INVESTIGATING MULTIPLE VALUE TYPES AND THEIR RELATION TO ENVIRONMENTAL BEHAVIOR AND ATTITUDES.

A Dissertation Presented

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ABSTRACT

Sustainable relationships among social and natural systems are predicated, in part, on values. The four studies that make up this dissertation are linked by their investigations of the diverse ways that communities value the natural environment and how their values ultimately interact with attitudes and action.

In my first study, I characterize the attitudes of members of the US public towards the relationship between the environment and economy. Using conceptual framing adapted from ecological economics, I determine whether people view the environment and economy as being in opposition or in concert with one another. I find that exposure to extreme, climate-related events predicts alignment with survey items that illustrate the economy as a dependent subset of the environment, even in light of strong political polarization. My second study reviews empirical literature featuring the relational values concept. I summarize the ways in which authors have operationalized a concept with philosophical roots in diverse research contexts and propose ways to promote cohesion in future work. My third and fourth studies focus on maple syrup-producing forests in Vermont to investigate interactions among financial costs, relational values, and biodiversity "friendly" forest management actions. Study three compares annual costs across varied engagement with forest management; I find that enrollment in conservation programming predicts management engagement, but costs do not. Study four investigates the impact of relational values on forest management actions. I find that maple syrup producers express distinct prioritizations of relational values, and that sustainability-aligned forest management actions are considered differently across value prioritizations.

This interdisciplinary collection of scholarship provides empirical evidence relevant to regional conservation partners and contributes to broad literatures interested in the complex relationships among diverse values, environmental sustainability, and human behavior.

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DEDICATION

To the memory of Dr. Katherine Chandler, who got me into this mess in the first place.

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INTRODUCTION

Largely unsustainable relationships among people and non-human nature have contributed to global challenges including climate change and biodiversity loss (IPCC, 2023). Widespread recognition of the inextricable connections between people and nature has inspired scholarship and policy-making to fundamentally re-consider the "mechanics" of these relationships (e.g., Cronon, 1995; Morgan et al., 2023), informing priorities that look to benefit both human and non-human communities. As such, interdisciplinary research that draws upon the social sciences (e.g., economics, psychology), the humanities, (e.g., philosophy), the and natural sciences can provide valuable insights towards achieving priorities that lead to more sustainable relationships among people and nature (Moon & Blackman, 2014).

The ecosystem services concept represents one interdisciplinary approach adopted by governmental bodies and scholars to characterize the relationships between humans and the non-human environment. (Daily, 1997; Haines-Young & Potschin, 2010). In short, ecosystem services are considered aspects of non-human nature that benefit human communities; ecosystems can be managed in ways that can provide different types of ecosystem services which are valued by diverse beneficiaries (Fisher et al., 2010; Fisher & Turner, 2008). Identifying and understanding the conceptual flows of ecosystem services to people has assisted in bringing attention to the multiple values associated with benefits derived from and relationships with non-human nature (Arias-Arevalo et al., 2018; Balvanera et al., 2022; Fisher et al., 2010).

People's values of nature, understood as, "…goals, beliefs, and importance that people assign to nature's different facets and components" (Balvanera et al., 2022; Pascual et al., 2017), are important in understanding decisions made in the context of resource use and policy (IPBES, 2022). Highly extractive relationships, for instance, can be justified through values that prioritize human ends over nature, whereas highly restrictive relationships can be justified through values that prioritize nature's ends (Anderson et al., 2022). Values scholarship has identified relational values as reflective of a "middle ground," where the sustainability of the relationship between people and nature is prioritized (Chan et al., 2016; Himes & Muraca, 2018). Importantly, relational values are considered to be "non-substitutable," meaning that they are not able to be fully expressed by or replaced with a monetary indicator (Himes et al., 2023). Given their relatively recent "entrance" into environmental valuation approaches, relational values' contributions to sustainability goals are still unclear (Gould et al., 2024).

This dissertation explores the connections between multiple values of nature, attitudes, and decision-making, using conceptual and methodological approaches drawn from a range of interdisciplinary sustainability scholarship. I investigate plural values and their influences on attitudes and actions by focusing on the impacts of experiences with extreme, climate-related events, as well as how individuals approach biodiversity-related forest management in working forested systems. This scholarship applies broad concepts to highly applied contexts, leading to findings that are relevant to both regional conservation efforts and broader scholarship on plural values.

In my first chapter, I gauge public attitudes toward survey items that reflect an embedded conception of the relationship between people and nature. These items suggest that the economy is a social system fundamentally embedded within a finite biosphere, and that an "adversarial" view between the two marked by irreconcilable tradeoffs is flawed. I term the underlying view that informs these items *ecological economics thinking*, though the idea of embedded social systems is pervasive across many sustainability-oriented disciplines (e.g., Morgan et al., 2023). I find that experience with extreme, climate-related events predicts support of *ecological economics thinking*, even across strong political and geographic differences.

In my second chapter, I conduct a systematic review of empirical literature that has utilized the relational values concept in the context of nature or natural resource use. The relational values concept comes from environmental ethics (Muraca, 2016) and refers to values associated with meaningful relationships among people and nature. The concept has been included in influential values frameworks (IPBES, 2022), therefore, has gained traction with sustainability scholars across the globe. In my review, I find that the relational values concept holds promise in its ability to characterize meaningful aspects of relationships with nature, but that its applications and interpretations across empirical literature have been relatively disjointed. I propose several suggestions to guide future scholarship that looks to incorporate this concept, in order to better achieve conceptual cohesion.

In my third and fourth chapters, I apply valuation approaches in the context of maple syrup-producing forests (termed "sugarbushes") in the state of Vermont.

Sugarbushes are representative of "working forests," which are proposed to appeal to multiple value types, given their ability to yield multiple ecosystem services to diffuse communities while retaining biodiversity (Kremen & Merenlender, 2018). I focus my studies in Vermont, given the major cultural and economic role that syrup production plays across the state (Hinrichs, 1998; Whitney & Upmeyer, 2004). Both chapters explore different conceptions of value and their relationships with behavior, as measured through forest management approaches.

In my third chapter, I measure specific financial costs linked to forest management borne by syrup producers (termed "sugarmakers"). I then compare costs across different "levels" of biodiversity-related forest management approaches. I also compare these costs across different degrees of engagement with two different conservation programs: USDA-Organic and Audubon Vermont's "Bird-Friendly Maple" program. I find that management costs were highly variable across different management "levels," and that costs did not relate to management approaches. Sugarmakers enrolled in both conservation programs tended to report engagement with more of the management approaches than sugarmakers enrolled only in USDA-Organic.

In my fourth chapter, I measure relational values and a set of biodiversity-linked management actions. I take a mixed-methods approach and utilize both quantitative and qualitative data to better characterize the relationships among values and action. I find sugarmakers expressed distinct prioritization of relational values. I also find that expressions of non-monetary, relational values were more associated with the regionally unique *practice* of sugarmaking, comparatively to specific sugarbushes.

In sum, this collection of scholarship provides actionable results and implications relevant to research and policy that is interested in motivating more sustainable relationships among people and nature through appeals to nature's diverse values.

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CHAPTER 1: "ECOLOGICAL ECONOMICS THINKING": TRENDS AND OPPORTUNITES AMONG U.S. PUBLIC OPINION OF ECONOMY-ENVIRONMENT RELATIONSHIPS

1.1. Abstract

Despite broad disciplinary consensus that the economy is nested within and fully dependent upon the environment, we have little understanding of how most members of society view this crucial relationship. This is because most public polls characterize the economy and the environment as separate entities subject to a stark tradeoff and force responses that implicitly accept this framing. In this paper, we examined responses to a set of novel statements that articulate what we term *ecological economics thinking* – i.e., a view that economic systems are fundamentally embedded within and dependent upon the environment. We also explored associations between this systemic thinking and experience with extreme, climate-related events. We surveyed U.S. adults (N=6,132) in 2020. We found that: (i) a majority of respondents aligned with statements that articulated *ecological economics thinking*; (ii) alignment with or against *ecological economics thinking* was most strongly predicted by political ideology, age, income, gender, and education; and (iii) experience with extreme, climate-related events predicted e*cological economics thinking*, independent of partisan divides. As opinion towards sustainability-focused decision-making becomes more polarized, it is important to identify the range of underlying views towards the economy and environment that are held by members of the public—and experiences, such as those with extreme, climate-related events, that may influence sustainability-aligned ways of thinking.

1.2. Introduction

Within the sustainability sciences, it is widely recognized that social and ecological systems are fundamentally intertwined, and that social systems are dependent upon larger, encompassing natural systems (IPBES, 2022). This consensus understanding contradicts an "adversarial" view between society and the environment—i.e., a tradeoff-based view that implies that the wellbeing of one most often results in costs to the other (Morgan et al., 2023). Decades of theoretical and empirical western scholarship (e.g., Cronon, 1995; Leopold, 1966) critique the idea of stark boundaries between society and the environment, and Indigenous and other marginalized groups have upheld and embodied these ideas for far longer (e.g., Christianson et al., 2022; Kimmerer, 2013; Steen-Adams et al., 2019). Characterizations that recognize social embeddedness in the environment may expand articulations of the plural values of nature expressed by diverse communities (Anderson et al., 2022) and inform creative and just solutions to address crises that stem from unsustainable relationships among society and the environment.

In the context of economics, a distinctly social system, the environment is more often considered a distinctly separate entity that exists to optimize economic functioning. Economic disciplines informed by neoclassical welfare theory broadly agree that natural systems benefit society through their outputs, which are then allocated through markets (Baumol & Oates, 1988). This type of economic outlook suggests that nature functions primarily as a source and waste sink to support economic function; this outlook thus ultimately prioritizes the wellbeing of social systems over the wellbeing of environmental systems (Buller, 2022; van den Bergh, 2001). Alternative conceptions of the relationship

between economic systems and nature have informed disciplinary approaches such as ecological economics. Such conceptions indicate that economic systems are fundamentally embedded within a finite, complex biosphere, and that economic functioning and growth are dependent upon the wellbeing of the environment (Erickson, 2022; van den Bergh, 2001).

Widespread polling is often employed to gauge public opinion on salient issues; public opinion (theoretically) motivates policy decisions in democratic societies (Burstein, 2003; Drews & van den Bergh, 2016). However, the manner in which polling instruments present, frame, and interpret issues is powerful: framing both reflects and perpetuates deeply held worldviews (Babbie, 2004). In reference to public opinion polling efforts, Stone (2020) argues, "Surveys not only find out *what* people think about public issues; they teach people *how* to think about public issues" (p. 150, emphasis in original). When polling efforts have looked to understand public opinion regarding economics and nature, items typically (Table 1. 1) frame the relationship as characterized by separation and tradeoffs. This singular framing hinders the ability to understand if members of the public characterize the relationship between the economy and nature in different ways. This matters, perhaps substantially, because these views relate to the kind of sustainability-related policy that people will ultimately support.

Table 1. 1. Three major public polling instruments and respective items that gauge public attitudes on the relationship between the environment and economy.

Public poll	***Specific item(s) wording***
Gallup (Gallup, 2024)	1. With which one of these statements about the environment and the economy do you most agree -- protection of the environment should be given priority, even at the risk of

	curbing economic growth (or) economic growth should be given priority, even if the environment suffers to some extent? 2. With which one of these statements about the environment and energy production do you most agree -- protection of the environment should be given priority, even at the risk of limiting the amount of energy supplies -- such as oil, gas and coal -- which the United States produces (or) development of U.S. energy supplies -- such as oil, gas and coal -- should be given priority, even if the environment suffers to some extent?
Pew (Pew, 2010)	Please tell me whether you completely agree, mostly agree, mostly disagree or completely disagree with the following statements...Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs
World Values Survey (World Values Survey, 2022)	Here are two statements people sometimes make when discussing the environment and economic growth. Which of them comes closer to your own point of view? A. Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs B. Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent

However, there exists a multitude of social and environmental factors that may explain variation in how people conceive of the fundamental relationship between the economy and environment. Here, we focus on one specific type of personal experience linked to both social and environmental impacts: experience with climate-change induced extreme weather events.

Extreme weather-related events can impact human communities over broad geographic regions; they are often linked to human-caused climate change and can cause long-term, costly damages to people and ecosystems (Chen et al., 2024; Hsiang et al., 2023). Given their increasingly ubiquitous nature, research has identified that exposure to and experiences with extreme events often lead to changes in attitudes towards climate change, and climate policy (Bergquist et al., 2022; Harris & Howe, 2023; Howe, 2021;

Howe et al., 2019). We are unaware, however, of research that explores any connections between experiences with extreme events and attitudes regarding fundamental relationships between the economy and environment.

1.2.1. Study Objectives and Research Questions

We developed three original survey items that allowed for participants to identify different characterizations of the relationship between the economy and nature; the item wording and design was adapted from broad summaries of ecological economics scholarship and broad summaries of neoclassical economic theory (Daly & Farley, 2011; van den Bergh, 2001). As such, we term understanding of the economic system as embedded within (and not in conflict with) the environment as *ecological economics thinking*. We term understanding of the economic system as separate from, or in conflict with the environment as *resource economics thinking*. We acknowledge that ecological economics is a complex, transdisciplinary endeavor that has developed different goals across regional contexts (van den Bergh, 2001), however, we use the phrase *ecological economics thinking* to refer to the undergirding, broad view of the economy's embeddedness within nature that informs alternative economic approaches, ethics, law, and other sustainability scholarship (Anderson et al., 2022; Morgan et al., 2023; Stone, 2017). Similarly, we are cognizant that our use of *resource economics thinking* represents a broad generalization of neoclassical-adjacent economic theory (Baumol & Oates, 1988; Drews & van den Bergh, 2016).

We purposely recruited participants in specific geographic regions across the contiguous U.S that are frequently experiencing large-scale and easily detectable climate-

related extreme events (e.g., hurricanes, wildfires) to understand if experiences with such events were related to views towards the environment and economy. Our research questions are as follows:

RQ1: How common is alignment with *ecological economics thinking* among members of the US public?

RQ2: What socio-demographic characteristics predict alignment with *ecological economics thinking* among members of the US public?

RQ3: Do experiences with extreme, climate-related events predict alignment with *ecological economics thinking* among members of the US public?

1.3. Methods

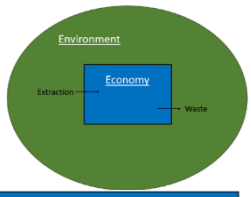
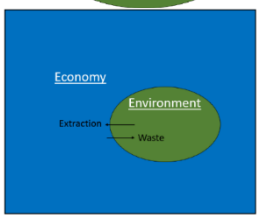
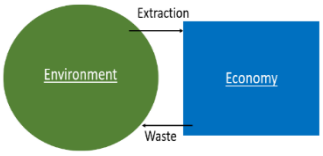
1.3.1 Dependent variables

We developed three original survey items to measure beliefs about economy-environment relationship (Table 1. 2). We created two items to elicit participant views on the fundamental relationship between the economy and environment. One of these items prompted respondents to choose a text statement that described differing types of relationships between the environment and the economy, and the other prompted respondents to choose an image that represented differing types of relationships between the environment and the economy. We refer to these items as "text-based relationship" and "image-based relationship" respectively. We exposed survey participants to either the text-based relationship item or the image-based relationship item randomly (half of our total sample responded to each). Response options for the text-based relationship items articulated different connections between the "health" or wellbeing of economic and

natural systems. Response options for the image-based relationship item represented differing degrees of the economy's embeddedness in nature, and input/output flows between economic and environmental systems.

We designed our third item to elicit views on the interdependence between climate change and economic growth and output. The item refers, in everyday language, to concepts such as steady-state economies and biophysical limits, via a statement about how climate impacts economic activity (Table 1. 2, (Daly, 2014; Daly & Farley, 2011; Kallis et al., 2018). We refer to this item as "climate change-economy relationship" for the remainder of the paper. Responses to the climate change-economy relationship item were originally captured by a six-point Likert-type response ("strongly disagree," "disagree," "somewhat disagree," "somewhat agree," agree," "strongly agree"); after data collection, we collapsed the six levels to two by grouping all "disagree" responses in one level and all "agree" responses in another level. We made this decision upon initial review of the descriptive statistics, as most responses were in the "strongly disagree" or "strongly agree" levels. All survey respondents were exposed to the climate change relationship item.

Table 1. 2. Three ecological economics thinking items (dependent variables) used in this study.

Survey Item	**Original survey item wording**	**Variable Type**	**Levels and Coding**
Climate Change-Economy Relationship	"To what extent do you agree or disagree with this statement: If we do not address climate change now, we threaten long-term economic growth and output."	binary	(0) Disagree (1) Agree
Text-based Relationship	"Which of the following best describes how you think about the relationship between the environment and the economy?"	categorical; unordered	(1) "The health of the economy depends upon the health of the natural environment" (2) "Protecting the natural environment often harms the health of the economy" (3) "The natural environment and the economy are not related to one another"
Image-based Relationship	"Please choose the image below that comes closest to representing how you think about the relationship between the environment and the economy."	categorical; unordered	(1)  (2)  (3) 

1.3.2. Independent variables

The independent variables in our study included socio-demographic characteristics (age, gender, highest level of education completed, geographic region in the US, yearly income, political leaning, voting activity in the 2020 US presidential election) and self-reports on experience with extreme, climate-related events. The specific levels used in each variable are outlined in Table 1. 3.

We collapsed the categories for multiple independent variables for our analysis based on the distribution of responses to the original categories. We collapsed categories as follows for age (reduced from a six-point ordered categorical scale to a three-point ordered categorical scale), race/ethnicity (reduced from six category options to two categories), geographic region in US (reduced from 13 category options to three categories), and income (reduced from an eight-point ordered scale to a three-point ordered scale). We also dropped responses from the following categories, given that they represented less than 1% of the total responses for those variables: "non-binary" (gender category), "pre-high school" (education category), "voted for someone else" (voting category).

Table 1. 3. Independent variables, with rates in our sample and in the US population overall.

			Study Sample	***US Population***
Independent Variable	**Variable Type**	**Levels and Coding**	**Frequency (%)**	**Percent**
Age	categorical; ordered	(1) 18-34	2,183 (35.6%)	*23%*
		(2) 35-54	2,090 (34.1%)	*25.4%*
		(3) 55 and older	1,859 (30.3%)	*30%*

Gender[a]	binary	(0) man	2,600 (42.9%)		[a]
		(1) woman	3,467 (57.1%)		[a]
Race/ethnicity	binary	(0) white	3,775 (65.8%)	*60.9%*	
		(1) all races/ethnicities and combinations other than white	2,364 (41.2%)	*39.1%*	
Education[b]	categorical; ordered	(1) high school diploma or equivalent	2,229 (37.2%)	*26.1%*	
		(2) college degree (2 or 4 year)	2,729 (45.6%)	*30.4%*	
		(3) graduate degree	1,031 (17.2%)	*14.1%*	
Region in US	categorical; unordered	(1) Northeast US (includes Maine, New Hampshire, New York, Vermont)	1,956 (31.9%)	*6.9%*	
		(2) Southeast US (includes Alabama, Georgia, Louisiana, Florida, Mississippi)	1,812 (29.5%)	*13.7%*	
		(3) Western US (includes California, Colorado, Oregon, Washington)	2,371 (38.6%)	*17.1%*	
Income[c]	categorical; ordered	(1) below US median yearly income range	3,313 (54.1%)		*
		(2) within US median yearly income range	1,090 (17.8%)		*
		(3) above US median yearly income range	1,725 (28.1%)		*
Prior lived experience with extreme weather events	binary	(0) no	3,086 (50.4%)		*
		(1) yes	3,037 (49.6%)		*
Political leaning	categorical; unordered	(1) conservative	2,020 (33%)		*
		(2) moderate	2,277 (37.2%)		*
		(3) liberal	1,821 (29.8%)		*
2020 Presidential election vote[d]	categorical; unordered	(1) did not vote	1,205 (21.4%)	*37.2%*	
		(2) Donald Trump	1,599 (28.4%)	*29.4%*	
		(3) Joe Biden	2,827 (50.2%)	*32.2%*	

[a] Excludes the <1% of respondents who identified as non-binary. Frequency and percent values in the "study sample" columns reflect this exclusion. Furthermore, the "US Population" percentage values are drawn from US census data on sex, an attribute that we did not ask participants to provide information on.
[b] Excludes the <1% who identified their highest level of education as "pre-high school." Frequency and percent values in the "study sample" columns reflect this exclusion.
[c] US median yearly income is specified as $64,994 in the 2020 US Census. The survey instrument included a range of $50,000 – 74,999, so we identified those who chose this range as "within" US median yearly income.
[d] Excludes the <1% who reported voting for "someone else." Frequency and percent values in the "study sample" columns reflect this exclusion.
* These categories did not match existing US Census data categories.
Citations for the table: (Federal Election Commission, 2022; Gallup, 2023; U. S. Census Bureau, 2022d, 2022e, 2022c, 2022b, 2022a)

1.3.3. Data collection and analysis procedures

Final data were collected in 2020-2021 from an online survey panel contracted with Qualtrics International, using their in-house survey service. Participants represented a quota sample that was stratified by gender, age, and geographic region in the US.

We addressed our first research question via analysis of simple descriptive statistics of our dependent variables. To address our second research question, we ran a series of multiple regression models to identify whether demographic characteristics and/or experience with extreme, climate-related events predicted *ecological economics thinking* (Figure 1. 1). For the climate change relationship item, we ran a general linear model (GLM) with "disagree" as the response baseline. For the text-based and image-based items, we ran Multinomial Linear Regression (MLR) models with the *ecological economics thinking* responses as baselines. MLR models are appropriate (compared to GLM) when the dependent variable is categorical with more than two outcomes (Petrucci, 2009). We determined model fit using AIC values. To do this, we ran nested models; we started with the intercept only, then added one covariate to each subsequent

model (Forthofer et al., 2007). All final models (with all independent variables included) indicated lower AIC values than partial nested models, indicating that the final models were most appropriate (Forthofer et al., 2007). We determined model goodness-of-fit by likelihood ratio tests, which compared our final models with all of the independent variables with a model that included only the intercept (Petrucci, 2009).

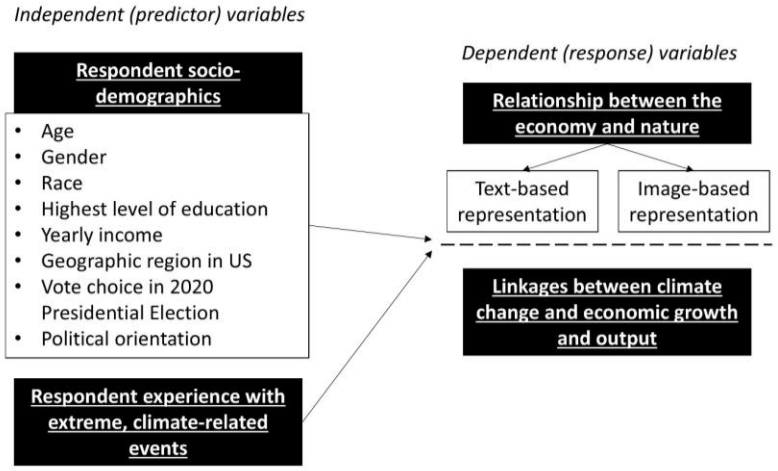


Figure 1. 1. Conceptual diagram for this study

Our GLM and MLR models yielded odds ratio coefficients, which indicate the relative magnitude of each covariate's impact on the odds of being in a particular category of the response variable (de Boer & Aiking, 2021, p. 5). In other words, the odds ratio coefficient highlights the odds of being in one category of the dependent variable (e.g., the response chosen in the survey) as opposed to that variable's reference category. An odds ratio with a value greater than one signifies the factor of increased likelihood of the associated independent variable influencing the category being chosen; values equal to one signify no influence from the independent variable; values less than one signify a decreased likelihood of the independent variable influencing the category

being chosen (Szumilas, 2010). We used R statistical software and corresponding package "nnet" to perform all regression analyses (v4.0.2, R Core Team, 2020; Venables & Ripley, 2002).

1.4. Results

1.4.1. How common is support for ecological economics thinking?

In both the climate change-economy relationship item and the text-based relationship item, most survey participants align with *ecological economics thinking*. Approximately 82% of respondents (5,009 of 6,132) for the climate change relationship item agreed with the statement, "if we do not address climate change now, we threaten long-tern economic growth and output." Approximately 61% of respondents (1,877 out of 3,061) for the text-based relationship item identified that the statement, "the health of the economy depends on the natural environment" best described how they think about the relationship between the environment and economy, whereas approximately 26% of respondents (783 out of 3,061) chose "protecting the natural environment often harms the health of the economy," and approximately 13% of respondents (401 out of 3,061) chose "the natural environment and the economy are not related to one another."

Our findings were less consistent regarding the image-based relationship item. Approximately 34% of respondents (1,106 out of 2,997) selected the figure that represents the economy embedded within the natural environment, approximately 26% of respondents (771 out of 2,997) chose the figure wherein the environment is a subset of the economy, and 40% (1,210 out of 2,997) selected the figure that represents the environment and economy as distinctly separate entities (Figure 1. 2).

