney, X. Tan, J. Mao, W. Simpson, P. DeCarlo, Wintertime spatial patterns of particulate matter in Fairbanks, AK during ALPACA 2022, Environmental Science: Atmosphere 3 (2023) 568–580.
[32] T. Ward, B. Trost, J. Conner, J. Flanagan, R. Jayanty, Source apportionment of PM2.5 in a subarctic airshed - Fairbanks, Alaska, Aerosol Air Qual. Res. (2012) 536–543.
[33] R. Kotchenruther, Source apportionment of PM2.5 at multiple Northwest U.S. sites: assessing regional winter wood smoke impacts from residential wood combustion, Atmos. Environ. 142 (2016) 210–219.
[34] L. Ye, Y. Wang, Long-term air quality study in Fairbanks, Alaska: air pollutant temporal variations, correlations, and PM2.5 source apportionment, Atmosphere 11 (2020) 1203.
[35] E. Robinson, M. Cesler-Maloney, X. Tan, J. Mao, W. Simpson, P. DeCarlo, Wintertime spatial patterns of particulate matter in Fairbanks, AK during ALPACA 2022, Environmental Science: Atmosphere 3 (2023) 568–580.
[36] Sierra Research, 2010 Fairbanks Home Heating Survey. Sacramento, California: Sierra Research, vol. 37, 2010.
[37] EPA, Air quality designations for the 2006 24-hour fine particle, in: (PM2.5) National Ambient Air Quality Standards. Washington DC: US Environmental Protection Agency, vol. 95, 2009.
[38] AK DEC, Air quality monitoring data, Anchorage, AK: Alaska Department of Environmental Conservation (2024). https://dec.alaska.gov/air/air-monitoring/alaska-concerns/community-data/fnsb-summary-pm25/. (Accessed 23 July 2024).
[39] A.K. Dec, Request to divide the Fairbanks nonattainment area, Anchorage, AK: Alaska Department of Environmental Conservation 63 (2015).
[40] ESRI, World Imagry, Environmental Systems Research Institute, 2024. (Accessed 23 July 2024).
[41] FNSB, FNSB GIS layer rest services, Fairbanks North Star Borough (2024). (Accessed 23 July 2024).
[42] AK DEC, Air quality advisories/episodes. Anchorage, AK: Alaska Department of Environmental Conservation. 2022. https://dec.alaska.gov/Applications/Air/airtoolsweb/Advisories/. (Accessed 23 July 2024).
[43] A.K. Dec, Fairbanks PM2.5 moderate SIP, Anchorage, AK: Alaska Department of Environmental Conservation 233 (2015).
[44] A.P.C.C. Fnsb, Air Quality Comprehensive Plan: Framework for Healthy Air, People and Economy, vol. 30, Fairbanks North Star Borough, Fairbanks, Alaska, 2016.
[45] A.K. Dec, Fairbanks PM2.5 serious SIP, Anchorage, AK: Alaska Department of Environmental Conservation 223 (2020).
[46] FNSB, Fairbanks air quality Stakeholders Group: final report, 2018, pp. 1–11. Fairbanks, AK: Fairbanks.
[47] A. Leiserowitz, Climate change risk perception and policy preferences: the role of affect, imagery, and values, Clim. Change 77 (2006) 45–72.
[48] G. Roberts, D. Pride, J. Little, J. Mueller, Willingness to pay for renewably-sourced home heating in the Fairbanks North Star borough, Energies 16 (2023) 3414.
[49] T. Yang, Consequences of asking sensitive questions in surveys, Annual Review of Statistics and its Application 8 (2021).
[50] D. Dillman, J. Smyth, L. Christian, Internet, Phone, Mail, and Mixed-Mode Surveys: the Tailored Design Method, Wiley, New Jersey, 2014.
[51] J.L. Rasmussen, Analysis of likert-scale data: a reinterpretation of Gregoire and Driver, Psychol. Bull. 105 (1989) 167–170.
[52] R. Schwom, D. Bidwell, A. Dan, T. Dietz, Understanding U.S. public support for domestic climate change policies, Global Environ. Change 20 (2010) 472–482.
[53] M. Siegrist, L. Luchsinger, A. Bearth, The impact of trust and risk perception on the acceptance of measures to reduce COVID-19 cases, Risk Anal. 41 (2021) 787–800.
[54] S. Jagers, S. Matti, A. Nilsson, How exposure to policy tools transforms the mechanisms behind public acceptability and acceptance—the case of the Gothenburg congestion tax, International Journal of Sustainable Transportation 11 (2017) 109–119.
[55] D. Kahan, E. Peters, M. Wittlin, P. Slovic, L. Ouellette, D. Braman, G. Mandel, The polarizing impact of science literacy and numeracy on perceived climate change risks, Nat. Clim. Change 2 (2012) 732–735.
[56] EPA, The EPA's Residential Wood Heater Program Does Not Provide Reasonable Assurance that Heaters Are Properly Tested and Certified before Reaching Consumers, vol. 41, Environmental Protection Agency, Washington, DC, 2023.
[57] B.J. Gerber, G.W. Neeley, Perceived risk and citizen preferences for government management of routine hazards, Pol. Stud. J. 33 (2005) 395–418.
[58] J. McMullen, D. Shepherd, Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur, Acad. Manag. Rev. 31 (2006) 132–152.
[59] I. Reeve, J. Scott, D.W. Hine, N. Bhullar, 'This is not a burning issue for me'': how citizens justify their use of wood heaters in a city with a severe air pollution problem, Energy Pol. 57 (2013) 204–211.
[60] A. Sahlberg, B. Karlsson, J. Sjöblomc, H. Strömc, Don't extinguish my fire – understanding public resistance to a Swedish policy aimed at reducing particle emissions by phasing out old wood stoves, Energy Pol. 167 (2022) 113017.
[61] B. Karlsson, M. Håkansson, J. Sjöblom, H. Ström, Light my fire but don't choke on the smoke: wellbeing and pollution from fireplace use in Sweden, Energy Res. Social Sci. 69 (2020) 11.
[62] P. Brewer, B. Ley, Contested evidence: exposure to competing scientific claims and public support for banning bisphenol A Public, Understanding of Science 23 (2012) 395–410.
[63] J. DeGroot, G. Schuitema, How to make the unpopular popular? Policy characteristics, social norms and the acceptability of environmental policies, Environ. Sci. Pol. 19–20 (2012) 100–107.
[64] A. Porter, T. Connolly, R. Heikes, C. Park, Misleading indicators: the limitations of multiple linear regression in formulation of policy recommendations, Pol. Sci. 13 (1981) 397–418.
[65] R. Groves, E. Peytcheva, The impact of nonresponse rates on nonresponse bias: a meta-analysis, Publ. Opin. Q. 72 (2008) 167–189.
[66] B. Holtom, Y. Baruch, H. Aguinis, G. Ballinger, Survey response rates: trends and a validity assessment framework, Hum. Relat. 75 (2022) 1560–1584.
[67] S. Maxwell, Sample size and multiple regression analysis, Psychol. Methods 5 (2000) 434–458.