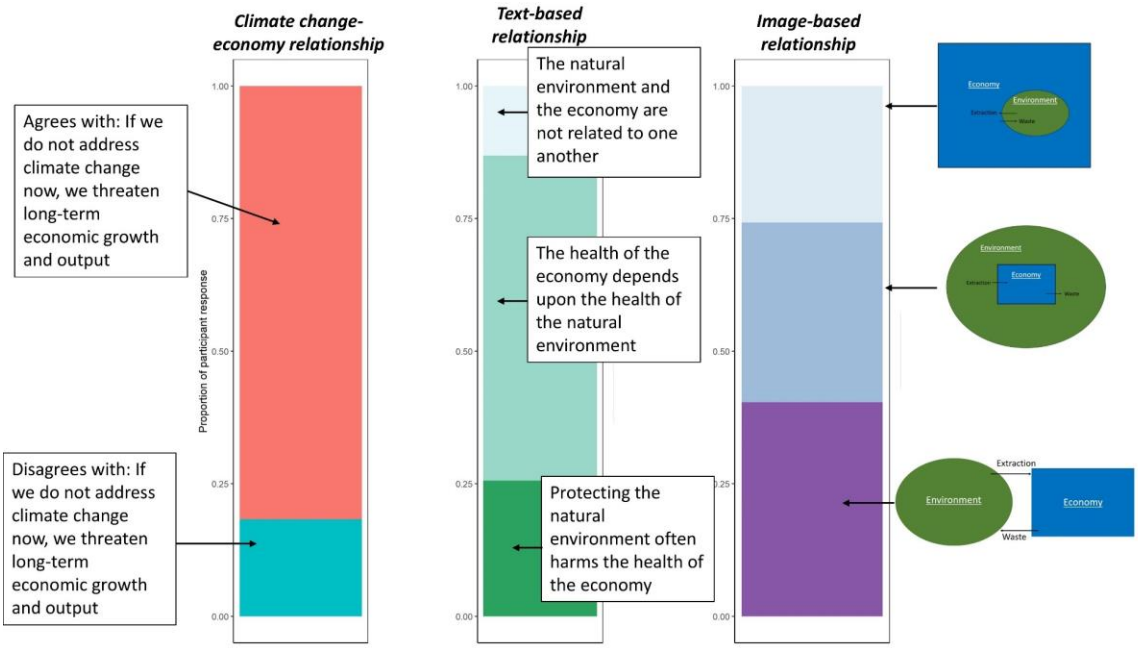


Figure 1. 2. Frequency of responses per each level of the three dependent variables used in this study.

1.4.2. What socio-demographic characteristics, political views, and lived experiences predict support of *ecological economics thinking*?

We modeled how our independent variables influenced the likelihood of agreement with all three of our item prompts (thus, alignment with *ecological economics thinking*). Table 1. 4 reports results (odds ratio coefficients with 95% confidence intervals) for the climate change-economy relationship variable. Results indicate that respondents who had experienced extreme disturbance events (relative to those who had not), women (relative to men), liberals (relative to moderates), and those who voted for Joe Biden in the 2020 US presidential election (relative to non-voters) were each significantly associated with a high likelihood of agreeing with the prompt. Out of these results, Biden voters were associated with the strongest likelihood, with increasing odds of agreeing with *"If we do not address climate change now, we threaten long-term*

economic growth and output" by a factor of 2.49, 95% CI [1.98, 3.13]. Conversely, respondents from the Southeast US (relative to the Northeast US), and Trump voters (relative to non-voters) were both significantly more likely to disagree with the item's prompt. Trump voters were associated with an odds ratio of 0.47, which corresponded to 53% lower odds, 95% CI [0.38, 0.54].

Table 1. 4. Results of the general linear regression model analysis for the climate change-economy relationship item: odds ratios and 95% confidence intervals of the odds ratios.

Reference level: Disagree with Climate change-economy relationship item statement *Independent variables*	*Agree with "If we do not address climate change now, we threaten long-term economic growth and output" (N = 5,401)*
Experience with extreme events?	
No	reference
Yes	1.17 [1.00, 1.37]*
Age	
18-34	reference
35-54	1.20 [0.98, 1.46]
55+	0.93 [0.76, 1.15]
Gender	
Man	reference
Woman	1.21 [1.03, 1.41]*
Race	
White	reference
Non-white or multi-racial	0.89 [0.74, 1.08]
Education	
High School Diploma	reference
College Degree	1.07 [0.90, 1.27]
Graduate Degree	1.20 [0.94, 1.54]
Region	
Northeast US	reference
Southern US	0.70 [0.57, 0.85]***
Western US	0.86 [0.71, 1.05]
Income	
Below median	reference
Within median	0.99 [0.80, 1.22]
Above median	0.96 [0.79, 1.16]

Political leaning	
Moderate	reference
Conservative	0.45 [0.38, 0.54]***
Liberal	1.28 [1.00, 1.64]***
2020 US Presidential Election vote	
Did not vote	reference
Trump voter	0.47 [0.38, 0.59]***
Biden voter	2.49 [1.98, 3.13]***

Statistics of the final model:
likelihood ratio chi^2 = 824.72 *df* 15 p <0.001 Nagelkerke R^2 = 0.23
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results for the text-based relationship item were similar (Table 1. 5). Previous exposure to climate-related extreme events, age (respondents between 35-54 and 55+), gender (women), income (within US median income), education (both respondents with college and graduate degrees), political leaning (liberal) and voting behavior (Biden voters) were all significantly associated with higher odds of selecting the *ecological economics thinking* option over the other choices. Non-white or multi-racial respondents, conservatives, and Trump voters were all significantly associated with higher odds of choosing the *resource economics thinking* item options.

Table 1. 5. Results of the multinomial linear regression model analysis for the text-based relationship item; we report odds ratios and 95% confidence intervals of the odds ratios.

Reference level: The health of the economy depends upon the health of the natural environment	*Response to "Which of the following best describes how you think about the relationship between the environment and the economy?" (N = 2,705). (Three options; likelihood of selecting statements below over reference level)*	
Independent variables	*Protecting the natural environment often harms the health of the economy*	*The natural environment and the economy are not related to one another*
Experience with extreme events?		
No	reference	reference

Yes	0.80 [0.66, 0.97]*	0.87 [0.68, 1.12]
Age		
18-34	reference	reference
35-54	0.71 [0.56, 0.90]**	0.66 [0.49, 0.89]**
55+	0.46 [0.35, 0.60]***	0.48 [0.34, 0.68]***
Gender		
Man	reference	reference
Woman	0.75 [0.62, 0.91]**	0.80 [0.62, 1.02]
Race		
White	reference	reference
Non-white or multi-racial	1.39 [1.12, 1.73]***	1.03 [0.77, 1.37]
Education		
High School Diploma	reference	reference
College Degree	1.21 [0.98, 1.50]	0.71 [0.54, 0.94]*
Graduate Degree	1.07 [0.78, 1.45]	0.54 [0.36, 0.82]**
Region		
Northeast US	reference	reference
Southern US	1.00 [0.86, 1.40]	0.90 [0.66, 1.24]
Western US	0.99 [0.78, 1.24]	0.90 [0.67, 1.21]
Income		
Below median	reference	reference
Within median	0.75 [0.58, 0.98]*	0.79 [0.56, 1.11]
Above median	0.90 [0.71, 1.15]	1.09 [0.80, 1.48]
Political leaning		
Moderate	reference	reference
Conservative	1.87 [1.48, 2.37]***	1.87 [1.39, 2.52]***
Liberal	0.73 [0.57, 0.95]*	0.66 [0.46, 0.94]*
2020 US Presidential Election vote		
Did not vote	reference	reference
Trump voter	1.73 [1.28, 2.33]***	1.72 [1.19, 2.47]**
Biden voter	0.67 [0.52, 0.87]***	0.56 [0.40, 0.79]***

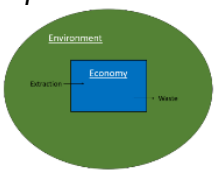
Statistics of the final model:
likelihood ratio chi^2 = 351.66 *df* 30 p <0.001 Nagelkerke R^2 = 0.14
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results for the image-based relationship item (Table 1. 6) indicate that income (respondents above median US income range), political stance (liberal) and voting behavior (Biden voter) were all significantly associated with lower odds of choosing either of the images that were *resource economics thinking*. Again, these variables were strongly associated with selecting the *ecological economics thinking*

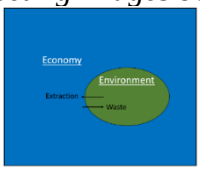
option over the other choices. Age (55+ respondents) and gender (women) were significantly associated with higher odds of choosing the image representing *resource economics thinking*.

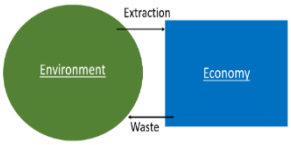
Table 1. 6. Results of the multinomial linear regression model analysis for the image based-relationship; we report odds ratios and 95% confidence intervals of the odds ratios.

Reference level:



Response to "Which of the following best describes how you think about the relationship between the environment and the economy?" (N = 2,634). (Three options; likelihood of selecting images below over reference level)





Independent variables

Experience with extreme events?		
No	reference	reference
Yes	0.90 [0.80, 1.22]	0.82 [0.68, 0.99]*
Age		
18-34	reference	reference
35-54	0.93 [0.72, 1.20]	1.05 [0.83, 1.32]
55+	0.77 [0.58, 1.03]	1.40 [1.10, 1.80]**
Gender		
Man	reference	reference
Woman	1.18 [0.95, 1.47]	1.23 [1.02, 1.49]*
Race		
White	reference	reference
Non-white or multi-racial	0.99 [0.78, 1.27]	0.99 [0.79, 1.22]
Education		
High School Diploma	reference	reference
College Degree	0.91 [0.72, 1.16]	0.99 [0.80, 1.22]
Graduate Degree	1.00 [0.72, 1.38]	1.03 [0.77, 1.37]
Region		
Northeast US	reference	reference
Southern US	1.00 [0.77, 1.33]	0.94 [0.71, 1.20]
Western US	0.84 [0.65, 1.08]	0.90 [0.72, 1.13]
Income		
Below median	reference	reference
Within median	0.90 [0.67, 1.19]	0.94, [0.73, 1.21]

Above median	0.77 [0.59, 0.99]*	0.85 [0.68, 1.10]
Political leaning		
Moderate	reference	reference
Conservative	1.29 [0.98, 1.69]	1.16 [0.91, 1.10]
Liberal	0.66 [0.51, 0.86]**	0.70 [0.56, 0.88]**
2020 US Presidential Election vote		
Did not vote	reference	reference
Trump voter	0.88 [0.63, 1.22]	0.86 [0.64, 1.16]
Biden voter	0.65 [0.49, 0.85]**	0.72 [0.56, 0.93]*

Statistics of the final model:
likelihood ratio chi^2 = 115.65 *df* 30 p <0.001 Nagelkerke R^2 = 0.05
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1.5. Discussion

We set out to understand general alignment with, as well as variables that predict *ecological economics thinking* in a subset of members of the US public. Our results indicate that most participants aligned with statements that articulated embeddedness between economic and environmental systems, what we refer to as *ecological economics thinking*. We also found that political ideology and voting behaviors were the most consistent predictors of item selection: liberals and Biden voters were more likely to choose *ecological economics thinking* items, and conservatives and Trump voters were more likely to choose the *resource economics thinking* items. We also found that experience with extreme climate-related events predicted support of *ecological economics thinking*, independent of other socio-demographics, including political affiliation and voting behavior.

Extreme climate-related events are globally ubiquitous phenomena that impact all socio-demographic groups (Chen et al., 2024; Konisky et al., 2016). Our results suggest that lived experience with these events may supersede the apparent politicization

of differing views toward the relationship between the economy and environment. We connect our results to previous empirical work, then discuss implications for sustainability research that looks to consider sustainability-aligned views toward the relationship between the economy and nature.

1.5.1. Political polarization and *ecological economics thinking*

Proposed solutions to issues resulting from unsustainable relationships between social and environmental systems, such as solutions that look to mitigate the impacts of human-induced climate change, are often predicated on the view that social systems are fundamentally dependent upon the environment (IPCC, 2023). However, evidence from our study indicates that significant portions of the US public consider the economy and environment as fundamentally separate from, and in certain instances, in opposition to one another. The divide in views toward economic-environmental relationships was most strongly predicted by political ideology in our study. As such, we suggest that opposition to sustainability-oriented policy may be explained, in part, by deeper-held views of the relationship between the environment and economy.

We found liberal participants and those who voted for Biden in the 2020 US presidential election had a stronger likelihood of choosing the items that espoused *ecological economics thinking*. Conservative participants, and those who voted for Trump in the 2020 US presidential election were both associated with a stronger likelihood of choosing *resource economics thinking* items. Our results generally square with several studies that have identified how liberals often prioritize environmental wellbeing and conservatives often prioritize economic wellbeing (Birch, 2020; Dunlap et al., 2016;

Ziegler, 2017). Our results add nuance to this discussion by also highlighting how conservatives in the US may view the economy and environment as separate systems, or systems in direct opposition to one another. Initiatives as broad as sustainable economic development and as specialized as ecological economics operate under the consensus that social systems are dependent upon and embedded within environmental systems (Costanza, 1989; Daly & Farley, 2011; Robert et al., 2005). Our finding that different views toward the relationship between the economy and nature are linked to strong US political polarization suggests that the uptake of policy informed by alternative approaches (such as *ecological economics thinking*) might be inherently limited by these approaches' ties to political affiliation. Therefore, proposals to significantly reform and change economic systems (e.g., Farley & Kish, 2021) in democratic societies may be hindered by strong partisan alignment to differing, fundamental relationships between the economy and nature.

1.5.2. Socio-demographics and *ecological economics thinking*

Several socio-demographic characteristics were strong predictors of *ecological economics thinking*, including gender, age, race/ethnicity, geographic region, income, and education. Women respondents were more likely than men respondents to support *ecological economics thinking* responses to the text-based relationship item and the climate change relationship item. These findings are generally consistent with previous studies across different contexts; women are, for example, more supportive than men of limits to fracking and oil extraction (Martínez-Espiñeira et al., 2019) and of climate-forward policies (such as caps on CO_2 emissions; (Douenne & Fabre, 2020; Rhodes et al.,

2017). Women also report higher pro-environmental attitudes in many, though not in all, studies that measure attitudes in different ways and across contexts (Kollmuss & Agyeman, 2002).

Women participants aligned with *resource economics thinking* in the image-based relationship item. One such explanation may be that concepts we aimed to measure were not effectively communicated through the conceptual diagrams; Fandel and colleagues (2018) note that conceptual diagrams, though highly common in sustainability scholarship, can be challenging for others to read without clear interpretations provided by the researchers.

Older respondents (35-54 years old; 55 and older) were more likely than the youngest age group (18-34) to align with *ecological economics thinkings*. This result adds to a somewhat inconsistent set of conclusions regarding the influence of age on environmental attitudes. For instance, some previous research finds older respondents to be more supportive of certain environmental regulations in Canada (Rhodes et al., 2017), whereas other research finds strong associations between older respondents and opposition to climate policies in Norway (Sælen & Aasen, 2023). Though we are unable to directly corroborate with studies focused on support or opposition of specific environment-related regulation, our result suggests that an increase in age may be linked to receptivity to *ecological economics thinking*.

In our analysis of the text-based relationship item, we found that non-white or multi-racial respondents were more likely than white respondents to choose *resource economics thinking* responses. Interpretation of this result warrants deeper consideration

of environmental justice literature than our current study allows for. In reaction to studies that took similar results at face-value, Macias (2016) analyzed environmental attitudes with an eye on racial and ethnic trends. He concluded that the specific foci of environmental concern may differ among racial and ethnic differences, driven by contextual factors such as regional industry, culture, and communities. Our result warrants more targeted research into the drivers of perceived environmental and economic incompatibility among non-white communities in the US.

We found that respondents in the Southeast US were significantly more likely to select *resource economics thinking* responses in the climate-change relationship item. This result represented the only instance in our models where geographic region influenced response choice. Our result speaks to the complexities of geographic regions and their potential influence on communities and attitudes; the Southeast US is forecasted to be strongly impacted by the effects of climate change (Plumer & Popovich, 2017), yet communities in the region often strongly deny the existence of climate change (Hudson & Spencer, 2017). In their nuanced exploration of climate change denial in the southeast US, Hudson & Spencer (2017) highlight how climate skepticism is common across political and socio-demographic differences, given the complex social and environmental history of the region. Our result aligns with this trend, as the response was only found in the item that specifically mentioned climate change.

Respondents within the median income range aligned with *ecological economics thinking* in the text-based relationship item, whereas respondents in the highest income range aligned with *ecological economics thinking* in the image-based item. These results

contribute to mixed findings on the associations between income and environmental opinion; certain studies that have linked income with political ideology have concluded that financially well-off conservatives are often associated with an individualist, economic worldview linked to neoclassical economic assumptions (Ballew et al., 2019, 2020; Baumol & Oates, 1988; McCright & Dunlap, 2011). Additionally, lower-income income communities, compared to higher-income counterparts, have reported climate change as more of a threat to wellbeing, suggesting a receptiveness to a worldview that espouses tight links between the environment and the economy (Cutler, 2016).

Finally, we found that highly educated individuals (those with either a college or graduate degree) were somewhat more likely than those with a high school diploma to align with *ecological economics thinking.* Consistent with previous studies of environmental attitudes, our finding suggests that education levels may correlate with certain expressions of environmental views in more specific contexts, or when "paired" with other explanatory variables such as political leaning (Douenne & Fabre, 2020; Martínez-Espiñeira et al., 2019; Sposato & Hampl, 2018). For instance, Democrats with higher science literacy were reported to be more likely to believe in human-caused climate change (Funk & Kennedy, 2016), whereas highly educated conservatives have been linked to strong climate denial (McCright & Dunlap, 2011).

In all instances above, the role that individual socio-demographic characteristics play in their influence on opinion is murky as highlighted by their relatively weak statistical significance. Additionally, their correlated nature (e.g., that race, income, and education levels are often associated) made the exercise of picking and choosing specific

socio-demographics as singly influential on resulting opinion somewhat fraught. To address the messy, multi-directional, and important links between various demographic characteristics and relations to nature, theorists from both feminist and critical race fields have developed "intersectional" research approaches (Cole, 2009; Ergas et al., 2021; Kaijser & Kronsell, 2014). These approaches recognize how intersectional identities and power dynamics may impact experiences and opinions and have been highlighted by ecological economists as critical to the development of the field (Ruder & Sanniti, 2019; Spencer et al., 2018).

We argue that our findings are troubling in that strongest support for *ecological economics thinking* exists within groupings of specific respondent characteristics (higher paid, highly educated, moderate/left-leaning) previously documented to be receptive to similar ideas (Druckman & McGrath, 2019). Findings are relevant to those who aim to reform relationships among social and natural systems, as association and engagement with respondents who hold different perceptions of the economy and environment (conservatives, Trump voters, non-white individuals).

1.5.3. Lived experience with extreme events

Given the increasingly deep divides in public opinion on social and natural systems in the US, a robust body of literature has emerged to investigate and identify factors that might change entrenched opinions (Hulme, 2009; Shove, 2010; Whitmarsh & Capstick, 2018). Emerging research suggests that one potentially influential factor is lived experiences with extreme, climate-related events (Howe, 2021; Howe et al., 2019). More specifically, literature suggests that the pronounced social and environmental

impacts that accompany experiences with extreme events can influence opinion and attitude on phenomena such as climate change (Chen et al., 2024; Howe, 2021; Howe et al., 2019; Sisco, 2021). Some research suggests that experience with extreme, climate-related events can challenge worldviews that espouse strong separation between social and natural systems (Akerlof et al., 2013; Bergquist et al., 2019; Broomell et al., 2015; Demski et al., 2017; Ogunbode et al., 2019; Weber, 2006). Our results indicate that similar experiences were predictive of *ecological economics thinking*.

We found weakly significant associations between experience with extreme events and *ecological economics thinking*, a finding that holds certain promise when considered carefully. Statistically, these associations were weak (low odds ratio coefficients' models with relatively low predictive power), but they were significant. Extreme event experience predicted *ecological economics thinking* independently of partisan influence. Furthermore, our findings suggest that the broad impacts of extreme events may form or solidify worldviews that acknowledge the economy's embeddedness in nature. Understanding whether this might be happening was one of our primary motivations for this study. Our results, which suggest that extreme event experience may lead people to think in terms outside of the traditional views of tradeoffs between social and environmental systems, open wide possibility for future research to further explore this interaction and its implications in the context of global changes.

As scholars committed to just futures, we urge caution in the application of such findings. Extreme, climate-related events are traumatic to communities impacted both acutely and on the periphery (e.g., Barkin et al., 2021; J. Cruz et al., 2020), and often

have the strongest impacts on more vulnerable communities (Benevolenza & DeRigne, 2019). To capitalize on extreme events in support of *ecological economics thinking* without acknowledgement of community needs may ultimately prioritize a more "predatory" dissemination of worldviews, cautioned by Ruder & Sanniti, (2019). As highlighted by Farley and colleagues (2007), we suggest that extreme events be considered as opportunities to which scholars may encourage disproportionately impacted communities to consider alternative paths forward, but in a manner that is sensitive to community experiences.

1.5.4. Study limitations

Our study has certain limitations. The climate change-economy relationship item presents the risk of a "double-barreled" survey prompt, as it links climate change, economic growth, and environmental wellbeing in one statement (Babbie, 2004; Drews et al., 2018). We interpreted agreement towards this item as broadly representative of *ecological economics thinking*, which acknowledges intricate interconnections, but recognize that the item forced associating climate change with economics and the environment. Future studies may look to split this item to understand opinion strictly on growth or environmental wellbeing.

We also recognize that the models used to predict *ecological economics thinking* responses in the text-based and image-based relationships items yielded relatively low R^2 values, which indicate that a majority of the variance was not explained by the independent variables in the model. Characterizing what predicts *ecological economics thinking* is challenging, as the antecedents to worldviews are multi-faceted (Anderson et

al., 2022) Given the complexity of the concept, we argue that our identification of specific variables that predict *ecological economics thinking*, out of the potentially enormous range of variables that might do so, ultimately helps to guide future exploration of the determinants of such thinking.

1.6. Conclusions

Scholars have argued that meaningful change towards sustainable futures should be based on a conception of embeddedness and cohesion between social and natural systems, rather than the dominant view of stark separation between society and nature. Given the pace and scope of global changes caused by unsustainable relationships among society and nature, it is useful to understand how the public views these relationships, and how global change events may be associated with such views.

Our study looked to determine what members of the public think about these relationships in the context of the economy, a social system intricately intertwined with environmental policy and decision-making. We found that a majority of respondents aligned with statements that articulated *ecological economics thinking*--i.e., most people agreed that economic systems are dependent upon environmental wellbeing. Upon further analysis, we found that alignment with or against *ecological economics thinking* was most strongly predicted by political ideology, age, income, gender, and education; this finding is broadly consistent with past research on environmental attitudes and opinions. Our most novel finding is that experience with extreme, climate-related events predicted e*cological economics thinking*, independent of political ideology. This finding suggests that such events may either form or solidify worldviews that acknowledge

interdependence between economic and environmental systems. More public support for *ecological economics thinking* may come from thoughtful engagement with communities who have experienced extreme events, as well as those with conservative political ideologies.

1.7. References

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CHAPTER 2. RELATIONAL VALUES IN EMPIRICAL RESEARCH: A SYSTEMATIC REVIEW

2.1. Abstract

In the past five years, scholarly and policy attention to relational values, a concept that articulates plural values of nature, has grown steadily. To date, there are no published syntheses of empirical research that explicitly addresses relational values. We perform a systematic literature review of $n = 72$ empirical studies of relational values to summarize the state of current research and to identify opportunities for future research and conceptual development. In our analysis, we categorize what authors identify as relational values and summarize study characteristics (e.g., study location, methods approach.) Authors collectively report $n = 312$ unique relational values. Categories of *identity*, *social cohesion*, *livelihoods*, *connection to place/human-nature connection,* and *sacred* are most common. Scholarship that explicitly addresses relational values has increased since 2017 and exhibits substantial diversity: in how relational values are conceptualized (or not); in disciplinary associations; in geographical location; and in data collection methods. We find that most empirical research on relational values does not justify how its results reflect characteristics that establish the relational values concept as unique from other environmental values concepts. As a result, diverse interpretations of the relational values concept pose the risk of the relational values concept being so broad and inclusive that it becomes meaningless, or at least meaning-light. Policy Implications: Understanding why and how nature matters to people is critical to inform effective and just conservation. Relational values can offer nuanced perspectives on the significance

associated with people-nature relationships. We argue that empirical relational values research that grounds itself in the concept's "core" characteristics can foster conceptual coherence and bolster the relevance of research findings to sustainability and conservation science.

2.2. Introduction

Relational values have recently emerged as a globally important concept in environmental sustainability-related research. A key reason for the recent interest in relational values is the links between this concept and understandings of deep aspects of environmental justice that recognize diverse worldviews and forms of people-nature relationships (Himes & Muraca, 2018; Muraca, 2016). Specifically, the concept resonates with understandings of people-nature relationships that have often been sidelined in conservation and economics discourse over the past century. Dominant understandings of environmental values center either how nature benefits people (instrumental value) or how nature has a moral right to exist regardless of a human valuer (intrinsic value) (Ott, 2008; Tallis & Lubchenco, 2014). Certain marginalized understandings of value instead center meaningful, continually shifting relationships between people and nature (West et al., 2020). These relationship-focused understandings are common in a diverse array of worldviews and experiences and associated literatures, including post-colonialism, feminism, and Indigenous knowledge (Muraca, 2011, 2016; West et al., 2020). The inclusion of relational values thus makes space for such marginalized voices in conservation discourse and recognizes narrow approaches to valuing nature through

measures that primarily represent either instrumental or intrinsic value (Chan et al., 2012, 2016).

Largely in recognition of the theoretical inclusivity inherent to the relational values concept, prominent international efforts have included relational values in central conceptual positions. Perhaps most notably, relational values comprise part of the conceptual framework and values typology of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). IPBES is a United Nations organization that aims to summarize scientific information for use in environmental policy (IPBES, 2022). Its inclusion of relational values aligns with a larger global effort to better integrate and reflect understandings of people-nature relationships in addition to those that dominate in Western scholarship and conservation practice.

In the field of environmental valuation, the concept of value pluralism is central to the move, within IPBES and beyond, to honor diverse perspectives. Current understandings of environmental valuation emphasize the importance of understanding the diverse values of nature in multiple – plural – ways, and conclude that to prioritize any one way alone is likely to be inadequate and unjust (IPBES, 2022; Jacobs et al., 2020). For instance, solely measuring the monetary value of ecosystems misses the non-monetary significance that communities ascribe to those ecosystems; in certain instances, monetary valuation of ecosystems may be considered culturally inappropriate (Chan et al., 2016). Thus, the inclusivity of the relational values concept leads to scholars describing it as "the key to pluralistic valuation" of human-nature relationships (Himes & Muraca, 2018, p. 1).

Likely due to intersecting academic and policy-related enthusiasm for the relational values concept, scholars have increasingly conducted empirical studies that feature relational values in communities around the world. However, we know of few attempts to review and assess the growing body of literature that is explicitly focused on the relational values concept. We fill this gap in understanding by performing a systematic review of empirical studies that employ the relational values concept.

We acknowledge that scholars in various fields that inform sustainability science and policy have published extensively on concepts closely connected to relational values. Select examples include sense of place (Brehm et al., 2013; Masterson et al., 2017), human identities and connections to nature (Devine-Wright, 2013; Soga & Gaston, 2016), and Indigenous and local ecological knowledges (Berkes, 1993; Schultz, 2002). Exploration of this large body of work has lent useful insights to research on relational values; certain reviews have identified links to relational values in literature on care (Jax et al., 2018; West et al., 2018); human connections to agroecosystems (Allen et al., 2018); coastal communities in the global South (Riechers et al., 2022); environmental psychology and design (Ross et al., 2018); and environmental education (Britto dos Santos & Gould, 2018). We take a different approach than these past reviews: we limit our review to work that explicitly studies relational values. We have two main reasons for this choice. First, many studies that explicitly use the relational values concept both respond and "speak" directly to the aforementioned academic and policy audiences who are interested in the applications of relational values to sustainability science and policy. Second, we wished to synthesize the characteristics and findings of the burgeoning

examples of empirical efforts to study a concept that emerged from philosophical roots. That is, the relational values concept bridges philosophical, policy-oriented, and empirical work: it was identified in philosophy, resonates with global science-policy interface efforts, and holds relevance to communities around the world. But to study and characterize that local relevance, which is connected to many policy-making applications, the concept needs to move beyond philosophy. This is what social science approaches have been doing—integrating the relational values concept into empirical work. We thus wished to synthesize those approaches, given their relevance both in philosophical and policy-oriented contexts. More specifically, we aimed to present how authors have, in varied contexts, worked with and explored the relational values concept, operationalized measurement tools, and articulated the significance of their findings.

In this paper, we do the following. First, we discuss a few "core" characteristics of relational values and provide a brief historical overview of notable conceptual developments in relational values research. This leads to our research questions. We describe our methods, then review the peer-reviewed literature on empirical research on relational values. Our discussion explores our main assessments of the literature we reviewed: that the relational nature of relational values in empirical studies is often unclear, that claims about the impacts of relational values often lack direct evidence, and that relational values are relevant in various contexts in the wider fields of interdisciplinary sustainability science and valuation.

2.2.1. What are relational values?

Relational values have been defined in various ways; we follow Chan and colleagues (2016) and understand them as preferences, principles, and virtues associated with relationships between humans and nature. As mentioned above, relational values emerged from work in environmental philosophy and broadened the instrumental/intrinsic dichotomy of environmental values. More specifically, relational values refer to importance that pertains to a relationship with an entity of meaning deemed non-substitutable (Chan et al., 2018; Deplazes-Zemp & Chapman, 2021; Himes & Muraca, 2018). We find it useful to consider relational values as pertaining to values both "about" a relationship (e.g., guiding principles) and the values "of" a relationship (e.g., relative worth); such consideration can help capture diverse meanings of relationships that are not easily classified as either intrinsic or instrumental (Chan et al., 2018). In short, scholars have positioned the relational values concept as a unique lens of interpretation on the importance people ascribe to nature. These scholars often note that: *a*) relational values are not solely instrumental ; *b*) relational values are values of or about relationships; *c*) the object(s) contributing to relational values are non-substitutable (Chan et al., 2016; Deplazes-Zemp & Chapman, 2021; Gould et al., 2023; Himes & Muraca, 2018).

There is a relatively short history of discourse clarifying the conceptual underpinnings and implications of the relational values concept, given its introduction to the philosophical literature just over a decade ago (Muraca, 2011). As Muraca continued to elaborate the concept's philosophical foundations (Muraca, 2016), the piece authored

by Chan and colleagues (2016) helped to situate the philosophical underpinnings of relational values within sustainability science and conservation research; it stressed that the definition of the concept in environmental valuation includes those relationships between people and nature. Chan and colleagues' (2018) editorial sought to situate relational values among other conceptions of value(s) (e.g., assigned, moral, held). Given the different definitions of and pervasive use of the word "value" in sustainability science, (e.g., Rohan, 2000; Tadaki et al., 2017), this editorial delineated relational values among both the assigned worth of objects and the moral principles guiding action. Himes and Muraca (2018) expressed relational values' importance for plural valuation, and they specified that relational values are non-substitutable and not solely instrumental, in addition to being associated with relationships. Stålhammar and Thorén (2019) articulated that relational values are relevant within the disciplinary perspectives of environmental ethics, environmental psychology, and ecosystem service valuation, and that they can help to address issues within each field. West and others (2020) named the scholarly activity around relational values as one component of a "relational turn" in sustainability science, which stresses the importance of relationality in many forms. Finally, Deplazes-Zemp and Chapman (2021) introduced the notions of mediating and indirect relational values, and they explored diverse pathways between valuer, relationship, and object of value. Themes from these works have been cited as components of the conceptual basis of relational values to support claims regarding what relational values are and what relational values can do.

Apparently spurred by the attention to relational values in sustainability science starting in 2016, researchers began to study relational values empirically. Yet in contrast to the conceptual literature described in the previous paragraph, there is relatively little literature that explicitly guides the application of relational values in empirical work. In the only such paper we know of, Schulz and Martin-Ortega (2018) outline both the challenges and potential benefits of employing quantitative methods in empirical research on relational values. The paper presents a case for quantifying relational values and outlines instances of how authors have approached such quantification in various other fields that study human-nature relationships (e.g., Q methodology, willingness to pay experiments, structural equation modeling.) However, the paper does not study relational values directly and there are few (if any) other resources that compile, assess, or focus on recommendations for empirical approaches to relational values research.

2.2.2. Research goals

We perform a systematic review to "take stock" of the attributes and findings of empirical research on relational values. Specifically, we identify the diverse methods, motivations, and findings in relational values research, as well as the various ways that relational values are operationalized. The research questions that guide our work are as follows:

RQ1. How are relational values operationalized in empirical research?

RQ2. What are the methods, contexts, and trends of empirical research on relational values?

2.3. Methods

For this review, we analyze empirical, peer-reviewed literature focused on relational values in the context of nature. Below we detail our selection and coding processes.

2.3.1. Study selection protocol

We used the search term "relational value*" in the following 5 databases: Web of Science, Academic Search Premier, Environment Complete, GreenFILE, and Social Science Full Text (H.W. Wilson). The initial searches yielded a total of 576 results, 421 of which were unique results (letters A and B in Figure 2. 1). For the first selection round, which narrowed our total number of records to 184, we screened result titles and abstracts and excluded any records that were not written in English and/or did not explicitly mention relational values in the context of nature (letters C and D in Figure 2. 1). Defining what constitutes nature is a contested exercise which we acknowledge wholeheartedly (e.g., Keune et al., 2022); for the purposes of this review, we operationalized nature by scanning abstracts for the following terms: "nature," "environment," "non-human," "landscape;" mentions of specific ecosystems (e.g., wetlands, oceans, forests); and mentions of specific species (e.g., trout, cranes, turtles). Given the dialogue that connects the relational values concept and to ecosystem services frameworks (Arias-Arévalo et al., 2018; Stålhammar & Thorén, 2019), we also included papers that include the term "ecosystem services" or abbreviations of closely related terms (e.g. "ES," "CES," "PES," "Nature's Contributions to People").

For the second round of selection, the lead author of this study (DP) scanned all remaining 184 full texts for eligibility (letter E in Figure 2. 1). We excluded articles that did not report on original research (i.e., theory or conceptual articles, commentaries, editorials, corrections, or replies), books, dissertations, other systematic literature reviews, and articles that employed the phrasing "relational values" but in ways far outside of the realm of our working definition of the concept (for instance, Manns and colleagues' (2017) study of pigeon brain functions uses the phrasing "relational values" to refer to relationships between brain hemispheres). We also decided to exclude articles that did not specifically include relational values as a component of the study design or analysis. These articles often listed "relational values" as a keyword and/or gave cursory explanation of the concept in the introductory or conclusion sections (letter F in Figure 2. 1). For instance, Gómez and others (2021) briefly connect their findings to "socio-ecological relational values," but do not include the relational values concept as a central component of their work. We came to a final sample of 72 papers for our review.

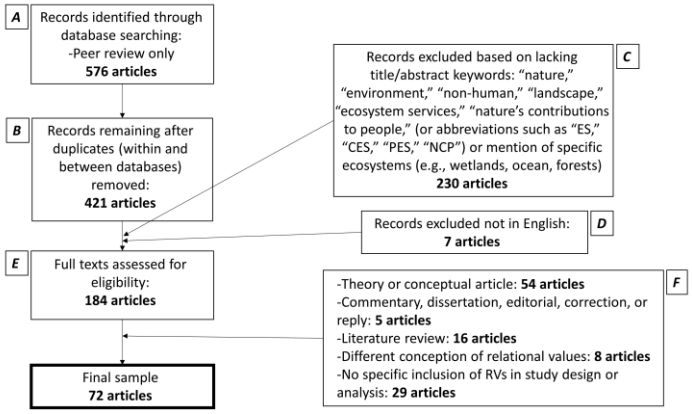

Figure 2. 1. The systematic approach taken to yield the final sample of journal articles reviewed in this study.

1.3.2. Coding protocol

We collected information from each of the 72 papers in our sample using 13 broad categories. Four categories addressed publication information: article title, study authors, year published, and journal. Four categories involved study basics: methods used, study participant total size, participant attributes (e.g., Indigenous communities, landowners, students), and study location. The remaining coding focused on relational values. We coded for definition of relational values employed by study authors and the particular relational values identified in the study design/analysis. We summarized the stated purpose and main findings of each study, and recorded notes on additional conceptual frameworks (e.g., ecosystem services) or theory (e.g., value-belief-norm theory) each study included. We also noted if and when papers justified their results with conceptual elements unique to relational values; this theme emerged during our analysis. To begin the coding process, we jointly read and coded a subset of 8 papers; this allowed us to identify areas where more interpretation was involved; we focused much of our attention on coding to identify particular relational values. After this initial "calibration", DP and NA completed coding the remaining papers. We remained in close contact throughout coding; any discrepancies were discussed and addressed in regular meetings to ensure consistency, and we contributed to/revised each other's entries.

In the final stages of coding, we developed a set of emergent categories based on the different definitions of relational values from studies reviewed. The categories reflect the content captured in the definitions. Additionally, DP and RG re-coded the particular relational values mentioned in each study, organizing them in descriptive categories.

First, we created a list of all unique words or phrases that study authors identified as particular relational values. We used thematic categories that study authors identified (e.g., if an author coded a participant response as representative of "social cohesion," we did not look at the original data for each code). Next, we categorized most of the values in the full list into descriptive groups based on the content of the value phrases. For instance, we coded the value "application of parcel specific knowledge" as both *knowledge* and *livelihood*. The final descriptive categories were partially determined by how frequently the specific phrasing constitutive of each category appeared in the database. We also created an "others" category as a catch-all for the value statements that differed from our groupings. We recognize that relational values are powerful in their descriptive nuance, but we chose to employ a more categorical approach for the sake of identifying and analyzing trends in the literature.

2.4. Results

To present our results, we first detail the general trends and summary statistics of characteristics of the studies in our sample; this addresses our first research question. We then summarize what authors are calling relational values in empirical studies; this addresses our second research question. Finally, we explore the study purposes and findings related to relational values, presenting instances of how this concept has been used in empirical research.

2.4.1. General characteristics of empirical research on relational values

Empirical research of relational values of nature has increased in frequency each year since 2018 (Figure 2. 2). The 72 articles we reviewed were published in 36 different

journals, most of which have an interdisciplinary focus. Studies were conducted in communities and areas across 6 continents (Figure 2. 3). Studies most frequently used surveys or questionnaires to collect data, followed by interviews. Examples of data collection approaches categorized as “other” include recording life histories, participatory video, “scraping” of social media posts and photos, and choice experiments (Figure 2. 4). See (https://datadryad.org/stash/dataset/doi:10.5061/dryad.34tmpg4qs) for a full list of the methods used in each study. Forty-six studies used one data collection approach; 22 studies used two data collection approaches, and five studies used three or more data collection approaches. The median sample size of human participants in studies was 136; the smallest sample was two participants and the largest sample was 2,203 participants.

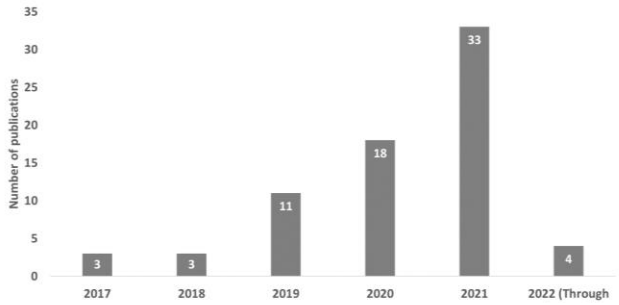

Figure 2. 2. Frequency of publications per year. We ended the search for this review in January 2022, so the 2022 bar is not representative of other publications from beyond January. Citations throughout this manuscript reflect the most recent updates from journals, which have shifted select citation years to 2023. However, this chart reflects the date of first publication online for each article in the review.

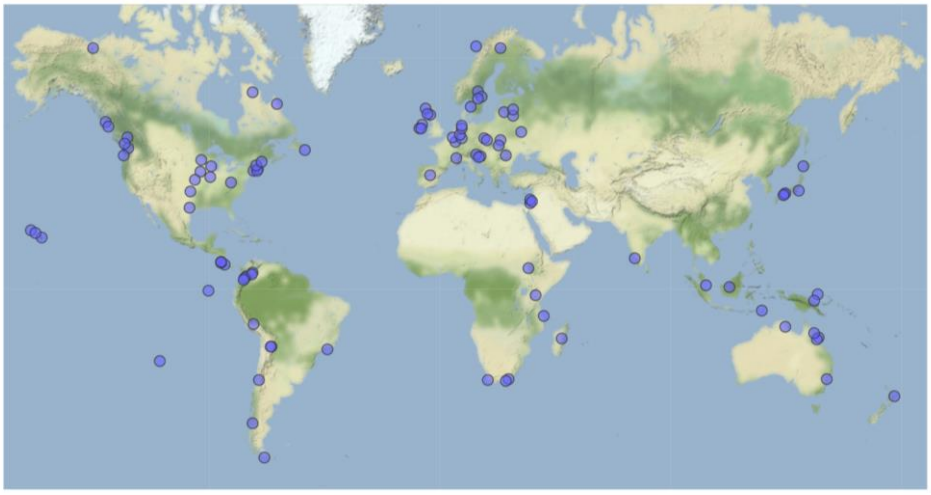

Figure 2. 3. Blue points represent the approximate locations of each study in our sample. A few locations were the site of multiple different studies, so there are less than 72 points on the map.

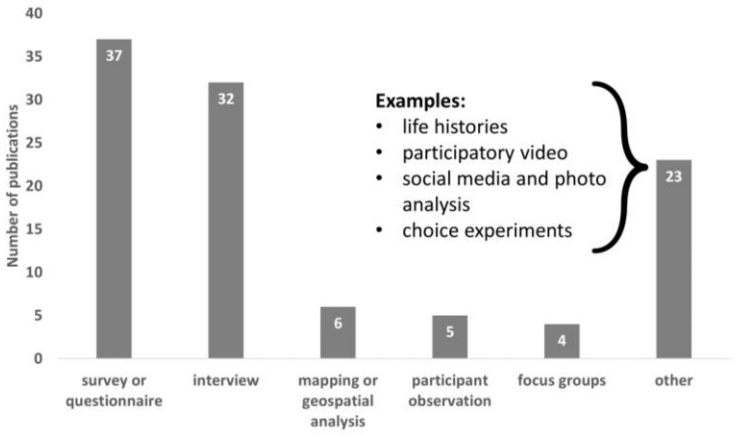

Figure 2. 4. Frequency of data collection methods used by studies. Note that methods were not used mutually exclusive. 'Other' methods include but are not limited to recording of life histories, participatory video, social media post and photo analysis, and choice experiments.

2.4.2. How authors conceptualize relational values

Authors employed a range of definitions to identify what relational values are (Table 2. 1). The most used definition (16 studies) cited a portion of Chan et al.'s (2016) definition of relational values (that full definition is "preferences, principles, and virtues associated with relationships, both interpersonal and as articulated by policies and social norms" (p. 1462)). A portion of definitions focused on the specific characteristics and mechanics of relational values. Elbakidze and colleagues (2021), for instance, defined relational values with a focus on how they form: "relational values are those that arise during or as a result of the processes of people being in, or interacting with, nature" (p. 3). Another portion of definitions focused on what relational values do. Kleespies and Dierkes (2020)'s definition stated potential normative implications of relational values: "[relational values] reflect the responsibility and relationship humans have toward nature and the place where they live. In addition, [relational values] give rise to questions regarding how to deal with nature and the land to live a good and meaningful life", p. 2). Other definitions of relational values pulled from a broader range of sources, often including aspects or corollaries of the relational values concept that were most salient to the context of the study. Nine studies did not include any formal, explicit definition of relational values, though some of these implied that they used the definitions of cited works.

Table 2. 1. Specific examples of the different definitions of relational values in reviewed studies**.**

Definition type	***Example(s)***
No definition	"We used the CES framework, combined with related research on relational values (Chan and others 2016), to examine the impacts of…" **(Gould et al., 2022, p. 7)**
Portion of Chan et al. (2016)	"The 'preferences, principles, and virtues associated with relationships both interpersonal and as articulated by social norms'" **(Thompson et al., 2020, p. 1806)**
Characteristics and mechanisms of relational values	• "The values that are imbedded in desirable (sought after) relationships, including those among people and between people and nature" **(Cundill et al., 2017, p. 141)** • "[Relational values] emerge from prescriptions about desirable characteristics of relationships either among humans or between humans and the non-human world" **(Gallemore et al., 2022, p. 2)**
What relational values do	• "Relational values comprise associations such as how nature shapes a person or peoples' place-based identity, social relations, or culture" **(Dawson et al., 2021, p. 3)** • "Relational values emphasize the range of different relationships (e.g., social cohesion, cultural identity, place attachment) we have with nature and people in natural environments" **(Olmsted et al., 2020, p. 497)**

Authors used 312 unique words/phrases to refer to particular relational values (see https://datadryad.org/stash/dataset/doi:10.5061/dryad.34tmpg4qs for full list). Of these 312 phrases, 230 fall within 17 broad categories (Figure 2. 5). Table 2. 2 provides examples of each category. Studies most frequently identified *individual identity* as a relational value, followed by *collective identity*, *social cohesion*, *livelihoods*, and *connection to place*. Eighty-two values were categorized in an "others" group as they did not fit into the broad categories we created.

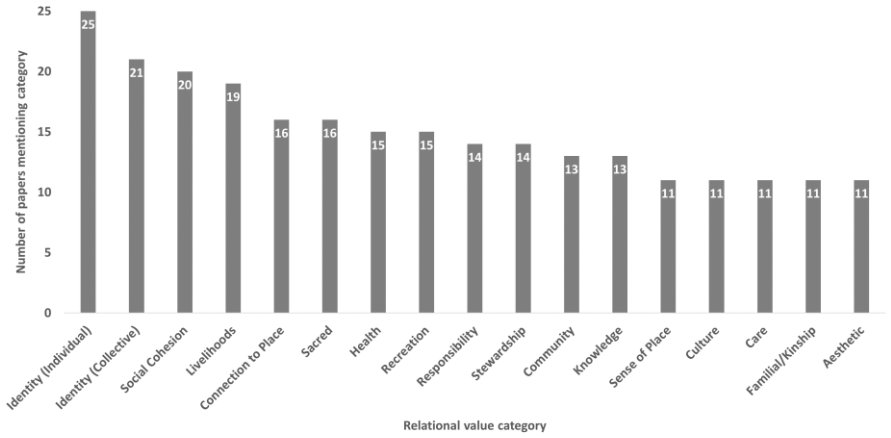

Figure 2. 5. Frequencies of relational value categories occurring in each study.

Table 2. 2. Categories of relational values reported in reviewed studies, with examples.

Relational value category (our coding)	***Example from survey/questionnaire prompt***	***Example from response to interview prompt (💬) OR study author categorization (✒)***
Individual Identity	"The rivers here are important to me, to who I am as a person" **(Espinoza-Cisneros, 2020, p. 245)**	💬 "The Otun River watershed is the identity of all of the people from Pereira" **(Arias-Arévalo et al., 2017, p. 7)**
Collective Identity	[item reverse coded] "My identity primarily revolves around other people and the things we produce, rather than the natural world" **(Eyster et al., 2022, supplementary info., p. 13)**	💬 "[Te Urewera National Park] provides opportunities that build identity that bonds individuals with predecessors, family, friends, youth, work colleagues, and community" **(Bataille et al., 2020, p. 443)**
Social Cohesion	"Relating to the sea at Hinase provides a vehicle for connecting with people" **(Uehara et al., 2020, p. 1604)**	💬 "Being in nature provides a means for me to connect with other people" **(Cundill et al., 2017, p. 141)**
Connection to Place	"I am rooted here**"** **(Paniotova-Maczka et al., 2021, supplementary info., p. 3)**	✒ "The connection to spontaneous/un-tended nature both on [farmers] land and beyond it" **(Kreitzman et al., 2022, p. 193)**

Sacred	"Nature has a religious, sacred or spiritual value to me" **(Lliso et al., 2022, p. 318)**	💬 "Land is a great God blessing" **(Bravo-Monroy, 2021, p. 4)**
Health	"My health or the health of my family is related one way or another to the natural environment." **(Klain et al., 2017, p. 5)**	💬 "…without forests and rural landscapes I would not be able to live around. It [nature] charges me and gives me strength and of course health." **(Elbakidze et al., 2021, p. 7)**
Recreation	"Natural areas are important to me because I use them for recreation." **(Gale & Ednie, 2020, p. 698)**	💬 "waterfalls"; "leisure for children"; "nature walk" **(Coelho et al., 2021, p. 8)**
Responsibility	"Humans have a responsibility to account for our own impacts to the environment because they can harm other people" **(Leveridge et al., 2021, p. 7)**	💬 "We can't let this [weed infestation] happen ... in 50 years' time my son will be a very old man and we'll be long gone ... the river will still be here ... so my vision is always to 'rescue the future'" **(Mould et al., 2020, p. 6)**
Stewardship	"Keeping the sea at Hinase [geographic region] healthy is the right thing to do" **(Uehara et al., 2020, p. 1604)**	✒ "Motivated by a sense of responsibility towards wetlands ecosystems, includes wetland protection (e.g. fencing wetlands; covenanting); wetland enhancement (e.g. managing or creating habitat for fauna or flora; planting); wetland construction" **(Bataille et al., 2020, p. 946)**
Community	"The rivers in this watershed are important to my community for defining who we are as a community" **(Espinoza-Cisernos, 2020, p. 245)**	💬 "Community agency over landscape" **(Chapman et al., 2019, p. 468)**
Knowledge	[No survey prompts specifically measuring knowledge as RV]	✒ "The embrace of knowledge production, observation, investigation, and innovation in the land, and for teaching and learning with others." **(Kreitzman et al., 2021, p. 193)**

Sense of Place	"The rivers in this watershed are important when I think of where I am from" **(Espinoza-Cisernos, 2020, p. 245)**	💬 "Everybody knows that if you are situated in Malmesbury or the Swartland [geographic regions], it is recognizable by the renosterbos [vegetation type]." **(Topp et al., 2021, p. 743)**
Culture	[No survey prompts specifically measuring culture as RV]	💬 "Cultural subsistence" **(Russell et al., 2020, p. 6)**
Care	"Caring for this green space shows my care for other people (present and future)" **(See et al., 2020, p. 3)**	💬 "Mālama: To take care of, tend, attend, care for, preserve, protect, beware, save, maintain" **(Gould et al., 2019, p. 1226)**
Familial/Kinship	"Plants and animals, as part of the interdependent web of life are like kin or family to me, so how we treat them matters" **(Klain et al., 2017, p. 5)**	💬 "We would like to be able to build a business for the next generations so that it stays in the family. And it's interesting, the more my husband and I get involved in this, the more excited I can see my dad and grandmother… happy about the farm" **(Chapman et al., 2019, p. 468)**
Aesthetic	"I value natural areas primarily for their beauty"; "The natural beauty of plants and animals is important to me" **(Gale & Ednie 2020, p. 698)**	💬 "…let it go back to grass and tea trees … it used to be beautiful when it was like that" **(Mould et al., 2020, p. 5)**

The median number of relational values identified per study was four (ranging from one to 42). A total of eight studies did not identify any specific relational values; these studies used the foundational elements of the relational values concept more as a theoretical lens to interpret findings, as opposed to using tools to measure and identify specific manifestations of relational values.

Another way to understand the diversity of approaches to relational values is to characterize the number of distinct conceptualizations of each of the categories we identified. Of the 17 different relational value categories that we identified and established, *livelihoods* had the greatest number of unique phrases/descriptors, followed by *knowledge*, *religion*, *responsibility*, and *connection to place* (Figure 2. 6).

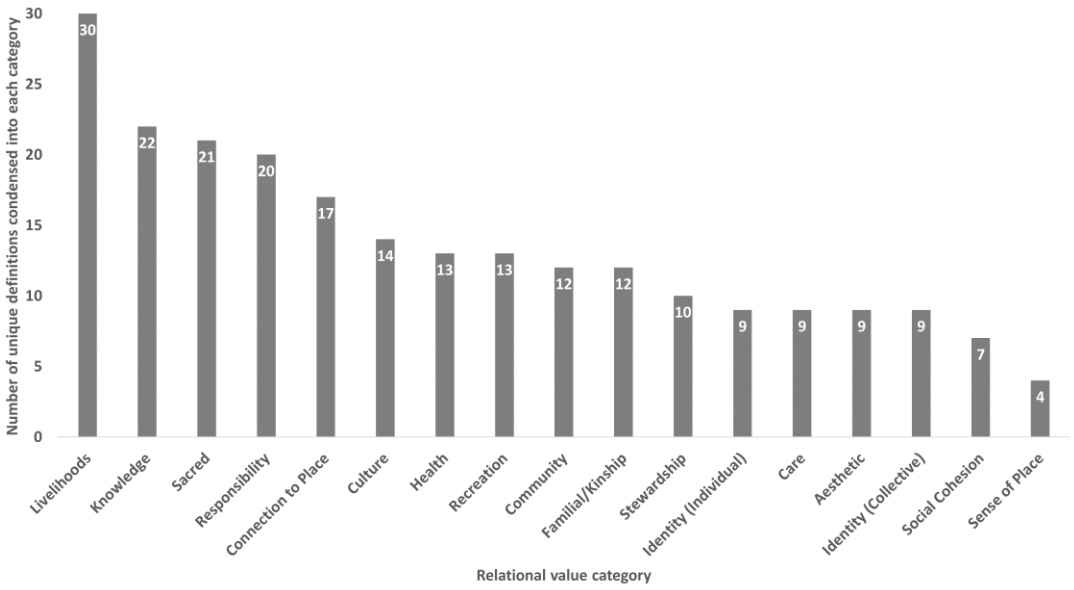

Figure 2. 6. Total number of unique phrases or descriptors used for each relational value category.

2.4.3. How are authors studying relational values?

We were interested in capturing how authors included the relational values concept in their studies, given the range of potential applications described in Schulz and Martin-Ortega (2018). As outlined below, authors explore different ways to study the existence of, changes in, or impacts of relational values.

Twenty-eight studies identified relational values within communities that were adjacent to/within landscapes governed by different types of environmental management policies. Six of these studies included Indigenous communities as participants. These 28 studies often investigated the impacts of management approaches on the values of surrounding communities, or to capture how future management initiatives could be informed by community values. Thompson and colleagues (2021), for instance, identified key social-ecological indicators tied to values of a First Nations community (Gitga'at) to describe how future marine resource management goals could include such indicators to align with the Gitga'at values. Fourteen studies that investigated the dynamics between communities and environmental management often linked their results to conflict management. These studies stated or implied that relational values lend themselves to managing environmental conflict. None of these studies documented recognition or use of relational values to aid in conflict management; they only made claims about relational values' helpfulness in conflict situations.

Eight studies investigated psychological indicators that have been previously recognized as relational values in conceptual or empirical research. More specifically, these studies focused on specific concepts (sense of place, land ownership, place connection, or stewardship), identified these concepts as relational values, and explored the concept's interactions with the broader study context. Rajala and colleagues (2020), for instance, examined aspects of psychological factors (place meaning and place attachment) hypothesized to contribute to survey respondents' sense of place in the context of their land management decision-making. These eight studies often took

methodological approaches that measured psychological indictors associated with the relational values concept, congruent with Stålhammar and Thorén's (2019) discussion on relational values and environmental psychology.

Six studies used the theoretical framing of the relational values concept to frame specific statements used in choice experiments. Lliso and colleagues (2021) concluded that statements that highlighted respondent relational values were linked to motivations to continue conservation practices after the lapse of payment for ecosystem services schemes. Three studies used existing methods approaches and indicated that such methods had not been previously used in relational values research. Ruiz-Frau and colleagues (2020), for instance, analyzed social media with graph theory network analyses and indicated that the approach offers "greater capabilities" (p. 1) in identifying relational values. Eastwood and colleagues (2021) studied youth participants' connections to natural areas using participatory video. They concluded that the participatory video process enabled connection with nature by motivating participants to interpret natural spaces on camera.

The remaining 27 studies applied the relational values concept in a variety of ways. These studies developed original survey items to measure relational values (e.g., Klain et al. 2017, Saito et al. 2022), compared values held by urban and rural community members, mapped the values of various ecosystem services across landscapes (García-Díez et al. 2020), compared benefits of forest management approaches among intrinsic, instrumental, and relational values (Himes et al. 2021), explored the mechanics of how

people form relational values (Flood et al. 2021), and used relational values to re-analyze economic survey results (Kim et al. 2021).

2.4.4. Other observed patterns

In addition to the systematic analysis above, we noted a variety of patterns present across many of the analyzed studies. Most authors did not justify how the relational values they studied aligned with core conceptual elements unique to relational values (e.g., relational values are not solely instrumental, relational values express values of/about relationships, entities contributing to relational values are non-substitutable). Many studies relied on prior identifications of relational values – e.g., because aesthetic value was at some point listed as a relational value, authors would connect a respondent's statement about the importance of aesthetics to the relational values concept without providing full contextual evidence of how this value rang consistent to relational values' foundational characteristics. Authors often included data related to one of the 17 most common categories of relational value (e.g., aesthetic) but did not specify why it was, for instance, a *relational* (as opposed to instrumental) aesthetic value (this issue is more pertinent for values that are more easily understood as instrumental and likely often manifest in highly instrumental ways - notably aesthetics, recreation, and livelihoods).

A small subset of studies addressed connections between relational values and three other domains: behavior, ecosystem services, and Indigeneity. Studies often noted that relational values had close associations to pro-environmental behaviors: they often suggest relational values motivated and/or developed from pro-environmental behavior. Engel and colleagues (2020), for instance, indicated that relational values motivated pro-

environmental behavior. They integrated relational values into the value-belief-norm theory (Stern 2000) and the norm-activation model (Schwartz 1977), concluding that efforts to motivate peoples' pro-environmental behaviors towards oceans were most successful when they highlighted peoples' care and concern for oceans (care and concern were considered relational values in this study). Conversely, Uehara and others (2020) concluded that relational values resulted from pro-environmental behavior (e.g., planting seagrass beds) embedded in environmental literacy programming. Certain studies in our sample sought to understand the synergies between relational values and ecosystem services, identifying relational values associated with results from ecosystem services assessments to better articulate why certain ecosystem services are prioritized by stakeholders. Finally, studies linked Indigenous worldviews with the relational values concept, uncovering similarities between the two that are of relevance to environmental management. Each of these patterns are discussed in more detail in the following discussion section.

2.5. Discussion

Understanding how and why nature matters to people is important in guiding effective conservation. Foundational literature on relational values proposes a way to expand conceptions of environmental values. Relational values can represent "deeper and more complex" contexts (Himes and Muraca 2018, p. 2), and by extension, are poised to assist scholars and policymakers to better understand a fuller range of reasons nature matters to people. The studies in our review document the varied values associated with people-nature relationships around the world. These studies' engagement with a range of

global communities brings diverse worldviews squarely into the academic discourse. However, our results indicate that there exists a range of interpretations (and degrees of specificity) as to what relational values might be. This range of interpretations potentially compromises consistency among applications of the concept. We discuss the results and claims that might benefit from adherence to foundational ideas guiding the relational values concept. We follow by discussing the varied applications of the concept in relation to multiple aspects of and topics relevant to interdisciplinary sustainability science. Our results indicate that empirical research on relational values has yet to elucidate strong connections between plural values and conservation outcomes, a finding of particular interest to conservation and sustainability science.

2.5.1. Unclear relationality of relational values

In conceptual literature, three commonly cited characteristics of relational values are as follows: *a*) relational values are different from instrumental and intrinsic values; *b*) relational values pertain to relationships; *c*) the object(s) contributing to relational values are non-substitutable (Himes and Muraca 2018, Deplazes-Zemp and Chapman 2021, Gould 2022). We found that most empirical research on relational values does not justify how its results reflect the theoretical characteristics that establish the relational values concept as unique from other environmental values. Such an approach to relational values scholarship risks leading to a concept so "messy" (Kenter et al. 2019) that it loses its theoretical meaning.

This phenomenon creates a complex tension. On one hand, embracing pluralism and diversity is central to the ethos of the relational values concept, however, ambiguity

can be problematic, as it risks, "…that the term 'relational' rapidly becomes a buzzword used to justify very different approaches…" (West et al. 2020, p. 318). Though this comment refers to relational sustainability research in general, it is highly relevant to relational values research specifically. Blurring the meaning of relational values risks hindering scholars in identifying, learning from, and building upon relational values research. Certain empirical research on relational values demonstrates ambiguity by cherry-picking elements of the relational values concept that may not reflect the entirety of the concept as articulated by the theoretical literature. We found this most often in the definitions of relational values and the various values that authors identified as relational values. Authors used a range of definitions of relational values, some of which focused on specific characteristics of relational values, and others focused on what relational values bring about. The cases where authors focused on defining the characteristics or resulting action from relational values, however, were marked by inconsistent references to prior conceptions of relational values (see Table 1 for examples.) This lack of reference to past relational values work creates a degree of ambiguity around the role of conceptual literature in informing what relational values are. We suggest that authors strive to consider the principles that make relational values unique from other environmental values when articulating their findings.

Additional justification for this recommendation comes from the many studies in our review that collected ample data on values but did not elaborate on how the values they identified were relational. We do not list the citations for these specific studies as we believe this "finger-pointing" does not contribute to productive dialogue; instead, we

offer a specific example of a study that does elaborate on how the values they identify are aligned with the characteristics of relational values.

In their discussion section focused on the "empirical recognition of plural values," Arias-Arévalo and colleagues (2017) presented a summary of how specific results from their study are best characterized as relational values, pulling from the core characteristics listed previously. More specifically, they unpacked the potential implications of considering aesthetic value associated with a *páramo* ecosystem as either instrumental or relational. The aesthetic *relational* value of the *páramo* implied that the specific ecosystem was a key component in the generation of value (aligning with component *c*,) and that the aesthetic value was a byproduct of deep relations between communities and that ecosystem (aligning with component *b*). We present this specific example to highlight one way to situate results with conceptual literature, not to discuss the merits of this particular study over others.

2.5.2. Common claims that require additional research

Scholars (e.g., Knight et al. 2011) have claimed that conflict between people in relation to environmental management can stem, in part, from stakeholder values that conflict with one another. Many studies in our review alluded to the potential role(s) that relational values might play in managing environmental conflict. Reviews authored by Ives and Kendal (2014) and Jones et al. (2016) indicate that the recognition of stakeholder values in environmental management decision-making processes can influence the impacts of such decisions (e.g., how management is evaluated by stakeholders, how stakeholders interact with managed areas) that drive conflict. Muraca

(2016) citing Martinez-Alier (2002), states that "environmental conflicts are ultimately value conflicts" (p. 36), and she posits that relational values promise an approach to productively manage such conflict. Despite the base of conceptual literature supporting this application of the relational values concept, we did not uncover any instances where authors documented how relational values played a role in managing conflict. Future work should look to provide empirical evidence that links relational values to changes in environmental conflict to substantiate future claims of the importance of values in conflict management.

Prior literature has explored a multitude of ways to conceptualize (Kollmuss and Agyeman 2010, Li et al. 2019) and measure (Lange and Dewitte 2019) the psychological pathways between attitudes and pro-environmental behaviors in differing contexts, considering the influences of values (Eyster et al. 2022). Future research may look to clarify the relationship between relational values and pro-environmental behavior, providing evidence on whether relational values are antecedents to or results of pro-environmental behavior – or as is somewhat likely, both (Maller 2021). Such clarification may add specificity to recommendations about behavioral interventions informed by values.

2.5.3. Relational values and ecosystem services

Relational values may offer a tool for thinking about ecosystems and people holistically, assisting in the applicability of ecosystem services in socio-cultural contexts. Fish and others (2016) argue that cultural ecosystem services (CES) are the result of "relational processes" between people and nature (p. 211). Studies in our review

demonstrated how relational values contributed to ecosystem services frameworks by articulating the values associated with ES, providing nuance to why such services matter to study participants. Lau and others, for instance, (2019) concluded that relational values provided communities with normative guidance in indicating the "appropriate" (p. 227) ways for co-producing and benefitting from ecosystem services. Community members placed high importance on maintaining certain provisioning ecosystem services due to their contributions to bequest values (which were identified as relational values). Other studies used relational values to illuminate instances where prioritizing certain ecosystem services negatively impacted relationships (and the values associated with such relationships) between people and ecosystems. Unks and colleagues (2021) investigated the impacts of conservation interventions on relational values of an Indigenous community (*Ilkisongo* Maasai) in Kenya; they concluded that conservation interventions (prioritizing biodiversity ecosystem services) decreased relational interactions between the Maasai community and wildlife species, leading to increased negative interactions and subsequent changes in values among the Maasai and surrounding wildlife. However, we urge future research connecting relational values and ES to remain cautious in making distinctions between the two concepts; we suspect that some authors may have conflated CES with relational values in certain instances (e.g., when values were identified as aesthetic, recreation, or livelihood-based).

2.5.4. Relational values and Indigenous communities

Researchers also used relational values as a conceptual tool to bridge gaps between worldviews of various stakeholders and Indigenous communities. They did this

in multiple ways. Some authors concluded that identifying relational values of Indigenous communities and non-Indigenous stakeholders led to successful collaborative management of natural areas (e.g., Bataille et al. 2021). Others looked to further build the theoretical underpinnings of relational values by exploring the concept's resonance with Indigenous worldviews (e.g., Sheremata 2018, Gould et al. 2019, Tadaki et al. 2022). Calls for integrating multiple values in holistic ecosystem assessments emphasize the need to include and honor the values of Indigenous communities (IPBES 2022), given that these communities have been historically marginalized, bear the disproportionate negative impacts of biodiversity loss, and have worldviews that offer many lessons for sustainability science (Stiglitz 2012, Kealiikanakaoleohaililani and Giardina 2016). Studies of relational values can continue to include and prioritize Indigenous voices in academic discourse, as studies in this review demonstrate that these communities have embraced the relational values concept long before it was articulated in academia – and indeed were some of the primary inspirations for the academic idea (Muraca 2011, 2016).

2.5.5. Novel research approaches to relational values

In addition to the trends outlined above, we found certain instances where authors used elements of the relational values concept in unique ways. Some studies (e.g., Maca-Millan et al. 2021, Eyster et al. 2022, Gallemore et al. 2022) used relational values to frame the wording in choice experiments by emphasizing participants' relationships to various natural contexts. Kim and others (2021) used relational values to re-assess survey results not fully explained by neoclassical economic theory. Himes and colleagues (2020) assessed tradeoffs among various forest ecosystem services, using relational values to

capture the values of those ES on different societal scales. This work demonstrates the relational values concept's flexibility as a tool to orient creative research approaches to work the complex relationships between people and nature. Gould (2023) notes that relational values (among other values concepts) are particularly suited for creative applications to research, and that creative approaches may increase both the explanatory potential and management relevance of pluralistic valuation. We encourage future work to continue to experiment with such approaches while remaining attentive to core principles to allow for cohesion in relational values research moving forward.

2.5.6. Study Limitations

Our approach to categorizing relational values was somewhat subjective, potentially compromising replicability for future reviews. To minimize this risk, we have detailed our approach and definitions as much as possible and think that it is likely that other researchers would categorize our raw data in similar, if not identical, ways. Given the relatively small number of studies in our review, we did not perform statistical analyses to determine statistically significant relationships among study characteristics. As relational values research grows, analyses that explore relationships between value categories and study characteristics (e.g., methods approach, ecological context, sample size; see Reichers et al. 2022 for an example) may illuminate influences on the relational values that studies reveal. Statistical analyses may be able to indicate, for instance, whether certain methods predict relational values categories more often than others. We focused exclusively on peer-reviewed literature. The expression and documentation of relational values is present in a range of sources, including policy documents, oral

narratives, and ceremony (Sheremata 2018, Ranspot 2019, Gould et al. 2019), the thoughtful inclusion of which would benefit future reviews on this topic.

2.6. Conclusions

We argue that the concept of relational values is relevant to understanding the diverse meanings humans associate with relationships with nature. Our results indicate that empirical research on relational values reflects this relevance through its investigations of communities across the globe. Yet the relational values concept runs the risk of being so broad and inclusive that it becomes meaningless, or at least meaning-light. Our results show that most of the studies in our review did not justify their findings with core conceptual characteristics of relational values. We encourage scholars to carefully consider the conceptualizations of relational values they use, and to walk the line between ideological hegemony and a confusing "anything goes" approach. We also think it is important to investigate claims about relational values' attributes (e.g., their connections to pro-environmental behavior or environmental conflict) to explore whether, how, and in what contexts they may and may not be valid. The papers in our review suggest that relational values are relevant and important to communities around the globe, and we hope this summary helps to advance and strengthen research into this important topic.

2.7. References

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CHAPTER 3. ASSESSING RELATIONSHIPS AMONG FINANCIAL COSTS, CONSERVATION PROGRAM ENROLLMENT, AND BIODIVERSITY-FOCUSED FOREST MANAGEMENT IN VERMONT SUGARBUSHES

3.1. Abstract

Private working forests can be managed to provide ecosystem services for a range of beneficiaries, but owners and managers bear the financial costs. Research has looked to identify opportunities where biodiversity conservation can be managed for in cost-effective ways. We measured engagement with eight biodiversity-focused forest management practices across 12,977 acres of maple syrup-producing forests managed by 70 maple syrup producers (sugarmakers) in the US State of Vermont to determine if annual forest management costs increased with biodiversity-focused forest management. Sugarmakers most often utilized a formal forest management plan and promoted coarse woody debris. Annual forest management costs were highly variable across our sample and did not differ across increasing biodiversity-focused management. Sugarmakers enrolled in both USDA-Organic and Audubon Vermont's "Bird-Friendly" programs tended to engage with more practices than strictly organic-certified sugarmakers. Our results suggest that forest management costs may not strongly influence engagement with biodiversity-related practices. They also highlight the relationships between conservation programs and management. Our findings are relevant to regional efforts that look to motivate cost-effective biodiversity conservation in working forests.

3.2. Introduction

Working lands, which include rangelands, forests, and cultivated lands, are common land uses across the globe (Ramankutty et al., 2018) and can be important contributors to cohesive biodiversity conservation efforts (Kremen & Merenlender, 2018). Working lands are primarily managed for the production of market goods, therefore, managers look to minimize management costs in order to maximize the financial income linked to market goods (Polasky et al., 2008). The provision of biodiversity conservation in private working lands, therefore, is linked to the ability of owners and managers to minimize financial costs associated with conservation management approaches (Naidoo et al., 2006).

A range of financial costs are associated with private ownership of working landscapes (Adams, 2024; Naidoo et al., 2006). Therefore, biodiversity-focused management interventions that either increase net costs or negatively impact income may not be as readily adopted by owners and managers of private working lands. Conservation scientists and economists have actively looked to quantify potential costs in the development and implementation of biodiversity-focused initiatives in order to inform cost-effective management interventions, which are proposed to lead to economically "optimal" benefits for both biodiversity and land users (e.g., Adams et al., 2012; Ando et al., 1998). Research that utilizes financial cost information in the context of conservation initiatives has operated under a range of objectives and approaches, including (but not limited to) comparing costs across varying spatial scales (e.g., Armsworth et al., 2011), private or public land ownership types (e.g., Main et al., 1999), and identifying resource-

dependent communities that bear higher costs than others as a result of conservation initiatives (e.g., Green et al., 2018). Costs can also be used to establish a financial baseline to inform individuals on what to expect when undertaking specific management approaches.

Forest ecosystems are highly prevalent across the Northeast United States, comprising more than 59% of total land cover in the region (Bigelow & Borchers, 2017). Of this total forestland, around 77% is owned by private entities (including individuals, families, and corporations) with a diverse array of values, objectives, and financial contexts related to their forest ownership (Bengston, 2020; Butler et al., 2023; Butler & Ma, 2011). Changes in regional socioeconomic priorities have spurred high rates of forest parcelization, which has distributed forest management decision-making across the diverse array of forest owners in the region (Germain et al., 2006; Littlefield et al., 2024). The opportunity for "working forests" in the Northeast US to contribute to regional conservation successes, then, largely depends on the interests and capabilities of forest owners to adopt biodiversity-appropriate management approaches. Relevant empirical data on the costs associated with biodiversity management can assist forest owners in achieving conservation goals cost-effectively (Beach et al., 2005).

Maple syrup producers (sugarmakers) are one community within the diverse assemblage of working forest owners in the Northeast US. Sugarmakers are actively involved with collecting sap from sugar maple (*Acer saccharum* M.) and red maple (*Acer rubrum* L.) trees in forested parcels (sugarbushes) that collectively contribute to a yearly syrup crop most recently valued at over $170 million USD (Northeastern Region Maple

Syrup Report, 2023). The long-term sustainability of maple syrup production depends on forested conditions suited to regional climate and disturbance patterns (Bradford & D'Amato, 2012; Chapeskie et al., 2006), yet paradoxically, market demand and recent production growth rates have the potential to incentivize management that encourages overstocking and maple monocultures in forests (Leak et al., 2014; Lenière & Houle, 2006; Whitney & Upmeyer, 2004) which can diminish forest resilience to disturbances and other climate-exacerbated changes (Rapp et al., 2019).

Several programs and initiatives which utilize financial incentives (e.g., price premiums on syrup; decreased property taxes levied on sugarbushes) have been established to motivate sugarmakers to prioritize biodiversity conservation through their forest management (Auld et al., 2008). These programs operate under the assumption that sugarmakers require market-based incentives to recoup the costs of managing "responsibly" above the status quo (Engel et al., 2020; Kinzig et al., 2011). However, we are unaware of empirical research that explores the financial costs of biodiversity-focused forest management in the context of maple syrup production. This gap in knowledge can lead to conservation programs and policies offering incentives that do not reflect on-the-ground expenditures associated with sugarbush forest management, impacting either program funders or end beneficiaries.

Understanding the relationships between costs and forest management approaches in the context of an economically significant regional crop is critical for efforts that look to motivate biodiversity conservation in private working landscapes. In this study, we tracked Vermont sugarmakers' engagement with a suite of biodiversity-

focused forest management practices across conservation program enrollments to understand how management behaviors related to annual forest management costs.

Our study context, the US state of Vermont, presents a useful case to illustrate the dynamics of sugarbush forest management, costs, and biodiversity. Forested landscapes represent around 74% of the state's total land cover, 78% of which are privately owned (Forests of Vermont, 2020, 2021). Vermont's working forests, given their composition and structural components, allow for a range of both migratory and resident species (Bakermans et al., 2012; Long et al., 2012). Additionally, maple syrup operations across Vermont have consistently produced the most maple syrup out of all US states since 1927, with the 2023 sugaring season totaling more than 2 million gallons produced, around 50% of total US syrup production (2022 Census of Agriculture. Vermont: State and County Data, 2024). Both the economic and cultural significance of syrup production (Hinrichs, 1998; Whitney & Upmeyer, 2004) may exert pressures on Vermont's forested landscape and its ability to foster biodiversity over time. By highlighting the prevalence of specific biodiversity forest management practices across Vermont sugarbushes, we assist local and regional efforts that look to motivate cost-conscious biodiversity conservation. We also contribute to the growing body of literature on the socio-economic facets of maple syrup production (e.g., Ahmed et al., 2023; Byerly et al., 2019; Hershberger et al., 2023; Velardi et al., 2023). Our research questions are as follows:

RQ1: What is the distribution of select biodiversity-focused forest management practices employed across Vermont sugarbushes?

RQ1.1: Are there differences in how many biodiversity-focused forest management practices are employed across conservation program enrollment?

RQ2: What is the relationship between financial costs and levels of biodiversity-focused forest management?

RQ3: Is it more costly to employ biodiversity-focused forest management practices in Vermont sugarbushes?

RQ3.1: Is it more costly to employ biodiversity-focused forest management practices in the context of conservation program enrollment?

3.3. Methods and analysis

3.3.1. Questionnaire development and distribution

We developed a questionnaire through multiple iterations of feedback from maple industry extension professionals, sugarmakers, landowners, and scientists (Appendix A). Given that no comprehensive list of Vermont sugarmakers exists, we adopted a convenience sampling approach focused on distribution through social and professional networks connected to sugarmakers. We distributed the questionnaire both in-person during the 2023 Vermont Maple Meeting, an annual trade meeting hosted for sugarmakers, and online via Qualtrics, an online survey host. We emailed the questionnaire to various email lists associated with maple syrup and forest landowner organizations in Vermont, who then forwarded the questionnaire URL to their email subscribers. Finally, we directly emailed the questionnaire to a subset of USDA-Organic certified operations, identified from the USDA INTEGRITY Database, following the approach outlined by Byerly and others (2019) (Appendix B). Given that we used

multiple outlets to distribute our questionnaire, we are unable to report a unified response rate. Participants who provided their contact information were entered into a raffle to win 1 of 10 gift cards valued at $250. University of Vermont's Institutional Review Board reviewed study procedures and determined they were exempt under approved protocol #00001666.

3.3.2. Management practices

We tracked sugarmaker engagement with eight different forest management practices associated with the provision of biodiversity outcomes in forested ecosystems (Figure 3. 1). The eight practices were adapted from guidelines and recommendations outlined by two popular conservation programs with Vermont sugarmakers: USDA Organic (VOF Guidelines for Certification of Organic Maple Sap & Syrup, 2016) and Audubon Vermont's "Bird-Friendly" Maple program (*Bird-Friendly Sugarbush Management Guidelines*, n.d.).

USDA Organic requirements for maple syrup production include several forest management practices that may influence forest biodiversity (Figure 3. 1). Organic certification can command market prices that are higher than conventional, non-certified syrup (Cannella et al., 2022); higher market prices represent a financial benefit associated with engagement in the program, thus, compliance with program requirements. Audubon Vermont's "Bird-Friendly" Maple program also requires participants to comply with a set of biodiversity-focused forest management practices, but the program differs from Organic in that participants are not subject to third-party audits or established participation fees (*Bird-Friendly Sugarbush Management Guidelines*, n.d.). Audubon

Vermont recognizes participating sugarmakers with promotional signage and materials, but there is no current evidence that a market price premium exists for maple syrup produced in "bird-friendly" sugarbushes. Therefore, the financial benefits associated with "bird-friendly" are less evident.

Several of the forest management practices that we focused on in this study were also linked to potential financial benefits, or to low financial expenditures in the context of sugarmaking operations (Figure 3. 1). For instance, possessing a current, state-certified forest management plan allows Vermont forest owners to participate in the state's land-use tax abatement program, which can provide significant decreases to annual property taxes (e.g., Foster et al., 2008; Maker et al., 2014). Leaving crowns and woody debris behind after tree harvests can reduce damage to residual overstory (i.e., sap-producing) trees (Huyler & LeDoux, 1999) and may represent a time- and cost-saving practice for sugarmakers (Clark & McLeman, 2012). However, the ability for sugarmakers to realize the financial benefits from the eight management practices depends on their operation's context (e.g., some may not enroll in the tax abatement program), therefore, we tracked engagement with practices across a wide range of operational scales.

Associated programs	Management Practice	Biodiversity outcome(s)	Financial benefit(s)	Financial Cost(s)	
	State-Certified Forest Management plan	Uncertain, outcomes determined by plan goals and objectives	Access to VT Current use, which reduces property taxes. Access to Organic, which increases syrup market value.	-Dependent on plan complexity and property size; NRCS estimates plans range from $800-$4500 depending on acreage	**Less costly (benefits considered)**
	Facilitate Bird Habitat Assessment	Uncertain, dictates future management to encourage birds in sugarbush	Uncertain short-term financial benefits	-Transaction costs to facilitate assessment with biologist	
	Maintain at least 2 snags per acre	Increased habitat opportunities for cavity-dwelling wildlife	Uncertain short-term financial benefits, allows for tapped trees to senesce (instead of paying to cut them down)	-Damage costs to equipment from falling limbs/snags	
	Leave crowns after harvesting trees	Creates physical barriers from browse to influence seedling regeneration; provides shelter for smaller invertebrates, reptiles, birds	Reduced damage to sap-producing trees during harvests, less need for heavy felling equipment and contractors	-Nuisance costs - navigating around dead wood. Opportunity cost if material was to be sold for energy feedstock	
	No harvesting during forest bird nesting season (May-July)	Increases forest nesting bird survivorship during nesting season	Uncertain short-term financial benefits	-Transaction costs to negotiate harvests in other seasons. Loss of "non-sugaring" time to complete harvesting	
	Promote diverse midstory and understory vegetation	Provides habitat opportunities for smaller invertebrates, reptiles, birds	When achieved through selective cutting, the woody material might be sold for income	-Dependent on cutting approach - minimal cost if done in-house. Costly if contracted out and timber is not merchantable	
	Eradicate non-native, invasive vegetation	Less invasives means better opportunity for shade-based tree regeneration, which creates future forest habitat for diverse species	Uncertain financial benefits, with the exception of NRCS-EQIP (cost-share program) monetary reimbursement	-If using chemicals, licensed applicators are required ($ for labor and $ for chemicals.) Mechanical management may be less costly if done in-house	
	Manage/maintain less than 75% sugar maple cover across sugarbush	Allows for greater habitat opportunities for generalists across the forest	Uncertain short-term financial benefits	-High management costs if sugarbush is mostly sugar maple (high opportunity costs here, too, given loss of tappable trees). Low/non-existent if sugarbush is already diverse	**More costly (benefits considered)**

Figure 3. 1. List of eight measured biodiversity-focused management practices, their associations with USDA Organic and Audubon Vermont's "Bird-Friendly" Maple program, proposed biodiversity outcomes, and financial costs and benefits. Biodiversity outcomes were informed by the following references: (*Bird-Friendly Sugarbush Management Guidelines*, n.d.; Clark & McLeman, 2012; Doerfler et al., 2018; Gamfeldt et al., 2013; Grodsky et al., 2024; Huyler & LeDoux, 1999; Leak et al., 2014).

3.3.3. Annual Financial Costs and Benefits

We collected reports of financial expenditures that represent a range of typical forest management costs associated with sugarmaking operations that were readily reported by sugarmakers. Specifically, we measured tree harvesting expenditures, invasive and non-native species management expenditures, damage costs associated with woody vegetation (i.e., falling limbs or snags), and paid forest management labor costs. Our initial goal was to measure direct financial costs associated with each of the eight management practices. After receiving feedback on our questionnaire, we determined that several practices were best characterized by their opportunity costs, rather than direct

financial expenses (See Figure 3. 1). Opportunity costs associated with private land management can be highly context-dependent, thus, challenging to accurately measure (Adams, 2024; Naidoo et al., 2006). We accounted for relative benefits through sugarmaker reports of average annual syrup yield. Details on variable coding are included in Appendix B.

3.3.4. Analysis

We calculated a "biodiversity-friendly" management score for each sugarmaking operation in our sample. The score was calculated on a scale from 0-1, where 1 represented an operation that employed all operationally-relevant forest management practices listed in Figure 3. 1. There were several instances when respondents indicated that specific practices were not relevant to the biophysical conditions of their sugarbush (for instance, certain sugarmakers did not manage invasive, non-native plant species because such species did not exist in their sugarbush). To account for these instances, we calculated scores based on the total number of relevant management practices per each sugarbush. We considered the presence or absence of each practice to represent actions that equally led toward forest conditions supportive of biodiversity, and we did not account for more descriptive attributes (e.g., the area of invasive species management). Thus, our "biodiversity-friendly" management scores represent an approximate estimation of management inputs across sugarbushes.

We divided the "biodiversity-friendly" management scores into three groups that represented minimal, moderate, and high engagement with management practices. We determined the cut points of the three groups by calculating quartiles of the

"biodiversity-friendly" scores: group 1 (minimal management, *n*=20) captured operations that scored below 0.58 (25% quartile), group 2 (moderate management, *n*=31) captured operations that scored between 0.58 and 0.85 (50% quartile), and group 3 (high management, *n*=19) captured operations that scored higher than 0.85 (75% quartile).

We normalized cost-specific questionnaire responses to represent dollars spent per acre, per year, in order to compare costs across different operational scales. We used a price-per-acre unit to ensure that our results were relevant to sugarmakers and other industry professionals. We calculated benefit-cost ratios by dividing annual syrup production and annual costs per acre. All subsequent statistical analyses were performed using R Statistical Software (v4.0.2, R Core Team, 2020).

3.4. Results

3.4.1. Sample description

We received 70 complete questionnaire responses for our final study sample. Nine questionnaires (13%) were completed by respondents in-person and the remaining 61 questionnaires (87%) were completed by participants on the Qualtrics web platform. We received an additional 21 responses on Qualtrics that were incomplete. Respondents took an average of 33 minutes to complete the questionnaire. Sugarmakers in our sample were largely 55 years or older (71%), white (97%), college-educated (59%) and earned more than $75,000 annually (60%). Less than 20% of sugarmakers reported that maple syrup or value-added maple products (candies, maple sugar, etc.) accounted for a majority of their yearly income.

Our sample represented 12,977 acres of tapped forestland in 12 of Vermont's 14 counties. Sugarmaking operations ranged in size from 24 to 93,000 taps and produced an average of 3,665 gallons of maple syrup in an "average" sugarmaking season. Twenty sugarmakers (29%) indicated that they leased sugarbush acreage from others, 17 of whom counted the leased acres as accounting for portion of their total sugarbush acreage. In other words, these sugarmakers owned a majority of their sugarbush and leased additional acres to add to their operation scale. See Appendix C for descriptive statistics for the study sample. The distribution of operations in our sample was roughly equivalent to the 2022 USDA NASS census data of Vermont sugaring operations, with a relatively consistent representation of operations by tap "size class," and with most syrup produced from operations with 10,000 taps or more (Table 3. 1).

Table 3. 1. Comparison of this study sample's operational characteristics against 2022 USDA NASS Census data (2022 Census of Agriculture. Vermont: State and County Data, 2024).

	2022 USDA NASS Census		***Study Data***	
Size Class (# Taps)	**Total Operations**	**Gallons Syrup Produced**	**Total Operations**	**Gallons Syrup Produced***
1-99	69 (5%)	2273 (0%)	3 (4%)	544 (0%)
100-499	279 (19%)	73100 (1%)	9 (13%)	438 (0%)
500-999	197 (14%)	132712 (2%)	4 (6%)	355 (0%)
1000-1999	179 (12%)	231986 (3%)	10 (14%)	4295 (2%)
2000-2999	143 (10%)	329502 (4%)	10 (14%)	9980 (4%)
3000-4999	152 (11%)	557724 (7%)	8 (11%)	10800 (5%)
5000-9999	191 (13%)	1335383 (16%)	13 (19%)	26399 (11%)
10000+	223 (16%)	5828040 (69%)	13 (19%)	181800 (77%)

*Six responses omitted due to reporting raw sap yields

3.4.2. Distribution of eight forest management practices across sugarbushes

We found that sugarmakers most often reported possessing a state-certified forest management plan, followed by leaving crowns and branches after harvesting trees

and maintaining two or more dead standing trees (i.e., snags) per acre of sugarbush. Out of the sugarmaking operations that could, most did not actively work to influence diverse midstory and understory vegetation (39%), harvested during months of forest bird nesting season (38%) and did not manage toward greater overstory tree species diversity (36%). Slightly over half of our study sample (56%) reported that their sugarbush contained less than 75% sugar maples, or that they were actively managing for a target coverage below 75% (Figure 3. 2).

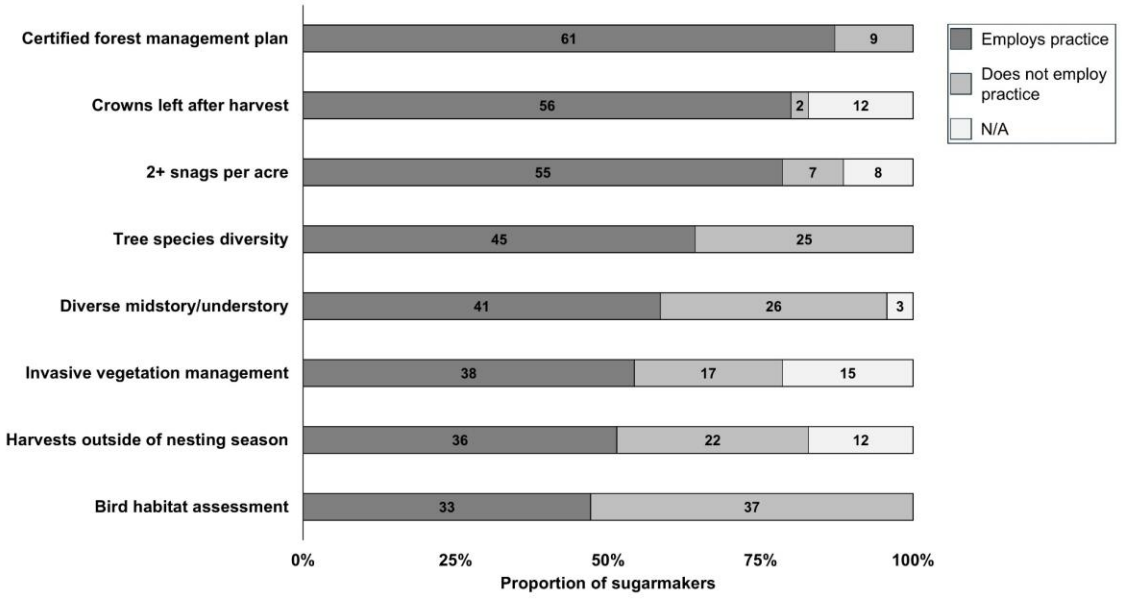

Figure 3. 2. Distribution of eight biodiversity-focused management practices across sugarmaking operations in our study sample.

3.4.3. Differences in "biodiversity-friendly" management scores across program enrollment

One-way analysis of variance (ANOVA) testing revealed significant differences in average "biodiversity-friendly" management scores across enrollment in USDA-Organic

and “Bird-Friendly” maple ($F(3, 66)=10.02$, $p<0.001$). Specifically, sugarbushes enrolled in both organic and “bird-friendly” scored significantly higher than non-enrolled sugarbushes and organic sugarbushes. Also, “Bird-Friendly” sugarbushes scored significantly higher than organic sugarbushes (Table 3. 2).

Table 3. 2. Differences in mean “biodiversity-friendly” scores across program enrollment types; differences in superscripts represent statistically significant differences in means.

Program enrollment status (*n*)	**Average “biodiversity-friendly” score (SD)**
Not enrolled (25)	0.63 (0.17)^{c}
Organic (13)	0.50 (0.19)^{bc}
“Bird-Friendly” (13)	0.75 (0.17)^{ab}
Organic + “Bird-Friendly”	0.81 (0.15)^{a}

3.4.4. Relationships among financial costs and three “biodiversity-friendly” management groups

We compared annual financial costs across the three “minimal,” “moderate,” and “high” groups calculated from the “biodiversity-friendly” management score quartiles. ANOVA testing revealed that there did not exist significant differences in average annual management costs across the three levels of “biodiversity-friendly” management scores ($F(2, 49)=0.64$, $p=0.53$). Median annual management costs were $18.80 per acre in the “minimal” group, $14.29 per acre in the “moderate” group, and $11.46 per acre in the “high” group (Figure 3. 3).

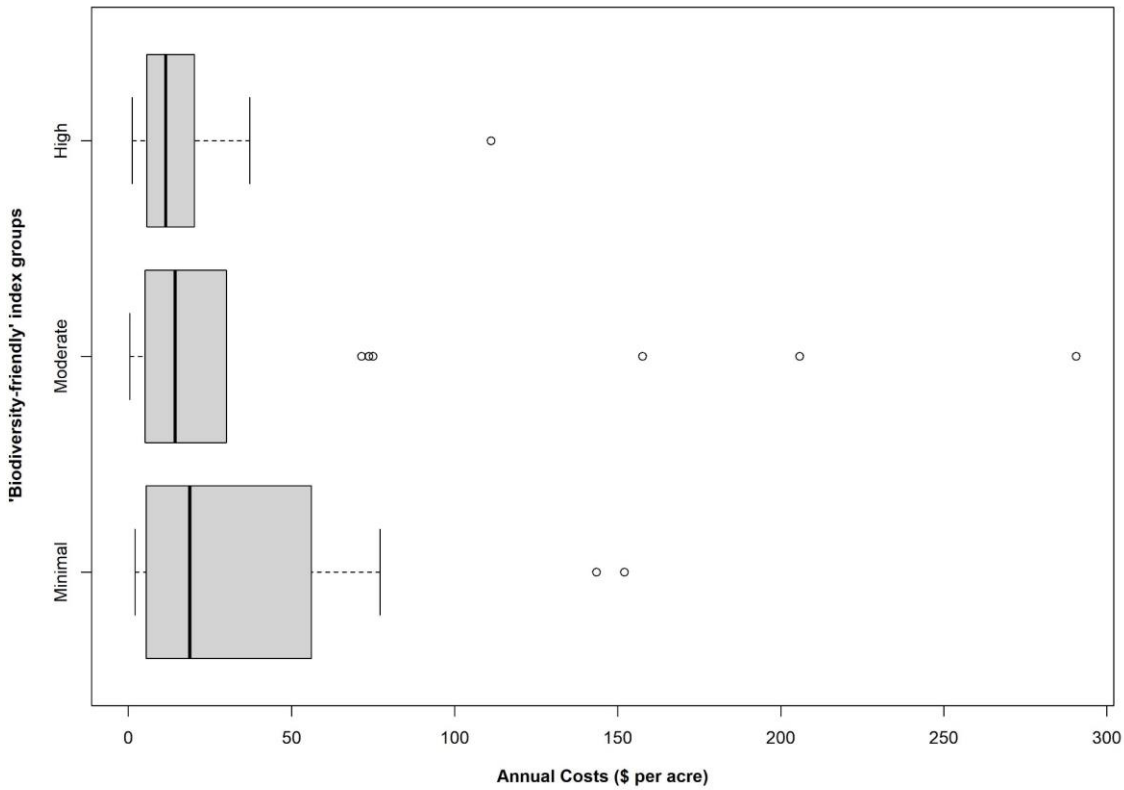

Figure 3. 3. Annual forest management costs (normalized by dollars spent per acre of sugarbush) across the three "biodiversity-friendly" index groups.

3.4.5. Benefit-cost ratios across three "biodiversity-friendly" management groups

We compared average benefit-cost ratios of sugarmaking operations across the three "biodiversity-friendly" management groups to determine the relative costliness of employing increasing degrees of biodiversity-focused forest management practices. ANOVA testing revealed that there did not exist significant differences in average benefit-cost ratios across the three levels of "biodiversity-friendly" scores ($F(2, 47)=0.35$, $p=0.71$). Median benefit-cost ratio values were 0.99 for the "minimal" group, 0.74 for the "moderate" group, and 2.11 for the "high" group (Figure 3. 4).

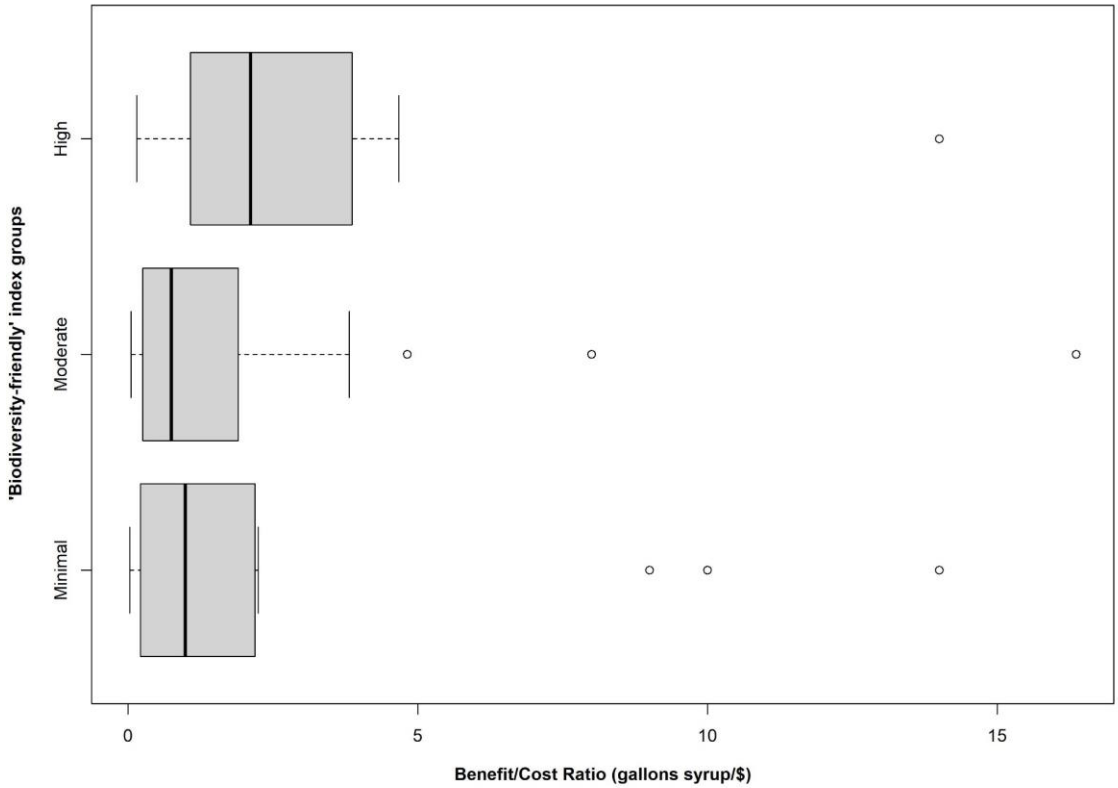

Figure 3. 4. Benefit-cost ratios (calculated from annual syrup yields and annual costs per acre) distributed across the three "biodiversity-friendly" index groups.

3.4.6. Benefit-cost ratios across degrees of program enrollment

We compared average benefit-cost ratios of sugarmaking operations across different configurations of enrollment (or not) in USDA-Organic and "Bird-Friendly" Maple. ANOVA testing revealed that there did not exist significant differences in average benefit-cost ratios across the four levels of program enrollment ($F(3, 46)=0.71$, $p=0.55$). Median benefit-cost ratio values were 0.85 for those who were not enrolled in any programming, 1.56 for those who were enrolled in USDA-Organic, 1.12 for those who

were enrolled in “Bird-Friendly” maple, and 1.34 for those who were enrolled in both Organic and “Bird-Friendly” (Figure 3. 5).

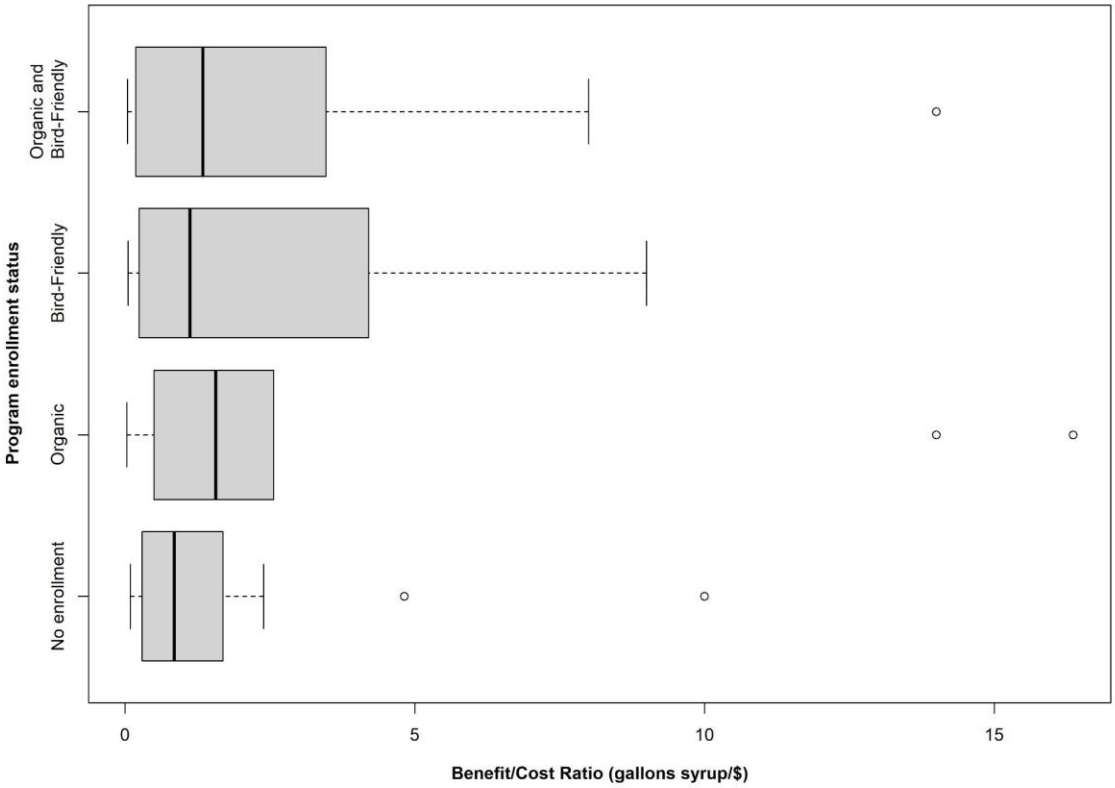

Figure 3. 5. Benefit-cost ratios (calculated from annual syrup yields and annual costs per acre) distributed across four different degrees of program enrollment.

3.5. Discussion

We set out to determine how common select biodiversity-focused forest management practices were across Vermont sugarbushes, and if these practices were associated with higher annual management costs. By tracking sugarmaker engagement with management practices linked to regional and national conservation programs, our study provides a timely description of private forest owner decision-making in the

context of a significant regional crop and forest-use approach (2022 Census of Agriculture. Vermont: State and County Data, 2024). Our results indicate that biodiversity-focused forest management in the context of sugarmaking operations were not associated with increased annual management costs. Owners and managers of working, maple syrup-producing forests report managing for biodiversity in a cost-efficient manner, a finding that holds implications for the role of similar private forest owners and associated conservation programming in achieving conservation successes (Hanley et al., 2012).

3.5.1. Distribution of forest management practices across sugarbushes

We found that sugarmakers most frequently maintained a state-certified forest management plan associated with their sugarbush. A majority of private forest owners in Vermont do not have a formal management plan (Caputo & Butler, 2024). Our data indicates that maple sugarmakers in our sample represented a subset of Vermont forest owners that readily engaged with this management approach, likely due to the monetary benefit from the cost savings afforded by management plans. Though private forest owners pay fees for forest management plans (both for their development and periodic renewal), plans are required for participation in several programs associated with potential financial benefit, including Vermont's Current Use land tax abatement program, and when relevant, USDA-Organic. The links between forest management plans and biodiversity outcomes are less direct, however. Forest management plans document forest owner goals and recommend specific practices that can be taken to reach those goals (Long et al., 2012). Future research may benefit from careful review of sugarmaker

management plans to better understand their contributions to biodiversity goals, given their high representation in our study.

We found that sugarmakers commonly retained or recruited woody material (i.e., leaving crowns and branches after harvesting trees and maintaining two or more dead standing trees) in their sugarbushes. Our findings align with Clark and McLeman's (2012) study of sugarmaker management behaviors in Ontario, which noted that many sugarbushes contained high amounts of coarse woody material. The authors attribute leaving woody material to relative ease of adoption; sugarmakers may be more inclined to adopt a management approach (e.g., leaving woody material after a harvest) that does not require additional, potentially costly effort to complete. Though woody material may cause costly damage to operational infrastructure (e.g., disconnecting tubing between trees), benefits linked to time savings and avoided harvesting-related damages to adjacent residual trees (Huyler & LeDoux, 1999) may have motivated the high engagement among sugarmakers in our sample.

Conversely, we found that sugarmakers often harvested during summer months (May through July) that correspond with forest bird nesting season in the Northeast US (Leak et al., 2014). Sap is generally harvested in early spring (Rapp et al., 2019; Whitney & Upmeyer, 2004), but sugarmakers spend significant portions of the months preceding and following the harvesting season preparing their operations (e.g., tapping trees, organizing equipment and tapping infrastructure). Therefore, summer months may be utilized for significant forest management. Though timber harvests in the same stand are most often spaced over longer periods of time (e.g., every 20 years) to allow for

regrowth, planning harvests during other seasons may conflict with other activities that facilitate sap harvesting.

3.5.2. "Biodiversity-friendly" management scores and program enrollment

We found several significant differences in average "biodiversity-friendly" management scores across types of conservation program enrollment. Namely, sugarbushes enrolled in both organic and "bird-friendly" scored significantly higher than non-enrolled sugarbushes and organic sugarbushes. Also, "Bird-Friendly" sugarbushes scored significantly higher than organic sugarbushes. Given that the eight management practices that we tracked are featured in the "Bird-Friendly" guidelines (Bird-Friendly Sugarbush Management Guidelines, n.d.), it is not surprising that those enrolled in the program scored highest. However, we found that USDA-Organic sugarmakers scored the lowest across all other enrollment types, including those who were not enrolled in any program. Organic standards look to achieve objectives that are split between limits to synthetic additives to food production and responsible land management (VOF Guidelines for Certification of Organic Maple Sap & Syrup, 2016). Our findings suggest that enrollment in organic does not equate to an increased level of biodiversity-focused forest management, in the context of our sample.

In general, guidelines associated with conservation programming can assist forest owners by informing clear objectives and identifying the appropriate management approaches to meet those objectives. Though our data suggests that a relationship exists between program enrollment and higher engagement with biodiversity management, we are unable to claim that enrollment led to biodiversity outcomes. This conceptual leap

between enrollment and ecological impact has been considered in reviews and meta-analyses (e.g., Börner et al., 2020; van der Ven & Cashore, 2018) which indicate that biodiversity outcomes are highly geographically context-dependent, and that programs "interventions" are often carried out in contexts where there exists lower pressure on resources. More local studies, however (e.g., Foster et al., 2008) have linked enrollment in Forest Stewardship Council certification to ecological conditions that encourage forest biodiversity. Similarly, Maker and colleagues (2014) found that participation in the state's Current Use tax abatement program was linked to increased "sustainable management practices." As such, future research efforts that compare sugarbush biophysical conditions across management regimes may consider connections between enrollment status and on-the-ground management (e.g., Faccio et al., 2023).

Our data suggests that "Bird-Friendly" enrollment seemed to have a compounding effect with organic certification; producers enrolled in both programs engaged with significantly more management practices than others. Sugarmakers who sell their product to bulk buyers often enroll in organic certification programs, given the higher price that organic syrup commands (Cannella et al., 2021). Bulk syrup pricing, however, requires larger numbers of taps deployed in a sugarbush for operational costs to break even with sales, implying that the potential biodiversity outcomes associated with organic certification standards are limited to larger operations. Our results indicate that the Bird-Friendly program has been adopted by a range of operations, which suggests that current requirements are "nimble" enough to be adopted by large and small operations. We argue that the program should continue to work in conjunction with other

certification standards rather than adopt requirements such as third-party audits and enrollment fees (e.g., Conde, 2023) in order to achieve biodiversity outcomes across a range of operational scales.

3.5.3. Relationships among costs and "biodiversity-friendly" forest management

Sugarmakers reported spending a yearly average of $37.11 per acre on forest management expenditures that included harvesting costs, invasive species management costs, paid labor costs, and damage costs. Annual management costs ranged from $0.38 per acre to $290.54 per acre. Average costs did not differ across increasing levels of our "biodiversity-friendly" forest management score, nor did the benefit/cost ratios differ across increasing management levels or program enrollment types. Taken together, these results suggest that increases in "biodiversity-friendly" forest management can be accomplished in a cost-efficient manner across a range of maple syrup production contexts. Our results contribute to the nascent literature that connects sustainability-adjacent outcomes with maple syrup production approaches (e.g., Byerly et al., 2019; Hershberger et al., 2023; Rapp et al., 2019; Velardi et al., 2023) and adds nuance to trends associated with forest management behaviors of private forest owners in the US (Butler et al., 2023).

Sugarmakers reported a wide range of annual forest management costs, especially those in the "moderate" management group. Broadly, these results are consistent with other studies that have looked to quantify the range of management costs borne by private forest owners in the US (e.g., Arano et al., 2002; Callaghan et al., 2019). Scoping reviews and meta-analyses of forest management trends almost universally

indicate that management is more frequent and less costly in larger parcels (Beach et al., 2005; Londo & Grebner, 2004; Silver et al., 2015). Given that our study focused on forested parcels primarily utilized for sugarmaking, the wider range of costs suggests that considerations of sap-producing trees (e.g., Sendak et al., 1982) and tapping infrastructure may influence costs comparatively to parcels primarily utilized for timber production. This range may be further explained by potential errors that result from self-reports of management data across relatively large parcels and chronological time periods (Dang et al., 2020; Winkler-Schor et al., 2024).

As outlined in Figure 3. 1, specific management behaviors were linked to varying degrees of relative costliness to sugarmakers. For instance, tree harvesting can yield significant financial benefit relative to costs (Long et al., 2012; Palik & D'Amato, 2017), whereas management of invasive, non-native vegetation most often yields no financial benefit in light of costs. Our data suggests that in aggregate, increasing levels of "biodiversity-friendly" forest management behaviors can be accomplished in a cost-efficient manner in maple sugarbushes. Studies that have investigated biodiversity conservation management in working lands often indicate that conservation management can be inherently costly to landowners and managers (e.g., Adams et al., 2012; Main et al., 1999; Naidoo et al., 2006; Polasky et al., 2008), thus, costs inhibit adoption of management practices. When considering the potential financial benefits associated with the eight forest management practices that we tracked across maple sugarbushes, our study indicates that financial costs may not play a strong role in inhibiting conservation-focused forest management in the context of maple syrup operations.

3.6. Conclusions

Our study sought to determine the extent to which Vermont sugarmakers engaged with select biodiversity-focused forest management practices, and if those practices were associated with annual management costs. We found that most practices were common across the majority of sugarbushes in our sample, and that costs were not significantly associated with increasing engagement with management. Future research may look to expand considerations of different forest management practices associated with specific conservation-related outcomes. Furthermore, work may look to collect information on costs (e.g., opportunity costs, transaction costs) directly associated with practices to better understand the interactions between increasing management and cost-efficiency.

Sugarbushes represent working forested landscapes that can be managed both for financial benefit and the provision of non-market ecosystem services and broader biodiversity conservation (Clark & McLeman, 2012; Kremen & Merenlender, 2018). Our sample of sugarmakers in Vermont demonstrate that management linked to conservation goals can be accomplished cost-effectively across a range of operational contexts. As maple syrup production expands across the forested landscape in the Northeast US, third-party conservation programming may play a key role in motivating engagement with select management approaches linked to potential biodiversity outcomes.

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CHAPTER 4: VALUES AND ACTION IN THE SUGARBUSH: INVESTIGATING BIODIVERSITY-FOCUSED FOREST MANAGEMENT AMONG VERMONT MAPLE SYRUP PRODUCERS

4.1. Abstract

Working forests that sustain human communities and support biodiversity are valued in diverse ways. Characterizing how non-monetary values relate to decision-making across working forests is critical for motivating sustainable relationships between people and forests. However, the connections between values and actions can be unclear across different resource-use contexts. We take a mixed-methods approach to investigate the relationships among relational values and forest management-related actions taken by maple syrup producers in Vermont, USA. We collected information on values and forest management actions from n=56 syrup producers and conducted semi-structured interviews with a subset of n=15 syrup producers. Our results indicate that a) different prioritization of relational values existed across Vermont sugarmakers; b) our quantitative measure of forest management action was not associated with differences in prioritizations of relational values; and c) actions were more tangentially related to values by their links to motivations and operational contexts. Our findings hold implications relevant to regional conservation efforts and broader scholarship around plural values of nature.

4.2. Introduction

Global-scale environmental issues have motivated research and policy that looks to utilize insights from the social sciences to characterize, assess, and ultimately shift human relationships to nature, with the purpose of addressing such crises and working towards sustainable futures (Balvanera et al., 2022; IPBES, 2022). A subset of this scholarship has focused efforts on understanding the diverse values of nature, as decades of theoretical and empirical research suggests strong connections between values and human behavior (Eyster et al., 2022; Gould et al., 2023). The interactions between values and actions are confounded by a ranging interpretations of the fundamental concept of value (e.g., Rohan, 2000). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) has aimed to establish cohesion across environmental valuation scholarship by developing an exhaustive "values assessment" that, in part, defined the values of nature as, "…goals, beliefs, and importance that people assign to nature's different facets and components" (Balvanera et al., 2022; Pascual et al., 2017). Importantly, values can refer to both monetary *and* non-monetary aspects of nature's importance or worth. However, there remain many questions on how these connections among values and actions function across different socio-ecological systems (Ostrom, 2009; Tadaki et al., 2017), scales of society (Cash et al., 2006), and institutional contexts (Vatn, 2009).

Varying interactions among human communities and forested ecosystems can be understood through the contexts of nature's values and forest management. Bennett's (2015) typology of forested plantations and protected areas outlined a marked trend

within forest management approaches that led to distinct separation between intensively managed forest plantations and isolated, protected forests marked by minimal management. These bifurcated forest management approaches incur different impacts on biodiversity; single-species plantations generally negatively impact biodiversity, comparatively to more complex forested ecosystems (Bauhus et al., 2015; Puettmann et al., 2009). The development of forest plantations can be understood with the concept of instrumental value, which gauges the value of an entity strictly based on its ability to satiate human preferences or needs (Himes et al., 2023). Instrumental values are often linked to substitutable, monetary indicators, even in the case of non-market goods (Spash, 2008). Forest protected areas refer to intrinsic value, which refers to the value of an entity in and of itself (Himes et al., 2023; Ott, 2008). Intrinsic values are often non-monetary and intangible. In sum, permissible actions within a forest plantation may differ from those in a protected forest, given the values associated with such actions and types of forested ecosystem.

Another subset of forest management approaches have been proposed to encourage forested conditions that effectively shift Bennett's (2015) typology into a spectrum; "ecological" forestry approaches look to represent multiple value types through management that yields multiple ecosystem services (Palik et al., 2020; Palik & D'Amato, 2017; Seymour & Hunter, 1999). Given its aims to foster multiple ecosystem services, ecological forestry approaches may positively impact biodiversity (Himes et al., 2020). Ecological forestry appeals to all value types, including a third: relational values. Relational values refer to the values associated with meaning-saturated, reciprocal

relationships between and among people and nature (Chan et al., 2016; Himes et al., 2023). These values are thought to expand the dichotomy between instrumental and intrinsic values and are considered key to characterizing the plural values of nature (Himes & Muraca, 2018). Relational values are commonly linked to non-monetary considerations of value, given that they refer to relationships that are, in theory, not substitutable (Chan et al., 2018; Pratson et al., 2023). Despite the hypothetical impact that relational values may have on developing sustainable environmental futures, the concept's (relatively) recent entrance into environmental valuation scholarship has posed challenges through diverse operationalization, applications, and interpretations across empirical research (Luque-Lora, 2023; Pratson et al., 2023).

Ecological forestry has been applied across different ecological and social contexts (Palik et al., 2020). For instance, ecological forestry is a component of the triad approach to forest management, where distinct, yet connected portions of a forested landscape are managed as either plantations, ecological reserves, or multi-objective ecological forests (Himes et al., 2022; Seymour & Hunter, 1992). However, the extent to which ecological forestry has been applied, as well as its impacts on biodiversity in the context of private forest ownerships is relatively unclear (Mayer, 2019). This uncertainty is well-illustrated in the United States, where an estimated one-third of forestland across the country is owned by private entities such as families, individuals, and family partnerships (Bulter et al., 2021). Researchers have looked to motivate the adoption of ecological management approaches in private working forests across the US (Kremen &

Merenlender, 2018) through understanding the diverse contexts of private forest owners (Butler et al., 2023; Kreye et al., 2021; Sharma & Kreye, 2022).

Given that private forest owners bear the financial costs of owning and managing their working forests, biodiversity conservation efforts have paid significant attention to the roles of economic cost-effectiveness in management actions (Adams et al., 2012; Naidoo et al., 2006). Though this attention helps to optimize monetary value, there exists the risk of flattening understandings of the values of nature in the context of human action by a singular focus on monetary conceptions of value. Indeed, claims such as, "Land-use decisions on working lands are based primarily on economic criteria, whether it is local people using land to make a living or corporations using land to maximize profits" (Polasky et al., 2008, pp. 1506) suggest that non-monetary values may need to be understood alongside monetary values when assessing the drivers of management actions.

4.2.1. Study objectives and research questions

In our present study, we aimed to elicit and characterize relational values associated with private working forests to better understand their relationships to biodiversity-focused management actions. We focused our study on maple syrup production in Vermont, USA. Maple syrup production is a common forest use approach in the Northeast US, a region that is 59% forested (Bigelow & Borchers, 2017). Recent, rapid growth in syrup production in the US (Cannella et al., 2022) has spurred concern that there exists a simultaneous increase in management that prioritizes forest monocultures for increased sap yields (Leak et al., 2014; Lenière & Houle, 2006); forest

monocultures are associated with a decrease in tree species structural and compositional diversity, as well as decreased resilience to climate-related stressors (Rapp et al., 2019). Vermont serves as a useful case study to represent this production approach for two reasons: Vermont syrup producers (sugarmakers) consistently produce a majority of the total annual US syrup crop (2022 Census of Agriculture. Vermont: State and County Data, 2024), and maple syrup represents a culturally significant practice, linked to concepts such as heritage, stewardship, and regional identity (Hinrichs, 1998; Lange, 2017; Whitney & Upmeyer, 2004) that are also often understood as non-monetary values (Azzopardi et al., 2023; Pratson et al., 2023; West et al., 2018).

We employed a mixed methods approach based around q-methodology (Brown, 1980; Creswell & Creswell, 2017; Watts & Stenner, 2014) by using a novel set of quantitative measures and semi-structured interviews to address the following research objectives: a) to quantify non-monetary, relational values, and forest management actions; b) to statistically assess the quantitative relationships between these measures; and, c) to characterize perceptions of the relationships among these concepts as expressed through interview responses. We developed our conceptual approach from extensive prior literature that has explored relationships among non-monetary values (e.g., Bengston, 1994; Karppinen, 1998; Kreitzman et al., 2022; Shishany et al., 2020) linked to management actions taken in private, working forests. Our research questions are as follows:

RQ1: What prioritizations of relational values exist among Vermont maple syrup producers?

RQ2: Do forest management actions differ among distinct prioritizations of relational values?

RQ3: How do Vermont maple syrup producers articulate links between forest management actions and relational values?

4.2. Methods and analysis

4.2.1. Study context

We focused our study on maple sugarmakers in the US state of Vermont. Maple syrup production represents both a regional food system and forest use approach that is prevalent across forests in the Northeast US and Canada (Farrell, 2013a). Syrup production pre-dates European settlers in the US, as Indigenous communities harvested sap and made syrup across the growing range of sugar maple (*Acer saccharum* M.) and red maple (*Acer rubrum* L.) trees, species that have relatively high sugar content in their sap (Perkins et al., 2022; Whitney & Upmeyer, 2004). To produce syrup, sugarmakers tap trees with a hollow spile which allows for sap to flow out into a collection vessel. The sap is then boiled until it is concentrated into syrup. Sap actively runs through the vascular systems of maple trees when temperatures fluctuate above 0°C during the day and below 0°C at night; these temperature fluctuations occur most often during December-April in North America, though both the duration and frequency of sap runs have shifted as a result of climate change (Perkins et al., 2022; Rapp et al., 2019, 2020). Technological advances (e.g., vacuum-draw tubing to collect sap, reverse osmosis to shorten boiling times, remote sensors to detect air leaks in tubing) has enabled sugarmakers to considerably expand the scale of their operations (Farrell, 2013b; Perkins et al., 2022),

which has effectively converted significant acreage of forests into sugarbush. Concern, then, has arisen regarding the impacts of sugarmaking on long-term forest resilience (Lenière & Houle, 2006).

Given the phenological timing of sap runs, communities involved with sugarmaking value the practice both as a financially beneficial endeavor in an otherwise non-existent growing season and as an optimistic sign of warmer months to come (Hinrichs, 1998; Whitney & Upmeyer, 2004). Several empirical studies have investigated the cultural significance of maple syrup production (Hinrichs, 1998; Lange, 2017; Whitney & Upmeyer, 2004); others have employed social and economic theory to characterize production-related behaviors such as operational expansion (Hershberger et al., 2023; Velardi et al., 2023), enrollment in conservation programming and educational programming (Byerly et al., 2019; Velardi et al., 2021), and climate change adaptation strategies (Ahmed et al., 2023; Caughron et al., 2021; Snyder et al., 2019). To our knowledge, our study is the first to utilize a relational values framework in the context of maple sugarmaking.

4.2.2. Q-method

We utilized components of q-methodology as a framework to guide portions of our study data collection, analysis, and interpretation. Q-methodology is an exploratory approach to characterize distinct views of select stakeholders (Brown, 1980; Watts & Stenner, 2014) and has been utilized in several studies to analyze prioritizations of relational values of nature (e.g., Inglis & Pascual, 2023; Neidig et al., 2023). Studies that use the q-method generally follow a series of four steps (Zabala et al., 2018). First,

researchers begin by identifying a context of interest, then they select relevant human subjects that hold salient perspectives on the context. Second, researchers collect an exhaustive list of statements linked to the study context (these statements are referred to as a concourse); the concourse is then pared down into a smaller subset of essential statements (referred to as a q-set). Third, the researchers present the q-set to the study subjects. Each subject sorts the individual items of the q-set into a forced quasi-normal distribution (i.e., a bell curve) based on the items' salience. Thus, fewer items are strongly salient at each tail of the curve, and more items are weakly salient in the center portion of the curve. Finally, researchers collect the results from each study subject (referred to as q-sorts) and determine different groups of similar ranking patterns using factor analysis.

To understand the perspectives linked to our study context, we first identified a concourse of statements representative of the relational values of nature by utilizing items used in previous empirical studies (see Pratson et al., 2023 for full list of studies and statements). We created our final q-set (items listed in Table 4. 2) through iterative dialogue and item testing with several scholars, scientists, and professionals that possess expertise in forest management, relational values, and maple syrup production. The final set of 10 statements are representative of relational values most commonly expressed and measured across recent empirical scholarship (Pratson et al., 2023). We distributed the q-set in a larger questionnaire that was sent to members of maple syrup or forest ownership interest groups. Specific details on the sampling and questionnaire distribution approach are outlined in Chapter 3. Each participant ranked the statements in the q-set on a scale

from 1-10, where 1 represented the statement that was most important and 10 represented the statement that was least important. We then re-coded each participant's set of rankings into a forced quasi-normal distribution with 5 categories (from -2 to 2).

We used the R package "qmethod" (Zabala, 2014) to extract factors from our re-coded dataset and identify q-sorts that were representative of each factor. We utilized principal component analysis (PCA) to extract factors from our dataset; we ultimately chose to extract two factors based both on their eigenvalues (following Kaiser's Criterion) and their logical explanatory power. We then utilized varimax rotation on each factor. Given that the extracted factors are representative of a larger subset of perspectives among the participating sugarmakers, we chose to extract factors that contained logical differences and similarities in value sorting (Watts & Stenner, 2014; Zabala et al., 2018). Finally, we identified q-sorts that were relevant to one of the two factors based on each q-sort's factor loading.

The two factors did not contain all q-sorts completed by sugarmakers. As such, we created a third group that captured the q-sorts not featured in the two extracted factors. Each of the two extracted factors contains an archetypal q-sort that is representative of all q-sorts in that factor. Generally, archetypal q-sorts are calculated in part through the factor loadings of each individual q-sort in the factor. Given that our third group represented the remainder of the un-factored q-sorts, we simply calculated the average ranking of each value statement to create the archetypal q-sort for the third group. We do not analyze the differences and similarities between the third group's

archetypal q-sort and the other two factors given the fundamentally different approach to calculating the third archetypal q-sort.

4.2.3. Forest management actions

We utilized the three groups of sugarmakers established through the q-method process to analyze trends in participant engagement with certain forest management-related actions. We identified, measured, and analyzed the forest management actions through the following steps. First, we identified ten forest management-related actions linked to a range of proposed biodiversity outcomes (Figure 4. 1). Eight of the ten actions were either featured in the guidelines of a regional USDA-Organic certifier and a conservation-specific program ("Bird-Friendly" Maple) established by Audubon Vermont (*Bird-Friendly Sugarbush Management Guidelines*, n.d.; VOF Guidelines for Certification of Organic Maple Sap & Syrup, 2016). Two of the ten actions tracked if sugarbushes were enrolled in either organic or "Bird-Friendly" programs.

Sugarmakers indicated their engagement with each action through different items featured in the questionnaire mentioned in the previous *Q-method* section; we then coded each response as a binary variable representative of whether the action was carried out by each participant. Finally, we created a proportion-based score representing the relative number of actions carried out by each sugarmaker in our sample. The score ranged from 0-1 and were assigned to each sugarmaker; scores closer to 1 represented those sugarmakers who carried out more actions and theoretically influenced more biodiversity-appropriate conditions in their sugarbush. Certain actions were not relevant to specific sugarmakers (i.e., sugarmakers did not manage non-native, invasive species

because those species did not exist in their sugarbush); therefore, their final score reflected the proportion of total relevant actions carried out in their sugarbush. We ran an analysis of variance (ANOVA) to compare average forest management scores across the three groups established through the q-method approach.

Associated programs	Management Practice	Biodiversity outcome(s)
+ USDA ORGANIC	***State-Certified Forest Management plan***	Uncertain, outcomes determined by plan goals and objectives
	Facilitate Bird Habitat Assessment	Uncertain, dictates future management to encourage birds in sugarbush
+ USDA ORGANIC	***Maintain at least 2 snags per acre***	Increased habitat opportunities for cavity-dwelling wildlife
+ USDA ORGANIC	***Leave crowns after harvesting trees***	Creates physical barriers from browse to influence seedling regeneration; provides shelter for smaller invertebrates, reptiles, birds
	No harvesting during forest bird nesting season (May-July)	Increases forest nesting bird survivorship during nesting season
	Promote diverse midstory and understory vegetation	Provides habitat opportunities for smaller invertebrates, reptiles, birds
	Eradicate non-native, invasive vegetation	Less invasives means better opportunity for shade-based tree regeneration, which creates future forest habitat for diverse species
+ USDA ORGANIC	***Manage/maintain less than 75% sugar maple cover across sugarbush***	Allows for greater habitat opportunities for generalists across the forest

Figure 4. 1. List of eight biodiversity-focused forest management practices, their links to select biodiversity outcomes, and their associations to USDA-Organic certification and "Bird-Friendly" Maple recognition. Biodiversity outcomes were informed by the following references: (*Bird-Friendly Sugarbush Management Guidelines*, n.d.; Clark & McLeman, 2012; Doerfler et al., 2018; Gamfeldt et al., 2013; Grodsky et al., 2024; Huyler & LeDoux, 1999; Leak et al., 2014)

4.2.4. Semi-structured interviews

We conducted follow-up, semi-structured interviews with sugarmakers who completed the questionnaire and expressed willingness to participate further. We selected interviewees using a purposive sampling frame based on their operational scale (total number of taps), sugarbush ownership status (leased or owned), and their engagement

with Audubon Vermont's "Bird-Friendly" Maple program. We used this sampling frame to solicit responses from a more representative range of possible operational arrangements; given the ubiquitous distribution of sugar and red maple trees across Vermont, maple syrup operations exist in a spectrum from non-commercial, residential yards to commercial entities that span hundreds of thousands of taps (2022 Census of Agriculture. Vermont: State and County Data, 2024). Several categories of our sampling matrix contained more than one sugarmaker where no new information was gleaned from the interview. This suggests relative saturation per each category in our sampling frame (Saunders et al., 2018)

We developed a semi-structured interview protocol (Appendix C) that focused on sugarmaker forest management approaches, relational values, and other operation-specific details. We adapted elements of our interview protocol from studies that have characterized relational values from qualitative data drawn from agricultural contexts, specifically Chapman et al., 2019, Chapman & Deplazes-Zemp, 2022, and Kreitzman et al., 2022. Interviews were conducted in-person (six interviews), via video call (three interviews), and via phone call (six interviews), depending on the sugarmaker's preferences. In-person interviews happened most often on properties, where the lead author was able to observe the sugaring operation and sugarbush. Interviews lasted an average of 61 minutes. We employed both inductive and deductive coding approaches to analyze our semi-structured interviews. Specifically, we coded for instances where sugarmakers attributed management actions to different value types. Furthermore, we

coded for differences in actions or values across the three groups established through the q-method approach.

We characterized relational values by statements that referenced guiding principles or judgements of importance in specific contexts. We also coded for emergent themes relevant to our research objectives and quantitative analysis approach. We used artificial intelligence software (otter.ai) to transcribe the interview audio files; the lead author listened to each audio file and corrected any errors on the initial transcriptions. We completed all coding work in NVivo software, version 14.23.2 (Lumivero International). Quotations included in this paper were lightly edited for clarity.

4.3. Results

4.3.1. Sample demographics

We collected a total of 91 questionnaires, but 35 sugarmakers did not complete the ranked values portion of the questionnaire. Non-responses on ranked values took two main forms: on the online questionnaire, the section was simply left blank (26 incomplete, online surveys), whereas on the paper questionnaire, respondents either ranked every value as most important (two out of nine paper questionnaires) or appeared to lose track of numbering (e.g., multiple values were ranked five; seven out of nine paper questionnaires.) We did not use the ranked value data from the paper questionnaires if the sum of all value rankings in a single questionnaire did not equal 55 before we re-coded values for the q-analysis.

Our final sample for the quantitative portion of this study consisted of n=56 unique responses from sugarmakers. Our interviewee sample consisted of a smaller

subset (*n*=15) of the 56 responses; for ease of interpretation, we report findings from our total sample in subsections 3.2-3.7, then shift to our interviewee sample subset in subsection 3.7.

Sugarmakers collectively managed 8,301 acres of sugarbush in 12 of Vermont's 14 counties; sugarmaking operations ranged from 1 to 1800 acres (an average of 45 taps per acre) and produced an average of 3239 gallons of syrup in an "average" season (Table 4. 1). The majority of sugarmakers were 55 years of age or older (72%), white (98%), had obtained a 2- or 4-year college degree (57%), and reported a yearly income of $75,000 or more (59%). Forty sugarmakers (71%) reported that less than 50% of their yearly income came from maple syrup or value-added maple products (candies, sugars, etc.) sales. Our sample demographics were roughly equivalent to those presented in Kuehn et al.'s (2017) study of Vermont and New York sugarmakers, the most recent regional study we could find that reports such demographic data. See Appendix D for further demographic details of the sample.

Table 4. 1. Select operational information from our study sample.

	Taps			***Acres tapped***			***Gallons syrup produced***		
	Min.	*Mean*	*Max.*	*Min.*	*Mean*	*Max.*	*Min.*	*Mean*	*Max.*
Questionnaire sample (*n*=56)	24	6690	65000	1	148	1800	5	3239	34000
Interviewee sample subset (*n*=15)	80	6764	30000	16	130	400	9	4055	18000

4.3.2. Q-sorts

We extracted two factors from the set of 56 completed q-sorts. The first factor contained q-sorts from 16 participants and the second factor contained q-sorts from 13 participants. We consider the remaining 27 q-sorts as a third group. Overall, our results across all groups suggest that sugarmakers generally considered statements linked to stewardship, identity, and kinship as most important to their forest management approaches. Our results also suggest that statements linked to community, care, and health were least important to sugarmakers' forest management approaches (Table 4. 2). In this subsection, we outline the perspectives expressed through the archetypal q-sorts of relational values from the first two groups and note the trends in average value rankings in group three. Then, we present the results from the average forest management scores across the three groups.

4.3.3. Group 1: Kinship

There were a total of 16 sugarmakers in Group 1. The archetypal q-sort linked to this group indicated that identity was most important to the group's forest management approaches, followed by kinship and stewardship. Aesthetic, awe, care, and health were in the indifferent, middle portion of the archetypal q-sort. Community and knowledge were less important to those in Group 1, and heritage was least important. Given that kinship was significantly more important in this group's archetypal q-sort compared to Group 2, we refer to Group 1 as the Kinship group for the remainder of the paper.

4.3.4. Group 2: Heritage

There were a total of 13 sugarmakers in Group 2. The archetypal q-sort linked to this group indicated that identity was most important to the group's forest management approaches, followed by heritage and stewardship. Aesthetic, community, kinship, and knowledge were in the indifferent, middle portion of the archetypal q-sort. Awe and care were less important to those in Group 2, and health was least important. Given that heritage was significantly more important in this group's archetypal q-sort compared to Group 1, we refer to Group 2 as the Heritage group for the remainder of the paper.

4.3.5. Group 3: Others

There was a total of 27 sugarmakers in Group 3, which contained the remainder of the unfactored q-sorts. We report the average rankings of value statements across the participants who made up Group 3 but note that the archetypal ranks in the Kinship and Heritage groups were calculated differently. Sugarmakers in Group 3 indicated that stewardship was most important to their sugarbush forest management, followed by awe and identity. Care, health, heritage, and kinship were in the indifferent, middle portion. Finally, sugarmakers in Group 3 ranked aesthetic and knowledge as less important to their sugarbush forest management, and community as least important to their sugarbush forest management. We refer to Group 3 as the Others group for the remainder of the paper.

Table 4. 2. Relational value statements arranged in alphabetical order and their correspondence to three distinct groups of Vermont sugarmakers. The numbers correspond to the archetypal ranking of relational values per group; rankings for the Kinship and Heritage groups were determined through factor analysis results, and rankings for the Others group were determined by mean rankings across the remainder of

participants not included in factors. A rank of -2 refers to “least important” (shaded in dark blue) and 2 refers to “most important” (shaded in dark green.)

Category	Full Statement	Kinship group	Heritage group	Others group
aesthetic	I promote my sugarbush's beauty	0	0	-1
awe	When I am in my sugarbush I experience awe and wonder	0	-1	1
care	My sugarbush responds to my care for it	0	-1	0
community	With my sugarbush, I have the opportunity to enjoy and deepen relationships with my friends, family, and other sugarmakers	-1	0	-2
health	My health and the health of my loved ones are directly tied to my sugarbush	0	-2	0
heritage	My sugarbush has heritage and history that is important for my traditions and way of life	-2	1	0
identity	I have strong feelings about nature; these views are part of who I am and how I live my life	2	2	1
kinship	Plants and animals, as part of the interdependent web of life, are like ‘kin’ or family to me, so how we treat them matters	1	0	0
knowledge	I learn about my sugarbush by working with it	-1	0	-1
stewardship	How I manage my sugarbush, both for plants and animals and for future people, reflects my sense of responsibility to and so stewardship of the land	1	1	2

4.3.6. Biodiversity management scores across three groups

Overall, a majority of the respondents across our entire sample indicated that they engaged with at least five of the 10 measured forest management-related actions (Figure 4. 2). The average biodiversity management score across all participants was 0.64, with a standard deviation of 0.2. One-way analysis of variance results found no

significant differences in average forest management scores across the three groups ($F(2, 52)=0.32$, $p=0.73$).

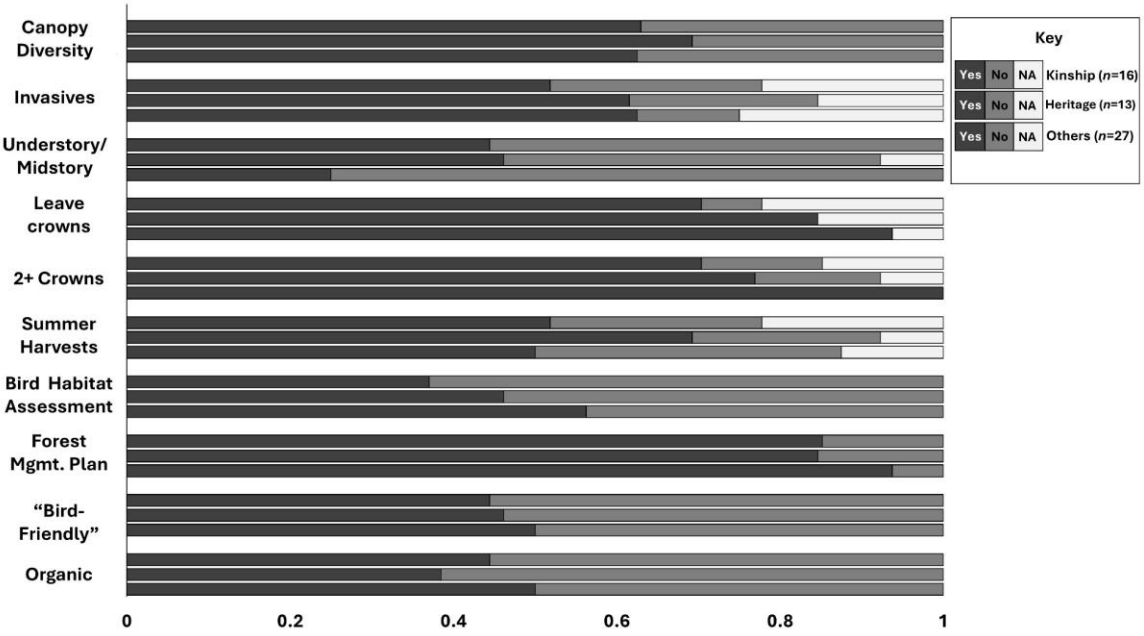

Figure 4. 2. Engagement with each forest management action making up our biodiversity score across the three groups in our study. The uppermost stacked bar in each cluster represents actions reported by the Kinship group, the middle stacked bar in each cluster represents actions reported by the Heritage group, and the bottom stacked bar in each cluster represents actions reported by the Others group.

4.3.7. Results from qualitative data

We explored the interactions among values and forest management-related actions during our semi-structured interviews with select participants. Out of 15 interviewees, six were in the Kinship group, three were in the Heritage group, and six were in the Others group. In general, participants were most comfortable discussing the range of forest management actions that they take (or have considered) in their sugarbush. Many participants seemed to be less comfortable with addressing explicit questions about the non-monetary importance associated with their decision-making. The

remainder of our results section centers around two themes that emerged during the interview and coding process which allowed for discussion of non-monetary values in conjunction with action: how sugarmakers articulated their relationships with their sugarbush, and the motivations attached to specific, costly actions. We discuss how each theme was addressed by interviewees across the three groups of sugarmakers established by the q-analysis.

4.3.8. Relationships to sugarbushes

4.3.8.1. Kinship group

The six sugarmakers in the Kinship group expressed multi-faceted relationships with their sugarbush. This was likely related to the fact that a majority in the group noted how their operations were more akin to hobbies (not profit-driven businesses). Several sugarmakers noted that they had purchased or rented forested land due to significant life changes, such as retirement from their careers. Others noted how their personal relationship with their sugarbush had grown over time and was facilitated through opportunities to learn from organizations and programming aimed towards forest landowners. Almost every sugarmaker in the Kinship group discussed specific forest management actions when asked about their relationship with their sugarbush. For instance, after noting how and when he purchased his forested property, a sugarmaker discussed how his involvement in the state tax-abatement program increased his technical understanding of the property, and ultimately inspired management action:

> *…we enrolled in current use [the tax-abatement program]. And that was hugely helpful because it reduced our tax burden a little bit. But [the program] also*

started to get me to understand the role I should be playing on land management a little bit. Shortly after that, I enrolled in NRCS [a federal cost-share initiative] programing for mast tree release and invasive species control.

Furthermore, this sugarmaker noted how the program influenced his values, given his mention of how his views on correct management approached changed upon participation (i.e., "the role I should be playing…"). This sugarmaker (and others) considered their historical and current management approaches and the ways in which they developed an understanding of these approaches as a key part of their relationship to their sugarbush. Several sugarmakers in the Kinship group discussed how their sugarbush and associated maple syrup operation was their source of retirement income and activity, as one sugarmaker noted: "Most of what I do here [at the sugarbush] is…to keep a retired homebuilder busy who can't sit and be an old person." Some of these retirees, however, noted how their relationship was characterized by a deeper sentiment akin to stewardship and care, as they discussed how their ultimate goals were to rehabilitate a portion of the forested landscape. When asked about his relationship with his sugarbush, one sugarmaker who had recently retired from a career in technology noted:

…it'd be my pet project, [to] improve the woods. The woods had been high-graded and degraded and had a lot of erosion on the interior roads. So for the last 20 plus years, I've been improving that.

4.3.8.2. Heritage group

The three sugarmakers in the Heritage group had more production-oriented relationships with their sugarbushes. Sugarmakers in this group were similar to one

another in that each managed sugarbushes that spanned several properties, or that they considered multiple, geographically separate sugarbushes as indicative of their total operation. These sugarmakers often noted how they rented land from others and had varying degrees of autonomy to make decisions about forest management actions. Furthermore, sugarmakers considered properties differently, based on their end-use. For instance, one sugarmaker noted how his sugarbush was located in one portion of a larger forested tract. The sugarmaker discussed how he employed intensive management in the larger tract with the intent to harvest trees for timber revenue. His sugarbush, on the other hand, was generally subject to less-intensive approaches:

> *…we haven't done a lot more other than maintenance…but [the sugarbush] is nearly pure maple. And we're just kind of going with it [laughs].*

Sugarmakers in the Heritage group expressed differing expectations from their sugarmaking operations, which led to different considerations of their relationships to sugarbushes. More specifically, two sugarmakers noted how the specific practice of sugarmaking (i.e., going out to tap trees in the winter months, boiling sap with others, participating in a unique, regionally specific practice) was more important to them than the actual property that they used to collect sap and make syrup. A sugarmaker articulated the significance of the practice by saying:

> *I love it [sugarmaking]…if I didn't have help, I'd probably be back to 30 buckets on a little backyard rig, but I'd still be doing it. I'm deeply committed to the idea of sugaring, and the process of sugaring, and basically the tradition.*

Others in the Heritage group, however, expressed how their property held more importance than the process of sugarmaking. One sugarmaker noted how the longer-term biophysical functioning and existence of his property was more relevant than its ability to produce sap:

> *I think that the intrinsic value of the forest itself is important, more important to me overall…I think that's probably of more importance to me. If I stopped sugaring, and whatever, it wouldn't be as big a deal. I would move on.*

In the course of both interviews noted above, the sugarmakers alluded to aspects of heritage. The first sugarmaker noted that his commitment to tradition was built through years of sugarmaking with different generations of family members. The second sugarmakers noted how he valued his property for the privacy that it allowed him and his family.

4.3.8.3. Others group

Given that the six sugarmakers in the Others group were similar in their wide array of value prioritizations, we did not uncover strong through-lines associated with the relationships among these sugarmakers and their sugarbushes. Relationships were varied and spanned in scale from large-scale operations to smaller setups adjacent to residential yards. One similarity shared by several of the interviewees in the Others group was that they managed large operations with 20,000 taps or more. As such, these sugarmakers considered their relationship to their sugarbush(es) in largely transactional manners and noted how the actions that they took were generally meant to yield income. For instance, one sugarmaker noted how “everybody has a forest plan” to guide management actions,

as forest management plans are required for participation in the state tax-abatement program.

Some sugarmakers in Group 3 described their relationship to their sugarbush through social connections with others. For instance, one sugarmaker described the process of purchasing his property at length, discussing some of the notable family history of his neighbors and the former owners. He also noted how his property allowed him to connect with members of his own family and community in meaningful ways:

> *But the thing that I didn't really anticipate…is the sense of community…it [the sugarbush] kind of, it's been a way to just have people come together…it's also kind of a sense of community in terms of being together and working on something that's similar, you know, builds kind of a sugaring community.*

This sugarmaker also noted how he utilized social connections to assist with different management actions and problems, a theme that was present across several others in the Others group. Another sugarmaker noted how his participation with a local non-profit wildlife group heavily influenced his approaches to forest management actions, and that he had become an active participant in group demonstrations and presentations:

> *…those three days of basic training of what's going on in your woodlot, and it wakes you up. At least it did me. Oh yeah, I looked at it [forest management] totally different after the training. I looked at it totally differently than what was out there. It was a wake up call, how to manage it.*

4.3.9. Values and motivations

4.3.9.1. Kinship group

Several sugarmakers in the Kinship group discussed carrying out harvests that did not yield immediate financial benefit, and in certain cases, no long-term financial benefit. These harvests were carried out for a variety of reasons, including to encourage regeneration, to open up space for healthy maple trees to grow, and to promote wildlife habitat. In the case of wildlife-oriented cutting, two sugarmakers described situations where they carried out financially costly harvests to achieve stewardship-based goals of wildlife habitat provision. In both situations, the sugarmakers contracted with loggers to create large openings in their sugarbushes to intentionally promote early successional habitat conditions, fulfilling wildlife-related management objectives. Both sugarmakers attributed their actions to stewardship and care, suggesting that the actions helped to actualize their values.

> *…so we had to end up paying…to get the forest management work done…we, you know, we were okay. We wanted, like you heard our goals. So those were our top goals. And yeah, it worked out that we had to pay a little money to get those goals [to provide wildlife habitat] done.*

The wildlife cuts did not yield any tangible financial benefits, and in both cases, the sugarmakers had to pay for the work to be done. In other cases, sugarmakers in the Kinship group discussed how their sense of responsibility to the landscape helped justify potentially costly action. In one instance, a sugarmaker noted how he refrained from harvesting and selling merchantable timber:

There's certainly potential there to like high-grade the woods [i.e., remove the best merchantable timber; generally seen as an unsustainable management practice]. And in that case, I wouldn't be following the forest management plan, but there's like a little bit more sort of professional and personal responsibility there to do a good job.

In the quote above, the sugarmaker notes how his forest management plan technically guided his decision to refrain from aggressive cutting. Deviating from his plan would jeopardize his enrollment in the state tax abatement program. However, this sugarmaker noted several other times how his historical ties to his property had developed a deeper sense of responsibility when considering appropriate forest management actions.

4.3.9.2. Heritage group

Sugarmakers in the Heritage group characterized their actions as being motivated by keeping their sugarmaking operations viable. Specific decisions were made based on the property's ownership status, or how the action in question was able to yield some sort of tangible benefit. For instance, a sugarmaker who rented his sugarbush from other landowners noted how he conducted all of the forest management work for the landowner that he rented from:

The landowner does not have a forestry plan in place, does not want to cover any of the costs of repair or upkeep in his woods. So, for instance, I tried to keep the roads all gravel, if I have to. Wherever I have erosion, I bring in stone. I do most of the clearing.

In the quote above, the sugarmaker carried out road-building and erosion control measures to ensure that he was able to access tappable trees in the sugarbush, and ultimately, to continue renting the land from his neighbor. In short, this sugarmaker (and others) expressed how relatively costly action was justified by the potential to achieve some benefit, such as being able to continue renting their sugarbush. Another sugarmaker discussed how he was interested in Audubon's "Bird-Friendly" program because of the potential benefits of increasing birds around his property:

> *…we use the birds as pest management…we create these large debris piles around the fields and the birds nest in there.*

4.3.9.3. Others group

Some of the sugarmakers in the Others group justified their actions based on the longer-term impacts associated with the actions, either financially or in service to other non-monetary values. Given that many sugarmakers in the Others group managed and owned large-scale sugarmaking operations, their operational income may have helped to balance out expenditures or effort associated with specific actions. For instance, one sugarmaker noted how he carried out a large-scale harvest that was partially motivated by his desire to create diverse habitat conditions for wildlife across his sugarbush. However, the harvest went awry due to miscommunications between him and the logger:

> *…that first cut, you know, there ended up being a timber trespass, and everyone's pointing a finger at whose fault it was, and the logger pulled up and left…[it] ended up being essentially high-grade job.*

He continued by noting that he had connected with other sugarmakers and foresters after the incident and that they had advised him on how to rehabilitate the logged area of sugarbush accordingly. Though the initial management was unsuccessful, he noted how he continued to carry out smaller-scale harvests in his sugarbush to encourage habitat diversity. Another sugarmaker noted how he was interested in utilizing different forest management approaches in his sugarbush to ensure the sustainability of his family's operation:

> *...we love going and listening to any kind of forestry talk about managing your sugar bush, and what you can do to better management. So we've been a lot more conscious of…don't just remove everything that's not a maple.*

The sugarmaker noted how this restraint (not encouraging a maple-dominant forest) represented a significant change in his family's forest management practices, yet how the change would ultimately lead to more "healthy" forested conditions over time.

4.4. Discussion

We sought to understand the relationships among values and actions in a forest-based food production system in Vermont, USA. Our quantitative results indicate that sugarmakers expressed different prioritizations of relational values, and these value prioritization types did not significantly associate with a measure of forest management action. Our qualitative results highlight marked differences among three groups of sugarmakers defined by their value prioritizations; these differences exist among considerations of relationships and motivators of action. Our work reflects an in-depth, mixed-methods case study of relational values expressed by individuals. Our findings

hold relevance to sustainability scholars calling for greater consideration of plural values in the context of natural resource decision-making and policy (Jacobs et al., 2020). We proceed with a discussion of our main findings in the context of relevant literature, then explore the implications of our work for regional and wider-scoping research efforts.

4.4.1. Relational value prioritizations across sugarmakers

We found two distinct prioritizations of statements linked to relational values across a relatively homogenous population, in terms of socio-demographic attributes and connections to Vermont's working forests. These two groups were largely characterized by sugarmakers' disagreement on the importance of heritage and kinship to their forest management approaches. The groups were similar in their relative indifference toward statements linked to aesthetics, awe, knowledge, and care, as well as the decreased importance of health and community.

Stewardship was of high importance across both groups. Given the strong use of the term "stewardship" in several programs aimed towards private forest owners in the region (Maker et al., 2014), this result is not surprising. Furthermore, stewardship is a highly common descriptor of many sustainability-oriented behaviors, especially in Western nations (Mathevet et al., 2018). Stewardship is often linked to deeper relational values of care (West et al., 2018); this connection was made clear through several interview responses that discussed how sentiments of responsibility and agency towards sugarbushes often informed management and certain (perceived) sustainability-oriented actions. Identity was also ranked highly across both groups. In their study of farming communities, Chapman and others (2019) note how communities can develop strong

identities based on their production-based livelihoods. They note that the identity of a "good farmer" can be linked to strong, value-based ideals of permissible management action and behavior (Burton, 2004). Though maple syrup production approaches and management techniques are much different from other methods of crop production, our finding suggests that production-based identity was almost universally important across our sample.

Heritage and kinship were ranked differently across the two, factor-based groups. That heritage was highly ranked across some sugarmakers is consistent with several studies that document the cultural aspects of sugarmaking in the Northeast US and Canada (e.g., Hinrichs, 1998; Lange, 2017; Whitney & Upmeyer, 2004); these studies indicate how certain sugarbushes and sugarmaking traditions have been upheld across various generations, thus, the importance of sugarmaking is linked to its connections to the past. This finding also corresponds to literature that links heritage to relational, non-monetary values of (Azzopardi et al., 2023). Heritage was also ranked as least important within members of the Kinship group, marking this relational value as the most polarizing out of any that we measured. Though interviewees did not elaborate on why this particular value was controversial, we suspect that potential political connotations associated with the phrasing of the heritage item (based on deeply-rooted conceptions of land ownership and historical power dynamics, e.g., Harrison, 2010) may have contributed to the split among groups.

Kinship was highly important for others, whereas it was indifferent for members of the Heritage group. In aggregate, these findings compliment understandings of

relational values in the context of resource use, given that values are often held in conjunction with one another (Gould et al., 2015). These findings suggest that differences in value prioritization exist among a sub-population of similar producers in one state, and that the exercise of eliciting values from individuals across communities may illuminate nuances relevant to community-wide initiatives (Morse et al., 2024).

4.4.2. Associations among values and actions

In our quantitative data, there was no statistically significant association among our measure of forest management actions and the three different groups of relational value prioritizations. At face value, this finding suggests the presence of a gap between values and corresponding action (e.g., Blake, 1999; Gould et al., 2023; Shove, 2010). However, several findings emerged from analysis of our qualitative data that shed light on the fundamental characteristics of relational values, and why these values may be tangentially related to action in this study context.

First, we found that sugarmakers most often described their relationships with their sugarbush by mentions of active forest management, similar to an "institutional" view of forestry summarized by (Himes & Dues, 2024). Thus, the values that were relevant to their relationship were also linked to a range of management approaches. This finding highlights how Vermont sugarmakers in our study sample represented an actively engaged subset of private forest owners in the US. Several studies in the US (Beach et al., 2005; Shanafelt et al., 2023; Silver et al., 2015) have indicated that forest management, particularly tree harvesting, is often challenging for private forest owners to facilitate. Though the frequency and volume of tree harvesting in Vermont sugarbushes may be

lower than a strict, timber-producing woodlot, it appears that the sugarmakers in our sample considered their role in sugarbushes as partially predicated on carrying out active management.

We also noted several instances where sugarmakers indicated that their sugarbush was substitutable in theory, whereas the practice of sugarmaking was non-substitutable. This finding is significant in that it adds to considerations of valued relationships to be investigated by values scholars. Understandings of relational values, especially in production-oriented contexts (Allen et al., 2018; Chapman et al., 2019; Chapman & Deplazes-Zemp, 2022; Kreitzman et al., 2022) often frame relationships as between/among human subjects and natural areas and/or species. Our study suggests that the regionally specific social-ecological system (Ostrom, 2009) of maple syrup production was considered as the partner in relationship to several sugarmakers. As such, actions in a sugarbush may be connected to values through considerations of how that sugarbush is just one component of the broader, syrup-producing system.

Relational values were often discussed as a motivating force that justified action. However, those actions were often linked to strong financial benefits. This finding has interesting implications, as it relates to how relational values are considered in working lands contexts where market goods are produced. Currently, market conditions support management that allows for trees to be utilized for sap production. If conditions shift in favor of timber revenue, it is unclear whether relational values would be considered as worth (relatively) the potential opportunity costs that may be felt with higher revenue for timber. In other words, we found little to no instances where costly actions were fully

supported or justified by relational values. Thus, we pose that the "price is right" for sugarmakers to engage in biodiversity-oriented management and attribute such engagement to both monetary income and non-monetary values. This sentiment was clearly addressed by many sugarmakers who expressed that uncertain timber markets and growing markets for maple products played a large role in incentivizing their production from the start. The maple industry is poised to continue to grow in production and scope (Isselhardt et al., 2022); even in Vermont, it is estimated that 12% of tappable trees are currently being utilized for maple sugaring (Matthews & Iverson, 2017). Increased pressures on sap yield and operational production may pose deep tradeoffs between management aligned with non-monetary value and financial benefit.

4.4.3. Study limitations

Our study reflects an in-depth, mixed-methods case on a regionally unique production system and forest use. As such, we cannot claim that our results are representative of all Vermont sugarmakers, nor of sugarmakers in aggregate across the Northeast US. However, our sampling approach allowed for a balanced representation of sugarmaking operational characteristics. Both our battery of questionnaire responses and interview questions focused on relational, non-monetary values were closed-ended and featured in the context of technical, management-related questions. Though this study design may have constrained sugarmakers' expression of other non-monetary values not explicitly featured in the measurement tools, we believe that the approach was more aligned with the self-sufficient attitude ubiquitous among Vermont's largely rural populace (Morse et al., 2014).

4.5. Conclusions

We sought to investigate the relationships among relational values and forest management actions in a sample of Vermont sugarbushes. Our results indicate that a) different prioritization of relational values existed across Vermont sugarmakers; b) our quantitative measure of forest management action was not associated with differences in prioritizations of relational values; and c) actions were more tangentially related to values by their links to motivations and operational contexts.

Sugarmakers attributed value to both their sugarbush and their practice in different ways. Our results relate to the broad conclusions drawn in Puettmann et al. (2009) – the distillation of highly complex and shifting relationships into simplistic models may end up leading to research efforts that obscure or "flatten" the fine-grained details associated with such relationships. Though Puettmann and colleagues (2009) aim their critique towards silvicultural practices, their general sentiment holds relevance in the context of human values and behaviors. Through our use of a mixed-methods approach, we demonstrate how deterministic conceptions of human behavior (presented through our statistical models) can overlook how concepts are experienced, and ultimately expressed. Future research aimed to better understand the links between diverse value types and behavior, especially in the context of working lands management approaches, may benefit from reflexive approaches toward data collection and analysis.

Our study contributes to calls for the inclusion of multiple values of nature in natural resources contexts (Anderson et al., 2022; Jacobs et al., 2020) through the quantification and analysis of relational values (Schulz & Martin-Ortega, 2018). Our

solicitation of plural values at the individual level highlights the meaning-saturated relationships among sugarmakers in Vermont; our results connect to prior literature that has identified aspects of non-tangible importance among communities and nature in the region (e.g., Hinrichs, 1998; Lange, 2017; Morse, 2024; O'Brien, 2006) and speak to broader efforts to characterize and include nature's diverse values in decision-making (IPBES, 2022).

4.6. References

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5. CONCLUSIONS

Evidence from these four studies demonstrates both the promise and challenges in leveraging nature's diverse values to inspire sustainable futures. The first, second, and fourth chapters of this dissertation demonstrated that non-monetary, relational values (and an associated view that considers social systems as fundamentally embedded within and dependent upon the environment) are salient across a wide range of resource use contexts, as well as among the general US public. The fourth chapter indicated that the expression of non-monetary, relational values are prevalent in an otherwise highly individualist, production-oriented context. The first, third, and fourth chapters address other contextual factors (e.g., socio-demographics, financial expenditures) that strongly influence how non-monetary values are considered.

The systematic literature review of relational values literature laid out several suggestions for scholars to consider when they undertake research on the concept; namely, that research ought to make clear how relational values are *non-substitutable, not solely instrumental*, and *indicative of relationships*. Reflecting on my experiences with data collection and analysis for chapter four, I recognized the inherent challenges of complying with these suggestions. Sugarmakers expressed that their practice and their properties were important in complex, and at times, conflicting ways. Though the fundamental act of owning and managing a sugarbush could be considered highly irrational and motivated by non-monetary conceptions of worth or importance, sugarmakers often defaulted to expressing how their management actions were cost efficient and logical. Scholarship interested in nature's plural values may look to better

consider how the concept can be appropriately measured and "mainstreamed" in Western, developed societies where substitutable monetary values are the default.

Our findings across Vermont sugarbushes also pose an important question: if non-monetary values assist in keeping forests forested (i.e., as sugarbushes), what motivates biodiversity-management? Given the results from chapter three, I suggest that conservation program outreach could work to link measurable biodiversity outcomes to specific management actions, given that many interviewees in chapter four expressed skepticism towards program goals. Though sustainability scholars have questioned the dominance of positivistic data as the only "purveyor of truth," it appears that sugarmakers needed this type of information to connect their actions to deeper conceptions of non-monetary value. As such, future research efforts that look to understand the non-monetary values that pervade forest management approaches in the Northeast US may look to intentionally engage with the role of technical, biophysical data in informing values, or in informing institutions that allow for the expression of values.

The inclusion of nature's multiple values in empirical research, and ultimately, decision-making, appears to allow for a fuller representation of meaning expressed by human communities. However, the enthusiasm around the inclusion of diverse values often stops short in providing meaningful suggestions on how to successfully accomplish a study that appropriately characterizes values. In ways, the studies in this dissertation can serve as guides for future research that looks to connect a broad concept to a specific regional context. Furthermore, these studies can help to identify future opportunities

where creative, re-imagined understandings of the fundamental relationships between human and non-human communities can contribute to wellbeing for both.

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APPENDIX A.

Your perspective on forest management in your sugarbush

A SURVEY FROM:

THE UNIVERSITY OF VERMONT
RUBENSTEIN
SCHOOL OF ENVIRONMENT
AND NATURAL RESOURCES

Research Study Information
Your perspective on forest management in your sugarbush

Description: We ask you to participate in a research study exploring the costs and values associated with forest management in support of maple syrup production in Vermont.

Study Procedures: This study involves participation in one survey, which should take about 15-20 minutes to complete.

Risks and Benefits: We do not foresee any risks to you as a participant. If you complete this survey, you will be entered into a raffle to be conducted in December 2023, for a chance to win 1 in 10 gift cards valued at $250. Winners will be notified after the raffle, using the contact information provided.

University of Vermont Research Payment Information: You will be required to provide your name and address each time you receive a payment. You will also be requested to provide your social security number if the amount of the payment is $100 or if the total payments from UVM are equal to or greater than $600 in a calendar year. If you are not a US Citizen or Permanent Resident Alien, you will be required to complete additional paperwork including your immigration status for payment. This information will be strictly confidential and will be used for tax withholding and reporting purposes only and will allow the University to determine your US residency for federal income tax purposes.

Confidentiality: All of your responses will be anonymous, unless you provide identifying information for us to contact you for entry into the raffle. If you do provide this identifying information, it will be stored in a secure, password-protected electronic file that will be permanently deleted upon the completion of this study. A unique identifier will be assigned to your survey responses for data analysis and reporting results.

Voluntary Participation: Participation in this study is completely voluntary. You are free to decline to participate, to end participation at any time for any reason, or to refuse to answer any individual question. Such a decline will not affect you in any way.

Contact Information: Questions: If you have any questions about this study, you may contact the Principal Investigator, Daniel Pratson, at Daniel.Pratson@uvm.edu, OR the faculty member managing this project, Dr. Rachelle Gould, at rgould@uvm.edu. Independent contact: If you have any questions about your rights as a research participant or concerns about the conduct of this study, you may contact UVM Human Subjects Research at (802) 656-5040. You may also visit their website at https://www.uvm.edu/irb/.

Study Funding: This research is funded through a USDA McIntire-Stennis grant.

INTRODUCTION

This survey asks you about forest management in your sugarbush to better understand the costs, objectives, and values associated with managing forest ecosystems for collecting sap and producing maple syrup. Specifically, we ask:

- Which forest management practices you use,
- Your management objectives and values, and
- Characteristics of your sugarbush and sugaring operation.

Results from this research will help inform initiatives to support the future sustainability of sugaring in Vermont. We will disseminate our findings from the study across many channels available to Vermont sugarmakers like you.

Thank you!

SECTION A: TO BEGIN, PLEASE TELL US ABOUT YOUR SUGARBUSH

We use the phrase **your sugarbush** throughout this survey. **Your sugarbush** refers to all of the forested land in Vermont that you use for sap collection and/or maple syrup production. If you own and/or lease multiple forested parcels in Vermont, please consider them together when you respond to the survey questions.

1. **How many total acres of forested land do you own?**

   _____ acres owned

2. **How many acres of sugarbush do you own?**

   _____ acres owned

3. **How many acres of sugarbush do you lease (rent) from others?**

   _____ acres leased (rented)

4. **How many acres of sugarbush do you lease (rent) to others?**

   _____ acres leased (rented)

5. **Who makes most of the day-to-day decisions about your sugarbush?**
   (Please choose all that apply)

   ☐ Myself
   ☐ My spouse/other family members
   ☐ My forester
   ☐ Other business partner(s)
   ☐ The person I lease (rent) my sugarbush from
   ☐ The person I least (rent) my sugarbush to
   ☐ Other (please specify): _____

6. **How many years has your sugarbush been used for sap collection?**

   _____ years

7. **How many years have you personally collected sap from your sugarbush?**

   _____ years

8. **How many taps are currently installed in your sugarbush?**

   _____ taps

9. Please complete the table below to identify how much syrup you produce OR sap you collect under different scenarios.

		Unit of measurement		What was produced/collected?	
	(Fill in amount)	*Gallons*	*Pounds*	*Syrup*	*Sap*
A bad season	_____	❑	❑	❑	❑
An average season	_____	❑	❑	❑	❑
A good season	_____	❑	❑	❑	❑

10. Is your sugarbush currently enrolled in Vermont's Value Use Appraisal Program (Current Use)?

☐ Yes – Forest Land
☐ Yes – Forest Land greater than 1 mile from a Class I, II, or III road
☐ Yes – Agricultural Land
☐ No

11. Is your sugarbush certified organic by NOFA-VT?

☐ Yes
☐ No
☐ Transitioning
☐ Certified by another organization (*please specify*): _____

12. Are you currently a participating producer in Audubon Vermont's Bird-Friendly Maple program?

☐ Yes
☐ No, never heard of it
☐ No, not interested in participating
☐ No, but in the process of enrolling in the program

SECTION B: FOREST MANAGEMENT IN YOUR SUGARBUSH

13. Do you have a current forest management plan certified by a licensed Vermont Forester?

☐ Yes → *if yes, please answer question 13 a.*
☐ No, my forest management plan is not certified
☐ No forest management plan

a. When are you required to next update your certified forest management plan?

_____ *(Please specify approximate date)*

14. **Please rank the following objectives (with 1 as most important, 10 as least important) as they relate to your forest management decisions in your sugarbush.**

	Indicate ranking here	*Is this featured in your forest management plan? (check the box if yes)*
Merchantable timber / timber products	_____	❑
Passing land on to family	_____	❑
Recreation and enjoyment	_____	❑
Forest carbon	_____	❑
Wildlife habitat	_____	❑
Collecting sap	_____	❑
Protecting nature	_____	❑
Land investment	_____	❑
Privacy	_____	❑
Other (please specify): _____ _____	_____	❑

15. **Please rank the following values (with 1 as most important, 10 as least important) as they relate to your forest management decisions in your sugarbush.**

	Indicate ranking here
I have strong feelings about nature; these feelings are part of who I am and how I live my life	_____
Plants and animals, as part of the interdependent web of life, are like 'kin' or family to me, so how we treat them matters	_____
I promote my sugarbush's beauty, as I see it	_____
My health and the health of my loved ones are directly tied to my sugarbush	_____
When I am in my sugarbush I experience awe and wonder	_____
My sugarbush has heritage and history that is important for my community's traditions and way of life	_____
How I manage my sugarbush, for plants and animals and future people, reflects my sense of responsibility to and stewardship of the land	_____
My care for my sugarbush helps me to lead a good and fulfilling life	_____
With my sugarbush, I have the opportunity to enjoy and deepen relationships with my friends, family, and other people	_____
I learn from my sugarbush by working with it	_____

16. Please tell us about tree harvesting in your sugarbush by completing the table below.
We are referring to live trees that are of sapling size class or larger.

	How often is this done?	About how much is removed per each harvest? (*please specify units in your response*)	How much do you invest in this?
Harvesting trees for merchantable timber	every _____ year(s)	_____	_____$/harvest
Harvesting trees to clear tap lines and/or sugaring access points	every _____ year(s)	_____	_____$/harvest
Harvesting trees for firewood	every _____ year(s)	_____	_____$/harvest
Harvesting trees to remove non-sugar maple tree species	every _____ year(s)	_____	_____$/harvest
Harvesting trees to influence understory and midstory vegetation growth	every _____ year(s)	_____	_____$/harvest
Harvesting trees for other purposes not stated above *Please specify other harvesting purposes:*_____ _____	every _____ year(s)	_____	_____$/harvest

17. Which month(s) of the year do you harvest trees from your sugarbush?
(*Please choose all that apply*)

Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

18. If you harvest trees in your sugarbush, do you leave the crown and branches behind to decompose?

☐ Yes
☐ No
☐ N/A

19. If you actively manage the understory and midstory vegetation (saplings, shrubs, etc.,) in your sugarbush, which of the follow best describes your management aims?

☐ Aim to increase understory/midstory cover
☐ Aim to decrease understory/midstory cover
☐ Aim to keep the understory/midstory cover how it is now
☐ N/A – I don't manage understory and midstory cover

20. Do you actively manage to eradicate/control invasive and/or non-native vegetation in your sugarbush?

☐ Yes → *if yes, please answer questions 20 a & b.*
☐ No, but I plan to
☐ No
☐ N/A – no invasive/non-native vegetation in my sugarbush

a. How often do you manage invasive and/or non-native vegetation in your sugarbush?

_____ days per year

b. How much do you invest in invasive and/or non-native vegetation management in your sugarbush?

_____ dollars per year

21. Roughly what percentage of trees in your sugarbush are sugar maple?

_____ % sugar maple

22. What is the target percentage of sugar maple in your sugarbush that you are currently managing for?

_____ % sugar maple

23. About how many dead standing trees (snags) larger than 10 inches in diameter are in your sugarbush?

_____ dead standing trees per acre

24. How many dead standing trees (snags) larger than 10 inches in diameter do you remove from your sugarbush each year?

_____ dead standing trees

*Please explain your answer.*_____

25. About how often do falling limbs and/or dead standing trees (snags) damage sugaring equipment in your sugarbush each year?

_____ instances per year

26. What is the yearly cost of damage to sugaring equipment from falling limbs and/or dead standing trees (snags)?

_____ dollars per year

27. Roughly how much downed (fallen) wood larger than 10 inches in diameter do you remove from your sugarbush each year?

- ☐ N/A
- ☐ Less than ½ cord
- ☐ ½ cord
- ☐ 1 cord
- ☐ More than 1 cord
- ☐ Other (please specify): _____

28. Has a bird habitat assessment ever been performed in your sugarbush?

- ☐ Yes
- ☐ No
- ☐ Unsure

SECTION C: SUGARING OPERATION CHARACTERISTICS

29. Please specify the total number of people you hire to work on forest management in your sugarbush each year.

_____ people

30. Please specify the total number of unpaid helpers (family members, etc.) who work on forest management in your sugarbush each year.

_____ unpaid helpers

31. Please specify the amount you invest in forest management labor each year.

_____ dollars per year

When thinking about your sugaring operation…

32. For about how much longer do *you personally* expect to keep collecting sap from your sugarbush?

_____ years

33. For about how much longer do you expect *future generations* might keep collecting sap from your sugarbush?

_____ years

Please explain your answer: _____

_____

34. Do you have plans to expand the number of taps you install in your sugarbush in the next few sugaring seasons?

☐ Yes → *if yes, please answer question 32 a.*
☐ No

Please explain your answer. Why or why not? _____

_____

a. Roughly how many additional taps do you plan to install in your sugarbush in the next few sugaring seasons?

_____ taps

35. Where in Vermont is your sugarbush located?

_____ Indicate zip code here

SECTION D: FINALLY, WE WOULD LIKE TO KNOW A LITTLE MORE ABOUT YOU

Your willingness to share limited background information will help us to more accurately report the demographic characteristics of Vermont sugarbush owners and operators.

Your responses will be kept confidential and we will never release your personal information to any individual, business, or government agency.

36. What is your gender?
☐ Man
☐ Woman
☐ Non-binary

37. What is your age?
☐ 18-24
☐ 25-34
☐ 35-44
☐ 45-54
☐ 55-64
☐ 65 or older

38. Which of the following describe(s) you?
(Please select all that apply)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Pacific Islander
☐ Spanish, Hispanic, or Latino
☐ White
☐ A race/ethnicity not listed here

39. What is the highest level of formal education you have completed?
☐ Some high school or less
☐ High school diploma or equivalent
☐ Completed a 2- or 4-year college degree
☐ Completed graduate or professional school

40. In a typical year, approximately what percent of your annual household income comes from the following activities related to your sugarbush?

_____ % (Selling sap, maple syrup, or value-added maple products)

_____ % (Selling timber, firewood, or other wood products from your sugarbush)

41. Please indicate your average annual household income.
☐ Less than $50,000
☐ $50,001 - $75,000
☐ $75,001 - $100,000
☐ $100,001 - $200,000
☐ More than $200,000

42. Please fill in your name and email address if you wish to be entered into a raffle for a chance to win 1 of 10 gift cards valued at $250:

_____

_____

43. Would you be willing to participate with our research team for a follow-up interview based on your survey responses?

☐ Yes
☐ No

Is there anything else you would like to share with us?

We sincerely appreciate your time and contributions to this study. Please return your completed survey in the postage-paid envelope as soon as possible.
Thank you!

APPENDIX B.

Email list contacted for survey distribution:

- Vermont Maple Sugarmaker's Association
- NOFA-VT
- Vermont Family Forests
- Vermont Coverts
- Vermont County Foresters (current list and contact information per each county listed here: https://fpr.vermont.gov/forest/list-vermont-county-foresters)

Emails to USDA Organic Maple Syrup Producers:

We downloaded a database of USDA Organic maple syrup producers from USDA's Integrity Database website (https://organic.ams.usda.gov/integrity) by searching "maple" in the "Certified Product" column and specifying Vermont as the target state. This resulted in a list of 362 contacts. We downloaded the results and manually excluded operations that were certified for products that used maple for flavoring or additive to other products (e.g., maple-flavored alcohol), narrowing the list to 342 contacts. We then conducted an internet search of the name of each of the 342 operations to retrieve their contact email address from their businesses' websites, which yielded a final list of 153 producers.

Table B.1. Questionnaire statements and associated coding changes per each variable measured in our current study.

Management Practices		
Statement	**Original response scale**	**Recoded scale**
Do you have a current forest management plan certified by a licensed Vermont forester?	1: Yes 2: No, my forest management plan is not certified 3: No forest management plan	1: Yes 0: No, my forest management plan is not certified AND No forest management plan
About how many dead standing trees (snags) larger than 10 inches in diameter are in your sugarbush?	Open ended response	1: Responses with 2 or more 0: Responses under 2
If you harvest trees in your sugarbush, do you leave the crown and branches behind to decompose?	1: Yes 2: No 3: N/A	1: Yes 0: No
Roughly what percentage of trees in your sugarbush are sugar maple?	Open ended response	1: Responses lower than 75%

		0: Responses greater than 75%
Do you currently manage to eradicate/control invasive and/or non-native vegetation in your sugarbush?	1: Yes 2: No, but I plan to 3: No 4: N/A	1: Yes 0: No, but I plan to AND No
Which month(s) of the year do you harvest trees from your sugarbush?	Closed ended response, participants chose all months they harvest trees	1: May, June, and July are not selected 0: May, June, or July are selected
Do you currently manage the percent cover of understory and midstory vegetation (saplings, shrubs, etc.) in your sugarbush?	1: Yes 2: No	1: Yes 0: No
Has a bird habitat assessment ever been performed in your sugarbush?	1: Yes 2: No 3: Unsure	1: Yes 0: No AND Unsure
Conservation Program Enrollments		
Is your sugarbush certified organic by NOFA-VT?	1: Yes 2: No 3: Transitioning 4: Certified by another organization	1: Yes AND Certified by another organization 0: No AND Transitioning
Are you currently a participating producer in Audubon Vermont's Bird-Friendly Maple program?	1: Yes 2: No, never heard of it 3: No, not interested in participating 4: No, but in the process of enrolling in the program	1: Yes AND No, but in the process of enrolling in the program 0: No, never heard of it AND No, not interested in participating
Annual Financial Costs		
Please complete the table to identify the costs, volume removed, and frequency of the various kinds of tree harvesting in your sugarbush	Open-ended, how much is this done? (reported in number of years), how much do you invest in this? (reported in $ per harvest)	Total harvest costs, $/acre/year
How much do you invest in invasive and/or non-native vegetation management in your sugarbush?	Open ended, dollars per year as unit	Invasive and non-native species management costs, $/acre/year
What is the yearly cost of damage to sugaring equipment from falling limbs	Open ended, dollars per year as unit	Damage costs, $/acre/year

and/or dead standing trees (snags)?		
Please specify the amount you invest in forest management labor each year	Open ended, dollars per year as unit	Labor costs, $/acre/year
	Operational characteristics	
How many acres of sugarbush do you own? AND How many acres of sugarbush do you lease (rent) from others?	Open ended, either acres owned or acres leased (rented) as unit	Sum of both items represent total acres tapped
How many taps are currently installed in your sugarbush?	Open ended, number of taps as unit	Not recoded

Table B.2. Select demographic information of sugarmakers from our sample.

Demographic	***Levels***	***Frequency (%)[a]***
Age	25-34	4 (6%)
	35-44	8 (11%)
	45-54	8 (11%)
	55-64	17 (24%)
	65+	33 (47%)
*Race/Ethnicity**	White	68 (97%)
	Asian	1 (1%)
*Education**	High school diploma or equivalent	7 (10%)
	2- or 4- year college degree	41 (59%)
	Graduate or professional school	22 (31%)
Annual Income	Less than $50,001	8 (11%)
	$50,001-75,000	12 (17%)
	$75,001-100,000	18 (26%)
	$100,001-200,000	19 (27%)
	More than $200,000	5 (7%)
% Income from maple products	Less than 50%	49 (70%)
	50% or more	13 (19%)

*We included additional levels for these demographic variables in our questionnaire and only report levels with data in this table.

[a]There were non-responses for both income and % income from maple items so percentages do not add up to 100 for these demographics.

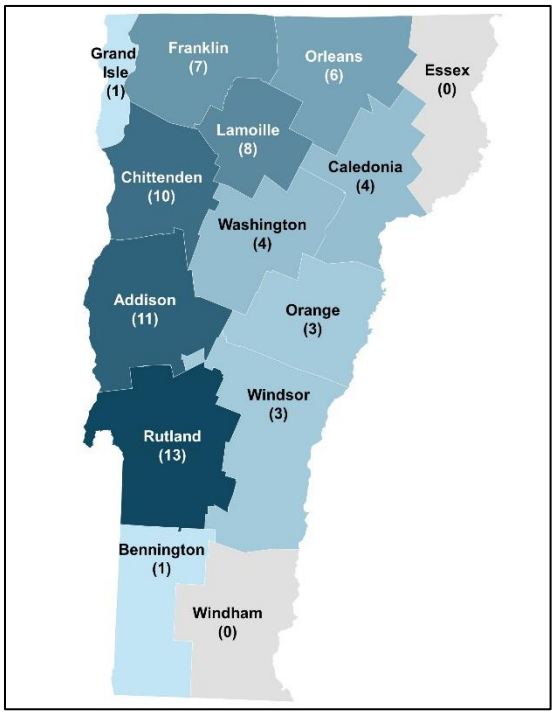

Figure B.1. Questionnaire responses across Vermont counties. Numbers in parentheses represent number of responses; colors represent relative frequencies, with the shade growing darker with higher response frequency.

Table B.4. Select operational characteristics across our sample.

	Acres tapped	***Taps deployed***	***Taps per acre***	***Gallons syrup produced in an average season****
Min.	1	24	.24	5
Mean	185.4	7689	48.1	3665.8
Median	70	2850	43.2	1000
Max.	2600	93000	240	40000

*Six responses omitted due to reporting raw sap yields.

APPENDIX C.

Interview questions for sugarmakers

Introduction

1. Introduce myself/project
    a. My name is Daniel Pratson and I am a Ph.D. Student in the Rubenstein School of Environment and Natural Resources at the University of Vermont. As you know from our emails and the survey you completed, I am working on research that investigates the costs and values that pertain to sugarbush forest management.
2. Review consent form
3. Introduce format of interview
4. Begin recording

Opening questions

5. To begin, I'd like to ask you to tell me about your sugarbush. Can you tell me about your relationship with the property? For instance, is there a specific anecdote that best captures the dynamic between you and your sugarbush?

6. Can you talk about your general approach to forest management in your sugarbush?

Survey results

7. Now, I'd like to revisit a few of your responses to the survey you completed in [*insert month here*]. You identified that [*ownership objective*] was most important to your forest management. Can you speak more on this? How do you manage for this objective?

8. You also identified that [*relational value*] is most important to your forest management.
    a. How would you describe the importance of [*relational value*]?

    b. Can you speak more about [*relational value*] and how it relates to your management?

9. You may have noticed that many of the survey questions focused on the costs of different management practices you may carry out in your sugarbush. How do financial costs come into play when you manage?

10. Do you feel like you are able to manage in a way that reflects [*ownership objective + relational value*]? What assists you in doing so? What gets in the way?

11. When you consider the future of your operation, what challenges are you most concerned by?

12. Finally, I'd like to ask you about your enrollment in programs involved with your sugaring.
    IF ENROLLED IN BFM/ORGANIC: What motivated you to enroll as a BFM and/or organic producer? Please tell me more about this process.

    IF NOT IN BFM/ORGANIC: Could you tell me more about your relationship with BFM/organic, and why you aren't interested in enrolling in these programs?

13. Do you have any other questions for me?

PURPOSIVE INTERVIEW SAMPLING MATRIX

	***Small* (*0 - 999 taps*)**		***Medium* (*1000 - 9999 taps*)**		***Large* (*10000+ taps)***	
	BFM Y	**BFM N**	**BFM Y**	**BFM N**	**BFM Y**	**BFM N**
Lease	1	1	1	2	2	1
Own	1	1	2	1	1	1

APPENDIX D.

Table E.1. Select demographic information of sugarmakers from our sample.

Demographic	***Levels***	***Frequency (%)[a]***
Age	25-34	3 (5%)
	35-44	6 (11%)
	45-54	7 (13%)
	55-64	15 (27%)
	65+	25 (45%)
*Race/Ethnicity**	White	55 (98%)
	Asian	1 (2%)
*Education**	High school diploma or equivalent	7 (13%)
	2- or 4- year college degree	32 (57%)
	Graduate or professional school	17 (30%)
Annual Income	Less than $50,001	8 (14%)
	$50,001-75,000	8 (14%)
	$75,001-100,000	15 (27%)
	$100,001-200,000	13 (23%)
	More than $200,000	5 (9%)
% Income from maple products	Less than 50%	40 (71%)
	50% or more	10 (18%)

*We included additional levels for these demographic variables in our questionnaire and only report levels with data in this table.

[a]There were non-responses for income and % income from maple items so percentages do not add up to 100 for these demographics.

Table E.2. Frequency of management actions across study sample

Management action	***Frequency (%)***
Refrain from whole-tree harvests, leave crown and branches behind (*n*=47)	45 (96%)
Current forest management plan certified by Vermont County Forester (*n*=56)	49 (88%)
Recruit and/or retain at least two snags per acre in sugarbush (*n*=52)	46 (88%)
Eradicate and/or control non-native and invasive plant species (*n*=44)	35 (80%)
Refrain from tree harvesting during forest bird nesting season (May through July) (*n*=46)	34 (72%)
Limit sugar maple monoculture, manage for less than 75% total sugarbush basal area as sugar maple (*n*=56)	34 (61%)

Promote understory and midstory vegetation cover (*n*=55)	29 (53%)
Facilitate forest bird habitat assessment in sugarbush (*n*=56)	26 (46%)